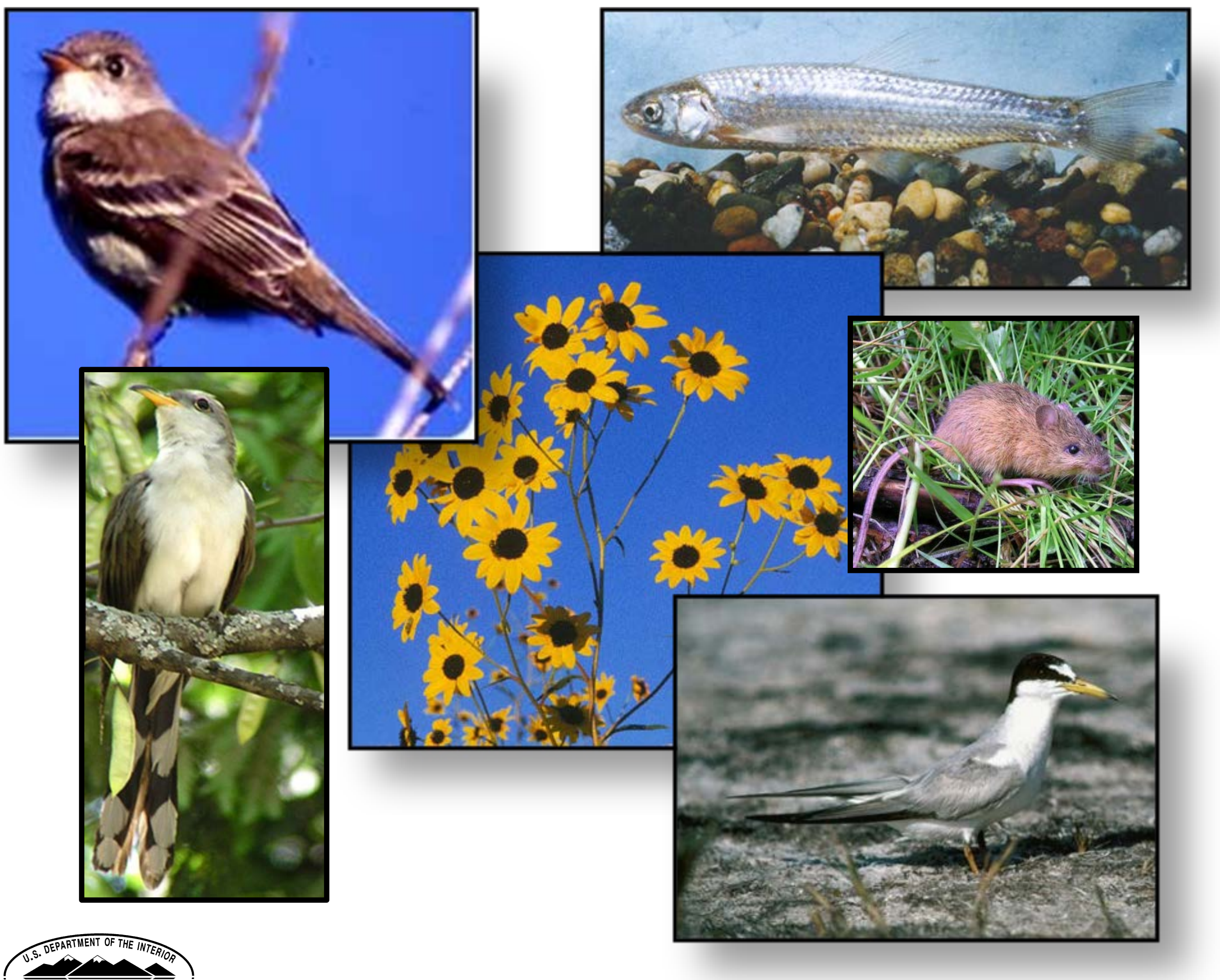
RECLAMATION
Managing Water in the West

Joint Biological Assessment

Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

Middle Rio Grande Project, New Mexico
San Juan-Chama Project, New Mexico
Upper Colorado Region



U.S. Department of the Interior
Bureau of Reclamation

August 2015

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

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.

The Bureau of Indian Affairs' mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes and Alaska Natives.

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Bureau of Reclamation **August 2015**

Joint Biological Assessment

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Part II – Proposed Action and Effects: Water Operations

Middle Rio Grande Project, New Mexico
San Juan-Chama Project, New Mexico
Upper Colorado Region

Submitted to the U.S. Fish and Wildlife Service

Rio Grande Silvery Minnow	**Southwestern Willow Flycatcher**
Yellow-billed Cuckoo	**New Mexico Meadow Jumping Mouse**
Pecos Sunflower	**Interior Least Tern**

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1. Description of Proposed Actions

1.1 Introduction

This BA evaluates the effects of the following water management actions, as well as Offsetting and Conservation Measures in the Action Area for both Reclamation and the MRGCD and State (collectively, the “non-federal entities”). Proposed actions are described fully in the following subsections. Part IV of this document provides a detailed description of the measures and their effectiveness. As mentioned in Part I, Reclamation’s proposed operation of the San Juan-Chama (SJC) Project, as described in this BA, includes only the release of SJC water from Heron Reservoir, the storage and release of SJC water from El Vado Reservoir, and MRGCD storage and release of SJC water in Abiquiu. Due to the beneficial effects from these actions for listed species and critical habitat and the absence of adverse effects, Reclamation would not normally include these actions in a request for formal consultation. However, Reclamation is requesting informal consultation from the Service on SJC actions in the BA as part of the larger programmatic consultation, for efficiency and to provide a more holistic view of management actions in the MRG basin.

The following is a summary of the proposed actions and Offsetting and Conservation Measures for this consultation:

1. Reclamation proposes the following water management actions:
    a. Operate Heron Dam and Reservoir as part of the SJC Project to deliver water to downstream users.
    b. Operate El Vado Dam and Reservoir to store and release water, including response to requests by the MRGCD and BIA.
2. BIA proposes to request storage and releases of water from El Vado to meet the Pueblos’ irrigation needs.
3. MRGCD proposes the following actions:
    a. Operate the MRG Project Diversion Dams to deliver water to MRGCD lands to meet agricultural demand of lands with appurtenant water rights, including the lands of the Six MRG Pueblos.
    b. Operate irrigation drains and wasteways to return water to the river.
    c. Request storage and release of water at El Vado to meet the irrigation needs of constituents

4. The State of New Mexico proposes the following actions:
    a. Continue its Rio Grande Compact related activities to administer relinquishment of New Mexico credit water and allocation of relinquished Compact credits.
    b. Continue to administer the surface water and groundwater resources to maintain hydrologic system balance by executing its statutory duties with respect to transfers of valid existing surface water rights and compliance with valid existing state water declarations, permit, licenses, and court adjudication.
    c. Continue to issue permits for small domestic, livestock, and temporary uses, as required by NMSA 1978 Sections 72-12-1.1 through 72-12-1.3, in accordance with the OSE 2006 Rules and Regulations Governing the Use of Public Underground Waters for Household and Other Domestic Use.
5. This BA also provides and evaluates the following measures that will be used to offset the above proposed actions (Offsetting Measures) for Reclamation and the non-federal entities, as well as additional Conservation Measures intended to improve species status. Part IV of this document provides a detailed description of the following measures and their effectiveness:
    a. Reclamation's Offsetting Measures:
        i. River Integrated Operations using Adaptive Management.
            - Lease Supplemental Water.
            - Develop conservation pool in coordination with MRGCD and State
            - Modify reservoir operations within current authorizations.
            - Adjust timing of storage at El Vado within current authorizations.
            - Exchanges of SJC water.
    b. BIA's Offsetting Measures:
        i. Work with Pueblos in developing species habitat.
        ii. Facilitate exchange actions for management of prior and paramount stored water.
        iii. Assess conditions of irrigation facilities on Pueblo lands to identify ways to increase efficiency of the irrigation infrastructure.
    c. MRGCD's Offsetting Measures:
        i. River Integrated Operations using Adaptive Management.
            - Develop conservation pool in coordination with Reclamation and State.
            - Modify reservoir operations within current authorizations.
            - Adjust timing of storage at El Vado within current authorizations.

- Exchanges of SJC water.
- Utilize diversion structures to aid in providing spawning.
- Closely match diversion to actual agricultural demand.
- Use diversions and conveyance system to deliver Supplemental Water.
- Exchange Rio Grande water allowing Supplemental Water to be used for species needs.

ii. Construction of gauging stations and monitoring.

iii. More consistent management of discharges.

iv. Management to assist in river recession.

v. Construction of surface return flow system at MRGCD south boundary.

vi. Adjustment of diversions to minimize egg entrainment.

vii. Configure MRGCD drain outfalls as habitat areas.

viii. Use MRGCD drains and wasteways to manage flows and recession.

ix. Use MRGCD drains and wasteways to convey and deliver Supplemental Water.

d. State's Offsetting Measures:

i. River Integrated Operations using Adaptive Management.

ii. Reduce effects during low flows using relinquished credit water.

iii. Habitat maintenance and monitoring.

iv. Staffing and expansion of the Los Lunas silvery minnow refugium.

e. Reclamation, MRGCD, and State Conservation Measure categories:

i. River Integrated Operations using Adaptive Management.

ii. Improve river connectivity at diversion structures.

iii. Improve and create habitat.

iv. Establish Recovery Implementation Program.

1.2 Description of Reclamation's Proposed Water Actions

Reclamation operates Heron and El Vado Dams and Reservoirs in consideration of a complex web of variables, including, but not limited to, precipitation, drought, inflow, downstream demand, and allocation of water supplies, MRGCD requests, and the Pueblos' prior and paramount water rights, and also in accordance with federal statute, NMOSE permit, and contracts with water users.[1] Reclamation operates the two facilities for the following purposes:

- Storage and delivery of water for agricultural uses (Heron and El Vado), and municipal and industrial uses (Heron).
- Assistance to New Mexico in meeting its downstream water delivery obligations mandated by the Rio Grande Compact of 1938 (El Vado).

Additionally, incidental purposes of Reclamation's operations include fish and wildlife benefits, and recreation at both Heron and El Vado, and flood control for El Vado. Reclamation operates both reservoirs in compliance with the Endangered Species Act and to manage water in Reclamation's Supplemental Water Program. Reclamation will use Adaptive Management as part of its future water operations.

1.2.1 San Juan Chama Project Operations at Heron Dam and Reservoir

SJC Project water at Heron Reservoir is allocated to contractors annually and subsequent deliveries out of Heron Reservoir are tracked with a daily accounting model. All inflows to Heron Reservoir that are native to the basin are passed through the reservoir and are not included with SJC Project accounting. Water allocated to MRGCD is released from Heron Dam each year at the request of the MRGCD, typically for delivery to El Vado Reservoir, where it is then released as needed to meet MRGCD's daily demand. Water allocated to the ABCWUA is released from Heron Dam to Abiquiu Reservoir, at the request of the ABCWUA, and eventually is delivered to ABCWUA's surface water diversion structure in Albuquerque or is used to offset depletions to surface water supplies caused by groundwater pumping, as assessed by the NMOSE (i.e., letter water deliveries). Water allocated to other contractors also may be released from Heron Dam to offset depletions (which generally either is directed to the Otowi gage, Elephant Butte, or El Vado, depending on if the calculated depletion impacted the Rio Grande Compact or the MRGCD), as determined by the NMOSE, or may be released for storage in allocated space at El Vado, Abiquiu Reservoir, and/or Elephant Butte Reservoir. Beginning in 2011, water allocated to Santa Fe is being released from Heron Dam to provide water to Santa Fe's Buckman Direct Diversion.

SJC Project water used to offset evaporation losses from the recreation pool maintained at Cochiti Lake may be partially released from Heron Dam during the first part of July but is generally released from Heron Dam in the late fall and winter. This action, as it relates to the

[1] The BA Partners do not necessarily agree with the characterizations of the respective parties' legal authorities and operations

Corps' operation of Cochiti Reservoir, is described in more detail as an interrelated and interdependent activity in Section 2.6.

1.2.1.1 SJC Project Contractor Allocation

Once Reclamation releases SJC Project water from Heron Reservoir, it belongs to SJC contractors and can be used immediately or stored in other facilities for future use. The total annual SJC Project contractor allocation is based on a firm yield analysis for Heron Reservoir that sets the annual allocation at 96,200 AF. Reclamation does not have discretion to release more than this firm yield amount. All of the existing contracts are repayment contracts with no expiration date; thus, potential renegotiation of SJC Project contracts and associated terms is not considered under this BA. Table II-1 summarizes SJC Project contracts, including a listing of the individual contractors, contract initiation dates, and the annual amount of SJC Project water allocated to each contractor.

1.2.1.2 Third-Party Subcontracting of SJC Project Water

Reclamation authorizes SJC Project contractors to subcontract water stored in Heron Reservoir to third parties. Reclamation's Supplemental Water Program consists primarily of SJC Project water that Reclamation subcontracts. Since 2003, all of the SJC Project contractors with the exception of Pojoaque Valley Irrigation District have subcontracted their water, at one time or another, to Reclamation.

Contracts with the following SJC Project contractors grant Reclamation a first-right-of-refusal to subcontract SJC Project water stored in Heron Reservoir:

- Village of Los Lunas
- Village of Taos Ski Valley
- Town of Taos
- City of Santa Fe
- Santa Fe County
- City of Española
- County of Los Alamos

Table II-1. San Juan-Chama Project contracts

Contractor	Allocated Water Amount (AF)	Date Initiated	Purpose
Albuquerque-Bernalillo County Water Utility Authority	48,200	1963	M&I
Middle Rio Grande Conservancy District	20,900	1963	Irrigation
Jicarilla Apache	6,500	1992	M&I
City of Santa Fe	5,230	1976	M&I
Cochiti Recreation Pool[1]	5,000	1964	Recreation
Taos Pueblo	2,215	2011	M&I
Ohkay Owingeh Pueblo	2,000	2001	M&I
Incorporated County of Los Alamos	1,200	1977	M&I
Pojoaque Valley Irrigation District	1,030	1972	Irrigation
City of Española	1,000	1978	M&I
For Aamodt Indian Water Rights Settlement	775	Allocated, but uncontracted	
Town of Belen	500	1990	M&I
Village of Los Lunas	400	1997	M&I
Town of Taos	400	1981	M&I
Town of Bernalillo	400	1988	M&I
County of Santa Fe	375	1976	M&I
Town of Red River	60	1990	M&I
Village of Taos Ski Valley	15	1978	M&I
TOTAL ALLOCATION:	96,200		

[1] SJC Project water is released to maintain a 1,200-surface-acre permanent pool for recreation and fish and wildlife purposes at Cochiti Reservoir; and 5,000 AFY is delivered to Cochiti to offset evaporative losses associated with maintenance of this pool. (Public Law 88-293)

1.2.1.3 SJC Project Offset of Pojoaque Tributary Unit Depletions (Nambe Falls)

The Pojoaque Tributary Unit, a component of the SJC Project, stores water at the Nambe Falls Dam and Reservoir located on the Rio Nambe, which is a tributary to the Rio Grande, and provides approximately 1,030 AF of Supplemental Water for about 2,768 acres of irrigated lands. About 34% of the irrigated lands are Indian lands located on the Nambe, Pojoaque, and San Ildefonso Pueblos. Construction of Nambe Falls Dam began in June 1974 and was completed in June 1976. Cyclical operations of Nambe Falls consist of non-irrigation season operations and irrigation season operations and cause depletions to native Rio Grande water.

To offset these depletions and to keep the river whole, Reclamation releases SJC Project water from Heron Reservoir, as described in the 1972 Contract (#14-06-500-1986) between Reclamation and the Pojoaque Valley Irrigation District. An annual depletion amount is calculated for Nambe Falls operations for the entire year, and the offsetting SJC Project water is released from water allocated for this purpose at Heron Reservoir. The actual annual SJC Project water allocation used to offset the effects of Nambe Falls Reservoir storage has varied.

1.2.1.4 Summary of Reclamation's Proposed Actions for SJC Project Operations of Heron Dam and Reservoir

Reclamation proposes to continue operating and maintaining Heron Dam and Reservoir consistent with current agreements to store water and in accordance with constraints and conditions applicable to the SJC Project. Reclamation can only store SJC Project water pursuant to statute and is prohibited from releasing water for ESA purposes unless Reclamation purchases the water from a willing contractor.

Reclamation delivers SJC Project water to users in the MRG based on water contracts with various entities, commonly referred to as SJC Project contractors, and based on subcontracts between SJC Project contractors and third parties. Delivery of SJC Project water is authorized for municipal, industrial, irrigation, and recreational purposes. Incidental benefits provided by operation of Heron Reservoir include domestic and fish and wildlife uses. SJC Project water must be consumptively and beneficially used in New Mexico, at a downstream destination and without harm to native Rio Grande water. Reclamation generally makes releases as follows:

- Releases for delivery of contractors' annual allocations to downstream storage occur at a rate of 165–500 cfs and typically occur in the months of November and December; however, releases may be made at the call of contractors throughout the year.
- Releases to offset depletions caused by contractors' groundwater pumping and/or actions upstream of the Otowi gage occur approximately every 3–4 months at a rate of 50–200 cfs.
- Releases occur to compensate evaporation losses at the Cochiti Recreation Pool to restore a minimum pool area of 1,200 surface acres at Cochiti Lake (Public Law 88-293).
- Releases occur to offset the operations of the Pojoaque Tributary Unit of the SJC Project, including storage in Nambe Falls Reservoir.
- Releases are deferred when ice cover on Heron Reservoir poses public safety issues.
- Releases cannot be made to meet ESA obligations unless Reclamation acquires the SJC Project water from one of its contractors.

- Waivers to extend the required date of delivery of the contractors' annual allocation until April 30 or September 30 of the following year are granted on a case-by-case basis if there is a benefit to the United States.

1.2.2 Operation of El Vado Dam and Reservoir

As discussed in Part I, MRGCD constructed El Vado Dam and Reservoir in 1935, and Reclamation and the Corps developed the MRG Project. With the establishment of the MRG Project, MRGCD pays Reclamation for operation of El Vado Dam and Reservoir. Pursuant to the Flood Control Acts, the 1951 Contract with the MRGCD, and Permit No. 1690, Reclamation stores water in and releases water from El Vado Reservoir at the request of MRGCD and to provide incidental flood control.

Both native Rio Grande water and SJC Project water are stored in El Vado Reservoir. Storage of native water may occur if native flows are available on the Rio Chama in excess of downstream Rio Chama direct flows rights and the MRGCD river diversion demand and restrictions on storage are not in place per Articles VII and VIII of the Rio Grande Compact[2] (see Part I for a discussion of the Rio Grande Compact and Article VII). Storage and release of SJC Project water are conducted according to contract. El Vado Reservoir also provides recreational opportunities and allots space for sediment control.

1.2.2.1 Irrigation Operations for the MRGCD

The plan for filling El Vado is to store all native flows in the reservoir that are in excess of downstream requirements, such as those for Rio Chama water rights holders. In general, native water is stored during the spring runoff for release later in the year when flows are lower than the MRGCD's river diversion demand for delivery of water to its constituents. Reclamation releases stored water from El Vado Reservoir, at the request of the MRGCD, when natural flow of the Rio Grande is not sufficient to meet the demands of the MRGCD and the Six MRG Pueblos. SJC Project water released from Heron Reservoir for immediate use downstream from El Vado Reservoir is simply passed through El Vado Dam.

Reclamation's irrigation operations primarily consist of changing the rate and timing of storage released from El Vado Reservoir, which increases flows in the MRG that the MRGCD diverts to meet its irrigation needs. Irrigation needs generally are determined by MRGCD in coordination with BIA, and Reclamation adjusts El Vado's gates to meet those needs.

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[2] When the amount of usable water in Rio Grande Project storage in Elephant Butte and Caballo reservoir combined is below 400,000 AF, the Rio Grande Compact limits upstream storage of river flows in reservoirs constructed after 1929.

1.2.2.2 Prior and Paramount Operations

As described in Part I, Reclamation shares the United States government's trust responsibility to Indian tribes, including the Six MRG Pueblos. Congress declared through the Act of March 13, 1928 (45 Stat. 312) that the water rights appurtenant to approximately 8,346 acres of then irrigated Pueblo lands in the MRG were "prior and paramount" to any rights of the MRGCD or other property holder.[3] Reclamation performs operations to reserve and store water at El Vado to meet the Pueblos' prior and paramount needs. The Designated Engineer, currently from BIA, and Reclamation perform a computation to determine the supply of water necessary at Otowi gage to meet prior and paramount needs. Factors in this determination are as follow:

- Crop demand using historically dry years
- On-farm and conveyance efficiencies from the point of diversion on the Rio Grande
- River efficiencies from the Otowi gaging station to diversion points on the river

Next, the Designated Engineer forecasts the monthly supply of water at the Otowi gaging station. A series of three forecasts is made based on the Natural Resources Conservation Service (NRCS) forecast values published in March, April, and May. Monthly distribution of flow volumes follows the percentages of the 1934 runoff season; the August to October forecast directly uses 1956 volumes. After the May publication by NRCS, the May runoff forecast is decreased by 20% for uncertainties associated with the forecast and is then used to project natural flow for May through July. Another adjustment, using coefficients specified in the 1981 Agreement, is made to the forecasted supply to account for anticipated conditions when the entire flow of the river cannot be captured at the river diversions.

Pursuant to the 1981 Agreement, the Designated Engineer and Reclamation calculate the need to store water in El Vado based on months in which the forecasted supply of the river is projected to be inadequate to meet the computed demand of 8,847 acres. Monthly forecasted shortages between supply and demand are increased by 20% to account for conveyance losses between El Vado and the Otowi gage. Monthly adjusted shortages are totaled, resulting in the quantity of water to be managed for the Pueblos in El Vado.

The 1981 Agreement is non-specific regarding release procedures. Currently, the Designated Engineer uses a spreadsheet tool for monitoring the daily natural supply at Otowi and uses the 1956 crop demand curve for monitoring daily demand until a better tool is developed. The Coalition of the Six MRG Pueblos (Coalition) currently directs the Designated Engineer to order Reclamation to release stored water over specified periods of time. The MRGCD delivers this

[3] The 1928 Act recognizes prior and paramount water rights appurtenant to approximately 8,346 acres of Pueblo lands, but on May 16, 1938, the Secretary of the Interior determined that the actual irrigated acreage was 8,847.

water to the Pueblos as appropriate through downstream diversions. At present, available water in El Vado to meet the prior and paramount needs that was stored when Compact Article VII restrictions were in place is released to satisfy Rio Grande Compact obligations after the irrigation season ends, usually in November or December. Remaining and available water stored to meet the Pueblos' needs without Compact Article VII restrictions is reassigned as native Rio Grande water for use by the MRGCD and remains in El Vado, and is then available for use on non-Pueblo and Pueblo land within the MRGCD.

1.2.2.3 Summary of Reclamation's Proposed Actions for Operation of El Vado Dam and Reservoir

Reclamation proposes to continue operating and maintaining El Vado Dam and Reservoir consistent with current agreements, the Compact, and the operational and hydrologic constraints and conditions of the MRG Project. Reclamation proposes to continue storing the flow of the Rio Chama in El Vado Reservoir as requested by the MRGCD and to ensure delivery of water as requested by the MRGCD and as requested by the Designated Engineer as part of prior and paramount operations. Retention and regulation of native Rio Grande flows will be performed consistent with the Doctrine of Prior Appropriation[4] and in coordination with the State, and to meet downstream senior flow rights.

Reclamation proposes to operate and maintain El Vado Dam and Reservoir as follows:

- Store water in and release water from El Vado Dam and Reservoir pursuant to the Flood Control Acts of 1948 and 1950, the 1951 Contract with MRGCD, in accordance with NMOSE Permit No. 1690 and to meet the downstream channel capacity of 4,500 cfs.
- Carry out NMOSE water user delivery requirements, Compact requirements, and MRGCD requests for water storage and release.
- Maintain safe storage elevation of El Vado Reservoir per standard operating procedures except under specific exceptions that consider flood routing criteria, water surface elevation, and river flow in the MRG Valley.
- Store native flows when Article VII of the Compact is not in effect.
- Store native flows as needed to meet the prior and paramount demands of the Six MRG Pueblos and release this water for the Six MRG Pueblos as requested by the Designated Engineer pursuant to the 1981 Agreement, notwithstanding Article VII of the Compact.

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[4] New Mexico water law follows the Doctrine of Prior Appropriation, which provides that water users that apply water to beneficial use earlier in time (senior users) will have a better right against later water users (junior users) in times of shortage. (NM Constitution, Article II, Section 2).

- Store and release SJC Project water, if requested by the MRGCD.

- Bypass native Rio Grande water flows into El Vado Reservoir up to 100 cfs between April 1 and September 1 to meet demands of Rio Chama water rights holders downstream from Abiquiu Dam.

- Operate to stay within the safe downstream channel capacity on the Rio Chama per standard operating procedures.

Additional considerations for Reclamation's operation of El Vado Dam and Reservoir are as follows:

- When water is available for release to downstream users or storage reservoirs, Reclamation manages releases to benefit a cold-water trout fishery below El Vado Dam from November to March.

- When water is available for release to downstream users or storage reservoirs, and in cooperation with effected parties, Reclamation manages releases for rafting during weekends in July, August, and September.

1.3 Non-Federal Proposed Actions

1.3.1 The Middle Rio Grande Conservancy District

The MRGCD requests releases of water from El Vado Reservoir, diverts Rio Grande surface water to provide water for irrigated agriculture using the works at Cochiti Dam, and operates diversion structures at Angostura, Isleta, and San Acacia (collective the Diversion Dams). Additionally, the MRGCD diverts from three diversion structures on the LFCC: the 1200 check structure, Neil Cupp, and Lemitar.

1.3.1.1 MRGCD Water Operations

The MRGCD uses water stored in El Vado during times when native Rio Grande flows are insufficient to meet irrigation demand (typically, these times are between June and September). It requests that Reclamation store native water in El Vado during times when Article VII restrictions are not in place. During times when Article VII restrictions are in place, the MRGCD may request storage up to the extent that New Mexico has relinquished credit water to Texas and authorized use by the MRGCD. During normal operations, when the natural system is producing less water than required by the MRGCD to meet irrigation demand, the MRGCD uses water from storage to augment the Rio Grande up to its needs. The MRGCD utilizes water from available and authorized water sources. In general, the MRGCD prioritizes the water released to supplement the natural flow as follows:

1. Rio Grande water stored under normal conditions (no Compact restrictions)
2. Water stored due to Rio Grande Compact credit relinquishment
3. SJC Project water

The MRGCD may reduce diversions, or cease calling for releases from El Vado Reservoir before the scheduled end of the irrigation season to conserve water for subsequent irrigation seasons. This becomes carryover storage in El Vado.

The MRGCD follows shortage-sharing operations at times when the natural flow is insufficient to meet the full irrigation demand and there is not sufficient water in storage at El Vado to make up the difference, or the MRGCD chooses to not call for release of available water in storage to make up the shortfall. At these times, the prior and paramount water needs for the lands of the Pueblos are met first, using flows from the main stem of the Rio Grande and upstream tributary flows, and then if natural flows are not sufficient, with water held at El Vado Reservoir to satisfy the prior and paramount needs of the Six MRG Pueblos. The delivery of prior and paramount water to Pueblo lands is carefully scheduled and monitored and involves a high level of coordination between Reclamation, BIA, the Six MRG Pueblos, and the MRGCD. Water to meet the needs of these lands primarily is diverted at the Cochiti Dam outlet works and at Angostura. Although much of Isleta Pueblo is served from the Angostura Diversion, small diversions sometimes are required at Isleta Dam to serve parts of Isleta Pueblo. Water delivery to Isleta Dam is most efficient and effective if the needed water is diverted at Angostura and routed through the MRGCD system. Any water remaining downstream from Isleta Pueblo after prior and paramount needs are met is shared equally among all users. The MRGCD satisfies water deliveries for the Pueblos' newly reclaimed lands without discrimination in the division and use of water of like MRGCD lands.

Reclamation coordinates with the MRGCD for releases of irrigation water from El Vado Reservoir at the request of MRGCD. During periods of high runoff on the Rio Chama and absent any restrictions on storage due to the Compact, MRGCD may request Reclamation to store up to 100% of the natural Rio Grande flow entering El Vado Reservoir.

MRGCD requests releases of supplemental irrigation water from El Vado Reservoir for the benefit of all irrigators in the most efficient manner practical, minimizing times when MRGCD is in prior and paramount operation. Minimizing prior and paramount operation periods benefits the species by reducing the need for Supplemental Water for the species. It also benefits the Pueblos by providing fully for their needs without the more restrictive scheduling and monitoring necessitated by prior and paramount operation.

To determine the rate of release, MRGCD evaluates the amount of native flow moving downstream in the Rio Grande at the Embudo gage and the amount of native flow contributed by the Rio Chama and other tributaries. That combined amount is then compared with the

MRGCD's estimated diversion demand. Irrigation storage is released only when the natural flow is insufficient to meet MRGCD's irrigation demands. Natural flow is generally only sufficient to meet that need during the snowmelt runoff early in the irrigation season and during periods of heavy monsoon activity late in the irrigation season.

MRGCD has a small (2,000 AF) re-regulation pool at Abiquiu Reservoir for its share of SJC Project water. While, in general, this has little effect on flows in the MRG, it occasionally is used to produce recreational benefits on the Rio Chama. Small blocks of water may be moved to Abiquiu Reservoir specifically to increase flow on the Wild and Scenic portion of the Rio Chama to an appropriate level for recreational whitewater rafting. This water is released later from Abiquiu Reservoir when needed to meet irrigation needs. This is done on a larger scale with movement of ABCWUA water supply from upstream reservoirs to Abiquiu; however, when ABCWUA is not moving water, the MRGCD re-regulation pool at Abiquiu will continue to be used for this purpose.

1.3.1.2 MRGCD's Water Diversions and Returns

The water that the MRGCD diverts consists of natural flows of the main stem of the Rio Grande and its tributaries (including the Rio Chama, if the water is passed through without being stored in El Vado), SJC Project water, native Rio Grande flows stored at El Vado (including water stored as the result of New Mexico credit relinquishment pursuant to the Compact [relinquishment water]). Under certain operations for the Pueblos' prior and paramount water rights, the MRGCD diverts native Rio Grande water stored in El Vado by Reclamation. The MRGCD operates the Diversion Dams to match actual agricultural demand as closely as practical. This allows the MRGCD to release less water from storage, and therefore may allow it to extend its irrigation season.

Typically, MRGCD diverts and delivers water from March 1–October 31 each year. The MRGCD Board of Directors determines the duration of the irrigation season. In recent years, the Six MRG Pueblos have requested delivery of irrigation water through November 15. The MRGCD has complied with this request for Pueblo lands, but has continued to end non-Indian deliveries on October 31. Irrigation demand correlates closely with climatic conditions and the physiologic properties of agricultural crops. Demand is highest during the months of May, June, and July, tapering off in August and through September. During the early and late part of the irrigation season, much of the water diverted by the MRGCD is returned directly to the Rio Grande. During the peak growing season, most water diverted is consumed by crops, and return flows are minimal. From March through mid-June, natural flows in the Rio Grande are generally greater than the MRGCD consumptive needs. However, after the end of the spring snowmelt runoff, naturally occurring flows often drop precipitously and are generally less than the consumptive needs of the MRGCD. At this time, the MRGCD augments the natural flow of the Rio Grande, up to its consumptive needs, through requests that Reclamation release stored water from El Vado Reservoir.

The MRGCD diversion flows are higher than consumptive use of water. This additional flow, often referred to as “carriage water,” is a common and necessary component of gravity-fed irrigation systems worldwide. It can lead to misrepresentations of agricultural water consumption. Much of the MRGCD’s carriage water returns to the Rio Grande through a variety of paths. Some simply passes down the length of a canal and returns directly to the Rio Grande through a wasteway. Some canals, farm ditches, and fields discharge surface water directly to the MRGCD drains. Some water seeps from canals or from field applications into the groundwater system and then is intercepted by the MRGCD drains to once again become surface flow. Flow recovered in the MRGCD drains may be discharged back to the Rio Grande or be recycled to another canal. However, some carriage water is truly lost from the system through evaporation, consumption by riparian vegetation along irrigation canals, and seepage to groundwater (which then is pumped and consumed by other users).

The MRGCD’s wasteways and drain outfalls provide water that may be rediverted downstream; therefore, the accounting of the total MRGCD diversion may account for the same water a number of times (Figure II-1).

Return flow from the Cochiti Division comprises about 18% of the supply for the Albuquerque Division. Return flows from the west side of the Albuquerque Division supply a portion of water directly to the west side of the Belen Division and Isleta Pueblo. Return flow from the east side reenters the Rio Grande a short distance upstream of Isleta Dam and is then diverted for reuse. Direct Albuquerque Division return flow comprises about 13% of supply for the Belen Division. When combined with indirect returns (returned to the Rio Grande before being rediverted), Albuquerque Division provides about 35% of Belen Division supply.

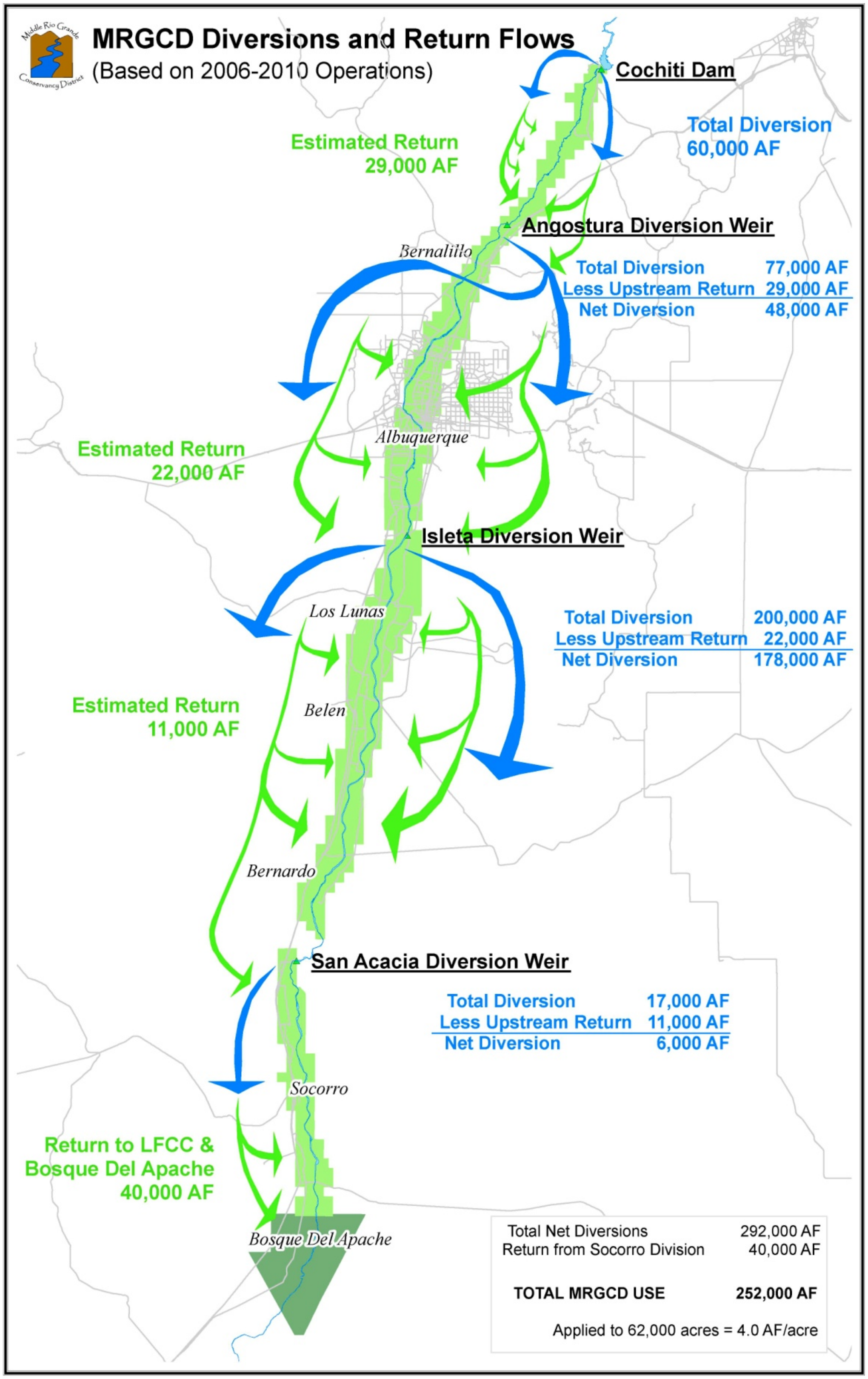

Figure II-1. MRGCD diversions and return flows

The Belen Division diverts water to both sides of the Rio Grande. The east side system consists of the Peralta Main Canal, San Juan Main Canal, and many laterals and acequias. Return flows from the east side may be delivered back to the Rio Grande from four outfalls, or routed all the way to the Lower San Juan Drain outfall, about 9 miles upstream of San Acacia Dam. At its terminus, the east side system delivers water to the La Joya Acequia Association (LJAA), an independent system not part of the MRGCD.

The west side system diverts water to the Belen High Line Canal, which supplies laterals and acequias. Return flows from the west side may be directed back to the Rio Grande at seven locations or may be delivered directly into the Socorro Division via the Unit 7 Drain. Direct Belen Division return flow comprises about 79% of supply for the Socorro Division.

San Acacia Diversion Dam is used primarily to supplement flows when necessary, or during periods when the Belen Division is unable to supply water. When flows in the Rio Grande are high, San Acacia Dam may be used preferentially over Belen return flows due to a lower salt content in the water at certain times of the year. During much of the year, water is intentionally diverted at Isleta Dam and routed to Socorro Division to minimize the very high evaporative conveyance losses incurred by the river during the summer months. The Socorro Main Canal receives water from both the Unit 7 Drain and San Acacia Dam. The Socorro Main Canal has North, Center, and South sections. To a large degree, return flows are collected from the North section to supply the Center section, and from the Center section to supply the South section. The LFCC recycles Socorro Division water supplies at three locations.

The MRGCD returns surface water from its canals directly to the LFCC at four wasteway points. The MRGCD then may divert this recovered water into its canal system at three locations. There is a single, small MRGCD wasteway that can return water directly to the Rio Grande by discharging to the Brown Arroyo, which crosses over the LFCC to enter the Rio Grande.

1.3.1.3 Summary of MRGCD's Proposed Actions

MRGCD proposes to continue coordinating with Reclamation for the release of irrigation water from El Vado Reservoir, operating the Diversion Dams and delivering return flows to the Rio Grande, as has been done since 1935, to provide water for use by the Six MRG Pueblos and as provided for by New Mexico law to non-Pueblo water users within the MRGCD service area, as described above, and in compliance with state and federal law.

MRGCD proposes to request releases from El Vado Reservoir and to operate and maintain the Diversion Dams pursuant to the 1923 New Mexico Conservancy Act, federal Congressional Acts of 1928 and 1935, NMOSE Permit No. 0620, and the 1951 Contract to meet the following requirements:

- Divert and deliver water stored in and released from El Vado Dam and native Rio Grande water to satisfy the needs of private property holders and users of water within its service area and lands of the Six MRG Pueblos.

- During times of shortage, divert and deliver native Rio Grande water for lands of the Six MRG Pueblos to satisfy the Pueblos' prior and paramount water rights, as requested by the BIA Designated Engineer.

- Redivert MRGCD's contracted SJC Project water, which, by statute, cannot be used by the United States for ESA purposes, except upon a willing seller basis.

- MRGCD proposes to continue to operate wasteways and drains to return both undelivered surface water and intercepted groundwater, either to the Rio Grande or to irrigation delivery canals, to meet the needs of private property holders and users of water within its service area and lands of the Six MRG Pueblos.

The following is an unedited statement and disclaimer from the MRGCD:

> "By requesting ESA coverage for these actions, MRGCD is not conceding that any federal authorization is required for MRGCD to exercise its statutory authority to divert and deliver water for irrigation purposes or that MRGCD's normal and lawful operations are subject to constraints imposed on federal actions by section 7 of the ESA. MRGCD is not conceding, nor does it believe, that its water related actions described herein contribute to jeopardy of the listed species. MRGCD's participation in this consultation is not evidence of any relinquishment to any federal agency of any of MRGCD's authority to conduct these normal and lawful operations, as established by the New Mexico Legislature in the Conservancy Act of 1923 and statutes and regulations enacted following the Conservancy Act. What are described in this BA as MRGCD's 'Proposed Actions' have been occurring in essentially their present form pursuant to State-law authority since 1935. The listed species have demonstrated an ability to successfully co-exist with MRGCD water actions over the past 80 years. It is probable that some MRGCD water actions have beneficial effects to these species that have contributed to their persistence in the Middle Rio Grande valley. Moreover, MRGCD's proposed Conservation Measures described in Part IV of this BA represent significant additional species conservation benefits to be provided by MRGCD and through the Recovery Implementation Program (RIP) under the BO resulting from this consultation."

1.3.2 State of New Mexico

Under New Mexico law, water rights are established by the beneficial use of water. State water policy and guidelines are designed and applied to protect existing water rights and to preserve compliance with the Rio Grande Compact by ensuring that the flows of the Rio Grande at the Otowi gage and delivery of Rio Grande water into Elephant Butte Reservoir are not diminished. The following is an unedited statement and disclaimer from the State:

> "By requesting this coverage, the State does not concede that its water related actions described herein contribute to jeopardy of the listed species. The State makes no admission that inclusion of all of these water related actions in the Biological Opinion is necessary to be in compliance with the ESA. Nor does

> the State waive its sovereign immunity, or any rights of entities or individuals under applicable law, statute, regulation or administrative code. The State does not waive its San Juan Chama Project contractual rights. The State does not waive its rights and obligations under the Rio Grande Compact nor waive its ability to comply with Rio Grande Compact delivery obligations."

The following subsections (Sections 1.3.2.1 through 1.3.2.3) briefly describe actions pertaining to the Rio Grande Compact, the State administration of surface water and groundwater rights, and the offset program. Section 1.3.2.4 summarizes the actions proposed by the State. A more detailed description of the State's actions can be found in the revised document provided by the State as Appendix F of this BA. The State's Offsetting and Conservation Measures approved by the New Mexico Commission in June 2015 are also described in Appendix F.

1.3.2.1 Rio Grande Compact

The 1938 Rio Grande Compact (53 Stat. 785) (Compact) apportions the native waters of the Rio Grande among the states of Colorado, New Mexico, and Texas, and is administered by the Rio Grande Compact Commission. The Compact is both a federal and state law that poses significant restrictions on water management, most specifically reservoir management, in the MRG. For purposes of this document, the Upper Rio Grande (URG) is defined as the reach from the Colorado-New Mexico state line to Otowi gage including the Rio Chama, and the MRG is defined as the reach from Otowi gage to Elephant Butte Reservoir. The two reaches combined are roughly the same area as that encompassed by the Collaborative Program.

New Mexico has an explicit but variable annual delivery requirement to the Elephant Butte Reservoir based upon the recorded annual native Rio Grande flow at the Otowi gage. The Compact does not require New Mexico to deliver the exact amount of water scheduled annually each and every year, but allows for the accumulation of over-deliveries (credit) and under-deliveries (debit). It is up to each state to decide how its water is used.

Several Compact restrictions affect reservoir operations in post-Compact reservoirs (reservoirs upstream of Elephant Butte that were constructed after 1929) and associated surface water management. All the reservoirs operated by the Corps and Reclamation are subject to these restrictions. However, Reclamation's Heron Reservoir and Nambe Falls Reservoir are excluded from these restrictions because they only store imported transbasin SJC Project water.

Article XVI of the Compact states that "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes." SJC Project water is imported transbasin water, is accounted as such, and is not subject to the Rio Grande Compact.

1.3.2.1.1 Credit Water Relinquishment

Under the Rio Grande Compact, all native Rio Grande water New Mexico delivers to Elephant Butte Reservoir in excess of the required annual delivery under Article IV of the Compact is accounted as “Credit Water.” Credit Water is stored in Elephant Butte Reservoir and accounted separately from the other water stored there. Under Article VII of the Compact, when Usable Water in Rio Grande Project Storage (the combined storage of Usable Water at Elephant Butte and Caballo Reservoirs) is less than 400,000 AF, native Rio Grande water cannot be stored in upstream reservoirs built after 1929. However, when New Mexico has an “Accrued Credit” under the Compact, Article VII provides a means for exchanging Credit Water so that native Rio Grande water can be stored in the upstream reservoirs when storage would otherwise be prohibited. This storage is accomplished through a unique feature of the Rio Grande Compact termed “relinquishment.”

New Mexico has relinquished Credit Water on a number of occasions in the past 10–12 years. Since signing the Emergency Drought Water Agreement (EDWA) in 2003, the State has made relinquishment credit available as follows: 91,000 AF for Reclamation to use in its Supplemental Water Program, 191,000 AF for the MRGCD for irrigation purposes, and 8,500 AF to the City of Santa Fe for municipal and industrial uses. As a result of implementing the EDWA, a total of 255,600 AF of relinquishment water was stored on the Rio Chama during the snowmelt runoff periods of 2003–2014. All of this water was stored during periods when it would otherwise not have been allowed because the Article VII storage restrictions were in effect.

The water stored and made available pursuant to the EDWA has been released during low natural flow periods, enabling the MRGCD to meet irrigation demand and to help meet the 2003 BO flow targets at the Albuquerque USGS gage for a longer time period. Consequently, during those time periods, Reclamation did not have to release stored water to meet the Albuquerque USGS gage flow targets. Reclamation has also used water allotted to it under the EDWA to meet 2003 BO flow targets at other times and circumstances. Depending on future conditions, the State will likely propose the continuation of relinquishments when possible. However, New Mexico’s ability to relinquish accrued Credit Water depends on its Compact credit status and the constraints of the Compact.

1.3.2.2 State Administration of Surface Water and Groundwater Rights

The NMOSE administers surface water and groundwater sources conjunctively in the Rio Grande Basin to prevent impairment to valid existing water rights by regulating depletions, thereby maintaining the overall hydrologic system balance. The NMOSE executes its statutory duties in accordance with State law, adjudications, and court orders. Under New Mexico law, water rights are established by beneficial use of water. Many water rights were so established prior to NMOSE jurisdiction (1907 for surface water rights, 1931 and subsequent basin declaration date for groundwater rights). Rights established under NMOSE jurisdiction follow a permitting process.

Administration is a term that encompasses numerous actions by the NMOSE in oversight of the exercise of existing water rights, the permitting process for changes in water use, and enforcement of New Mexico water law in the case of illegal water use. Examples of administration include the following:

- Enforcement of offset requirements associated with permits (discussed in detail below).
- Enforcement of diversion limits associated with permits, licenses, and adjudications of the court.
- Enforcement against waste of water and illegal water use.
- Administrations of water rights by date of priority during shortages or under a priority call (priority administration).
- Facilitation of the development of alternative administration and enforcement of alternative administrative conditions. Alternative administration is based upon agreements by water right owning parties that resolve water disputes under conditions of shortage without the necessity for priority administration and curtailment of junior water rights. Examples of alternative administration in the MRG and URG include the following:
  - The alternative administration program on the Rio Chama, in which diversions by the Rio Chama acequias downstream of Abiquiu Reservoir in excess of their very senior right to native water are repaid by exchange to the MRGCD through purchase of SJC Project water.
  - An alternative administration mechanism that has been developed for the Taos Valley as part of the Abeyta Adjudication, in which (1) the Taos Pueblo has agreed to limit exercise of its senior irrigation water rights until junior Acequia rights are retired, and (2) it has been agreed that major groundwater users can deal with their tributary impacts by making offsets directly to the Rio Grande, while contributing to a tributary mitigation system involving augmentation wells and a recharge project for the Buffalo Pastures wetland.
  - An alternative administration on the Jemez River that is based on an agreement adopted on July 2, 1996 between the United States, the Pueblo of Jemez, the Pueblo of Zia, and the Jemez River Basin Water Users Association. Under this agreement, a priority call may be made by the Pueblos of Jemez and Zia during times of shortage. Under these circumstances, all non-Pueblo entities must follow rotation schedules under which surface water will be provided to the Pueblos and the members of the Jemez River Basin Water Users Association.

- Granting of licenses for pre-basin declared water rights limited to the historical legal maximum diversion amount.

- Evaluating and acting upon applications to appropriate water (and thus obtain water rights) and/or modify water use associated with existing water rights.

  - The NMOSE does not accept applications to develop new water rights in most of the Rio Grande Basin. Surface water has been considered fully appropriated since 1907, and any additional groundwater use in aquifers hydrologically connected to the Rio Grande or its tributaries must be fully offset (as described in more detail below).

  - Applications accepted by the NMOSE are evaluated, as per Statute, and in accordance with applicable NMOSE rules, guidelines, and policies (such as the 2006 Surface Water Transfer Requirement to Offset Effects on the Rio Grande, the 2009 Return Flow and Discharge Credit, and the 2011 Depletion Offsetting for Habitat Restoration Projects within the Middle Rio Grande Project policies). The NMOSE evaluates the potential for impairment of other water rights, and whether granting the application would be contrary to conservation within the State or detrimental to the public welfare of the State.

  - If the NMOSE approves an application, conditions are applied to ensure water use does not exceed the legal extent of the water rights, and to ensure full offset of impacts to the Rio Grande (as described in more detail below).

Further, in the Rio Grande Basin, the following specific constraints related to protection of the flows of the Rio Grande are generally applied in approval of such applications:

- In order to maintain compliance with the Rio Grande Compact, depletions to the Rio Grande above the Otowi gage must be maintained at or below pre-Compact levels (1929).

- Water rights are not transferable from above Otowi gage to below Otowi gage, or vice versa.

- There can be no net increase of impact to the Rio Grande stream system (including tributaries). All surface water impacts occurring at a new location as the result of a transfer must be offset by a decrease in surface water depletion at the move-from location. Exceptions to the offset requirement apply to small domestic, livestock, and temporary-use wells approved under NMSA 1978 §§ 72-12-1 *et. seq.*

- Water rights are not transferable from above Elephant Butte Dam to below Elephant Butte Dam, or vice versa.

1.3.2.2.1 Permitted Groundwater Pumping Offset Programs (Offset Program)

In issuing groundwater permits, the NMOSE requires that impacts to tributaries to the Rio Grande are offset (this includes numerous streams, including the Rio Chama, the tributaries to the Rio Chama, and the numerous Rio Grande tributaries located in the Taos, Pojoaque, Española, and other valleys). In general, depletions to a tributary stream must be offset on the affected tributary itself in order to prevent impairment of existing water rights associated with the tributary. In some cases an alternative method for offset and mitigation can be developed, such as has occurred in the Taos Valley as part of the Abeyta Settlement, which allows tributary impacts to be offset on the Rio Grande as long as mitigation is provided to the acequias on the tributaries.

Offsets to stream depletions are accomplished by a combination of the three mechanisms described below:

- Transfer of existing valid surface water rights
  - Only valid pre-1907 water rights may be used for this purpose. In the MRG this is determined by a rigorous historical land use evaluation process.
  - In cases where surface water used for irrigation is transferred to a different use, only a fraction of the actual diversion may be transferred to offset the groundwater use—the part generally corresponding to the calculated consumptive irrigation requirement. The carriage water component of the diversion is not transferrable, and remains in the surface water system.
  - The NMOSE routinely provides the MRGCD with geospatial data that identify all those lands from which pre-1907 surface water rights have been severed.
- Actual return flow of surface water to the Rio Grande, pursuant to an NMOSE approved return flow plan.
- The NMOSE “Letter Water Program” for the release and/or storage by exchange of SJC Project water under contract by the permitted groundwater rights owners, to offset their impacts.

1.3.2.3 Administration of Domestic, Municipal, Livestock, and Temporary Uses

The NMOSE will continue to administer groundwater resources within the allowable limits in the following manner:

- The NMOSE will continue to issue permits for small domestic, livestock, and temporary uses as required by NMSA 1978 Sections 72-12-1.1 through 72-12-1.3, in accordance with the NMOSE 2006 Rules and Regulations Governing the Use of Public Underground Waters for Household and Other Domestic Use.

1.3.2.4 Summary of State of New Mexico's Proposed Actions

The State proposes to continue administer its water resources as follows:

- The ISC proposes to continue its Rio Grande Compact related activities to administer relinquishment of New Mexico credit water and allocation of relinquished Compact credits.

- The NMOSE proposes to continue to administer the surface water and groundwater resources to maintain hydrologic system balance by executing its statutory duties with respect to transfers of valid existing surface water rights and compliance with valid existing state water declarations, permit, licenses, and court adjudication.

- The NMOSE will continue to issue permits for small domestic, livestock, and temporary uses, as required by NMSA 1978 Sections 72-12-1.1 through 72-12-1.3, in accordance with the OSE 2006 Rules and Regulations Governing the Use of Public Underground Waters for Household and Other Domestic Use.

2. Effects Analysis

"Effects of the action" refers to the direct and indirect effects of the Proposed Action on listed species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline to determine the overall effects on the species (50 CFR Part 402.02). For purposes of this BA, effects on listed species and designated critical habitat are analyzed for the full suite of Proposed Water Management Actions as well as individually, where possible, for the discrete actions.

This section presents an evaluation of the hydrologic impacts resulting from the Proposed Water Management Actions and the predicted effects that those would have on the listed species. Reclamation has deemed that the effects of these Proposed Water Management Actions can best be presented through a combination of analyses.

These include the following:

- Assessment of the composition (in terms of the source of water, and whether the water has been stored in a reservoir) of the flows that provide supply to the MRG, as well as the distribution of uses of that water.

- Evaluation of the total, aggregate impacts of Reclamation and non-federal Proposed Water Management Actions without the use of Supplemental Water (Proposed Water Management Action). The model runs used assume operation of the facilities to meet the flow targets as defined by the 2003 BO. These actions are not part of the Proposed Action but were necessary to define the operations for the model.

- Action-by-action analysis of the relative effects of individual components of the Proposed Water Management Actions, to the extent practical, through the comparison of a simulation with those actions to a simulation in which those actions did not occur. Individual components of the Proposed Water Management Actions that were evaluated in the action-by-action analysis include:
    - Reclamation's operations at Heron Dam.
    - Actions by Reclamation, BIA, and the MRGCD related to the operation of El Vado Dam.
    - MRGCD's surface water diversions and associated water management actions.
    - The State's proposed water management actions.

Part IV provides an assessment of the effectiveness of proposed Offsetting and Conservation Measures of Reclamation, BIA, the State, and the MRGCD.

2.1 Approach, Tools, and Methods for Hydrologic Analysis

Reclamation performed the hydrologic analyses that support this effects analysis using a combination of hydrologic modeling and analytical computations. URGWOM was used for the majority of the analyses. URGWOM is a computational, rule-based, water operations computer model that simulates physical processes and operations of facilities in the Rio Grande Basin in New Mexico. URGWOM has been developed through an interagency effort and is constantly being refined. It is the only model available that can perform the needed analyses at a daily time-step and can make computational estimates of river drying. URGWOM individually tracks water allocated for specific uses, and Reclamation has used this capability to isolate the effects of individual actions evaluated in the action-by-action portion of this effects analysis.

Reclamation completed the simulations, as well as the analytical computations that support the modeling, using five 10-year synthetic hydrologic sequences developed with reference to paleoclimate data to represent the range of past hydrologic variability in the MRG Basin. The hydrologic sequences represent hydrologic conditions for which total annual flow at Otowi gage has a 10%, 30%, 50%, 70%, and 90% chance of being exceeded (higher exceedance curve represents drier conditions). Reclamation, in cooperation with the Population and Habitat Viability Assessment (PHVA) workgroup of the Collaborative Program, developed these sequences to capture the full range of variability in the hydrology and climate that have been experienced over the past 604 years, as captured in tree-ring records (Roach 2009, Appendix 1). These sequences represent a range of hydrologic conditions that might reasonably be expected to occur during the time period associated with this BA.

The sequences were developed through a statistical sorting of the hydrologic years contained in the 604-year reconstruction (Gangopadhyay and Harding 2008, Appendix 1). From the years within the reconstruction, 1,000 10-year sequences were constructed. The sequences of years were corrected to ensure that the year-to-year transitions were consistent with those in the hydrologic record but were otherwise randomly composed. For each of these sequences, the total flow past Otowi gage over the 10 years was calculated and compared to the range of 10-year total flows for the full set of 1,000 sequences. The five sequences for which the total flow past Otowi gage over the 10-year period was closest to having a 10%, 30%, 50%, 70%, and 90% chance of exceedance among the full suite of sequences (i.e., for the 90% sequence, 90% of the sequences had more water flowing past Otowi gage over the 10-year period than flowed past the gage in this sequence) were selected as the sequences for which Reclamation would analyze the impacts of the Proposed Water Management Actions in this BA. Each year in a selected sequence was then matched to the actual year in the URGWOM record (1975–2007) with the most similar total flow past Otowi gage, and that year's daily hydrologic record was used to distribute the total annual flow to daily flow for the modeled year.

It should be noted that these sequences were developed based on the total flow past Otowi gage, which is upstream of the MRG. The flow past Otowi gage is a good indicator of the total snowmelt runoff in a given year but does not fully reflect the strength of the summer monsoons, particularly in years for which summer moisture is distributed disproportionately downstream of Otowi gage. However, the years contained in the URGWOM record reflect a range of monsoon conditions. Because actual years in the 1975–2007 period are used in the simulations as representations for hypothetical years in the sequences, the monsoon volumes in the sequences are paired with flows past Otowi gage as they have been in recent years.

Figure II-2 provides a comparison of the hydrologic conditions, as depicted by the distribution of flows at Otowi Bridge, in the five synthetic hydrologic sequences against the mean of those experienced under baseline conditions for this BA.

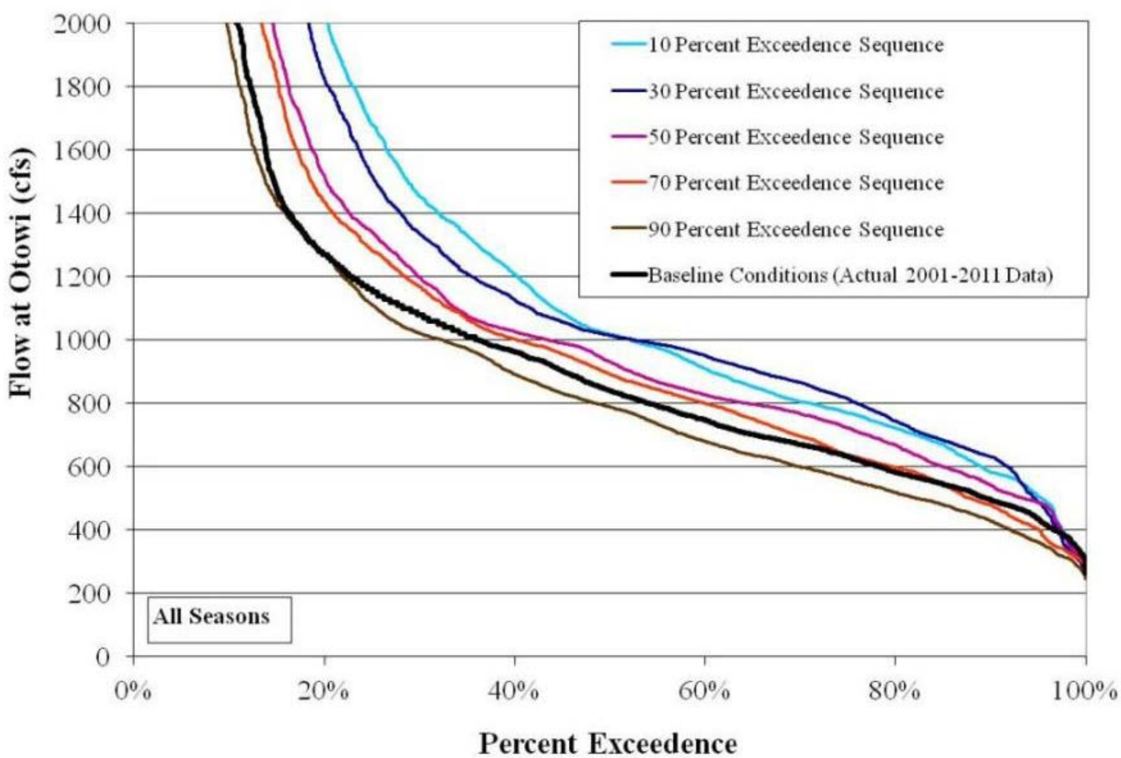

Figure II-2. Comparison of flows at the Otowi Bridge for the Proposed Water Management Actions under the five hydrologic sequences against baseline conditions.

The distribution of flows at Otowi Bridge experienced during the baseline period (2001–2011) is within the envelope of flows defined by the five hydrologic sequences. Except among the very lowest flows (percent chance of exceedance 95–100%, for which the baseline and synthetic sequences are all in approximate alignment), baseline conditions fall between the two driest synthetic sequences, those with a respective 70% and 90% chance of exceedance.

The modeling analyses presented in this section do not explicitly consider the potential impacts of climate change on water resources and on Reclamation's water operations. However, the inclusion of the range of hydrologic variability, as determined from the 604-year tree ring analysis, serves as a proxy for quantitative climate-change analysis, in that it allows for consideration of a wider range of hydrologic variability than has been experienced during the period for which flows have been monitored. Past and current climatic conditions are described in Part I, Chapter 4, Environmental Baseline. A more detailed discussion of the current and potential impacts of climate change is contained in Part I, Chapter 5, Cumulative Effects Analysis.

In the action-by-action analysis, Reclamation analyzed the discrete impacts of individual actions by utilizing model runs for the Proposed Water Management Actions and sequentially turning off specific actions, so that the model runs without a particular action could be compared to model runs with that action, and the difference between the two could be assessed. Please note that the Proposed Action model runs also include the State Letter Water releases and interrelated and interdependent actions of the Corps.

The combined impacts on river flows of the Proposed Water Management Actions and the impacts of individual actions in the action-by-action analysis are presented through several graphical methods, including box-and-whisker plots, which characterize ranges of variation in flows as the result of particular actions, and flow exceedance curves, which present flows, or differences in flows, that result from particular actions against total flow. The flow exceedance curves represent the percentage of time that a given river flow is equaled or exceeded. The majority of the curves were assembled using the results for all of the five hydrologic sequences, so they represent 50 years of simulation results and a broad range of historical hydrologic variability. They can be used to interpret the chance of occurrence of overbank flows, as well as the chance of river drying.

2.1.1 Model Uncertainty and Refinements to Support Hydrologic Analysis

The URGWOM model realistically simulates water management scenarios through the Rio Grande/Rio Chama system to Cochiti Reservoir based on past gage data, expected runoff volumes, and reservoir operating rules. However, the outputs from the URGWOM become appreciably less certain for locations downstream from Cochiti Dam. This is due to a highly complex interaction of consumptive uses and groundwater exchange into and out of the river. In recent years, significant effort has gone into calibrating the URGWOM to better reflect MRG conditions, and it has improved. Still, calibration has only been possible against observed conditions, and the No Action condition, in which none of the Proposed Water Management Actions are being performed, has not occurred since before flow monitoring began. Because of this lack of knowledge about the No Action condition, the model is unlikely to accurately reflect the extent and duration of river drying. Therefore, the extent of river drying under the No Action condition has been assessed and compared to the extent of river drying under the Proposed Water Management Actions using an analytical spreadsheet model developed by the MRGCD (Appendix H).

Because of the uncertainty in the degree of river drying under the No Action condition, graphs are provided in this effects analysis that present the difference in flows between model runs. These graphs depict the effects of proposed actions in terms of relative changes to flow rather than the absolute flows. Also, additional analyses have been performed using a spreadsheet model developed by the MRGCD to compare the drying, as well as high flows, under the Proposed Water Management Actions relative to the No Action condition. The results of these computations are provided in tabular form. The PHVA workgroup of the Collaborative Program and Reclamation, in coordination with the URGWOM Technical Team (an interagency team of modelers who have been working together to create and refine the URGWOM), have made significant enhancements to the URGWOM planning module and to URGWOM's representation of the rules that govern operational policy in this basin to support the modeling efforts presented in this BA. These include refinements and corrections to the model, as well as the incorporation of new processes, such as the ABCWUA drinking water project and the Buckman Direct Diversion. A full data management interface (DMI) was established in URGWOM to allow model inputs to be set efficiently for all simulations, and spreadsheet tools were set up to facilitate post-processing and review of results from all the completed model runs. These enhancements were made both prior to and during the modeling efforts to support this BA. The list includes enhancements made in response to comments received on the first draft of this BA, which was distributed to members of the water management community on August 18, 2011. The current configuration of the URGWOM planning model and the refinements made to it as part of this process are summarized in the URGWOM modeling report presented in Appendix 7 of the 2013 BA.

An analysis has been completed to develop appropriate initial conditions for reservoir storage and account status to use in BA model runs. These initial conditions reflect conditions as of December 31, 2011, and are described in Appendix 4 of the 2013 BA.

2.1.2 Approach for Analysis of Effects to Listed Species

URGWOM hydrologic modeling represents Reclamation's best understanding of the hydrologic impacts that may occur as a result of the Proposed Water Management Actions. Effects to the species are evaluated using this modeling and the species information presented in the baseline. Additional modeling results are presented in this section as needed to better understand conditions that may affect listed species.

Most environmental conditions and water management decisions within the MRG are interconnected spatially and temporally, and are generally not independent of each other.

The extant[5] population of silvery minnow persists solely within the project area, as described in this document. As such, actions that occur within this area have direct ramification to the species' existence. Timing and magnitude of discharge and geomorphic trends through the MRG are key factors driving population levels. Proposed Water Management Actions may affect spring runoff, magnitude, and duration of summer drying as well as winter flows. These hydrologic variables affect each life stage of silvery minnow (spawning, egg and larval development, and juvenile and adult survival), as well as habitat availability, habitat quality, and water quality. There is evidence presented both by population monitoring and preliminary PVA analysis that suggests that successful recruitment of silvery minnow is strongly linked to the magnitude and duration of spring runoff, with population increases coinciding with the inundation of overbank habitats supporting larval development (PVA Workgroup, 2011). Drying of the river, which occurs mainly during summer and fall, causes both stress and mortality of silvery minnow.

The MRG currently supports a large proportion of the total population of the endangered flycatcher and threatened cuckoo, when compared rangewide. Water operations can have both positive and negative effects on flycatchers and cuckoos and the vegetative habitat suitable for the species. In general, actions that promote overbank flooding or maintain soil moisture during territory establishment (approximately May 10–June 30) are beneficial for flycatchers and cuckoos, as well as vegetative health and prey base. Suitable flycatcher and cuckoo habitat typically only remains suitable for a short time period (5–20 years depending on environmental conditions) when vegetation composition and structure are within a certain age class. For this reason, flycatchers and cuckoos depend on an ever-changing environment where vegetation has the opportunity to continuously over mature in some areas and regenerate in other areas.

With the exception of BDA, the population status of the jumping mouse in the MRG is uncertain. The only known population within the MRG occurs in BDA along the Riverside Canal, but historically jumping mice also were known to occur at Isleta and Ohkay Owingeh Pueblos (Service 2014c). There is potential for both positive and negative effects to jumping mice and their habitat resulting from these Proposed Water Management Actions. In general, actions that maintain soil moisture that sustains or creates tall dense wetland vegetation are beneficial to jumping mice and their habitat.

[5] Does not include the non-essential experimental population within the Big Bend region of the Rio Grande in Texas, whose population status is currently unknown.

There are currently two populations of Pecos sunflower in the MRG. The La Joya population is mainly affected by actions that would change the delivery of water to the La Joya SWA. The Rhodes population is in the floodplain of the river and would be affected by actions that change the incidence of overbank flows in the San Acacia Reach. There is no critical habitat in the MRG for Pecos sunflower. Pecos sunflower effects are consolidated in Section 2.3.5, while silvery minnow and flycatcher effects are presented with each action.

As previously mentioned in the Status and Distribution section of this analysis, the interior least tern can be considered a vagrant in the MRG, 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 range-wide survey conducted in 2005 (Lott 2006). Due to the low potential for occurrence and the infrequent and/or temporary presence during migration, the tern likely would not be affected by the project; no further analysis will be completed on behalf of the species.

2.1.3 Continuation of Geomorphic Trends

The reduction in spring runoff peaks, increased low-flow duration due to water use within the basin and prolonged recent drought, and reduced sediment supply from in-place dams has altered the geomorphology of the MRG from a wide, active channel to a narrow, stabilized system. The historical pattern was characterized by large, high-energy flows, which reworked sections of the river and floodplain, removed vegetation, supplied sediment, and may have relocated the main channel laterally to lower elevations. This pattern resulted in a wide, braided, sandy channel that was well connected to the floodplain.

The current condition, with lower peak discharges, allows vegetation to establish that, in turn, causes the channel to narrow and become more simplified with little within-channel habitat diversity. In reaches where sediment supply is low, the river has become disconnected from the floodplain and is less likely to inundate the floodplain than in the historical condition. Generally, areas that have high sediment load and low sediment transport have a greater connectivity to the floodplain and provide more complex habitat at all flows; however, these sections are also more prone to intermittency due to the perched nature of the channel causing the flow to go subsurface.

The Proposed Water Management Actions are not anticipated to have trend-reversing effects on the geomorphology within the MRG. The river is expected to continue to trend toward a narrower, more simplified channel. Channel degradation downstream from Cochiti Dam is expected to continue and to extend further downstream. Currently, the designated safe discharge from Cochiti Dam is 7,000 cfs; significantly larger discharges would be needed to reverse the geomorphic trends. Habitat restoration and river maintenance activities have had some impact on this trend, but it is not possible to return the river to predevelopment conditions. These restoration projects also will require periodic maintenance to function as designed.

2.2 Sources of Middle Rio Grande Flows

This section breaks down sources of water providing flows to the MRG at Cochiti Dam as well as of water used to meet the MRGCD diversion demand for the Six MRG Pueblos, the MRGCD's non-Indian irrigators, and BDA. These breakdowns indicate the original sources of the water (native versus non-native), whether or not the water has been stored (natural flow versus released from storage), and the use or fate of the water (diverted for beneficial use or delivered to Elephant Butte). These breakdowns were developed from URGWOM simulations performed for this BA and present these water sources and fates for each of the five synthetic hydrologic sequences.

The breakdowns of the sources and fates of water that are presented in this section represent the range of 10-year average hydrologic conditions that are likely to be encountered under stable climatic conditions as well as the degree of variability of these conditions in individual years. These breakdowns provide an indication of the scale of the effect of upstream water management actions presented in this BA, as well as the degree to which changes to these actions can affect flow conditions in the MRG.

Natural flow, which constitutes the majority of MRG flows, consists of natural flow from the main stem, unregulated tributary inflows, and native water from the Rio Chama that has been bypassed from storage at El Vado Dam. The natural flow bypassed at El Vado may be regulated at Abiquiu or Cochiti Dams, and still maintains its designation as natural flow for this analysis.

The analysis also shows native water released from storage at El Vado Reservoir and non-native SJC Project water. Native water released from storage at El Vado Reservoir includes:

- Water stored during times in which native inflow to El Vado exceeded irrigation demand, and in which Article VII restrictions under the Rio Grande Compact are not in effect.
- Water stored in El Vado, during times in which Article VII restrictions under the Rio Grande Compact are in effect, to meet the prior and paramount water rights requirements for the Six MRG Pueblos' lands.
- Water stored in El Vado during times in which Article VII restrictions under the Rio Grande Compact are in effect, but storage is allowed in equal exchange for delivery credits by New Mexico to Texas that have been relinquished under the terms of the Rio Grande Compact. Water has been stored at El Vado under this process in the past decade by agreement (i.e., EDWA) between the State of New Mexico, the MRGCD, Reclamation (for its Supplemental Water Program), and New Mexico municipalities.

The EDWA is only a result of initial conditions, not additional relinquishments or allocations.

SJC Project water includes water released from Heron Reservoir to meet the needs of 16 SJC project contractors, including ABCWUA and the MRGCD, as well as water leased by Reclamation under its Supplemental Water Program. SJC Project water may be released to meet contractors' needs or may be released as "Letter Water," to offset the impacts of groundwater pumping. SJC Project water released from Heron may be temporarily stored or reregulated at El Vado, Abiquiu, or Cochiti Reservoir and still be presented as SJC Project Water for this analysis. SJC Project water maintains its identity until it is fully depleted within the State of New Mexico.

2.2.1 Sources of River Flow at Cochiti Dam

To better understand water management in the MRG, it is important to first understand the composition of water under various conditions. This section shows the average percentage contributed by each source of water that provides flows at Cochiti Dam (Table II-2) and the average uses or fates of that water over a calendar year for the five hydrologic sequences used in this effects analysis. The first three rows of this table (shown in blue) indicate that, on average, about 90% of the water in the MRG is composed of the natural flow in the Rio Grande system, consisting of native water of the Rio Grande and its tributaries that has not been stored for beneficial use at a Reclamation reservoir. Of that 90%, over 32% is used to meet MRGCD's irrigation demand, and the rest is conveyed to Elephant Butte Reservoir to support New Mexico's compliance under the Compact. Releases of native water from El Vado (shown in green, in the second block of rows) total an average across the calendar year of only 3% of the flow out of Cochiti Dam, including native storage, storage for irrigation of lands with prior and paramount water rights, and relinquished credit water under the Rio Grande Compact ("EDWA water"). SJC Project water (shown in purple, in the third block of rows) makes up an average of just over 7% of the flow out of Cochiti Dam. Table 2 presents the percentage of the total flow that goes to the major SJC Project contractors—MRGCD and ABCWUA—as well the portion that is used to supplement river flows under Reclamation's Supplemental Water Program. Flow to other contractors that do not lease their contracted water to the Supplemental Water Program is negligibly small.

Table II-3 depicts the composition of flows, by percentage, that make up the supply used to meet the MRGCD diversion demand over the calendar year. The water diverted by the MRGCD is used to meet the needs of the Six MRG Pueblos as well as the MRGCD's non-Indian irrigators. Diverted water that remains at the end of the MRGCD's system is delivered to BDA. The MRGCD estimates this delivery to be 40,000–60,000 AFY, most of which is passed through the refuge and returned to the LFCC. The actual volumes associated with the MRGCD's diversion demand are provided in Appendix 5 of the 2013 BA, by month and by diversion structure.

Table II-2. Composition of river flows below Cochiti Dam as percent: Calendar year

Wetter ⟶ *Drier*

Water Source or Use	10% Exceedance Sequence		30% Exceedance Sequence		50% Exceedance Sequence		70% Exceedance Sequence		90% Exceedance Sequence		Avg
Natural Flow of Rio Grande System	90.8		89.6		90.5		90.1		89.2		89.8
Diverted to meet MRGCD and BDA Demand		23.4		27.0		31.0		33.5		37.5	32.3
Delivered to Elephant Butte		67.4		62.6		59.5		56.6		51.7	57.6
El Vado Releases	4.3		4.1		2.7		2.7		2.4		3.0
Native Storage		3.5		3.2		1.1		0.8		0.1	1.3
Prior and Paramount, for demand		0.1		0.1		0.2		0.2		0.4	0.2
Prior and Paramount, unused, evacuated		0.2		0.2		0.7		0.9		1.0	0.7
EDWA (MRGCD)		0.3		0.3		0.4		0.4		0.5	0.4
EDWA (Reclamation)		0.2		0.3		0.3		0.3		0.4	0.3
SJC Project Water	4.9		6.4		6.9		7.2		8.4		7.2
MRGCD		1.4		2.4		2.6		2.5		3.4	2.7
ABCWUA Diversion		2.7		3.1		3.5		3.7		3.8	3.5
Supplemental Water Program		0.8		0.8		0.8		1.1		1.1	1.0

Table II-3. Composition of the diversion demand of the MRGCD, as percent: Calendar year

Wetter ⟶ *Drier*

Water Source or Use	10% Exceedance Sequence		30% Exceedance Sequence		50%-Exceedance Sequence		70%-Exceedance Sequence		90%-Exceedance Sequence		Avg
Natural Flow of Rio Grande System	78.8		80.8		82.0		79.3		74.5		79.2
Releases from Storage	12.0		8.4		6.3		4.9		4.0		5.9
Native Storage		10.1		6.5		2.9		1.3		0.1	2.7
Prior & Paramount, for demand		0.3		0.3		0.5		0.4		0.8	0.5
Prior & Paramount, unused, evacuated		0.6		0.6		1.9		2.1		2.1	1.7
EDWA (MRGCD)		1.0		1.0		1.0		1.0		1.0	1.0
MRGCD SJC Project Water	4.8		7.2		6.8		5.9		6.8		6.7
Deficit	4.4		3.5		4.9		9.9		14.7		8.2

The composition of the water that is used to meet the diversion demand of the MRGCD differs somewhat from the composition of water at Cochiti Dam, but shows the same general character in which most the water is supplied by the natural flow of the Rio Grande and its tributaries. Additionally, 79% of the diversion requirement at the MRGCD's four main stem diversions (Cochiti Dam and Angostura, Isleta, and San Acacia Diversion Dams, but not the LFCC diversions) is met by natural flows of the Rio Grande system, consisting of native flows not stored at El Vado Reservoir and over which Reclamation has no control. Only 5.9% of water diverted at these four main stem MRGCD diversions consists of Reclamation's releases of Rio Grande water from storage at El Vado Reservoir. Reclamation's SJC Project releases account for approximately 6.7% of the MRGCD's irrigation demand. The remainder of the MRGCD's irrigation demand (as defined by the irrigation demand curves used in the URGWOM model (Appendix 5 of the 2013 BA) remains unmet.

Table II-4 shows sources of flow and uses or fates of water for the five hydrologic sequences during the snowmelt runoff season (March–July). A comparison of Table II-3 to Table II-5 shows that the proportion of the flow out of Cochiti that consists of the natural flow of the Rio Grande system is higher during the snowmelt runoff season than in the year overall. This is because, during the snowmelt runoff season, natural flow typically provides more than sufficient water to meet the irrigation demand; therefore, releases of native water in storage or SJC Project water are usually not needed to meet demand (native water is usually being stored in El Vado during this period). Some releases of native water from El Vado and SJC Project water occur during this period, particularly in the later part of this period in years for which the runoff ends before July, but the amount is lower than during the year overall.

Table II-5 shows the composition of flows out of Cochiti Dam during the later part of the irrigation season, after the snowmelt runoff is complete (August–October). During this period, the use of stored native water and SJC Project water is at its maximum. However, even during this period, over 79% percent of the flow is composed of natural flow.

Table II-4. Composition of river flows below Cochiti Dam as percent: Runoff season (March–July)

Wetter → *Drier*

WATER SOURCE OR USE	10% Exceedance Sequence		30% Exceedance Sequence		50% Exceedance Sequence		70% Exceedance Sequence		90% Exceedance Sequence		Avg
Natural Flow of Rio Grande System	94.1		92.8		93.3		91.6		89.7		91.8
Diverted to meet MRGCD and BDA Demand		24.8		28.2		32.9		36.1		43.1	35.1
Delivered to Elephant Butte		69.3		64.6		60.3		55.5		46.6	56.8
El Vado Releases	2.2		1.6		2.1		1.8		2.4		2.0
Native Storage		1.6		0.9		0.8		0.4		0.1	0.5
Prior and Paramount, for demand		0.1		0.1		0.2		0.3		0.5	0.3
Prior and Paramount, unused, evacuated		0.0		0.0		0.2		0.1		0.5	0.2
EDWA (MRGCD)		0.3		0.1		0.5		0.5		0.7	0.5
EDWA (Reclamation)		0.3		0.4		0.4		0.5		0.6	0.5
SJC Project Water	3.7		5.7		4.7		6.6		7.9		6.2
MRGCD		1.2		2.8		1.5		2.7		3.7	2.7
ABCWUA Diversion		1.4		1.9		2.2		2.2		2.6	2.2
Supplemental Water Program		1.1		0.9		1.1		1.7		1.6	1.3

Table II-5. Composition of river flows below Cochiti Dam as percent: Late (post-runoff) irrigation season (August–October)

Wetter → *Drier*

Water Source or Use	10% Exceedance Sequence		30% Exceedance Sequence		50% Exceedance Sequence		70% Exceedance Sequence		90% Exceedance Sequence		Avg
Natural Flow of Rio Grande System	72.1		77.2		75.6		81.9		82.5		79.3
Diverted to meet MRGCD and BDA Demand		51.2		54.3		59.7		69.4		67.2	62.7
Delivered to Elephant Butte		20.9		23.0		15.8		12.5		15.3	16.6
El Vado Releases	17.3		12.7		8.3		8.0		5.5		8.6
Native Storage		14.5		9.7		3.9		2.1		0.0	3.9
Prior and Paramount, for demand		0.1		0.1		02		0.1		0.5	0.2
Prior and Paramount, unused, evacuated		1.2		1.2		3.7		5.2		4.3	3.6
EDWA (MRGCD)		0.9		1.7		0.5		0.7		0.7	0.9
EDWA (Reclamation)		0.5		0.0		0.0		0.0		0.0	0.0
SJC Project Water	10.7		10.1		16.1		10.0		12.0		12.1
MRGCD		4.6		3.5		10.3		5.0		7.1	6.5
ABCWUA Diversion		5.4		5.2		5.0		4.9		3.9	4.8
Supplemental Water Program		0.7		1.4		0.8		0.1		1.0	0.9

The tables presented thus far in this section depict average conditions over 10-year periods for a variety of hydrologic conditions. Table II-6 displays the degree to which these conditions can vary in individual years, based on the volume of the natural flow and the availability of water stored in reservoirs from previous years. The largest component of natural flow would occur in a year for which the initial reservoir storage is small and the natural flow is large. In the modeled year for which these conditions are most extreme, the percentage of MRG flows made up of natural flow of the Rio Grande system is 95.2%. In this high-natural-flow year, the component of MRG flow that is made up of water that had been stored in El Vado is 3.0%, and the component made up of SJC Project water is 1.8%. The largest contribution of stored and non-native water would be in a year with large initial reservoir storage and a small natural flow. In the modeled year for which these conditions are the most extreme, the percentage of MRG flows made up of natural flow is only 74.0%. In this low-natural-flow year, the component of MRG flow that is made up of water that had been stored in El Vado is 9.8%, and the component made up of SJC Project water is 16.2%.

Table II-6. Composition of river flows below Cochiti Dam, as percent: range of variability for individual years

Water Source or Use	Individual Year with Small Reservoir Storage and Large Natural Flow	Individual Year with Large Reservoir Storage and Small Natural Flow
Natural Flow of Rio Grande System	95.2	74.0
Diverted to meet MRGCD & BDA Demand	17.1	38.8
Delivered to Elephant Butte	78.1	35.2
El Vado Releases	3.0	9.8
Native Storage	1.8	6.5
Prior & Paramount	0.0	2.4
EDWA (MRGCD)	0.8	0.0
EDWA (Reclamation)	0.4	0.9
SJC Project Water	1.8	16.2
MRGCD	0.1	5.8
ABCWUA Diversion	1.7	6.9
Supplemental Water Program	0.0	3.6

2.3 Comparison of Hydrologic Conditions with and without the Proposed Water Management Actions

This section compares modeled hydrologic conditions under the Proposed Water Management Actions to modeled hydrologic conditions in the absence of those actions (referred to as the "No Action" condition in this section, for convenience). The Proposed Water Management Actions do not include Reclamation's Supplemental Water Program, which is evaluated separately as an Offsetting Measure in Part IV. Both conditions have been modeled and evaluated using the five synthetic hydrologic sequences described in Section 2.1. In the simulations of the Proposed Water Management Actions, Reclamation operates Heron Dam to provide SJC Project water to its contractors. Reclamation, in coordination with the MRGCD, stores native water in El Vado Dam and releases that water as needed to meet MRGCD diversion demand, and the MRGCD operates its MRG diversions. In the simulation of the No Action condition, these operations are turned off in the model. However, MRGCD irrigation demand is not turned off. Therefore, if water is available to the irrigation network, such as from interior and riverside drains, that water will be used to meet irrigation demand if it can be delivered to the turnout without being diverted from the river. The flow targets set by the 2003 BO are used as operating rules for all model runs. Additionally, through 2013, the Corps can deviate its operations of Cochiti Dam to enhance the timing and shape of the spring hydrograph in the MRG, an interrelated and interdependent action to this BA, which is turned on in all model runs.

There are effects to both high-flow and low-flow conditions within the MRG from the Proposed Water Management Action when compared to a No Action scenario. Figure II-3 presents a comparison of the modeled duration of continuous high flows at Central Avenue under the Proposed Water Management Actions, relative to the No Action condition. This figure shows that, on average, the Proposed Water Management Actions decrease the length of time that the spring snowmelt runoff peaks persist in the MRG. For example, there is a 4-day difference between the duration of flows exceeding 3,000 cfs and a 10-day difference in the duration of flows exceeding 1,000 cfs under the Proposed Water Management Actions relative to the No Action condition. This change is due to both diversion of flows and storage of water at El Vado. The difference is more pronounced in the Isleta Reach decreasing the duration at 3,000 cfs by 6 days and 1,000 cfs by over 20 days. The Corps deviation program is included through 2013 in the model runs for both Proposed Action and No Action scenarios. The deviation is not likely to change the total flow volume but may extend the number of days that flow remains above a threshold level.

The effect is more pronounced during lower flows. Figure II-4 provides a summary of the impact of the Proposed Water Management Actions on flows in the MRG, relative to the No Action condition, at key locations within the MRG, including the Albuquerque/Central Avenue gage, downstream from Isleta Diversion Dam, downstream from San Acacia Diversion Dam, and at San Marcial, from July 1 to October 31. Each colored bar shows the combined effects on flows of both federal and non-federal actions in the Proposed Water Management Actions, including operation of Heron Dam under the SJC Project, Operation of El Vado Dam, and MRGCD diversions, at these key locations. It shows that the Proposed Water Management Actions result in lower flows across the normal range of flows at this location.

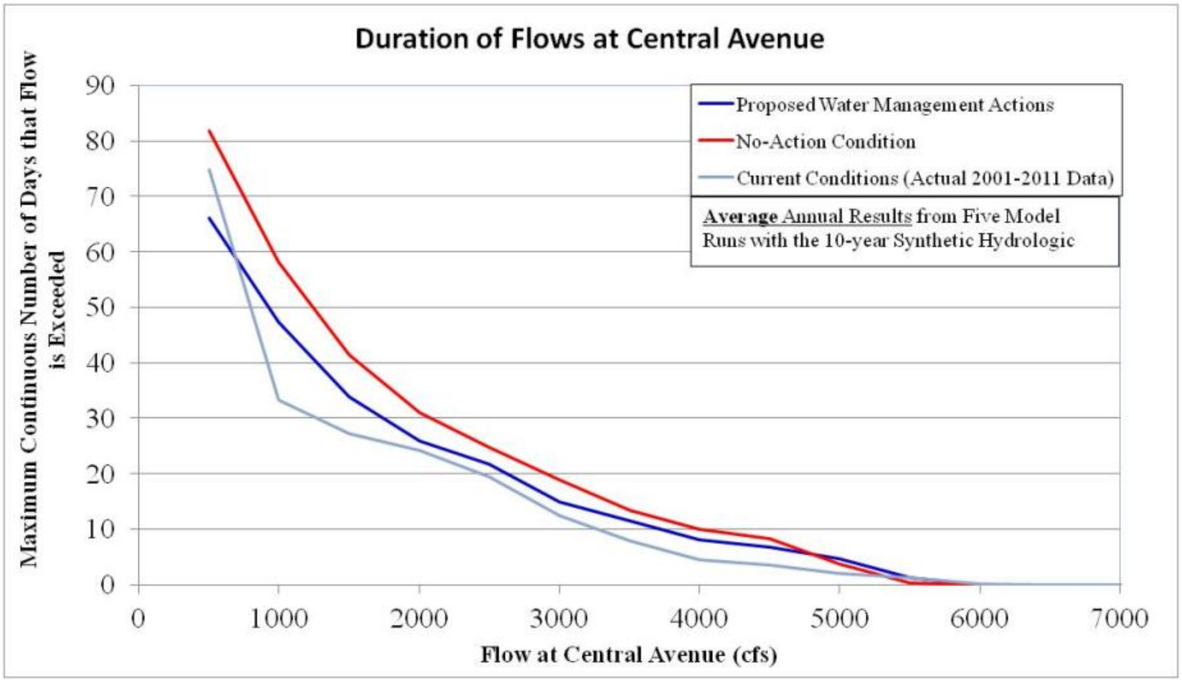

Figure II-3. Comparison of the duration of continuous days of high flow under the Proposed Water Management Actions, relative to the No Action condition, at Central Avenue gage, Rio Grande, New Mexico, in the 500–7,000 cfs range.

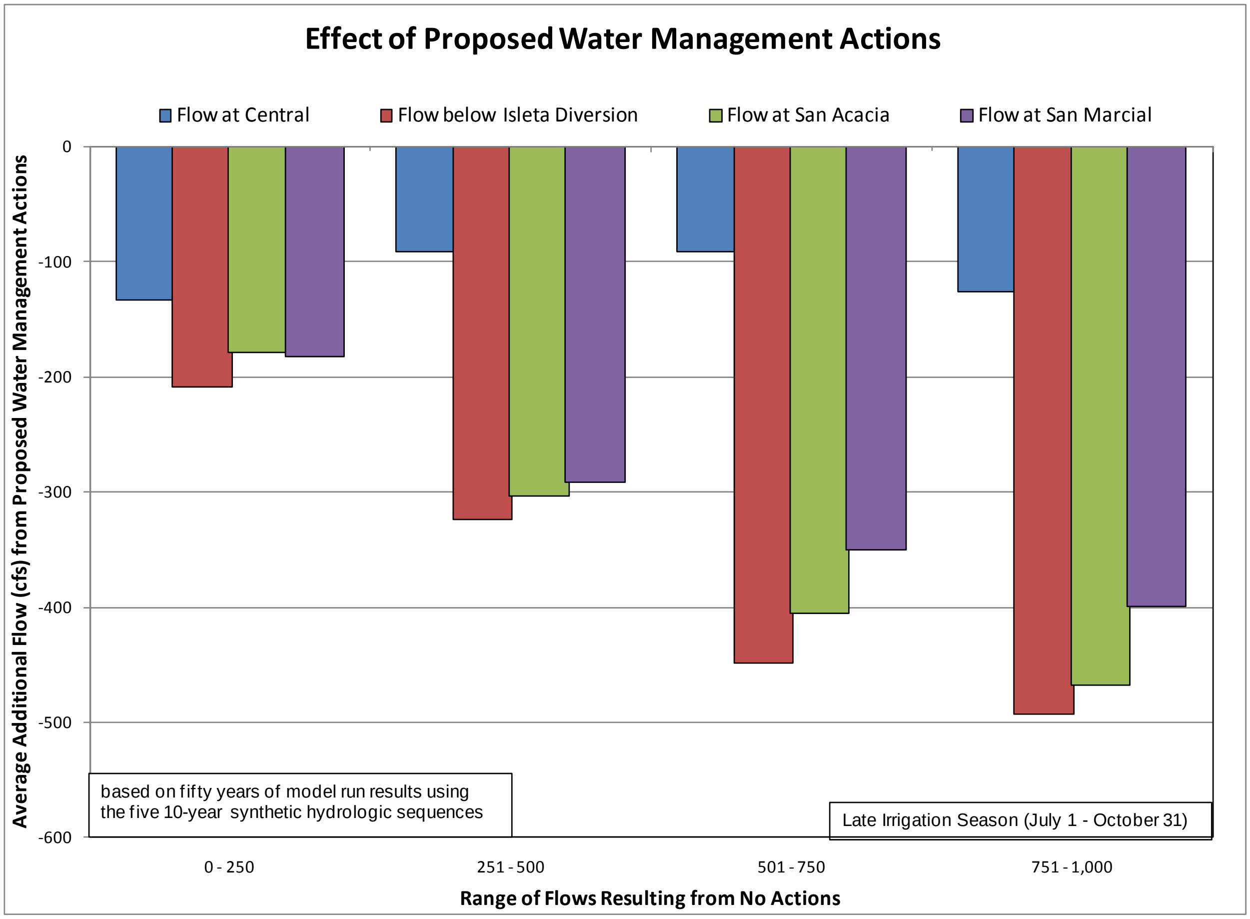

Figure II-4. Change in modeled flow under the Proposed Water Management Actions to flow modeled under the No Action condition over the calendar year.

This effect is concentrated in the irrigation season. The difference between the Proposed Water Management Actions and the No Action condition during the non-irrigation season is very small. The model runs and the spreadsheet analysis presented here indicate that Proposed Water Management Actions likely will result in additional miles of river drying. The relative differences between modeled flows under the Proposed Water Management Actions and the No Action persist downstream through the remaining reach of the MRG.

As explained in Section 2.1.1, the portrayal of the No Action condition in URGWOM is subject to considerable uncertainty because this condition has not been monitored in the MRG; the model therefore has not been calibrated to this condition. An additional computational tool, a depletion-based spreadsheet model developed in MS Excel by the MRGCD, provides a more refined description of the MRGCD's operations and impacts for the middle valley between Cochiti and River Mile 60. MRGCD's complete description of the methods and spreadsheet are included in Appendix H, and are summarized along with the action-by-action analysis below.

2.3.1 Effect of Proposed Water Management Actions on Silvery Minnow

2.3.1.1 Magnitude, Duration, and Timing of Spring Runoff

The Proposed Water Management Actions can decrease the magnitude and duration of spring snowmelt runoff peaks in the MRG, which may have a negative effect on silvery minnow spawning and the development of silvery minnow eggs and larvae. The difference in the mean number of days that would be expected at each discharge level increases as the peak flow decreases. Thus, in years with high overbank potential (flows greater than 3,000 cfs at Albuquerque) there is a less noticeable decrease in high flows than in those years with minimal snowmelt. Therefore, effects are less noticeable when natural runoff volumes are higher. The relationship of October catch rates of silvery minnow and number of days greater than 3,000 cfs (Figure I-6) revealed that, since 1993, only 1 year with fewer than 30 days with discharge greater than 3,000 cfs had a mean October catch rate greater than 5 fish per 100 m^2 (Table II-7). A linear regression of this relationship indicates an approximate change in mean October CUPE by 2 fish per 100 m^2 for every 5 days change in spring discharge > 3,000 cfs.

Table II-7. Relationship of mean October CPUE with number of days with discharge greater than 3,000 cfs in May and June from Figure I-6

Year	Mean October CPUE (#/100 m2)	# Days Discharge >3,000 cfs (May and June)	Graph Value (Figure I-6)
1993	11.8	59	1.9
1994	12.6	60	2.0
1995	26.8	61	2.3
1996	1.4	0	0.7
1997	13.6	43	2.2
1999	6.3	30	1.3
2000	0.4	0	0.3
2001	0.9	2	0.4
2002	0.1	0	0.1
2003	0.0	0	0.0
2004	0.9	0	0.4
2005	37.3	57	2.9
2006	1.3	0	0.6
2007	10.8	10	1.7
2008	8.3	46	1.6
2009	15.5	34	2.2
2010	1.2	19	0.6
2011	1.2	0	0.5

The Corps deviation program is included through 2013 in the model runs for both the Proposed Water Management Actions and No Action scenarios. The deviation is not likely to change the total flow volume but may extend the number of days that flow remains above a threshold level, which could benefit silvery minnow. There is little difference between the Proposed Water Management Actions and the No Action condition for the duration of flows over 5,000 cfs, which are the flows that are high enough to alter the channel; therefore, the Proposed Water Management Actions have little direct effect on current silvery minnow habitat features within the MRG. However, the Proposed Water Management Actions do provide low summertime flows, which allow vegetation growth, and therefore contribute to channel narrowing and simplification. This indirect effect is compounded by the lack of channel-resetting high-flow events due to flood control operations by the Corps at Cochiti Dam. There is a complex relationship between sediment transport and silvery minnow habitat. Generally, areas that have high sediment load and low sediment transport have a greater connectivity to the floodplain and provide more complex habitat at all flows; however, these sections are also more prone to intermittency due to the perched nature of the channel causing the flow to go subsurface. These processes are described in detail in Part III of this BA. Depending on their operation, diversion dams may interrupt sediment downstream transport and cause degradation within the channel.

2.3.1.2 Low Flows and Drying

In addition to the spring runoff timing, magnitude, and duration, October catch rates are related to the onset of low-flow conditions (Figure I-7). The early onset of low flows is negatively related to the recruitment of silvery minnow as measured in the October population monitoring. Modeling predicts that the Proposed Water Management Actions increase the likelihood that low-flow conditions (indicated by 200 cfs at San Marcial) begin earlier in the year (Figure II-5). Modeling runs of the Proposed Action also indicate that the duration of low-flow conditions and drying are increased under the Proposed Water Management Actions as compared to the No Action scenario. In the modeled scenarios, there is increased probability of drying in all reaches with the Proposed Water Management Actions as compared to the No Action scenario. Increased drying is likely to adversely affect silvery minnow, especially juvenile and adults during summer and fall timeframes.

The Proposed Water Management Actions may increase winter flows during the transfer of water to Elephant Butte after the irrigation season. This is considered to have little effect on silvery minnow because the flow levels tend to be sufficient and stable during winter. Stable water conditions should allow silvery minnow to remain in a single overwinter habitat without having to expend energy seeking out new suitable habitats as flows change. Higher flows also may provide some amount of thermal stability during times of extremely low air temperatures. A summary of the effects of the Proposed Water Management Actions on silvery minnow is presented in Table II-8.

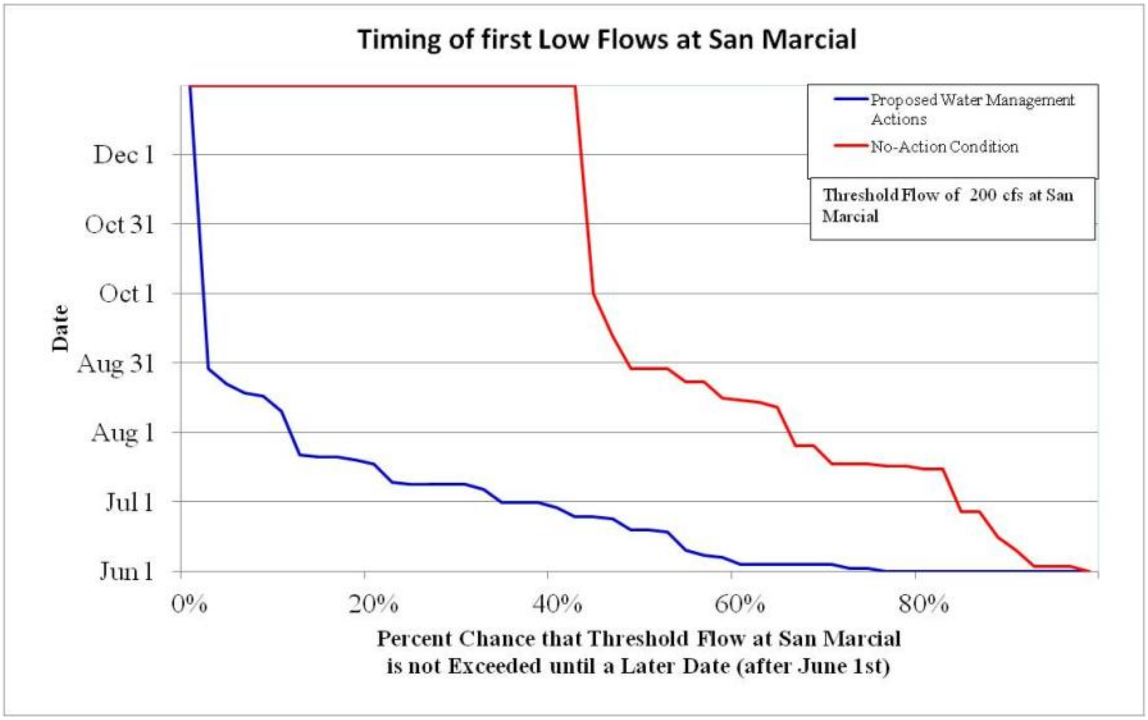

Figure II-5. Comparison of the timing of the first low flows at San Marcial under the Proposed Water Management Actions to flows under the No Action condition after June 1

Table II-8. Summary of the effect of the full Proposed Water Management Actions on the life history elements and critical habitat PCEs of silvery minnow

<table>
<tr><th></th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (March–June)</td><td colspan="3">The Proposed Action will cause a small decrease in the magnitude and duration of runoff in the MRG. This decrease is anticipated to be minor. The spatial extent and duration of inundation of overbank habitats is related to spawning and recruitment of silvery minnow. Direct and Indirect – The Proposed Water Management Actions are likely to adversely affect silvery minnow egg development and larval recruitment due to the decreased magnitude and duration of spring runoff.</td><td></td><td>There is little information on how spring flows are related to adult survival of silvery minnow. The anticipated minor changes in the spring hydrograph from the Proposed Water Management Actions are not likely to directly or indirectly adversely affect adult silvery minnow.</td></tr>
<tr><td>Summer (June–Sept)</td><td></td><td></td><td colspan="3" rowspan="2">The Proposed Water Management Actions are anticipated to cause decreased summer and fall flows and drying as compared to the No Action scenario. Both low flows and drying are likely to cause mortality of silvery minnow. Thus, Direct and Indirect – The Proposed Water Management Actions are likely to adversely affect silvery minnow during summer and fall periods.</td></tr>
<tr><td>Fall (Sept–Nov)</td><td></td><td></td></tr>
<tr><td>Winter (Dec–Feb)</td><td></td><td></td><td></td><td></td><td>Water releases for SJC Project contractors generally occur in November and December. These releases provide higher flows through the MRG, which are of sufficient amount and generally stable. Direct and Indirect – The Proposed Water Management Actions are not likely to adversely affect winter survival of adult silvery minnow.</td></tr>
</table>

Table II-8. Summary of the effect of the full Proposed Water Management Actions on the life history elements and critical habitat PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Critical Habitat PCEs					
Hydrologic Regime					
A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.	The Proposed Actions have an effect on the duration of channel resetting, habitat forming flows and also contribute to the base flow levels that continue the long-term geomorphic trends within the MRG, which is trending toward a narrower, more simplified channel due to trends discussed in Part III. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects. There are indirect effects as well as beneficial effects on silvery minnow critical habitat from the storage and release of water from reservoirs which changes sediment transport capacity and disrupts peak flows, but also provides water and additional habitat that would otherwise not exist. There are ***indirect effects that may adversely affect silvery minnow critical habitat.***				
Presence of a diversity of habitats for all life history stages					
Sufficient flows from early spring (March) to early summer (June) to trigger spawning	Silvery minnow are known to spawn with very small flow increases. However, the Proposed Action may result in a minor decrease in high flows especially in years with limited spring runoff; therefore,***this may have minor direct and indirect effects and is likely to adversely affect critical habitat for spawning of silvery minnow.***				
Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow		The Proposed Action increases the likelihood of low-flow periods and drying in the MRG as compared to No Action. **Direct and Indirect –** ***The Proposed Action is likely to adversely affect silvery minnow critical habitat by increasing the duration of low flow and drying within the MRG.***			
Constant winter flow				Water releases for SJC Project contractors generally occur in November and December. These releases provide higher flows through the MRG that are of sufficient amount and generally stable. **Direct and Indirect –** ***Actions are not likely to adversely affect winter critical habitat.***	

Table II-8. Summary of the effect of the full Proposed Water Management Actions on the life history elements and critical habitat PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Unimpounded stretches of river with a diversity of habitats and low-velocity refuge areas					
River reach length	Currently, diversion dams are in place; no new cross channel structures are proposed. The actual length of wetted river within each reach changes depending on channel sinuosity. Sinuosity changes depending on geomorphology and discharge levels. Sinuosity of the thalweg may increase during low flows that increase the length of the river but also may promote vegetation growth on point bars within the river channel. The lack of flood stage flows also changes the potential that the river will move outside its current channel. The Proposed Action ***is not likely to adversely river reach length.***				
Habitat "Quality" in each reach and refugial habitats.	Habitat quality in each reach is dependent on the structure and diversity of available habitat. Channel trends throughout the MRG are toward a more simplified channel due to vegetation encroachment. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects. The quantity of suitable habitat within each reach also changes at different flows; this relationship is not linear in most sections of the river and is dependent on channel shape. The Proposed Action ***may have indirect effects that adversely affect silvery minnow critical habitat.***				
Substrate of sand or silt					
Substrates of predominantly sand or silt	The Proposed Action is not likely to affect the current trend of substrate coarsening in the Cochiti Dam and Angostura Reaches or deposition within the lower reaches. Much of the sediment in the MRG is introduced from tributary flows that are largely unregulated. The presence and operation of diversion dams within critical habitat interrupts sediment transport and may affect the substrate size downstream from the structures. Direct and Indirect – The Proposed Action ***is likely to adversely affect substrate composition within silvery minnow critical habitat.***				
Water quality					
Temp >1° - <30°C DO > 5 mg/L pH (6.6–9.0)	Water temperature, DO, and pH within the MRG may be affected during low-flow conditions, especially in intermittent areas. ***Direct and Indirect – The Proposed Action is likely to adversely affect water quality due to increased low-flow periods.***				
Other Contaminants	Drain and irrigation return water has the potential to have poor water quality, but recent studies (Buhl 2011) found no biologically significant levels of contaminants in the tested wasteway water. The Proposed Action reduces the amount of water that is available to dilute contaminants that are introduced to the river from outside sources. This lack of dilution may have ***indirect effects but is not likely to adversely affect silvery minnow***.				

2.3.2 Effect of Proposed Water Management Actions on Flycatcher

The suitable habitat within the project area that would be affected by the Proposed Water Management Actions currently includes areas in the upper end of Cochiti Reservoir in the Otowi to Cochiti Dam Reach,from just south of Albuquerque to the Isleta Diversion Dam, Isleta Diversion Dam to Rio Puerco, and Rio Puerco to San Acacia Reaches, and from the BDA to RM 73 (just south of the BDA) in the Arroyo de las Cañas to San Antonio Bridge, San Antonio Bridge to RM 78 and RM 78 to RM 62 Reaches (reach boundaries are described in Part III). Areas that are not on the list likely will not reach suitability in at least the next 10 years based on vegetation trends in the last 10 years and/or the depth to groundwater is likely too deep to encourage new growth of native-dominated vegetation communities. An extensive effort beyond water operations would be required to establish flycatcher suitable habitat in those areas.

Above Cochiti Reservoir, other factors influence hydrology and flycatcher habitat, such as water coming in from tributaries, reservoir storage, and beaver activity that maintains ponded areas of water within the Cochiti Reservoir delta. Into the future, flycatcher habitat in this area is predicted to remain well within the 50-meter distance to water and have saturated soils associated with flycatcher preference to establish territories and conditions suitable for vegetation health and recruitment. This prediction is based on historical flows observed at the Otowi Bridge gage over the last 10 years.

The area from the confluence of the Rio Grande and the Rio Chama to Otowi Bridge is proposed critical habitat for flycatchers; however, that area would not be affected by the Proposed Action because MRGCD's water diversions do not take place this far north. Additionally, due to the 1,800-cfs channel capacity on the Rio Chama below Abiquiu Reservoir, flows from the Chama alone would make little impact on the occurrence of recruitment or overbank flows in the MRG.

Overbank flooding events tend to attract flycatchers and lead to territory establishment. These events also contribute to vegetation health, seedling establishment, and insect prey base abundance. The methodology described in the following paragraphs was used in an effort to determine the relative change in the potential for overbank flooding due to the decrease in high-flow periods from the Proposed Water Management Actions.

The one-dimensional modeling from the River Maintenance, Most Likely Strategies and Methods by Reach Attachment uses the a value of 4,700 cfs as an indicator for predicting overbank flows. The 2-year return rate of 4,700 cfs was modeled to predict the frequency of when an overbank flooding event would occur. For example, a value is over 1 signifies a higher frequency of overbank flows at lower discharge than 4,700 cfs. Values under 1 signify lower frequency of overbank flows. This modeling effort does not include overbank flows on islands; therefore, it is likely an overestimate of the flows required to inundate those areas. Table II-9 describes the modeling value for overbank flows in each reach related to a discharge of 4,700 cfs.

Table II-9. Modeled predictions of overbank flooding at 2-year return rate of 4,700 cfs

Reach	Inundation Value
Angostura Diversion Dam to Isleta Diversion Dam	0.76
Isleta Diversion Dam to Rio Puerco	0.70
Rio Puerco to San Acacia Diversion Dam	0.53
Arroyo del las Cañas to San Antonio Bridge	1.74
San Antonio Bridge to RM 78	3.36
RM 78 to RM 62	0.53

Overbank discharge values were less than 1 in most reaches, signifying that more than 4,700 cfs would be needed for overbank flows with the exception of areas in the BDA. Because the Arroyo del las Cañas to San Antonio Bridge and San Antonio Bridge to RM 78 Reaches had overbank discharge values over 1, flows less than 4,700 cfs would trigger an overbank flooding event. A recent Colorado State University study determined actual overbank flows occur at a discharge of 1,400 cfs for that reach.

Hydraulic modeling indicates a small change in the overbank flooding potential in all reaches due to the Proposed Water Management Actions (Figures II-6, II-7, and II-8) with no Supplemental Water sequence and during the early irrigation season that covers the period of flycatcher territory establishment. There would be a difference of 1–3 days of overbank flows in all reaches from Albuquerque to RM 62 with the exception of the area from Arroyo del las Cañas to RM 78 when comparing the Proposed Water Management Actions to No Action (Table II-10). This difference is likely inconsequential for flycatcher, considering that these areas often require more than the 4,700 cfs for flooding, and areas that flycatchers occupy are typically along the rivers' edge and within the 50-meter distance to water where 94% of flycatcher nests are located.

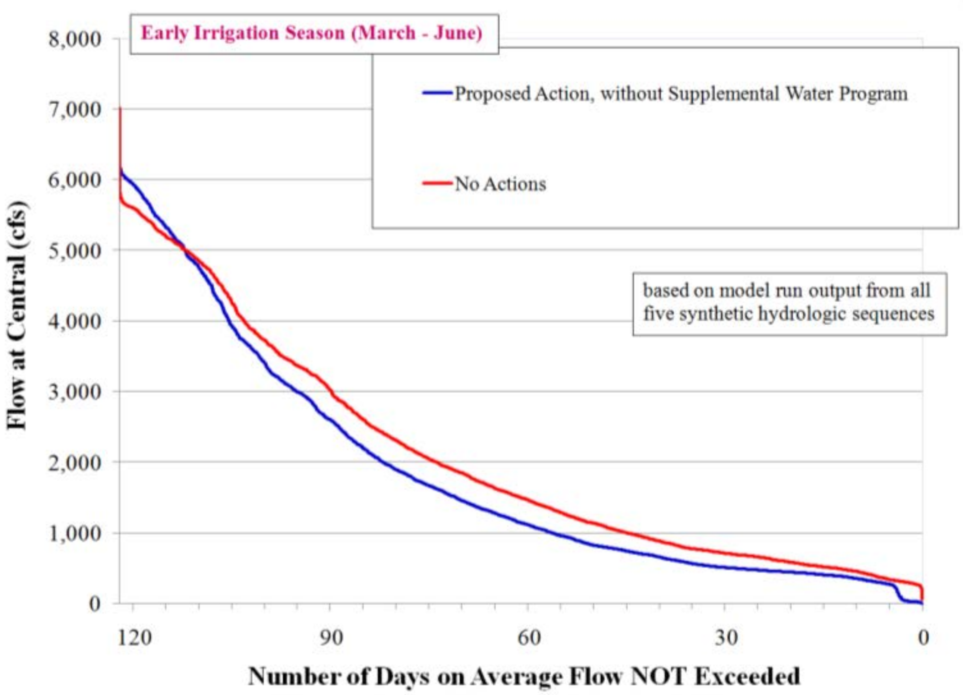

Figure II-6. Relative comparison of modeled flows at Central gage considered Proposed Action with no Supplemental Water Program compared to No Action during the flycatcher territory establishment period

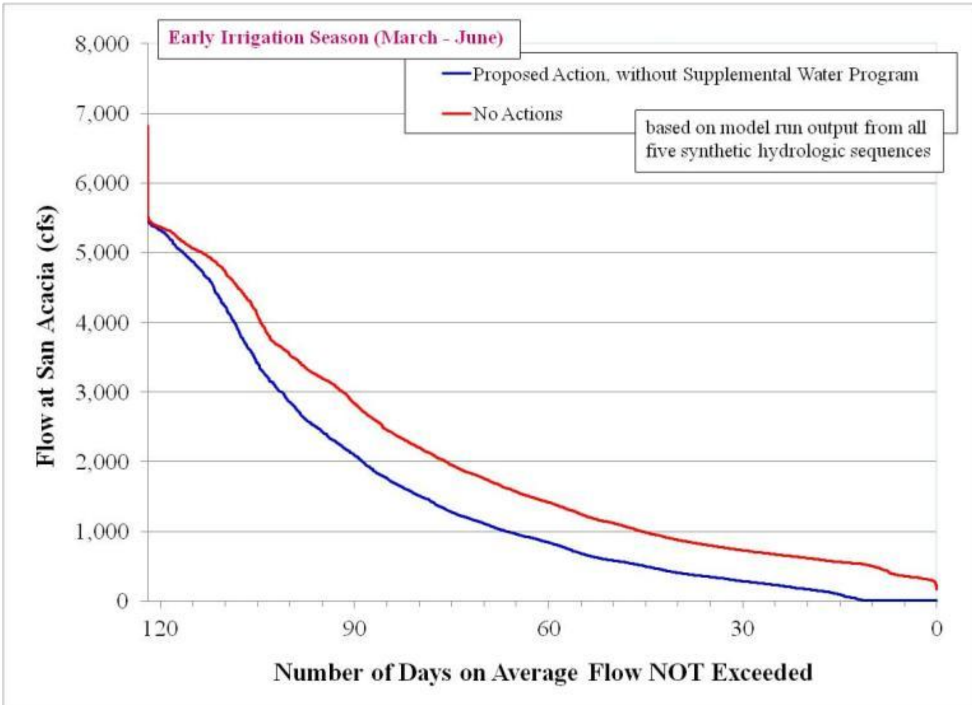

Figure II-7. Relative comparison of modeled flows at San Acacia gage considered Proposed Action with no Supplemental Water Program compared to No Action during the flycatcher territory establishment period

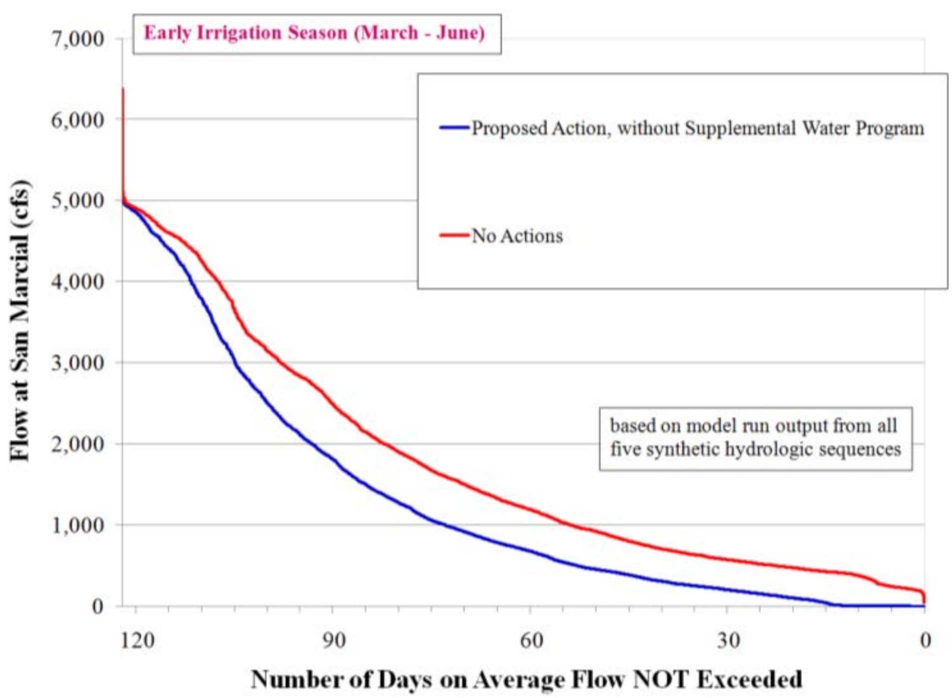

Figure II-8. Relative comparison of modeled flows at San Marcial gage considered Proposed Action with no Supplemental Water Program compared to No Action during the flycatcher territory establishment period

Table II-10. Effects of the Proposed Water Management Action compared to No Action and the difference in potential days of overbank flooding events during early irrigation season and flycatcher territory establishment. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the Time Flows reach 4,700 cfs with Proposed Action	Number of Days Flows Reach 4,700 cfs with Proposed Action	Percent of the Time Flows Reach 4,700 cfs with No Action	Number of Days Flows reach 4,700 cfs with No Action
Central	10.20%	12	11.30%	14
San Acacia	7.10%	9	10.00%	12
San Marcial	3.10%	4	4.40%	5

Hydrologic modeling for the late irrigation season from July to October indicates a small decrease in water but relatively minor differences between the No Action versus Proposed Water Management Actions scenarios (Table II-11).

Table II-11. Effects of the Proposed Water Management Action compared to No Action and the difference in potential days of overbank flooding events during late irrigation season and flycatcher nesting period. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the Time Flows Reach 4,700 cfs with Proposed Action	Number of Days Flows Reach 4,700 cfs with Proposed Action	Percent of the Time Flows Reach 4,700 cfs with No Action	Number of Days Flows Reach 4,700 cfs with No Action
Central	1.8%	2	2.2%	3
San Acacia	1.8%	2	2.4%	3
San Marcial	1.7%	2	2.3%	3

For the Arroyo del las Cañas to RM 78 Reach, modeled flow at the San Acacia gage was analyzed with the Proposed Action at the 1,400 cfs required for inundation within the BDA area. According to calculations, this area would meet overbank flows 45.0% of the time in the No Action sequence and 36.3%, or 44 days, in the Proposed Action sequence (Table II-12). This 10-day difference would be more substantial when compared to the other reaches but territories within this area are found along the river and are typically within 50 m of water as long as the river is wet, which would be the majority of time in the March–June time period.

Table II-12. Effects of the Proposed Water Management Actions compared to No Action and the difference in potential days of overbank flooding events during early irrigation season and flycatcher territory establishment in the reaches from Arroyo del las Cañas to RM 78

Gage Location	Percent of the Time Flows Reach 1,400 cfs with Proposed Action	Number of Days Flows Reach 1,400 cfs with Proposed Action	Percent of the Time Flows Reach 1,400 cfs with No Action	Number of Days Flows Reach 1,400 cfs with No Action
San Acacia	36.30%	44	45.00%	55

The modeling results for the late irrigation season from July–October at the San Acacia gage indicate a 5-day difference in potential overbank flooding during that time period (Table II-13). If vegetation declines in value for flycatchers during this time period, their nests would be more visible and subject to predation due to decreased foliage cover. Table II-14 summarizes the effects of Heron and El Vado Dam operations and MRGCD diversions on flycatchers in the MRG.

Table II-13. Effects of the Proposed Water Management Actions compared to No Action and the difference in potential days of overbank flooding events during late irrigation season and flycatcher nesting period in the reaches from Arroyo del las Cañas to RM 78

Gage Location	Percent of the Time Flows Reach 1,400 cfs with Proposed Action	Number of Days Flows Reach 1,400 cfs with Proposed Action	Percent of the Time Flows Reach 1,400 cfs with No Action	Number of Days Flows Reach 1,400 cfs with No Action
San Acacia	6.2%	8	10.5%	13

Table II-14. Effect of Proposed Water Management Actions on life history elements and PCEs of flycatchers

Life History Element	Migration (April–June and July–September)	Arrival to Territories/ Territory Establishment/ Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April–September)	The Proposed Action would ***not likely adversely affect*** flycatcher stopover locations during migration because flycatchers will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect flycatcher habitat on a negligible level***. Because the Proposed Action, when compared to No Action, would ***decrease the potential of overbank flooding and decrease the overall water available for vegetation***, this could cause a decline in territory recruitment and canopy cover/plant health/seed establishment and ***could potentially adversely affect flycatcher habitat,*** particularly in periods of drought. However, it should be noted that the decrease in water between the two scenarios is a relatively small amount.	Territory recruitment at this stage is no longer an issue as flycatchers are more invested in their territories and less likely to abandon nests should conditions dry or decline in value. However, if vegetation does not have adequate water resources, canopy cover likely will decrease, and predation and/or parasitism likely would be more prevalent. Because the Proposed Action would result in less water in the system, there would be an increased possibility of vegetation not having adequate water to maintain health, and thus ***would adversely affect flycatcher habitat and potential nest success,*** again particularly in times of drought.
Critical Habitat PCES			
Riparian Vegetation	Riparian habitat in a dynamic successional environment to be used for nesting, foraging, migration, dispersal, and shelter. Dense tree or shrub vegetation in close proximity to open water or marsh areas. With a decrease in the water amount reaching flycatcher suitable habitat patches, the Proposed Action could ***potentially adversely affect flycatcher riparian vegetation***.		

Table II-14. Effect of Proposed Water Management Actions on life history elements and PCEs of flycatchers

Life History Element	Migration (April–June and July–September)	Arrival to Territories/ Territory Establishment/ Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. The minimal difference between the No Action and the Proposed Action ***may affect, but is not likely to adversely affect the insect prey populations***. It is also important to note that a dry river does not impact insect populations when ponded water and adjacent drains are present.		

2.3.3 Effect of Proposed Water Management Actions on Cuckoo

Although there is currently no model to determine cuckoo habitat suitability, based on historical detection locations, it is assumed that within the project area, the areas that would be affected by the Proposed Action include select large patches of habitat from the Isleta Diversion Dam to Rio Puerco Reach to the RM 78 to RM 62 Reach (reach boundaries are described in Part III).

The area just the north of the confluence of the Rio Grande and the Rio Chama is proposed critical habitat for cuckoos; however, that area would not be affected by the Proposed Action because MRGCD's water diversions do not take place this far north. Effects to the cuckoo from the State's Proposed Water Management Action are described in Section 2.5. Additionally, due to the 1,800-cfs channel capacity on the Rio Chama below Abiquiu Reservoir, flows from the Chama alone would make little impact on the occurrence of recruitment or overbank flows in the MRG.

Overbank flooding events tend to contribute to vegetation health, seedling establishment, and insect prey base abundance. The methodology described in Section 2.3.2, Effect of Proposed Action on Flycatcher, used to determine the relative change in the potential for overbank flooding due to the decrease in high-flow periods from the Proposed Water Management action, can also be used for cuckoos. Please refer to that section for additional details. Table II-15 summarizes the effect of the Proposed Action on life history elements and PCEs of cuckoos.

Table II-15. Effect of Proposed Water Management Actions on life history elements and PCEs of cuckoos

Life History Element	Migration (May–June and August–September)	Arrival to Territories/ Territory Establishment/ Nest Building (June)	Egg Laying/Incubation/ Nestling/Fledgling (July–August)
Breeding Season (June–August)	The Proposed Action would ***not likely adversely affect*** cuckoo stopover locations during migration because cuckoos will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect cuckoo habitat on a negligible level***. Because the Proposed Action, when compared to No Action, would ***decrease the potential of overbank flooding and decrease the overall water available for vegetation***, this could cause a decline in territory recruitment and canopy cover/plant health/seed establishment and ***could potentially adversely affect cuckoo habitat,*** particularly in periods of drought. However, it should be noted that the decrease in water between the two scenarios is a relatively small amount.	If vegetation does not have adequate water resources, canopy cover likely will decrease, and predation could be more prevalent. Because the Proposed Action would result in less water in the system, there would be an increased possibility of vegetation not having adequate water to maintain health, and therefore ***would adversely affect cuckoo habitat and potential nest success*,** again particularly in times of drought.
Critical Habitat PCES			
Riparian Woodlands	Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats. With a decrease in the water amount reaching cuckoo suitable habitat patches, the Proposed Action could ***potentially adversely affect riparian woodlands***.		
Adequate Prey Base	Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas. The insignificant difference between the No Action and the Proposed Action indicates that this action ***may affect, but is not likely to adversely affect the insect prey base,*** particularly because the cuckoo diet is so variable.		
Dynamic Riverine Processes	River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g. lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old. With a decrease in the water amount as well as the decrease in probability of overbank flooding reaching cuckoo habitat patches, the Proposed Action is ***likely to adversely affect dynamic riverine processes that help to sustain cuckoo habitat***.		

2.3.4 Effect of Proposed Water Management Actions on Jumping Mouse

The proposed critical habitat units for the jumping mouse in the MRG are based on recent and historical detections and are limited to the BDA and Isleta and Ohkay Owingeh Pueblos. The largest known population of the jumping mouse in the MRG occurs on the BDA along the Riverside Canal in approximately 10.12 acres of suitable habitat (Service 2014e). Historically, the jumping mouse was also found at Isleta and Ohkay Owingeh Pueblos, but the Isleta Pueblo location has not been surveyed since 1987, and no jumping mice were found during surveys in 2012 at Ohkay Owingeh Pueblo (Service 2014e). The Service currently considers the proposed critical habitat units at both Pueblos to be completely unoccupied and may ultimately be exempted from listing (Service 2014e). Although no habitat suitability model for the jumping mouse has been developed to date, Frey and Kopp (2014) evaluated vegetation data through a GIS process with limited field work, including identifying habitat polygons inferred as "suitable" for jumping mouse habitat. Because the vegetation GIS layers were not at the level required to reliably identify suitable mouse habitat and tended to overassign "suitable habitat," Reclamation will use the Frey and Kopp (2014) report as a guide for areas to investigate for suitable mouse habitat through field checks. While features of suitable habitat may exist in other areas within the MRG, these areas often lack sufficient patch size and habitat connectivity needed to allow for dispersal of individual mice to new areas (Service 2014c). These locations would likely be unoccupied and would be evaluated on a project and location specific basis by Reclamation.

Within the MRG, there is a decrease in the amount of water in the river influenced by diversions, which decreases the possibility of overbank flooding, and increases the potential for drying the river. This action also has the potential for affecting groundwater levels that would impact the health of native vegetation. Jumping mice in the MRG, however, are in habitats associated with irrigation canals and ditches rather than the river. Minimal fluctuations in surface water elevations typically occur in these irrigation canals and ditches as water delivery obligations make them more reliable and consistent than the river elevations, even in drought situations. Sudden high flows would only be localized events in response to monsoon events and not a result of water operations. The irrigation water supports the dense wetland and riparian habitat that the jumping mouse relies on for both cover from predators and a food resource to store enough energy to survive the hibernation period. Little is known about jumping mouse hibernacula other than they are found in drier, upland areas within or adjacent to the floodplain, and are possibly associated with the base of shrubs and trees. During times of drought, there may be less overbank flooding needed to maintain this upland and floodplain vegetation that is potentially utilized by jumping mice, but water in the drains and ditches is still available for seepage and to maintain groundwater levels.

Maintenance of the drains has been limited in recent years. In the past, Reclamation performed maintenance on portions of the drains that was largely funded by the State. The responsibility for O&M of the drains is currently under consideration. Effects of maintenance are discussed in Part III.

Reclamation's Water Management actions (operation of Heron and El Vado) mainly extend the supply of water available for diversion during irrigation season and the storage of water would have no effect on the jumping mouse in the MRG, with beneficial effects from release of stored water at El Vado (Table II-16). Water delivered through the MRGCD system to the BDA for their use in habitat management would be beneficial to preserve wetland and riparian habitat for jumping mice. BDA is responsible for management of all water passing through their system and their drains and ditches within the refuge boundary.

Table II-16. Effects of Proposed Water Management Actions on jumping mouse within the Middle Rio Grande, New Mexico

Action Category	Active Season (May – October)	Dormant Season (November – April)
Heron Releases – Release of non-native SJC Project water from Heron Reservoir	The release of SJC Project water provides water that would otherwise not be in the Rio Grande system. Minimal fluctuations in surface water elevations would typically occur in irrigation canals and ditches that jumping mice utilize as water delivery obligations make them more reliable and consistent than the river elevations, even in drought situations. ***Direct and Indirect Effects - No effect to the jumping mouse***	The release of SJC Project water would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain. ***Direct and Indirect Effects - No effect to the jumping mouse***
El Vado Reservoir Operations – Manage (store, release, administer) non-native SJC Project water, including MRGCD SJC storage and release in Abiquiu	The release of SJC Project water provides water that would otherwise not be in the Rio Grande system. Minimal fluctuations in surface water elevations would typically occur in irrigation canals and ditches that jumping mice utilize as water delivery obligations make them more reliable and consistent than the river elevations, even in drought situations. ***Direct and Indirect Effects - No effect to the jumping mouse***	The release of SJC Project water would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain ***Direct and Indirect Effects - No effect to the jumping mouse***
Relinquishment – Allocation of relinquishment credit for storage and release of relinquished water (primarily storage is in El Vado)	Allocation of New Mexico relinquished credit for irrigation, M&I and environmental uses is beneficial to the ecosystem because it provides more water to the system during low-flow periods. ***Direct and Indirect Effects - may affect, but is not likely to adversely affect the jumping mouse***	Allocation of New Mexico relinquished credit primarily occurs during summer and would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain. ***Direct and Indirect Effects - No effect to the jumping mouse***
El Vado Reservoir Operations – Store native water at the request of MRGCD or reserve water for P&P lands at request of BIA; store allocated relinquished water	The storage of native water at El Vado Reservoir does not change the water levels in the irrigation canals and ditches utilized by jumping mice. ***Direct and Indirect Effects - No effect to the jumping mouse***	The storage of native water at El Vado Reservoir does not change the water levels in the irrigation canals and ditches utilized by jumping mice. ***Direct and Indirect Effects - No effect to the jumping mouse***

Table II-16. Effects of Proposed Water Management Actions on jumping mouse within the Middle Rio Grande, New Mexico

Action Category	Active Season (May – October)	Dormant Season (November – April)
El Vado Reservoir Operations – Release native water from storage for Middle Rio Grande irrigation uses, or at the request of BIA, MRGCD, or the NMISC; release allocated relinquished credit water	River levels at BDA may be beneficially impacted by releases from storage at El Vado Reservoir. Releases may add water to the river, which may also benefit groundwater levels. However, jumping mice are found on the irrigation canals and ditches, which have minimal fluctuations in surface water elevations due to water delivery obligations. ***Direct and Indirect Effects - may affect, but is not likely to adversely affect the jumping mouse***	The release of native water from storage for the MRG for irrigation uses would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain. ***Direct and Indirect Effects - No effect to the jumping mouse***
Operate Diversions – Divert water, for delivery to and consumption by agricultural users, at Cochiti, Angostura, Isleta, San Acacia Dams	Diversions can affect river levels negatively but also beneficially affect drains, and any negative impact to habitat on BDA close to the river would be insignificant compared to the water provided in drains. Jumping mice are found on the BDA irrigation canals and ditches, which have minimal fluctuations in surface water elevations due to water delivery obligations. ***Direct and Indirect Effects - may affect, but is not likely to adversely affect the jumping mouse***	Diversions would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain. ***Direct and Indirect Effects - No effect to the jumping mouse***
Operate Drains and Wasteways – Collect and return water to river	Drains and wasteways returning water to the river provides water to users downstream, including the BDA for habitat management, potentially providing a beneficial effect to the jumping mouse. ***Direct and Indirect Effects - may affect, but is not likely to adversely affect the jumping mouse***	Drains and wasteways returning water to the river would not impact the jumping mouse during hibernation when it is found in drier, upland areas within or adjacent to the floodplain. ***Direct and Indirect Effects - No effect to the jumping mouse***
Administration of Surface water and Groundwater Supplies	The total hydrologic impacts are a reduction in river flows of 1.5 cfs, increasing to 7 cfs over 10 years, but this reduction is unlikely to cause fluctuations in canal and drain water levels due to water delivery obligations. Therefore, this proposed action would have no effect on the jumping mouse ***Direct and Indirect Effects - No effect to the jumping mouse***	Hydrologic impacts are very small on river water levels, so there would be little impact on upland and floodplain vegetation, and therefore no effect on the jumping mouse. ***Direct and Indirect Effects - No effect to the jumping mouse***

Table II-16. Effects of Proposed Water Management Actions on jumping mouse within the Middle Rio Grande, New Mexico

Action Category	Active Season (May – October)	Dormant Season (November – April)
Administration of Domestic, Municipal, Livestock and Temporary Uses	Hydrologic impacts are zero cfs, increasing to about 2.5 cfs at Albuquerque and 3.4 cfs at the headwaters of the Elephant Butte Reservoir after 10 years, but this reduction is unlikely to cause fluctuations in canal and drain water levels due to water delivery obligations. Therefore, this proposed action would have no effect on the jumping mouse. ***Direct and Indirect Effects - No effect to the jumping mouse***	Hydrologic impacts are very small on river water levels, so there would be little impact on upland and floodplain vegetation, and therefore no effect on the jumping mouse. ***Direct and Indirect Effects - No effect to the jumping mouse***
Proposed Critical Habitat PCEs		
1. Riparian Community	"Riparian communities along rivers and streams, springs and wetlands, or canals and ditches characterized by one of two wetland community types: persistent emergent herbaceous wetlands dominated by beaked sedge (*Carex rostrate*) or reed canarygrass (*Phalaris arundinacea*) alliances; or scrub-shrub riparian areas that are dominated by willows (*Salix* spp.) or alders (*Alnus* spp.)." The Proposed Action ***may affect, but is not likely to adversely affect*** the riparian community utilized by jumping mice. With a decrease in available water to the river, riparian conditions may be compromised, leading to a decline in vegetation diversity and altering the wetland community type. However, the water delivery to the MRG proposed critical habitat units on Isleta and Okhay Owingeh Pueblos, and BDA would have a beneficial effect on the riparian community PCE in these areas because this habitat is located along the drain and not the river.	
2. Vegetation Structure and Composition	"Flowing water that provides saturated soils throughout the jumping mouse's active season that supports tall (average stubble height of herbaceous vegetation of at least 69 cm (27 inches), and dense herbaceous riparian vegetation (cover averaging at least 61 vertical cm (24 inches) composed primarily of sedges (*Carex* spp. or *Schoenoplectus pungens*) and forbs, including, but not limited to one or more of the following associated species: spikerush (*Eleocharis macrostachya*), beaked sedge (*Carex rostrate*), reed canarygrass (*Phalaris arundinacea*), rushes (*Juncus* spp. and *Scirpus* spp.), and numerous species of grasses such as bluegrass (*Poa* spp.), slender wheatgrass (*Elymus trachycaulus*), brome (*Bromus* spp.), foxtail barley (*Hordeum jubatum*), or Japanese brome (*Bromus japonicas*), and forbs such as water hemlock (*Circuta douglasii*), field mint (*Mentha arvense*), asters (*Aster* spp.), or cutleaf coneflower (*Rudbeckia laciniata*)." The Proposed Action ***may affect, but is not likely to adversely affect*** the vegetation structure and composition of proposed critical jumping mouse habitat. Water availability in the irrigation canals and ditches is reliable and consistent for supporting the vegetation composition and structure PCE, even during periods of drought due to water delivery obligations. With a decrease in available water to the river, riparian conditions within may be compromised, leading to a decline in vegetation diversity and altering the wetland community type. However, proposed critical habitat units on Isleta and Okhay Owingeh Pueblos, and BDA are located along the drain and not the river and; therefore, the effect of the proposed water delivery through the drain return flows would be beneficial.	
3. Habitat Area (active season)	"Sufficient areas of 9 to 24 km (5.6 to 15 mi) along a stream, ditch, or canal that contain suitable or restorable habitat to support movements of individual New Mexico meadow jumping mice" The Proposed Action ***may affect, but is not likely to adversely*** *affect* the area of proposed critical jumping mouse habitat in the MRG utilized during the active season. This habitat is located on irrigation canals and ditches that typically maintain reliable and consistent water elevations that support existing habitat areas.	

Table II-16. Effects of Proposed Water Management Actions on jumping mouse within the Middle Rio Grande, New Mexico

Action Category	Active Season (May – October)	Dormant Season (November – April)
4. Habitat Area (hibernation)	"Include adjacent floodplain and upland areas extending approximately 100 m (330 ft) outward from the water's edge (as defined by the bankfull stage of streams)." The Proposed Action ***may affect, but is not likely to adversely affect*** the adjacent floodplain and upland areas of jumping mouse habitat utilized during hibernation as these areas are at higher elevations, dry, and not likely to be affected by the proposed water management actions.	

2.3.5 Effect of Proposed Water Management Actions on Pecos Sunflower

In the MRG, the Pecos sunflower is presently known to exist within the La Joya WMA of the NMDGF Ladd S. Gordon Waterfowl Complex. This is one of the largest populations of *H. paradoxus*, consisting of 100,000 to 1,000,000 plants. This unit is 854 acres (346 ha) in Socorro County, New Mexico. This population is located about 7 mi (11 km) south of Bernardo within Socorro County near the confluence of the Rio Grande and the Rio Puerco. The La Joya population is bounded to the west by I-25 and to the east by the Unit 7 Drain. The plants exist entirely within the managed area of the NMDGF wildlife area. Ponds, springs, and wetted soils are features within the La Joya Unit that strongly influence the presence and distribution of Pecos sunflower. Both groundwater and managed water create these wet features where Pecos sunflower is found. The interaction between these is complex and not well understood (NMDGF 2007). One or all three may be a source of water for the Pecos sunflower, possibly to varying degrees at different times of the year. Water is delivered to this area via the Unit 7 Drain and the La Joya drain which is part of the "former state drain system."

In recent years, the maintenance of the drains has been limited. In the past, Reclamation performed maintenance on portions of the drains that was largely funded by the State. Currently, the responsibility for O&M of the drains is under consideration. Effects of maintenance are discussed in the Part III. Reclamation's Water Management actions (operation of Heron and El Vado) mainly extend the supply of water available for diversion during irrigation season and have little or no effect on the Pecos sunflower in the Middle Rio Grande (Table II-17). Water delivered through the MRGCD system to manage the Ladd S. Gordon Waterfowl Complex for migratory waterfowl habitat is beneficial to preserve wetland habitat for *H. paradoxus*. Parts of the riverside drains also function as conveyance channels during the irrigation season, causing drain stage to be above the water table. Therefore, riverside drains either can lose or gain water from the aquifer system depending on the drain stage and drain bed altitude relative to the water table. The groundwater modeling by USGS (Bartolini and Cole 2002, McAda and Barroll 2002) indicate that groundwater elevation in the region near the sunflower population has been generally steady in recent history. There is no designated critical habitat for Pecos sunflower in the MRG.

Table II-17. Effects of Proposed Water Management Actions on Pecos sunflower within the Middle Rio Grande, New Mexico

Proposed Actions	Effect on Pecos Sunflower
General	**Direct and Indirect –** Flow from drains and return channels provide water to maintain wetland conditions suitable for Pecos sunflower, and is therefore beneficial to the species. ***The delivery of water is beneficial to Pecos sunflower.*** Actions that decrease the potential for overbank flooding in the area of the Rhodes population have an insignificant effect and ***may indirectly affect but are not likely to adversely affect Pecos sunflower***.
Reclamation's Proposed Actions	
Heron Dam and Reservoir	The sunflower population is supported from MRGCD drain and return water. The operation of Heron Dam and SJC Project water only provides roughly 7% of the total water diverted by MRGCD. Therefore, the difference in the hydrograph is insignificant and Heron Dam operations have an insignificant effect on the high flows that would be needed to inundate the Rhodes population. Direct and Indirect – ***Not likely to adversely affect Pecos sunflower*****.**
El Vado Dam and Reservoir	The sunflower population is supported from MRGCD drain and return water. Storage and release of water from El Vado does not have a significant impact on the amount of water available to the Pecos sunflower population. El Vado operations may decrease the potential for overbank flooding on an insignificant level; the effect on flows is only noticeable during years that main stem Rio Grande flows are low and overbank flows are not present anyway. Direct and Indirect – ***Not likely to adversely affect Pecos sunflower*****.**
Non-Federal Proposed Actions	
MRGCD Diversion Operations	
Operation of Diversion Dams and Returns	Direct and Indirect – Flow from drains and return channels provide water to maintain wetland conditions suitable for Pecos sunflower, and therefore is beneficial to the species. ***The delivery of water through MRGCD drains is beneficial to Pecos sunflower at La Joya SWA****.* MRGCD diversions decrease the water within the River and the frequency of overbank flows. This decrease in frequency is insignificant and ***may affect but is not likely to adversely affect Pecos sunflower*** within the floodplain of the Rio Grande.

Infestations of exotic plant species continue to destroy or degrade desert wetlands and riparian areas. High densities of saltcedar (*Tamarix* sp.), Russian olive (*Elaeagnus angustifolia*), and perennial pepperweed (*Lepidium latifolium*) can have adverse impacts to cienegas. Saltcedar and Russian olive trees transpire considerable amounts of water from shallow water tables, which could reduce water available for Pecos sunflower. These invasive species also create an overstory canopy that reduces light in the understory and further degrades Pecos sunflower habitat. Perennial pepperweed reduces species diversity in cienegas and space otherwise available for Pecos sunflowers. The Pecos sunflower habitat management plan identifies their strategy to control exotic plants within the wildlife area (NMDGF 2007).

The newly established Rhodes population is likely to be inundated only during high-flow conditions. The area did inundate during the winter of 2011 due to an ice dam forming in the area. However, streamflow levels in the winter are typically sufficient to prevent ice dams, and an unusual, extreme cold period in winter 2011 allowed the ice dam to form. There are no effects to the population during base flow conditions. The effects of water operations on the inundation of the population would be relative to those described in the flycatcher section for this reach. Frequent inundation is not necessary for this population as springs and groundwater maintain the wetland conditions and frequent inundation may possibly be detrimental, bringing in non-native species and affecting the salinity.

2.4 Action-by-Action Analysis of Effects

2.4.1 Approach to Action-by-Action Analysis

In the action-by-action portion of this hydrologic impacts analysis, effects of individual actions are parsed out from the overall effect of the Proposed Water Management Actions to identify the relative effect of each discrete action, to the extent practical. The effect of each action is evaluated by comparing a condition in which that action does not occur. The analyses presented in this section distinguish the relative impacts of the discrete actions, and therefore can contribute to developing and evaluating potential mitigative alternatives and additional Conservation Measures.

Reclamation's action-by-action analysis differentiates the effects of the following management actions:

- Reclamation's releases from Heron Reservoir at the request of project contractors, under the SJC Project.
- Storage of water in and release of water from El Vado Reservoir, by Reclamation and in coordination the MRGCD.
- MRGCD operations of the MRG diversion structures to provide flows to MRGCD irrigators, including the Six MRG Pueblos, and tail water to the BDA.

The simulations included in the action-by-action analysis are summarized in Table II-18. The second row in this table explains how the comparisons between runs are used to determine the impact of each discrete action. The runs are compared sequentially in a step down approach, from the full suite of actions on the right to the No Action condition on the left. The effects of Reclamation's Heron Dam operations under the SJC Project are simulated by comparing the Proposed Water Management Actions to a run that simulates only Reclamation's El Vado Dam operations and MRGCD diversions. The effects of El Vado Dam operations under the MRG Project are determined by comparing simulations of El Vado Dam operations and MRGCD diversions to a set of simulations of MRGCD diversions of the natural flow, but no El Vado Dam operations.

Table II-18. Summary of water operations included in each action-by-action model run

Across: Action-by-Action Model Runs Down: Modeled Operations	No Action	MRGCD Diversions Only	El Vado Dam Operations and MRGCD Diversions (No SJC Project Operations)	Proposed Water Management Actions	Proposed Water Management Actions and Reclamation's Supplemental Water Program
	Compare with next scenario to evaluate impact of MRGCD diversions; compare with 4th column to evaluate impact of all actions	Compare with next scenario to evaluate impact of El Vado Dam operations	Compare with Proposed Action to evaluate impact of Heron Dam operation	Compare with next scenario to evaluate impact of Reclamation's Supplemental Water Program	Offsetting Measure evaluation
Heron Dam Operations					
Reclamation leases					X
LFCC Pumping					X
SJC Project diversions				X	X
Heron waivers				X	X
MRGCD SJC Project storage at El Vado				X	X
ABCWUA storage at Abiquiu, diversions, and Letter Water delivery				X	X
SJC Combined-account storage at Abiquiu, and Letter Water delivery				X	X
Refilling of Cochiti Recreation Pool				X	X
Maintenance of target flows				X	X
El Vado Dam Operations					
Prior and paramount water storage at El Vado			X	X	X
Release of prior and paramount water according to daily demand schedule			X	X	X
Storage of unused allocation of Emergency Drought Water (MRGCD and Supplemental Water Program)			X	X	X
Rio Grande Storage at El Vado			X	X	X
Release Rio Grande water from El Vado for the MRGCD demand			X	X	X
El Vado reregulation for the channel capacity below El Vado			X	X	X

Table II-18. Summary of water operations included in each action-by-action model run

Across: Action-by-Action Model Runs Down: Modeled Operations	No Action	MRGCD Diversions Only	El Vado Dam Operations and MRGCD Diversions (No SJC Project Operations)	Proposed Water Management Actions	Proposed Water Management Actions and Reclamation's Supplemental Water Program
	Compare with next scenario to evaluate impact of MRGCD diversions; compare with 4th column to evaluate impact of all actions	Compare with next scenario to evaluate impact of El Vado Dam operations	Compare with Proposed Action to evaluate impact of Heron Dam operation	Compare with next scenario to evaluate impact of Reclamation's Supplemental Water Program	Offsetting Measure evaluation
MRGCD Diversions					
Diversions for MRGCD non-Indian irrigators		X	X	X	X
Diversions for Pueblos		X	X	X	X
Other Operations					
Cochiti Deviations (years 1 and 2)	X	X	X	X	X

Finally, the effects of the MRGCD diversions are determined by comparing the simulation of the MRGCD diversions only to a run that includes none of the federal or non-federal Proposed Actions. The effects of the Proposed Water- Management Actions, in total, are evaluated by comparing the Proposed Water- Management Actions simulation to the simulation of the "No Action" condition.

Figures II-9 through II-12 summarize the range of impacts of the discrete actions evaluated in this action-by-action analysis under low-flow conditions during the late irrigation season, the period most likely to have river intermittency and drying. As discussed above, in these graphs, the impacts of discrete actions are evaluated through comparing sequential steps in the stepped-down sequence of URGWOM simulations presented in Table II-18. The vertical axis on these plots depicts the difference in flow that results from the action being evaluated, in comparison to a situation in which that action is not performed. The gray boxes on these "box and whisker plots" show the middle 50% of impacts.

These plots show that, during low-flow conditions in the late irrigation season, Heron and El Vado Dam operations each provide a small, but occasionally significant, increase in flow. The impacts are largest at Central Avenue, and progressively smaller at Isleta, San Acacia, and San Marcial. MRGCD diversions decrease flows in times of low-flow conditions, which increases with distance downstream, due to the cumulative effects of diversions on river flows. The impact of the combined Proposed Water Management Actions, shown in the final box and whisker, represents the impact of the discrete actions combined. The combined Proposed Water Management Actions have a consistently negative impact on low flows.

At Central Avenue (Figure II-9), the positive impacts of Heron Dam operations on low flows during the late irrigation season are typically (the middle 50%) between 0 and 60 cfs, and the impacts of El Vado Dam operations are typically between 0 and 240 cfs. The downward impacts on flows of MRGCD diversions are typically between 200 and 300 cfs at Central Avenue, and the total impact of the Proposed Action typically ranges from 180–240 cfs.

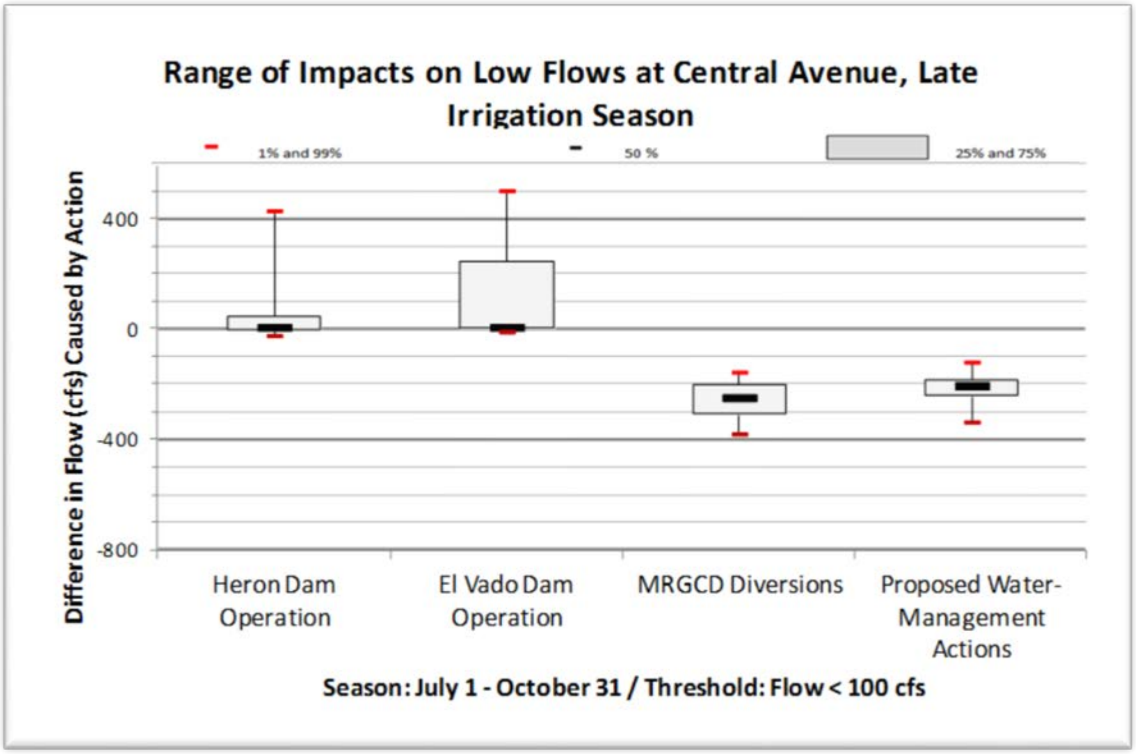

Figure II-9. Range of impacts for the step-down comparison of discrete actions on low flows at the Central Avenue Gage in Albuquerque during the post-runoff season

Downstream of Isleta Diversion (Figure II-10), model results show a smaller positive impact from Heron and El Vado Dam operations on low flows during the late irrigation season and a larger negative impact from MRGCD diversions, typically 380–520 cfs. Therefore, the combined effects of discrete actions, represented by the Proposed Water Management Actions, also cause a negative effect during low flows.

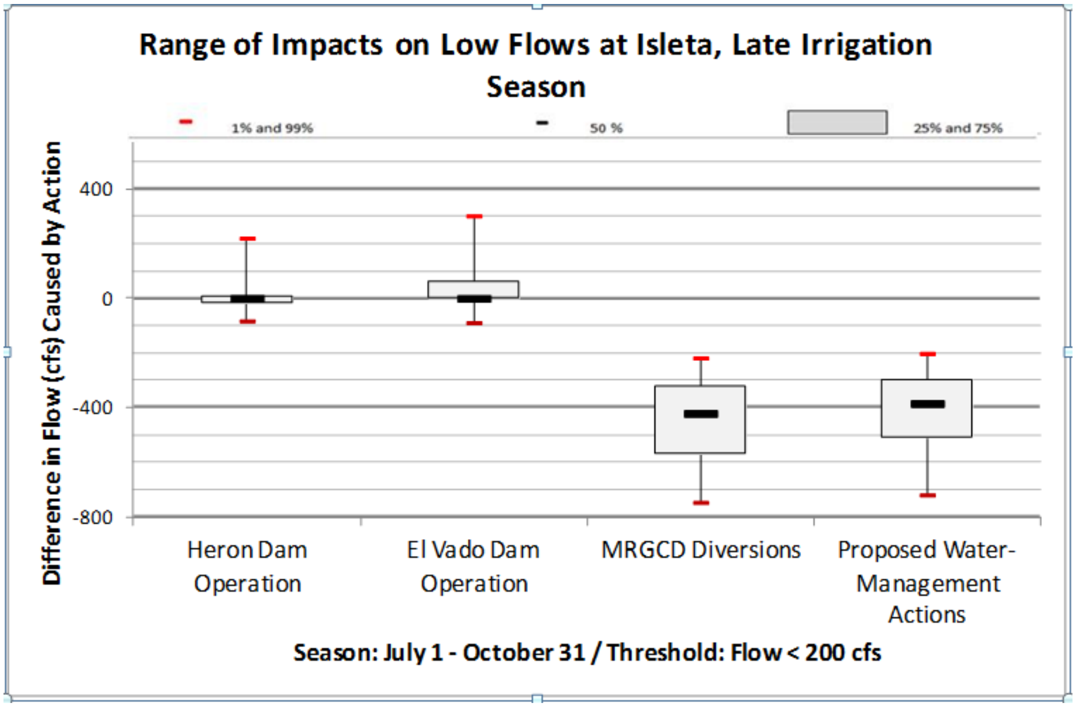

Figure II-10. Range of impacts for the step-down comparison of discrete actions on low flows downstream of the Isleta Diversion Dam during the post-runoff season

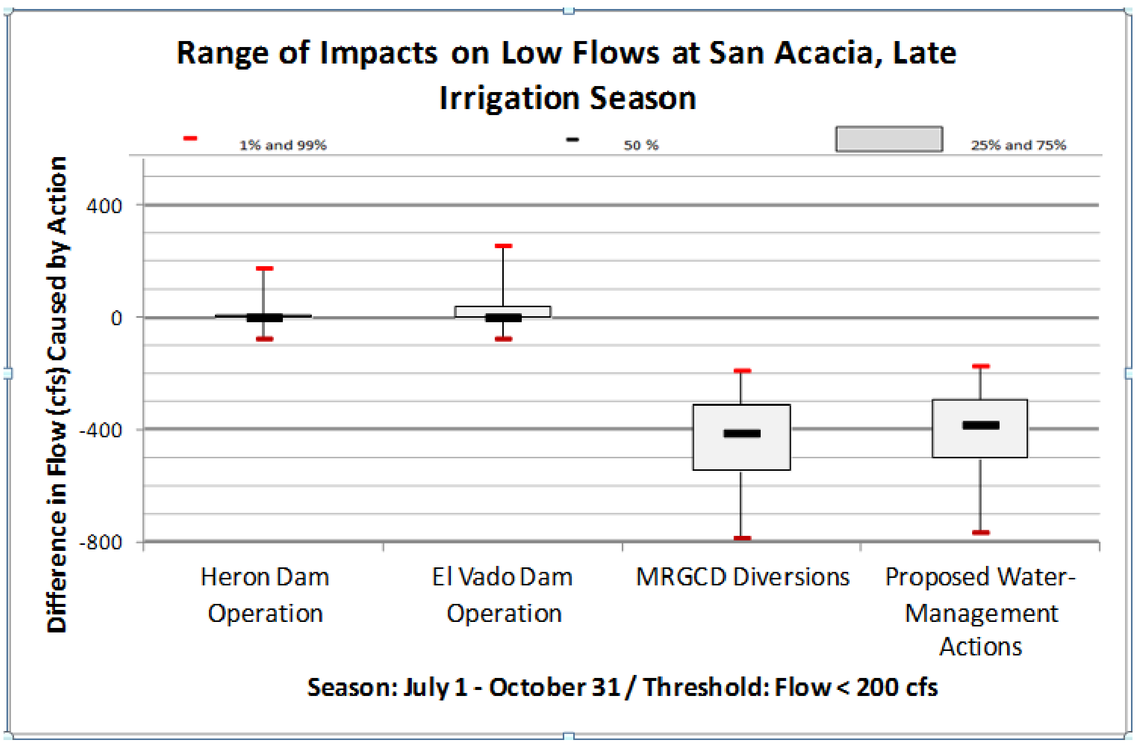

Figure II-11. Range of impacts for the step-down comparison of discrete actions on low flows downstream of the San Acacia Diversion Dam during the postrunoff season

Downstream of San Acacia Diversion (Figure II-11), this trend, in which the positive impact of Heron and El Vado Dams on flow is lessened, and the negative impact on flows of MRGCD diversions is increased due to the cumulative effect of upstream diversions, continues. However, the differences between the effects downstream of Isleta Diversion and those downstream of San Acacia Diversion are small because there is relatively little water diverted at San Acacia.

At San Marcial, which is downstream of the MRGCD and the BDA (Figure II-12), the positive impact on flows of Heron and El Vado Dam operations is very small. The negative impact of diversions is also decreased, due to return flows, especially from the BDA. At this location, the cumulative negative impact on low flows of the Proposed Water Management Actions is 200–400 cfs.

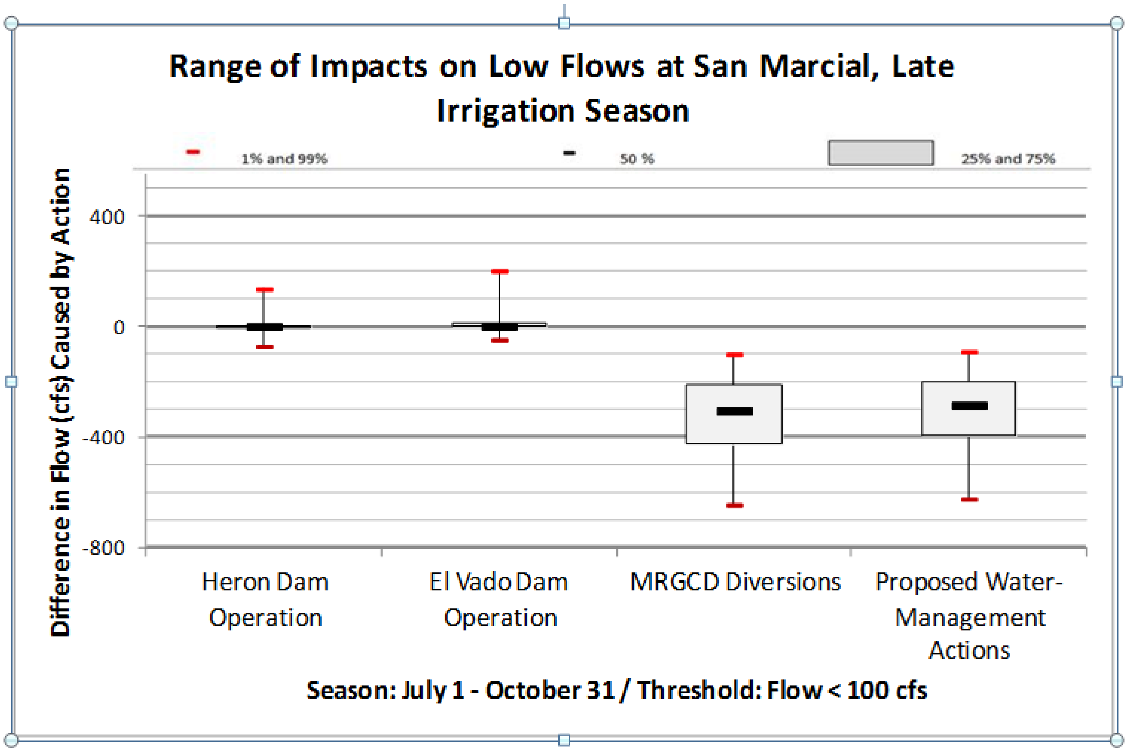

Figure II-12. Range of impacts for the step-down comparison of discrete actions on low flows at San Marcial during the postrunoff season

Table II-19 summarizes the average impacts of the discrete actions at the key locations presented in the plots. In this table, the impacts are depicted as positive (increasing flows in the low flow range) or negative (decreasing flows when flows are already low), and near zero (less than 20 cfs), minor (20 cfs to less than 50 cfs), or major (greater than 50 cfs). The patterns of impact are essentially the same as has been described for the "box and whisker" plots. However, the average impact of Supplemental Water on low flows downstream from Isleta has been characterized as "major" due to the influence of Supplemental Water released to comply with continuous flow requirements.

Table II-19. Qualitative assessment of average impact on low flows in the Middle Rio Grande

Location	Season	Supplemental Water	Heron Dam Operation	El Vado Dam Operation	MRGCD Diversions	Proposed Water-Management Actions	Threshold Flow (cfs)
Central Avenue Gauge	Early Irrigation	minor (+)	major (+)	major (+)	major (-)	major (-)	100
Downstream of Isleta Diversion Dam		major (+)	~0	~0	major (-)	major (-)	200
Downstram of San Acacia Diversion Dam		minor (+)	~0	~0	major (-)	major (-)	200
San Marcial Floodway Gauge		major (+)	~0	~0	major (-)	major (-)	100
Central Avenue Gauge	Late Irrigation	~0	major (+)	major (+)	major (-)	major (-)	100
Downstream of Isleta Diversion Dam		~0	~0	minor (+)	major (-)	major (-)	200
Downstram of San Acacia Diversion Dam		~0	~0	minor (+)	major (-)	major (-)	200
San Marcial Floodway Gauge		~0	~0	~0	major (-)	major (-)	100
	Legend	50	to	1000	major (+)		
		20	to	49.99	minor (+)		
		-19.99	to	19.99	~0		
		-49.99	to	-20	minor (-)		
		-1000	to	-50	major (-)		

Further details on the impacts of each of the discrete actions are provided in the following subsections.

2.4.2 Effects of Heron Dam Operations under the SJC Project

2.4.2.1 Approach to the Analysis of Reclamation's Actions under the SJC Project

URGWOM runs were used to evaluate Reclamation's Heron Dam operations under the SJC Project. In this analysis, Reclamation's Heron Dam operations include deliveries to all contractors, whether or not those contractors have completed ESA consultations for the delivery and use of their SJC Project water. Entities that have separate ESA consultations for their use of SJC Project water include the City of Santa Fe and Santa Fe County (for the Buckman Direct Diversion Project) and ABCWUA (for the Albuquerque Drinking Water Project).

Without Reclamation's release of SJC Project water from Heron Reservoir, the MRGCD would not have access to its annual allocations of SJC Project water, and the ABCWUA would not have supplies for its drinking-water diversion project. Also, no deliveries would be made to offset evaporative losses from the Cochiti Recreation Pool, and there would be no "Letter Water" deliveries to offset impacts of groundwater pumping on MRGCD irrigators and the Compact.

As shown later in this discussion and described above, the effects of Reclamation's Heron Dam operations are evaluated by comparing a simulation of the Proposed Water Management Actions to a simulation of when the only aspects of the Proposed Water Management Actions that are included are El Vado Dam operations and MRGCD diversions (i.e., Heron Dam operations are turned off). The simulations when Heron Dam operations are turned off specify no importation of water from the San Juan Basin, no new allocations of SJC Project water to contractors, and no releases of SJC Project Water at Heron Dam.

Note that under the initial conditions for these model runs, some SJC Project water is already in storage by the MRGCD, the ABCWUA, and other contractors at El Vado and Abiquiu Reservoirs. For the analysis, these stored waters are used to meet standard demands, but no new SJC Project water is available once these supplies are depleted. All SJC Project water initially in Heron Reservoir is retained and gradually evaporates. In general, these runs do not include the Supplemental Water Program that is evaluated as an Offsetting Measure. Supplemental Water available under initial conditions is used as long as supply lasts, but no additional SJC Project water is made available for lease to the Supplemental Water Program.

2.4.2.2 Effects of Reclamation's Heron Dam Operations under the SJC Project

Reclamation's operations of Heron Dam under the SJC Project result in augmented flows below Cochiti Dam as a result of ABCWUA deliveries to its surface water diversion and MRGCD deliveries of its SJC Project water allocation to irrigators in the MRG. While increased flows are evident below Cochiti Dam and at Central Avenue, much of the additional flow is diverted at the ABCWUA diversion or at MRGCD diversions at Cochiti, Angostura, or Isleta.

Figure II-13 compares flows below Cochiti Dam and the Cochiti diversions with and without Reclamation's operations of Heron Dam. Both curves summarize hydrologic conditions compiled from all of the synthetic hydrologic sequences. This comparison indicates that Heron Dam operations increase flows during low-flow periods downstream from Cochiti Dam as a result of the additional supply for ABCWUA and MRGCD irrigators.

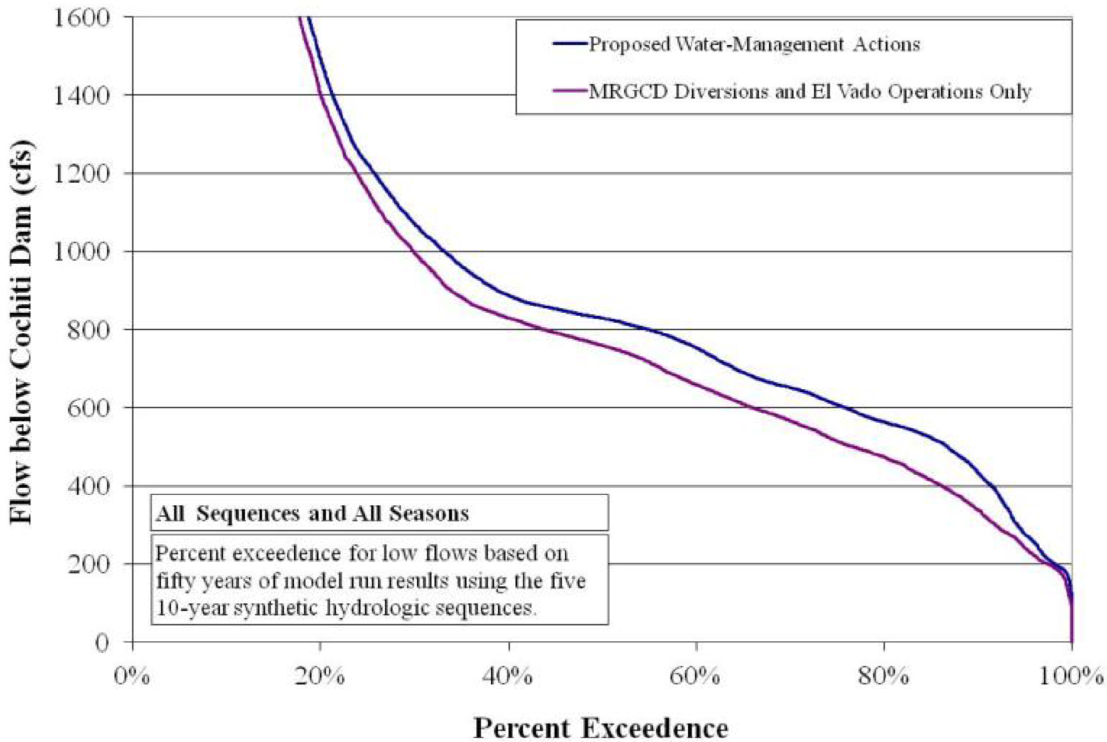

Figure II-13. Relative effect of the Heron Dam operations on flows downstream from Cochiti Dam and Diversion

Figure II-14 shows that the benefit of flow augmentation by SJC Project water is less pronounced at the Central Avenue gage, as this gage is located downstream from the ABCWUA's diversion for its drinking water project, and therefore does not get the benefit of flows of SJC Project water to that diversion. The benefit of Reclamation's Heron Dam operations at Central Avenue is due to the MRGCD's SJC Project water deliveries to Isleta diversion. This graph does not indicate a significant incidence of drying at the Central Avenue gage with or without Reclamation's Heron Dam operations.

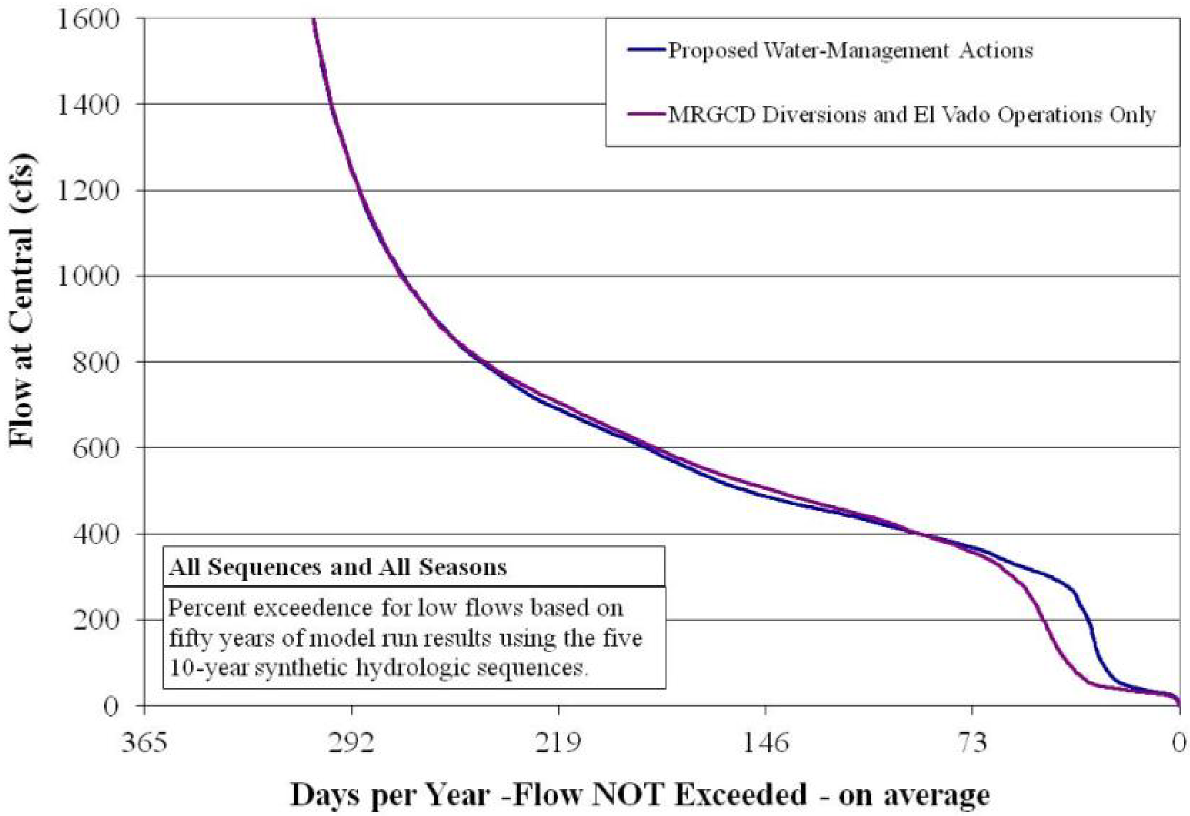

Figure II-14. Relative impact of the Heron Dam operations at the Central Avenue gage.

The positive impacts of SJC Project water are most apparent during dry conditions when the MRGCD has depleted its native supplies and is operating using SJC Project water. The MRGCD's use of SJC Project water, which constitutes an average of about 7% of its diversions (including Letter Water allocated to the MRGCD), helps to reduce the amount of time that the MRGCD is in shortage operations. Because there is a greater chance of critically low flows in the Albuquerque and Isleta Reaches during shortage operations, Reclamation's SJC Project operations help to maintain flows in these reaches during critical periods. Flow exceeds 300 cfs more frequently with Heron Dam operations than without. Hence, SJC Project releases increase flows at Central Avenue during times of shortage.

Other uses of SJC Project water, such as that by Santa Fe's Buckman Direct Diversion or the Cochiti Recreation Pool, are upstream of Cochiti Dam and do not affect flows in the MRG. Many contractors use their SJC Project water to provide an offset to MRGCD irrigators and the Compact for depletions caused by groundwater pumping, as administered by the Office of the State Engineer's Letter Water program. Letter Water deliveries to the MRGCD typically are stored in El Vado Reservoir and used to supplement MRG irrigation along with the remainder of the MRGCD's SJC Project allocation. Letter Water deliveries to the Compact typically are released in the winter. SJC Project releases are not of sufficient magnitude to significantly impact the size of the spring snowmelt runoff peak in the MRG.

Downstream from the Isleta Diversion Dam, there is essentially no difference in flows between simulations with and without Heron Dam operations, as Isleta Diversion Dam is the farthest-downstream point of diversion for any significant amount of SJC Project water.

2.4.2.3 Effect of Heron Dam Operation on Silvery Minnow

Prior to reaching the upstream boundary of silvery minnow critical habitat, there are three major dams (El Vado, Abiquiu, and Cochiti) downstream from Heron Dam. The importation of SJC Project water provides more water to meet MRG water demands. Model results indicate that SJC Project water delivered during low-flow periods of the irrigation season is detectable in the MRG until Isleta Diversion Dam and may help maintain continuous flow within the Angostura Reach. There are very few detectable geomorphic or water quality effects within silvery minnow critical habitat from the operation of Heron Dam. Table II-20 presents the effects of Heron Dam operation on the life history elements and critical habitat PCEs of silvery minnow.

Table II-20. Effect of Heron Dam operation on life history elements and PCEs of silvery minnow

<table>
<tr><th></th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (April–June)</td><td colspan="3">Timing of the Rio Chama peak spring runoff does not normally coincide with the Rio Grande peak. Channel capacity of the Rio Chama below Abiquiu is limited. The anticipated effect on the hydrograph within occupied habitat during spring runoff is minor. Direct and Indirect – Heron operations are not likely to adversely affect silvery minnow spawning or recruitment.</td><td></td><td>The anticipated effect on the hydrograph within occupied habitat during spring runoff is minor. Direct and Indirect – Heron operations are not likely to adversely affect adult silvery minnow.</td></tr>
<tr><td>Summer (June–Sept)</td><td></td><td></td><td colspan="3" rowspan="2">Heron Dam operations increase flows during low-flow periods below Cochiti Dam till Isleta Diversion Dam. Much of this water is utilized at the ABCWUA diversion. Model runs indicate that this water helps maintain perennial flow within the Angostura Reach. Direct and Indirect – Heron Dam operations are beneficial to silvery minnow during summer and fall periods.</td></tr>
<tr><td>Fall (Sept–Nov)</td><td></td><td></td></tr>
</table>

Table II-20. Effect of Heron Dam operation on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Winter (Dec–March)					Water releases for contractors generally occur in November and December. These releases provide higher flows through the MRG that are of sufficient magnitude and generally stable. **Direct and Indirect – *Operations are not likely to adversely affect winter survival of adult silvery minnow.***
Critical Habitat PCEs					
Hydrologic Regime					
A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.	***Direct and Indirect – Heron Dam operations are not likely to adversely affect*** the hydrology and maintenance of silvery minnow habitats within the MRG. There may be some beneficial effects due to decreased chances of drying in the Angostura Reach.				
Presence of a diversity of habitats for all life history stages		There is ***not likely to be an adverse effect*** on geomorphology or silvery minnow habitats in the MRG from Heron Dam operations. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects.			
Sufficient flows from early spring (March) to early summer (June) to trigger spawning	Timing of the Rio Chama peak spring runoff does not normally coincide with the Rio Grande peak. Channel capacity of the Rio Chama below Abiquiu is limited. There is little effect on the hydrograph within occupied habitat during spring runoff. **Direct and Indirect – *Operations are not likely to adversely affect silvery minnow critical habitat for spawning.***				

Table II-20. Effect of Heron Dam operation on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow	Heron Dam operations increase flows during low-flow periods below Cochiti Dam. Much of this water is utilized at the ABCWUA diversion. Model runs indicate that this water helps maintain perennial flow within the Albuquerque Reach. Thus, **Direct and Indirect– *Heron Dam operations are beneficial to silvery minnow critical habitat during summer and fall periods*.**				
Constant winter flow				Water releases for contractors generally occur in November and December. These releases provide higher flows through the MRG that are of sufficient magnitude and generally stable. **Direct and Indirect – *Heron operations are not likely to adversely affect winter critical habitat.***	
Unimpounded stretches of river with a diversity of habitats and low-velocity refuge areas					
River reach length	The actual length of wetted river within each reach changes depending on channel sinuosity. Low-flow conditions are supplemented by the operation of Heron Dam. Sinuosity changes depending on geomorphology and discharge levels. Sinuosity of the thalweg may increase during low flows and increases the length of the river but also may promote vegetation growth on point bars within the river channel. The operation of Heron Dam ***is not likely to adversely affect river reach length.***				
Habitat "quality" in each reach and refugial habitats.	There is ***not likely to be an adverse effect*** on geomorphology or silvery minnow habitats in the MRG from Heron Dam operations. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects.				
Substrate of sand or silt					
Substrates of predominantly sand or silt	Heron Dam is on Willow Creek, a small tributary of the Rio Chama. El Vado, Abiquiu, and Cochiti Dams capture sediment downstream prior to water entering critical habitat. There is ***no effect*** on sediment transport in the MRG from Heron Dam operations.				
Water quality					
Temp >1° - <30°C DO > 5 mg/L pH (6.6–9.0)	Water temperature, DO, and pH within the reservoir are not likely to have any effect on these parameters within critical habitat. However, increased water availability in the MRG during low-flow periods is likely to maintain water quality within the described range. **Direct and Indirect – *Heron Dam operations are beneficial to silvery minnow critical habitat during summer and fall periods.***				
Other contaminants	All chemical parameters were well below levels of concern in Heron; however, there is a listing for mercury in fish tissue. It is unknown how contaminants in this reservoir affect water quality in critical habitat, but it is likely a minor factor. **Direct and Indirect – *Heron Dam operations are not likely to affect silvery minnow critical habitat.***				

Figures II-15 and II-16 show the stepped down effects of the various components of the Proposed Water Management Actions on two of the most important elements for silvery minnow recruitment, the magnitude and duration of spring high flows, and the timing of the onset of low-flow conditions. There is minor beneficial impact from Heron Dam operation on the magnitude and duration of high-flow events. There is also beneficial impact on the timing of the onset of low flows. The Supplemental Water Program, which is not considered in these graphs, helps manage the recession of runoff.

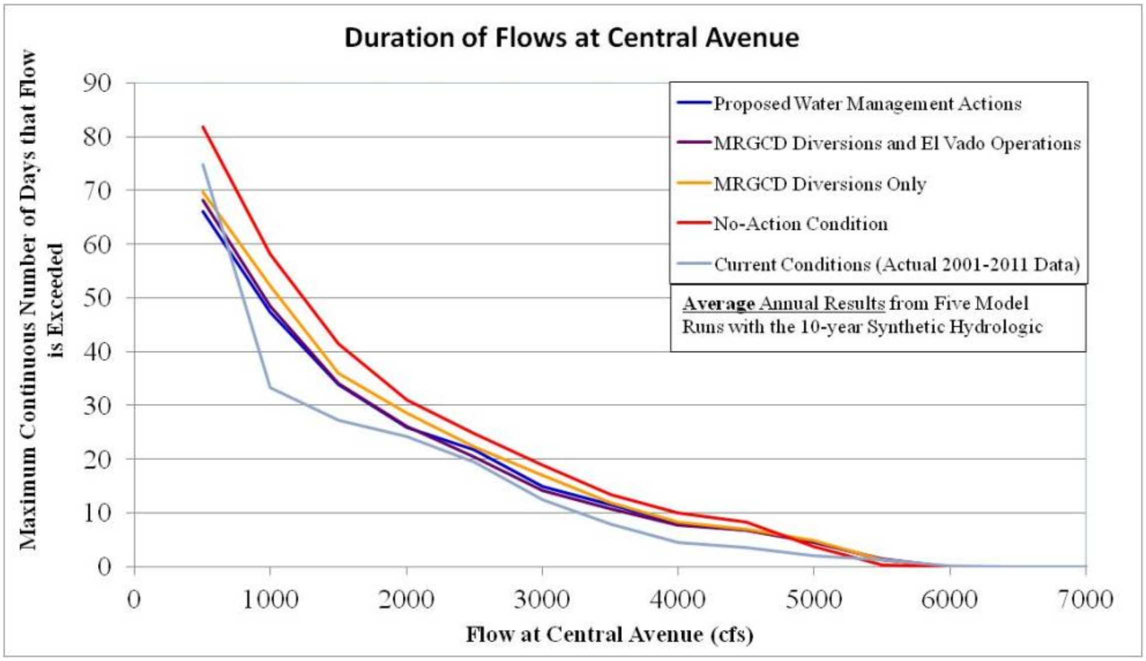

Figure II-15. Modeled average annual results of maximum number of continuous high-flow days from five model runs with the 10-year synthetic hydrologic sequences at San Acacia gage, Rio Grande, New Mexico

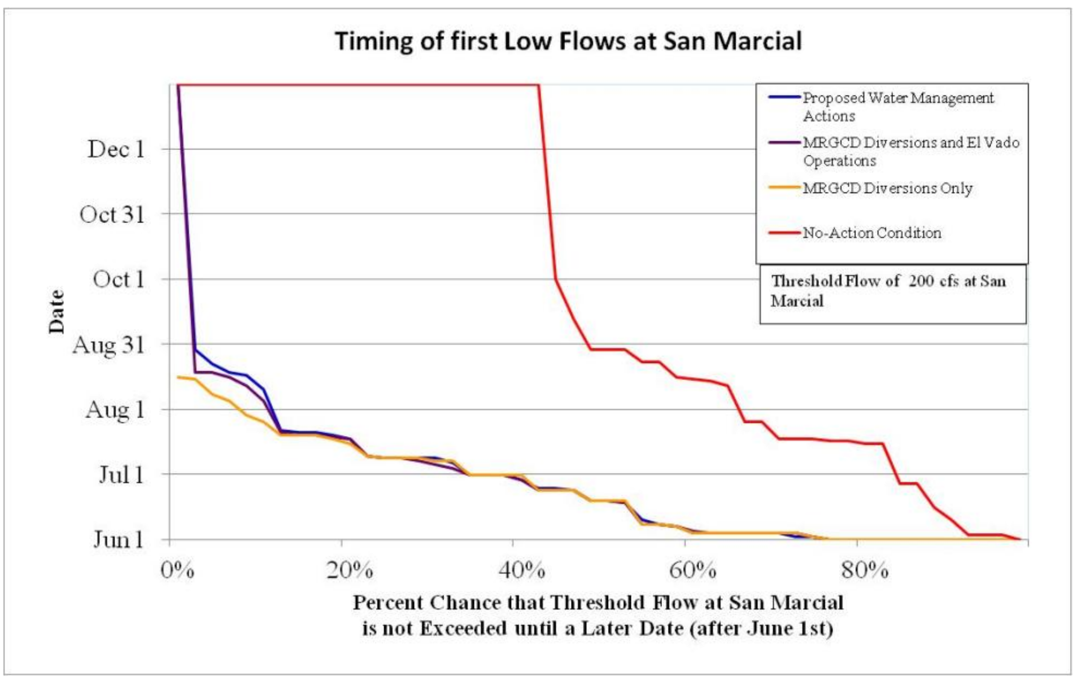

Figure II-16. Modeled average annual results of the relative percentage of time low flow (< 200 cfs) begins prior to June 1 at San Marcial gage, Rio Grande, New Mexico from five model runs with the 10-year synthetic hydrologic sequences

2.4.2.4 Effect of Heron Dam Operation on Flycatcher

The effect of Heron Dam operation on flycatchers is minimal, and results in an increased amount of water in the river at times of lowest flows which may help maintain and establish vegetation. However, Heron Dam operations essentially have no impact on overbank flow conditions that are essential for flycatcher recruitment. Figures II-17 and II-18 display those model results, comparing Central to San Marcial gages during the flycatcher territory establishment period. The result of minimal difference between actions is also evident in the late irrigation season.

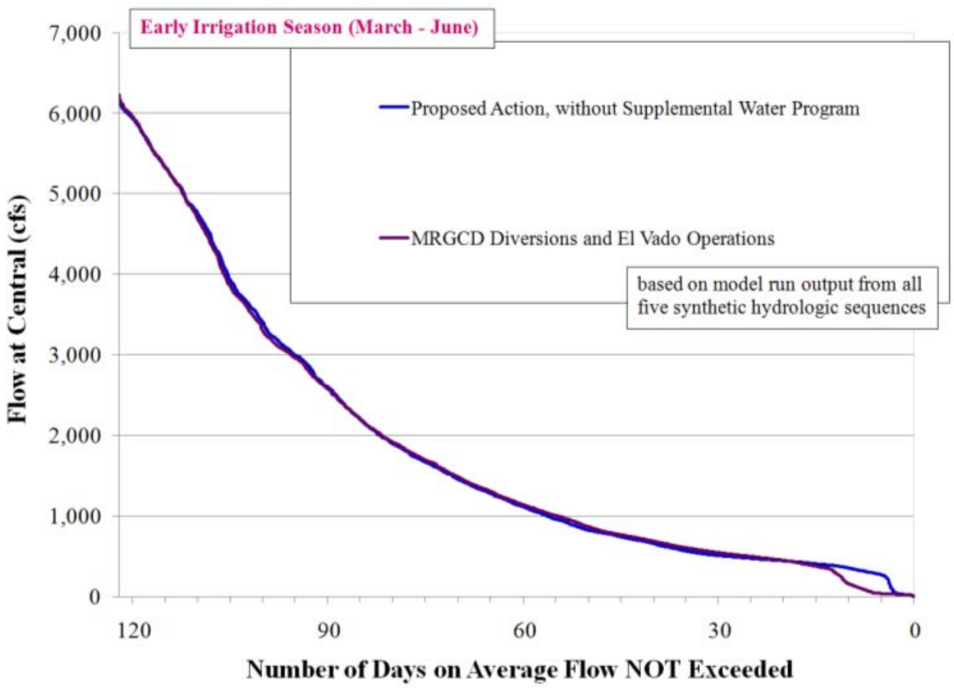

Figure II-17. Relative comparison of flows at Central gage considered Proposed Action with no Supplemental Water Program compared to MRGCD diversions and El Vado Operations during the flycatcher territory establishment period

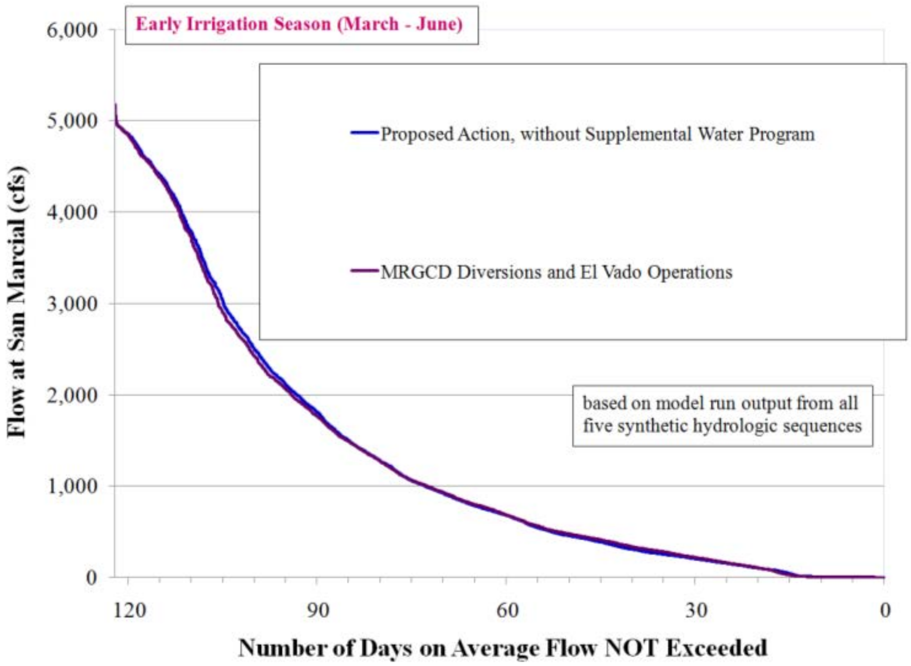

Figure II-18. Relative comparison of flows at San Marcial gage considered Proposed Action with no Supplemental Water Program compared to MRGCD diversions and El Vado operations during the flycatcher territory establishment period

It is also important to review information from the hydrological effects section. Due to the 1,800-cfs channel capacity on the Rio Chama below Abiquiu Reservoir and the normal release schedule from Heron Reservoir, Heron Dam operations for the SJC Project have essentially no impact on the occurrence of recruitment or overbank flows in the MRG.

There is a minimal difference in potential overbank flooding occurrence during early irrigation season due to the operation of Heron Dam (Table II-21). This difference is largely inconsequential, especially when considering that these areas often require even more than the 4,700 cfs for flooding, and that areas that flycatchers occupy are typically along the rivers' edge, and therefore within the 50-meter distance to water where 94% of flycatcher nests are located. For late irrigation season, from July–October, this comparison indicates no difference in the potential days of flooding (Table II-22).

Table II-21. Effect of Heron Dam operation on the potential days of overbank flooding events during early irrigation season and flycatcher territory establishment. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the Time Flows Reach 4,700 cfs with all Proposed Actions	Number of Days Flows Reach 4,700 cfs with all Proposed Actions	Percent of the Time Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD diversions	Number of Days Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD diversions
Central	10.20%	12	9.8%	12
San Acacia	7.10%	9	6.8%	8
San Marcial	3.10%	4	2.2%	3

Table II-22. Effect of Heron Dam operation on the potential days of overbank flooding events during late irrigation season and flycatcher nesting period. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the Time Flows Reach 4,700 cfs with all Proposed Actions	Number of Days Flows Reach 4,700 cfs with all Proposed Actions	Percent of the Time Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD diversions	Number of Days Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD diversions
Central	1.8%	2	1.7%	2
San Acacia	1.8%	2	1.7%	2
San Marcial	1.7%	2	1.7%	2

For the reach below San Acacia gage, modeling indicates that the Proposed Action would meet the 1,400 cfs required for inundation within the BDA area and would meet overbank flows 36.1% of the time in the MRGCD diversions and El Vado operations sequence and 36.3% in the Proposed Action sequence. There would be no difference in potential overbank flows by Heron Dam operations (Table II-23). For late irrigation season, from July–October, there is a very small increase in the probability of 1,400-cfs flows at the San Acacia gage due to the operation of Heron Dam. These results indicate minimal difference in potential overbank flooding during that time period (Table II-24). Flycatchers do not occupy the MRG during the winter; therefore, there is no direct effect on flycatchers from Heron Dam operations during this time. Table II-25 summarizes the effects of Heron Dam operations on flycatchers in the MRG.

Table II-23. Effect of Heron Dam operation on the potential days of overbank flooding events during early irrigation season and flycatcher territory establishment in the reaches from Arroyo del las Cañas to RM 78

Gage Location	Percent of the Time Flows Reach 1,400 cfs with all Proposed Actions	Number of days Flows Reach 1,400 cfs with all Proposed Actions	Percent of the Time Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD diversions	Number of days Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD diversions
San Acacia	36.30%	44	36.1%	44

Table II-24. Effect of Heron Dam operation on the potential days of overbank flooding events during late irrigation season and flycatcher nesting period in the reaches from Arroyo del las Cañas to RM 78

Gage Location	Percent of the Time Flows Reach 1,400 cfs with all Proposed Actions	Number of days Flows Reach 1,400 cfs with all Proposed Actions	Percent of the Time Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD diversions	Number of days Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD diversions
San Acacia	6.2%	8	5.8%	7

Table II-25. Effect of Heron Dam operations on life history elements and PCEs of flycatchers

Life History Element	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April to September)	The Proposed Action would **not likely adversely affect** flycatcher stopover locations during migration because flycatchers will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect flycatcher habitat on a negligible level***. Because the Proposed Action when compared to MRGCD Diversion and El Vado Dam Operation would ***increase flows in the river.*** At times of lower flows, it would ***minimally increase the overall water available for vegetation*** and could cause an increase in plant health. This ***could potentially and beneficially affect flycatcher habitat,*** particularly in periods of drought. This action would not affect the potential for overbank flows and likely would have no affect on territory recruitment. However, it should be noted that the increase in water between the two scenarios is a relatively small amount.	Territory recruitment at this stage is no longer an issue as flycatchers are more invested in their territories and less likely to abandon nests should conditions dry or decline in value. However, if vegetation does not have adequate water resources, canopy cover likely will decrease and predation and/or parasitism likely would be more prevalent. Because the Proposed Action would result in a little more water in the system, there would be an decreased possibility of vegetation not having adequate water to maintain health, and therefore ***would beneficially affect flycatcher habitat and potential nest success,*** again particularly in times of drought.

Table II-25. Effect of Heron Dam operations on life history elements and PCEs of flycatchers

Life History Element	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Critical Habitat PCES			
Riparian Vegetation	Riparian habitat in a dynamic successional environment to be used for nesting, foraging, migration, dispersal and shelter. Dense tree or shrub vegetation in close proximity to open water or marsh areas. With an increase in the water amount reaching flycatcher suitable habitat patches, the Proposed Action could ***potentially beneficially affect flycatcher riparian vegetation***.		
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. The minimal difference between the No Action and the Proposed Action ***would have no effect to the insect prey populations***. It is also important to note that a dry river does not impact insect populations when ponded water and adjacent drains are present.		

2.4.2.5 Effect of Heron Dam Operation on Cuckoo

The effect of Heron Dam operation on cuckoos is minimal, and results in an increased amount of water in the river at times of lowest flows that may help maintain and establish vegetation (Table II-26). However, Heron Dam operations essentially have no impact on overbank flow conditions that are essential for seed establishment and germination. The methodology described in Section 2.4.2.4, Effect of Heron Dam Operation on Flycatcher, used to determine the relative change in the potential for overbank flooding due to the decrease in high-flow periods from the Proposed Water Management action can also be used for cuckoos. Please refer to that section for additional details.

Table II-26. Effect of Heron Dam operations on life history elements and PCEs of cuckoos

Life History Element	Migration (May–June and August–September)	Arrival to Territories/Territory Establishment/Nest Building (June)	Egg Laying/Incubation/ Nestling/Fledgling (July–August)
Breeding Season (June to August)	The Proposed Action would **not likely adversely affect** cuckoo stopover locations during migration because cuckoos will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect cuckoo habitat on a negligible level***. Because the Proposed Action when compared to MRGCD Diversion and El Vado Dam Operation would ***increase flows in the river.*** At times of lower flows, it would ***minimally increase the overall water available for vegetation*** and could cause an increase in plant health. This ***could potentially and beneficially affect cuckoo habitat,*** particularly in periods of drought. This action would not affect the potential for overbank flows and likely would have no effect on territory recruitment. However, it should be noted that the increase in water between the two scenarios is a relatively small amount.	If vegetation does not have adequate water resources, canopy cover likely will decrease and predation likely would be more prevalent. Because the Proposed Action would result in a little more water in the system, there would be an decreased possibility of vegetation not having adequate water to maintain health, and therefore ***would beneficially affect cuckoo habitat and potential nest success,*** again particularly in times of drought.

Table II-26. Effect of Heron Dam operations on life history elements and PCEs of cuckoos

Life History Element	Migration (May–June and August–September)	Arrival to Territories/Territory Establishment/Nest Building (June)	Egg Laying/Incubation/ Nestling/Fledgling (July–August)
Critical Habitat PCES			
Riparian Woodlands	Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70%), and have a cooler, more humid environment than the surrounding riparian and upland habitats. With an increase in the water amount reaching cuckoo habitat patches, the Proposed Action could ***potentially beneficially affect riparian woodlands***.		
Adequate Prey Base	Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas. The insignificant difference between the No Action and the Proposed Action indicates that this action ***is not likely to adversely affect the insect prey populations***, particularly because the cuckoo diet is so variable.		
Dynamic Riverine Processes	River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g. lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old. Because there would be a minimal beneficial increase in the water amount, the Proposed Action ***is not likely to adversely affect dynamic riverine processes that sustain cuckoo habitat***.		

2.4.3 Analysis of Effects of El Vado Dam Operations under the Middle Rio Grande Project

2.4.3.1 Approach to Analysis of Effects of the Operation of El Vado Dam under the Middle Rio Grande Project

Impacts of El Vado Dam operations were evaluated comparing URGWOM simulations of the Proposed Water Management Actions of when Heron Dam operations are turned off to another set of URGWOM simulations of when both Heron Dam operations and El Vado Dam operations are turned off.

In the runs for which El Vado Dam operations are shut off, native inflows are not stored for use within the MRGCD. SJC Project water is not stored for use by MRGCD water rights holders when native Rio Grande flows drop below demand. MRGCD non-Indian irrigators would have available any native and SJC Project water present in El Vado Reservoir under initial conditions, but no additional native and SJC Project water would be stored beyond that required to meet prior and paramount water needs.

The following discussion covers effects of the following proposed actions:

- Reclamation's operation of El Vado Dam and Reservoir to store and release water, including response to requests by the MRGCD and BIA.
- BIA's requests for storage and releases of water from El Vado to meet the Pueblos' irrigation needs.
- MRGCD's requests for storage and release of water at El Vado to meet the irrigation needs of constituents

2.4.3.2 Effects of El Vado Dam Operations under the Middle Rio Grande Project

Operation of El Vado Dam and Reservoir involves storage of water from the Rio Chama during springtime peak flows, and calls for and use of that stored water in the MRG in times of low flow. The two types of operation have markedly different effects, but it must be clearly understood that they are inextricably linked. Releases cannot occur with storage, and vice versa. El Vado Dam storage operations therefore result in decreased peak flows on the Rio Chama and decreased in flows in the MRG associated with the Rio Chama runoff peak, which generally occurs prior to the main stem spring runoff peak. Conversely, release of stored water from El Vado results in an increase in flows on the Rio Chama and the MRG during low-flow periods, primarily in the summer/fall.

Figure II-19 compares flows at the Central Avenue gage for two sets of model simulations: one including El Vado Dam operations and one without these actions. The difference between the two curves on Figure II-19 indicates the effects on flows at Central Avenue of El Vado Dam operations. Storage at El Vado Reservoir results in a small (about 5-day-per-year) decrease in the number of days with flows above 800 cfs, but also causes a minor increase in the number of days per year that flows are above 100 cfs at Central Avenue.

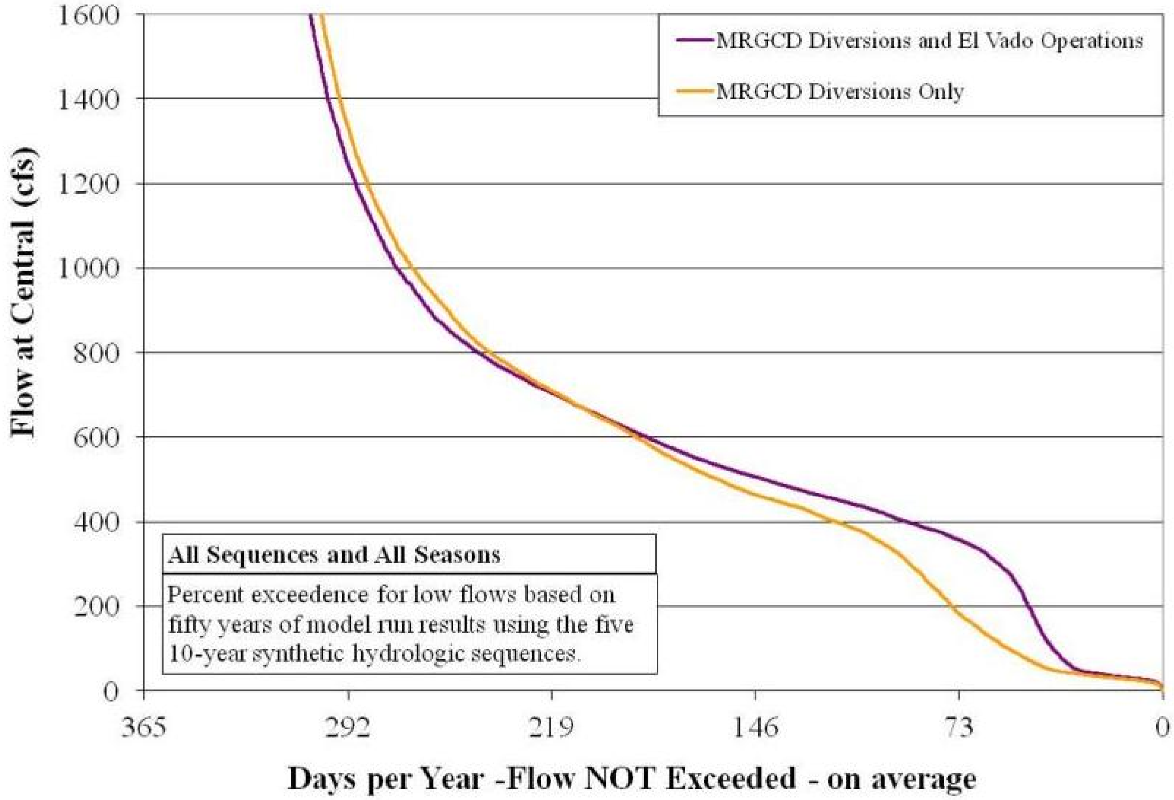

Figure II-19. Relative comparison of flows at Central Avenue gage with and without El Vado operations, for the calendar year

In most years, operation of El Vado Dam does not significantly affect the spring runoff peak in the Rio Grande, as these operations affect the flows on the Rio Chama, and the Rio Chama spring runoff peaks are typically earlier in time and smaller than those on the main stem Rio Grande. In the rare years in which the Rio Chama spring runoff peaks coincide with the main stem runoff peaks, El Vado Dam operations have a greater effect; however, the effects of the Rio Chama runoff are still limited due to the 1,800-cfs channel capacity on the Rio Chama below Abiquiu Reservoir. Therefore, El Vado Dam operations have a minimal impact on the peak spring discharges in the MRG.

Reclamation releases available water from storage in El Vado Reservoir at the request of the MRGCD to meet the MRG irrigation demand during periods when the natural flow is insufficient to meet these demands. This release of stored water reduces the occurrence of critically low flows and drying, especially in the Cochiti Dam and Albuquerque Reaches, and increases river flows during those periods. This effect may be evident even when Article VII restrictions under the Compact are in effect because, under Article VII restrictions, native water that was stored at El Vado Reservoir prior to the initiation of Article VII restrictions may still be released.

Model results indicate that river drying in the reaches downstream from Isleta Diversion Dam would occur with or without El Vado Dam operations. However, without El Vado Dam operations, river drying in the MRG would be more frequent and more prolonged, especially during times when the daily MRGCD irrigation demand cannot be met by the natural flow of the river. These effects are magnified in the lower reaches of the MRG. Without the release of stored water from El Vado Reservoir, model results indicate that the MRGCD would be in shortage operations, where MRGCD has no storage water to meet demand for some portion of almost every irrigation season. During shortage operations, diversions at Angostura typically are increased to allow the limited river flow to be used as efficiently as possible and ensure that water is delivered to the Six MRG Pueblos, and to non-Indian irrigators as well if sufficient water is available. Under shortage operations, river drying could be expected in the Albuquerque Reach as well as in the Isleta and San Acacia Reaches. Without El Vado Dam operations, river drying would be expected to increase below the Isleta Diversion Dam, as shown in Figure II-20.

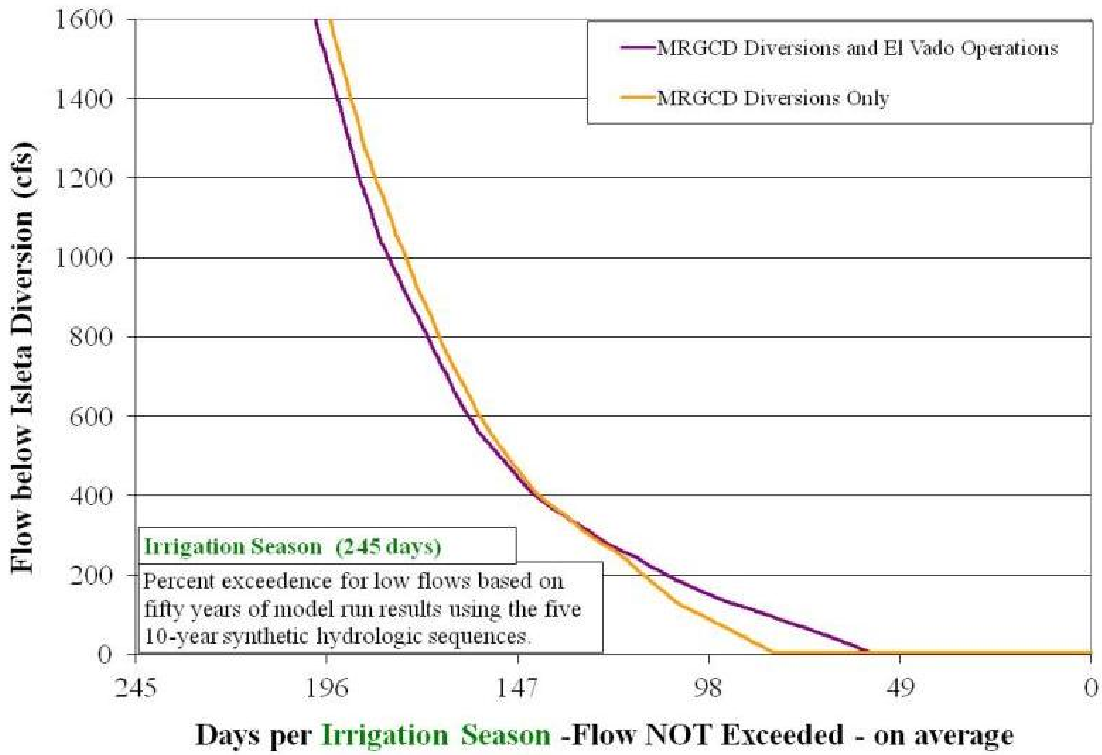

Figure II-20. Relative comparison of flows below Isleta Diversion during the irrigation season with and without El Vado operations

The effect on flows of Reclamation's El Vado Dam operations is less in the San Acacia Reach, downstream from the MRGCD's downstream-most diversion point from the Rio Grande. Still, due to return flows to the river and variations in demand, model simulations indicate that Reclamation's El Vado Dam operations decrease the duration of river drying below San Acacia Diversion, as indicated by the flow exceedance curves in Figure II-21.

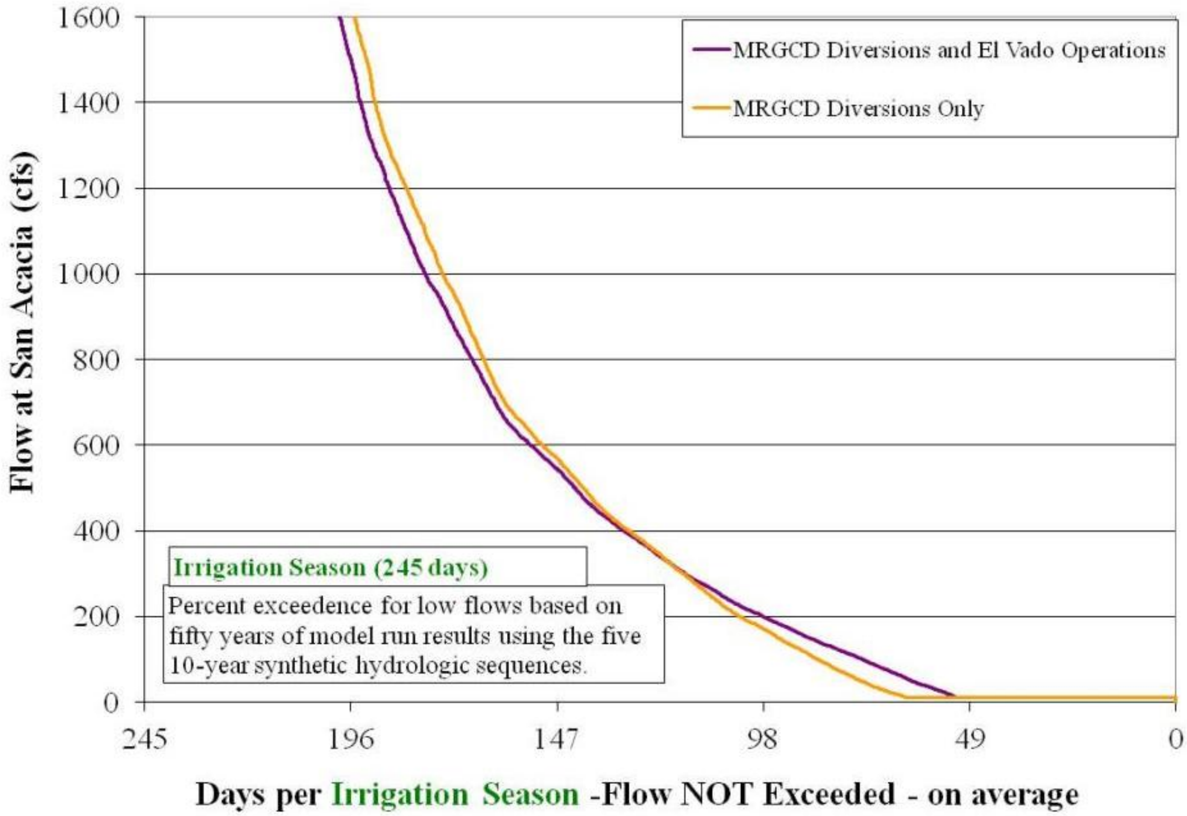

Figure II-21. Relative comparison of flows downstream from San Acacia Diversion during the irrigation season with and without El Vado operations

2.4.3.3 Effects of El Vado Dam Operations on Silvery Minnow

The modeled effects of El Vado Dam indicate that the storage of springtime peak flows from the Rio Chama causes a slight decrease in the duration and magnitude of spring flows within silvery minnow habitat. The decrease in duration is more noticeable when springtime discharge is low to moderate (less than 4,000 cfs at Central Gage). The modeled difference in the magnitude of discharge during runoff caused by El Vado storage is less than 200 cfs. This stored water is later released for irrigation purposes. The release of this water decreases the duration of drying that would be predicted without this management action below Isleta Dam and San Acacia Dam.

There are two major dams between El Vado Dam and the upstream boundary of silvery minnow critical habitat. Any effects to sediment transport caused by operation of El Vado are masked by Abiquiu and Cochiti Dams. Additionally, the effect of operations on other geomorphic trends within occupied habitat is minor due to the limited difference in high flows from operations. Similar to Heron, El Vado water quality surveys in 2007 determined that all physical and chemical parameters were well below levels of concern except for dissolved oxygen (DO). This report questioned the low DO readings and thought it might be due to equipment malfunction. Regardless, the low DO in El Vado is unlikely to have effects down into silvery minnow critical habitat.

El Vado has recently had positive microscopy test results for quagga mussels, though the presence has not been confirmed. The long-term indirect effects downstream from potential quagga mussel establishment in El Vado are difficult to predict for the MRG. Quagga mussels do not appear to be increasing to any extent in the Ohio and Mississippi Rivers, even after being present in these rivers for over a decade. In contrast, numbers in the Colorado River system have continued to increase since the quagga mussel was first reported (Nalepa 2008). It is predicted that high levels of suspended sediment and high inorganic:organic particle ratios may limit, or possibly prevent, mussel expansion in the main stem portions of the Colorado River (Kennedy 2007). However, changes in water quality (i.e., dissolved nutrients, phytoplankton, and zooplankton) in infested reservoirs may impact food web structure or trophic linkages in the downstream riverine ecosystem. A summary of the effects of El Vado Dam on silvery minnow is presented in Table II-27.

Table II-27. Effect of El Vado Dam operation on life history elements and PCEs of silvery minnow

<table>
<tr><th></th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (April–June)</td><td colspan="3">Timing of the Rio Chama peak spring runoff does not normally coincide with the Rio Grande peak. Due to existing channel restraints and the flood control operations authorized by law at El Vado, Abiquiu, and Cochiti Reservoirs, storage of RG water can have a maximum effect on flow through the MRG critical habitat area of less than 1800 cfs. Because of tributary inflows at points below reservoirs, the maximum effect is often lessened during the spring runoff peak. During most years, there is limited effect on the hydrograph magnitude, timing, and duration within occupied habitat during spring runoff, in part, due to the proportionally low volumes on the Rio Chama as compared to the mainstem Rio Grande. Though the impact on silvery minnow spawning and recruitment is anticipated to be minor, the Direct and Indirect effects of El Vado operations are likely to adversely affect silvery minnow spawning and recruitment.</td><td></td><td>There is little information on how spring flows are related to adult survival of silvery minnow. The small differences in the spring hydrograph from El Vado operations are not likely to (directly or indirectly) adversely affect adult silvery minnow.</td></tr>
<tr><td>Summer (June–Sept)</td><td></td><td></td><td colspan="3" rowspan="2">El Vado Dam releases increase flows during low-flow periods below Cochiti Dam to Isleta Diversion Dam. The majority of this water is diverted by MRGCD at their diversions. Model runs indicate that this water helps maintain perennial flow within the Albuquerque Reach and decreases drying in the Isleta Reach. Thus, Direct and Indirect – El Vado Dam operations are beneficial to silvery minnow during summer and fall periods.</td></tr>
<tr><td>Fall (Sept–Nov)</td><td></td><td></td></tr>
</table>

Table II-27. Effect of El Vado Dam operation on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Winter (Dec–March)					Water releases for contractors and Compact deliveries generally occur in November and December. These releases provide higher flows through the MRG, which are of sufficient magnitude and generally stable. **Direct and Indirect – *El Vado operations are not likely to adversely affect winter survival of adult silvery minnow.***
Critical Habitat PCES					
Hydrologic Regime					
A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.	***Direct and Indirect – El Vado Dam operations are not likely to adversely affect the hydrology and maintenance of silvery minnow habitats within the MRG.*** There may be some beneficial effects due to decreased chances of drying in the Angostura and Isleta Reaches during low-flow periods.				
Presence of a diversity of habitats for all life history stages		In most years, storage at El Vado has no effect or minor effects on PCEs of critical habitat in the spring. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects.			

Table II-27. Effect of El Vado Dam operation on life history elements and PCEs of silvery minnow

<table>
<tr><th></th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Sufficient flows from early spring (March) to early summer (June) to trigger spawning</td><td>Timing of the Rio Chama peak spring runoff does not normally coincide with the Rio Grande peak. Channel capacity of the Rio Chama below Abiquiu is limited. There is little effect on the hydrograph within occupied habitat during spring runoff. Direct and Indirect – El Vado operations are not likely to adversely affect silvery minnow critical habitat for spawning.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow</td><td colspan="5">El Vado Dam releases increase flows during low-flow periods below Cochiti Dam. The majority of this water is diverted by MRGCD at their diversions. Model runs indicate that this water helps maintain perennial flow within the Albuquerque Reach and decreases drying in the Isleta Reach. Direct and Indirect – El Vado Dam operations are beneficial to silvery minnow critical habitat during summer and fall periods.</td></tr>
<tr><td>Constant winter flow</td><td></td><td></td><td></td><td colspan="2">Water releases for contractors generally occur in November and December. These releases provide higher flows through the MRG that are of sufficient magnitude and generally stable. Direct and Indirect – El Vado operations are not likely to adversely affect winter critical habitat for silvery minnow.</td></tr>
<tr><td colspan="6">Unimpounded stretches of river with a diversity of habitats and low-velocity refuge areas</td></tr>
<tr><td>River reach length</td><td colspan="5">Currently, diversion dams are in place; no new cross channel structures are proposed. The actual length of wetted river within each reach changes depending on channel sinuosity. The sinuosity changes depending on geomorphology and discharge levels. Sinuosity of the thalweg may increase during low flows that increases the length of the river but also may promote vegetation growth on point bars within the river channel. The lack of flood stage flows also changes the potential that the river will move outside its current channel. The Proposed Action is not likely to adversely river reach length.</td></tr>
<tr><td>Habitat "quality" in each reach and refugial habitats.</td><td colspan="5">In most years, storage at El Vado has no effect or minor effects on PCEs of critical habitat in the spring. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects.</td></tr>
<tr><td colspan="6">Substrate of sand or silt</td></tr>
<tr><td>Substrates of predominantly sand or silt</td><td colspan="5">Abiquiu and Cochiti Dams capture sediment downstream from El Vado prior to delivered water reaching critical habitat. There is no effect on sediment transport in the MRG from El Vado Dam operations.</td></tr>
</table>

Table II-27. Effect of El Vado Dam operation on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Water quality					
Temp >1° - <30°C DO > 5 mg/L pH (6.6–9.0)	Water temperature, DO, and pH within El Vado Reservoir are not likely to have any effect on these parameters within critical habitat. However, increased water availability in the MRG during low-flow periods is likely to maintain water quality within the described range. **Direct and Indirect – *El Vado Dam operations are beneficial to silvery minnow critical habitat*** during summer and fall periods.				
Other contaminants	All chemical parameters were well below levels of concern in El Vado; however, recent quagga mussel tests indicate that mussels may be present. It is unknown how quagga mussels in this reservoir may affect water quality in Critical Habitat but establishment within the main stem seems unlikely. **Direct – *El Vado Dam operations are not likely to affect silvery minnow critical habitat.*** **Indirect – *El Vado Dam operations are not likely to affect silvery minnow critical habitat*** due to the unknown impacts from quagga mussels and unlikely establishment of mussels in the main stem.				

2.4.3.4 Effects of El Vado Dam Operation on Flycatcher

Model results indicate a very minor change when comparing El Vado Dam operations with MRGCD diversions compared with MRGCD diversions alone. The main difference is noticed during the late irrigation season and farther north where the El Vado Dam operations maintain a more water within the channel during low flows (Figure II-22) and may beneficially supply additional groundwater to support vegetation. Conversely, earlier in the season, by storing additional water in El Vado Reservoir when the river is experiencing higher flows, this action has a negative impact on the potential for overbank flows though El Vado operations alone have a very minimal impact on the occurrence of recruitment or overbank flows in the MRG.

Hydraulic modeling predicts on average that there is a minimal difference in potential for overbank flooding occurrence during early irrigation season for El Vado Dam operations. This difference is largely inconsequential, particularly when considering these areas often require even more than the 4,700 cfs for flooding, and areas that flycatchers occupy are typically along the rivers' edge, and therefore within the 50-meter distance to water where 94% of flycatcher nests are located (Table II-28). The same comparison for the late irrigation season from July–October using the MRGCD diversion and El Vado Dam operations sequence indicates no difference in the potential days of flooding (Table II-29).

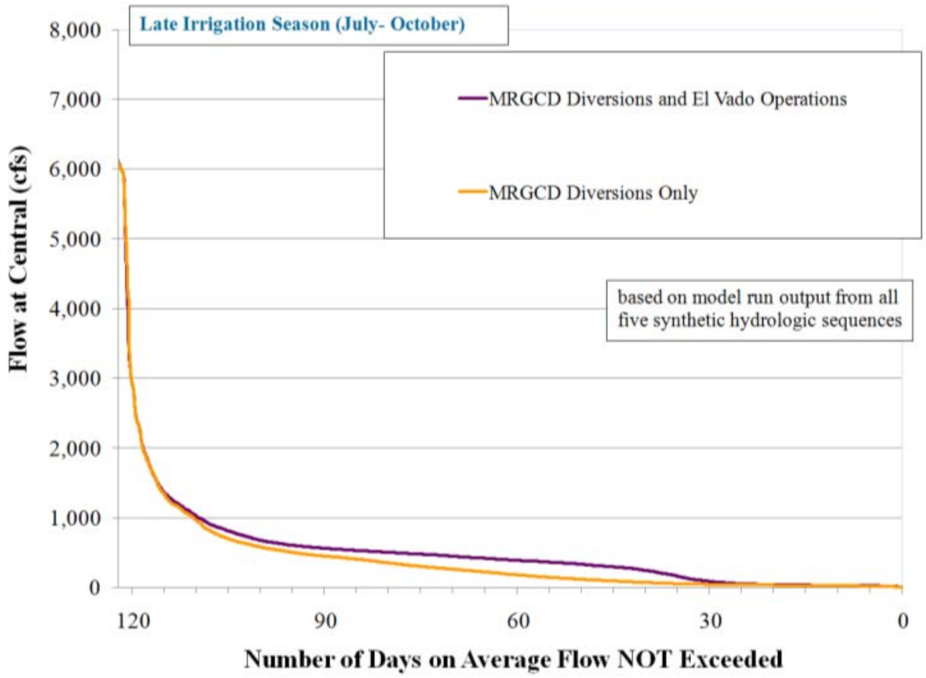

Figure II-22. Relative comparison of flows at Central Avenue gage with and without El Vado operations during the flycatcher breeding period.

Table II-28. Effect of El Vado Dam operation on the potential days of overbank flooding events during early irrigation season and flycatcher territory establishment. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the time Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD Diversions	Number of days Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD Diversions	Percent of the Time Flows Reach 4,700 cfs with MRGCD Diversions Only	Number of Days Flows Reach 4,700 cfs with MRGCD diversions Only
Central	9.8%	12	10.4%	13
San Acacia	6.8%	8	7.2%	9
San Marcial	2.2%	3	2.9%	4

Table II-29. Effect of El Vado Dam operation on the potential days of overbank flooding events during late irrigation season and flycatcher nesting period. This includes all reaches from Albuquerque to RM 62 with the exception of the reaches near the BDA.

Gage Location	Percent of the Time Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD Diversions	Number of days Flows Reach 4,700 cfs with only El Vado Dam Operation and MRGCD Diversions	Percent of the time Flows Reach 4,700 cfs with MRGCD Diversions Only	Number of Days Flows Reach 4,700 cfs with MRGCD diversions Only
Central	1.7%	2	1.8%	2
San Acacia	1.7%	2	1.7%	2
San Marcial	1.7%	2	1.7%	2

For the reach below the San Acacia gage, 1,400 cfs, required for inundation within the BDA area, would meet overbank flows 36.1% of the time with MRGCD diversions and El Vado operations sequence and 39.0% of the time with MRGCD diversions alone sequence (Table II-30). This 4-day difference would be more substantial than other reaches, but territories within this area are found along the river and are typically within 50 m of water as long as the river is wet, which would be the majority of time in the March–June time period.

Table II-30. Effect of El Vado Dam operation on the potential days of overbank flooding events during early irrigation season and flycatcher territory establishment in the reaches from Arroyo del las Cañas to RM 78

Gage Location	Percent of the Time Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD Diversions	Number of Days Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD Diversions	Percent of The Time Flows Reach 1,400 cfs with MRGCD diversions Only	Number of days Flows Reach 1,400 cfs with MRGCD diversions Only
San Acacia	36.10%	44	39.0%	48

From July–October at the San Acacia gage, flows would be approximately 1,400 cfs for 7 out of 123 days, or 5.8% of the time in the MRGCD diversions alone sequence, or 7 days and 5.8% of the time with MRGCD diversions and El Vado Dam operations. These results indicate no difference in potential overbank flooding during that time period (Table II-31).

Table II-31. Effect of El Vado Dam operation on the potential days of overbank flooding events during late irrigation season and flycatcher nesting period. This includes the reaches from Arroyo del las Cañas to RM 78.

Gage Location	Percent of the Time Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD Diversions	Number of Days Flows Reach 1,400 cfs with only El Vado Dam Operation and MRGCD Diversions	Percent of the Time Flows Reach 1,400 cfs with MRGCD Diversions Only	Number of Days Flows Reach 1,400 cfs with MRGCD Diversions Only
San Acacia	5.8%	7	5.8%	7

The effects of El Vado Dam on flycatchers are summarized in Table II-32.

Table II-32. Effect of El Vado Dam operations on life history elements and PCEs of flycatchers

	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April–September)	The Proposed Action would **not likely adversely affect** flycatcher stopover locations during migration because flycatchers will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect flycatcher habitat on a negligible level***. Because the El Vado Dam operation would decrease the potential of overbank flooding, but would increase the water available to vegetation at times of lower flows; overall, this would increase the potential for vegetation health, and ***could potentially beneficially affect flycatcher habitat,*** particularly in periods of drought. The benefit of maintaining the vegetative health outweighs the potential of initial territory recruitment via overbank flooding, particularly because most flycatcher habitat is along the river and within 50 meters of water anyway. However, it should be noted that the decrease in water between the two scenarios is an extremely small amount.	Territory recruitment at this stage is no longer an issue, as flycatchers are more invested in their territories and less likely to abandon nests should conditions dry or decline in value. However, if vegetation does not have adequate water resources, canopy cover will likely decrease and predation and/or parasitism would likely be more prevalent. Because the Proposed Action would result in a little more water in the system at times of low flows and increased plant stress, there would be an decreased possibility of vegetation not having adequate water to maintain health, and therefore ***would beneficially affect flycatcher habitat and potential nest success,*** again particularly in times of drought.
Critical Habitat PCES			
Riparian Vegetation	Riparian habitat in a dynamic successional environment to be used for nesting, foraging, migration, dispersal and shelter. Dense tree or shrub vegetation in close proximity to open water or marsh areas. With an increase in the water amount reaching flycatcher suitable habitat patches, the Proposed Action could ***potentially beneficially affect flycatcher riparian vegetation***.		
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. The minimal difference between the No Action and the Proposed Action ***would not affect the insect prey populations***. It is also important to note that a dry river does not impact insect populations when ponded water and adjacent drains are present.		

2.4.3.5 Effects of El Vado Dam Operation on Cuckoo

Model results indicate a minor change when comparing El Vado Dam operations with MRGCD diversions compared to MRGCD diversions alone. The main difference is noticed during the late irrigation season and farther north, where the El Vado Dam operations maintain more water within the channel during low flows (Figure II-22) and may beneficially supply additional groundwater to support vegetation. Conversely, earlier in the season, by storing additional water in El Vado Reservoir when the river is experiencing higher flows, this action has a negative impact on the potential for overbank flows, although El Vado operations alone have a very minimal impact on the occurrence of recruitment or overbank flows in the MRG.

Hydraulic modeling predicts on average that there is a minimal difference in potential for overbank flooding occurrence during early irrigation season for El Vado Dam operations. This difference is largely inconsequential, particularly when considering that these areas often require even more than the 4,700 cfs for flooding.

The methodology and analysis described in Section 2.4.3.4, Effect of El Vado Dam Operation on Flycatcher, to determine the relative change in the potential for overbank flooding due to the decrease in high-flow periods from the Proposed Water Management action can also be used for cuckoos. Please refer to that section for additional details.

A summary of the effects of El Vado Dam on cuckoos is presented in Table II-33.

Table II-33. Effect of El Vado Dam operations on life history elements and PCEs of cuckoos

	Migration (May–June and August–September)	**Arrival to Territories/Territory Establishment/Nest Building (June)**	**Egg Laying/Incubation/ Nestling/Fledgling (July–August)**
Breeding Season (June–August)	The Proposed Action would **not likely adversely affect** cuckoo stopover locations during migration because cuckoos will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect cuckoo habitat on a negligible level****.* Because the El Vado Dam operation would decrease the potential of overbank flooding, but would increase the water available to vegetation at times of lower flows; overall, this would increase the potential for vegetation health, and ***could potentially beneficially affect cuckoo habitat,*** particularly in periods of drought. However, it should be noted that the decrease in water between the two scenarios is an extremely small amount.	If vegetation does not have adequate water resources, canopy cover will likely decrease and predation and/or parasitism would likely be more prevalent. Because the Proposed Action would result in a little more water in the system at times of low flows and increased plant stress, there would be an decreased possibility of vegetation not having adequate water to maintain health, and therefore ***would beneficially affect cuckoo habitat and potential nest success,*** again particularly in times of drought.
Critical Habitat PCES			
Riparian Woodlands	Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70%), and have a cooler, more humid environment than the surrounding riparian and upland habitats. With an increase in the water amount reaching cuckoo habitat patches, the Proposed Action could ***potentially beneficially affect riparian woodlands****.*		
Adequate Prey Base	Presence of a prey base consisting of large insect fauna (e.g., cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas. The insignificant difference between the No Action and the Proposed Action indicates that this action ***is not likely to adversely affect the insect prey base,*** particularly because the cuckoo diet is so variable.		

Table II-33. Effect of El Vado Dam operations on life history elements and PCEs of cuckoos

	Migration (May–June and August–September)	Arrival to Territories/Territory Establishment/Nest Building (June)	Egg Laying/Incubation/ Nestling/Fledgling (July–August)
Dynamic Riverine Processes	River systems that are dynamic provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old. Because there would be a minimal beneficial increase in the water amount, the Proposed Action ***is not likely to adversely affect dynamic riverine processes that sustain cuckoo habitat***.		

2.4.4 Effects Analysis of Non-Federal Proposed Actions: MRGCD Diversions

The MRGCD diverts water for its irrigation works at Cochiti Dam and operates diversion structures at Angostura, Isleta, and San Acacia. The MRGCD diverts a large portion of all water moving to and through the MRG. In the process, its operations have distinct and measurable effects on water flow and distribution, and therefore on the habitat of the listed species. MRGCD effects may be positive or negative, and in some cases may be both depending on the timing and location of events.

While the primary effect of MRGCD operation of the diversion dams is to remove a portion of flow from the river, resulting in a proportional reduction in flow below each diversion dam, the effect is not as simple as it might first appear. In previous analyses performed for this BA, diversions and upstream water operations have been artificially separated. While useful for comparative effect analysis, this is not a realistic condition; diversions go hand-in hand with upstream reservoir operations. The occurrence of return flow and naturally occurring losses are also major factors. Diversions and returns are variable over time, and any analysis should consider whether water being diverted would have been there and available for diversion if the MRGCD were not operating. Diversions decrease the amount of water within the river during the irrigation season, which may reduce the amount of wetted habitat. However, releases from storage associated with diversions during the irrigation season augment natural flows and can increase the extent of available habitat. Due to these factors, which are not considered in the URGWOM for the middle valley, the MRGCD has developed a more refined model for the middle valley between Cochiti and RM 60. The MRGCD's complete description of the methods and hydrologic impacts from the MRGCD model are included in Appendix H, and summarized below.

The MRGCD typically diverts and delivers water from March 1–October 31 each year, although in recent years, delivery of irrigation water to the Six MRG Pueblos has continued through November 15. Diversions impact river flows up to the capacity of MRGCD diversions, or until the river dries. River flows are subsequently augmented, especially in the Albuquerque and Isleta Reaches, by return flows from drains and MRGCD wasteways.

Irrigation demand correlates closely with climatic conditions and the physiologic properties of agricultural crops. Demand is highest during the months of May, June, and July, tapering off in August and September. From March through mid-June, natural flows in the Rio Grande are generally greater than MRGCD consumptive needs. Therefore, during this early part of the irrigation season (March–mid-May), much of the water diverted by the MRGCD is returned directly to the Rio Grande through wasteways and drains in the Cochiti, Albuquerque, and Isleta Reaches. However, after the end of the spring snowmelt runoff, naturally occurring flows often drop precipitously and are generally less than the consumptive needs of the MRGCD.

During the peak growing season, most water diverted is consumed by crops, and return flows are minimal. During this time, MRGCD augments the natural flow of the Rio Grande, up to its consumptive needs, with releases of stored water from El Vado Reservoir. Return flow at the end of the MRGCD system is delivered to the BDA.

2.4.4.1 Approach for Analyzing Impacts of MRGCD Diversions

There are no historical data for years in which there were no diversions during the irrigation season; therefore, URGWOM is not calibrated for these conditions. For this reason, the model is not able to accurately predict daily flow and river drying under these conditions. Analyses based on past river flows have suggested that river drying still would be expected during dry periods even with no diversions (Flanigan 2004). Due to the uncertainties of the URGWOM at predicting middle valley flows as described herein, MRGCD has developed a more refined model for the middle valley between Cochiti and RM 60. MRGCD's spreadsheet flow model (FM) was developed to fully assess the hydrologic impacts of MRGCD operation through the MRG. The FM depends on an URGWOM-derived inflow to the MRG at Cochiti Reservoir, then estimates flows downstream based on anticipated diversion rates; agricultural, riparian, and evaporative depletions; return flows; and rates of leakage to drains. FM outputs can be easily evaluated in terms of minimum/maximum rates of flow at key locations, occurrence of specified flow conditions, and daily inflow/outflow of river reaches. Output from the FM also allows a relative estimate of river drying expected to occur under different operational scenarios.

A full description of the MRGCD's FM, results, and discussion of past and present MRG conditions related to the operation of MRGCD is presented in Appendix H. MRGCD's summary of hydrologic impacts and species effects resulting from MRGCD operations is presented below.

2.4.4.2 Hydrologic Impacts of MRGCD Diversions

2.4.4.2.1 Cochiti Diversion

The MRGCD operation of the diversion works in Cochiti Dam reduces the flow immediately below Cochiti Dam by about 200 cfs. During spring runoff, the diversion of water by the MRGCD at Cochiti Dam has an impact of reducing flows below the dam between 3% and 27%. During the summer/fall low-flow period, the diversion of water by the MRGCD at Cochiti Dam has an impact between 29% and 100%.

These reductions in flow occur only immediately below Cochiti Dam. For the remainder of the Cochiti Reach and downstream reaches, the impact of Cochiti diversion is moderated by flows from drain outfalls and wasteways, which return a portion of the diverted water to the river. The impact of MRGCD operations in Cochiti Reach can range from between about 30 and 120 cfs, depending on climate and time of year. The overall maximum impact of the Cochiti Reach during the spring runoff is therefore to reduce flows between 2% and 16%. For the summer/fall low flow period, the overall impact on the Cochiti Reach is a potential maximum reduction of flows between 17% and 100% (rare, 3 out of the 50 modeled years). In half of all years, the maximum impact of Cochiti diversions on flows in the Cochiti Reach is 25% or less. During the winter months, when the MRGCD is not operating to divert water at Cochiti Dam, there is no hydrologic impact from diversion operations.

When natural flows fall below levels needed to supply water to all diversion dams, MRGCD requests that Reclamation release stored water from El Vado Reservoir. Virtually all stored water released from El Vado is expected to pass downstream of Cochiti Dam, increasing flows through the Cochiti Reach. Exceptions can occur when the MRGCD has no water stored in El Vado Reservoir that it can use to supplement natural flow.

2.4.4.2.2 Angostura Diversion

MRGCD operation of Angostura Dam variably reduces flow below Angostura Dam by up to about 300 cfs. During spring runoff diversion of water by the MRGCD at Angostura Dam has an impact of reducing flows between 4% and 48%. During the summer/fall low-flow period, diversion of water by MRGCD at Angostura Dam is between 48% and 100%. During the winter months, when the MRGCD is not operating to divert water at Angostura Dam, there is no hydrologic impact from diversion operations.

The reductions in flow caused by Angostura diversion impact most of the Albuquerque Reach. Return flow may re-enter the river in a few places, but most return flow remains in canals and drains until just upstream of Isleta Diversion Dam. Adding the impact of Cochiti diversion (adjusted for return), the overall impact on the Albuquerque Reach during the spring runoff is to reduce flow between 4% and 43%. For the summer/fall low flow period, the overall impact of MRGCD diversions on the Albuquerque Reach is a potential maximum reduction of naturally occurring flows between 43% and 100%.

However, just as with Cochiti Reach, when natural flows are less than required for normal operation, MRGCD requests release of water stored in El Vado Reservoir, and contracted SJC Project water, to increase flows to the level required for diversion at Isleta Dam. This lessens or reverses the impact to Albuquerque Reach by increasing inflow above natural rates. The incidence of river drying in the Albuquerque Reach is thus moderated by the release of stored water. In the No Action condition drying (defined as less than 100 cfs at Central Avenue gage) would be expected in 36% to 40% of all years. Under the Proposed Action (normal MRGCD operation), drying would be expected in 30% to 42% of all years.

Angostura Dam is an impassable barrier to fish movement in an upstream direction, and may discourage downstream movement of fish. However, operation of the dam to divert water has no effect on fish passage in either direction. Operation of the dam to divert water has no appreciable impact on water quality when in normal operations.

2.4.4.2.3 Isleta

MRGCD operation of Isleta Dam variably reduces flow below Isleta Dam by up to about 800 cfs. During spring runoff diversion of water by the MRGCD at Isleta Dam has an impact of reducing flows between 12% and 100%. During the summer/fall low-flow period, diversion of water by MRGCD at Isleta Dam has an impact on flows below the dam up to 100% in most years. During the winter months, when the MRGCD is not operating to divert water at Isleta Dam, there is no hydrologic impact from diversion operations.

Adding the impact of Cochiti and Angostura diversions (adjusted for return) the overall impact on the Isleta Reach during the spring runoff is to reduce flow between 15% and 100%. The 100% impact (complete drying) occurs in about 16% of years. In 52% of all years, less than a 25% reduction in spring runoff occurs, demonstrating a general pattern of feast or famine for the MRG. For the summer/fall low flow period, the overall impact of MRGCD diversions on the Isleta Reach is 100% reduction in many (44%) years.

When requesting release of water from storage, MRGCD only releases up to the amount required to cause a desired quantity for diversion to arrive at Isleta Dam. As discussed above, this has an impact to Cochiti and Albuquerque Reaches of increasing flow and reducing drying; however, it has no impact on the incidence of drying in the upper 20 miles of the 53-mile Isleta Reach. Normal MRGCD operation changes the pattern of drying in the Isleta Reach, causing the lower 33 miles of the reach to remain wet. When MRGCD is not in normal operation, the lower 33 miles may be expected to also dry in years (46%) in which natural MRG inflow drops below about 670 cfs.

The impact of Isleta Dam (including Cochiti and Angostura) on the summer/fall low-flow period with respect to drying is complex. In 40% of years natural inflow is not sufficient to reach Isleta Dam, and there is no impact on Isleta Reach (or the downstream reaches) due to operation of Isleta Dam. In 18% of years there are variable impacts on the Isleta Reach (drying between Isleta Dam and San Acacia Dam) due to the operation of Isleta Dam. In 34% of years, there are variable drying impacts on the San Acacia Reach due to the operation of Isleta Dam. In 4% of years, the operation of Isleta Dam has an impact on flows downstream of San Marcial. In the remaining 4% of years no drying occurs in the MRG as a result of Isleta Dam operation.

Isleta Dam serves as a variably permeable barrier to fish passage when in operation (8–9 months/year). When gates are lowered to provide operating head to divert water, fish are unlikely to be able to pass through the structure in an upstream direction, except during periods of unusually high flow. During winter months Isleta Dam gates are lifted from the water, allowing fish passage upstream. Operation of Isleta Dam to divert water likely has an impact on downstream water quality, specifically on water temperature during the summer/fall low-flow period.

2.4.4.2.4 San Acacia

MRGCD operation of San Acacia Dam variably reduces flow by up to about 265 cfs. During spring runoff, diversion of water by the MRGCD at San Acacia Dam has a potential impact of reducing flows between 5% and 100%. During the summer/fall low-flow period, diversion of water by MRGCD at San Acacia Dam can reduce flow by between 35% and 100%. During the winter months, when the MRGCD is not operating to divert water at San Acacia Dam, there is no hydrologic impact from diversion operations.

When considered collectively with upstream operations, return flows resulting from Isleta Dam operation typically equal or exceed diversions at San Acacia Dam, so there are no additional impacts to spring runoff from San Acacia Dam operation. The same is generally true during the summer/fall low-flow period. Operation of San Acacia Dam causes a slight increase (8%) in the numbers of years in which water arrives at San Acacia Dam throughout the entire year, due to release of stored water and associated increase in return flow from Isleta Dam operation. When MRGCD is in normal operation, the presence of water in the canal adjacent to the river has an impact on flow below San Acacia Dam, causing about 9 miles to remain wet. As with Isleta Dam operation, there is a change in the pattern of wet/dry in the San Acacia Reach, from extremes under the No Action condition to more consistency with the Proposed Action.

A temporary exception can occur because the San Acacia Diversion Dam is situated downstream of two significant, but ephemeral, tributaries—the Rio Puerco and the Rio Salado. Inflows from these tributaries occasionally make up a large portion of the flow of the Rio Grande that reaches San Acacia Dam. At these times, operation of San Acacia Dam may have the full impact on flows in the San Acacia Reach. These tributaries are normally short-duration events.

The incised nature of the river downstream of San Acacia Dam creates a situation in which fish are unlikely to pass upstream through the structure under any operation. The operation of San Acacia Dam may affect water quality (temperature); however, due to the relative magnitude of flow, time of year, and rates commonly diverted, it is unlikely to have a significant impact.

2.4.4.3 Effects of MRGCD Water Management Actions on Species

2.4.4.3.1 Silvery Minnow

The MRGCD's effects analysis, based on their more refined model for the middle valley between Cochiti and RM 60, is provided below. The MRGCD's complete description of the methods and hydrologic impacts from the MRGCD model are included in Appendix H.

The effects of operation of the diversion dams on silvery minnow are primarily indirect, related to the hydrologic impact of water withdrawal. Diversion of all or a portion of flow at diversion dams results in a changed habitat condition downstream of each diversion dam. Water consumed by MRGCD users and not returned to the river has a cumulative impact on flows in the river in downstream reaches. Effects to the species resulting from hydrologic impact are highly variable, depending on time of year, physical location (dam and reach), and magnitude of naturally occurring flow.

Operation of diversion dams to divert water for the MRGCD has a minor indirect effect on silvery minnow during the spring spawning and reproduction period. Flows of magnitude and duration required for successful spawning and recruitment (minimum of 2500 cfs at Albuquerque for 7 days between April 15 and June 15) occur in 64% of modeled years in the No Action condition. With operation of the diversion dams as described by the Proposed Action, the occurrence of these conditions is 58% of modeled years, a minor reduction of 6%. MRGCD operations are likely to adversely affect silvery minow spawning and recruitment through flow changes, although the effect is minor. Operation of diversion dams has an indirect effect of reducing the habitat available for spawning and recruitment. At lower flows, diversion represents a larger percentage of flow, but habitat is confined within banks and does not change appreciably with flow. At higher flows when overbanking flows are achieved, diversion represents a much smaller percentage of total flow, minimizing the effect on available habitat.

Operation of diversion dams has an indirect effect on silvery minnow through reduction in water quality. Removal of available flow may result in elevated temperature, concentration of dissolved solids, and reduced oxygenation in remaining flow, and is therefore likely to adversely affect silvery minnow.

Operation of diversion dams has a direct effect on silvery minno spawning and recruitment through entrainment of eggs and larvae into irrigation canals. Entrainment is believed to be inversely proportional to total flow, possibly mitigating effects of entrainment during higher-flow years when spawning tends to be more successful. Although relatively small in number, monitoring has detected the presence of eggs in irrigation canals, leading to a determination of likely to adversely affect silvery minnow.

The effect of diversion dams on silvery minnow during the summer/fall low-flow period is indirect, through the presence or absence of habitat potentially usable by silvery minnow. The effect is to reduce the availability of habitat potentially usable by silvery minnow. On average, operation of diversion dams reduces the number of river miles that remain wet year-round by about 10 miles (out of a possible 172 miles). The effect on the species is likely to adversely affect.

The effect of diversion dams when considered in the overall context of MRG habitat is indirect, through the redistribution of drying and habitat potentially usable by silvery minnow. The effect is to modify a pattern of wetted perennial habitat only being present at the upstream end of the MRG, to one of patches of wetted habitat scattered throughout the MRG at various locations that are likely to persist in a greater number of years. Most notable are the lower 32 miles of the Isleta Reach and upper 9 miles of San Acacia Reach, which tend to remain wet as a result of MRGCD operations. This may affect, but is not likely to adversely affect the species, and may be beneficial.

The operation of diversion dams produces upstream reservoir releases that in turn result in an increase in water entering the MRG during the summer/fall low-flow period in many years. The effect on the species from the releases is to increase the likelihood of perennial flow upstream of Isleta Dam, which is generally beneficial. Therefore, this action may affect, but is not likely to adversely affect, water quality upstream of Isleta Dam.

Operation of MRGCD facilities to deliver water for irrigation modifies the groundwater gradient between river and drains. The effect in some areas is to lessen or reverse the gradient away from the river, increasing the habitat likely to remain wet and potentially usable by silvery minnow. This is beneficial, and therefore may affect, but is not likely to adversely affect the species.

Operation of diversion dams at Cochiti, Angostura, and San Acacia has no effect on fish passage or river connectivity. Operation of Isleta Dam prevents the passage of silvery minnow in an upstream direction. Operation of Isleta Dam is likely to adversely affect silvery minnow through river connectivity 71% of the time. During winter months there is no effect from Isleta Dam operation.

The summary of MRGCD effects is presented in Table II-34.

Table II-34. Effect of operation of MRGCD diversions on life history elements and PCEs of silvery minnow

<table>
<tr><th></th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (April–June)</td><td colspan="3">The duration and magnitude of spring runoff in the MRG is decreased by MRGCD operations. The decrease to the duration of inundation of overbank habitats, which is related to spawning and recruitment of larval silvery minnow, is anticipated to be minor. Eggs and larvae may be entrained into the irrigation system; but with modified management during peak egg production, this is expected to be minor.

Direct and Indirect – Operation of diversions is likely to adversely affect silvery minnow spawning and recruitment.</td><td></td><td>There is little information on how spring flows are related to adult survival of silvery minnow. Decrease in the spring hydrograph from MRGCD operations is anticipated to be minor. Adult entrainment into the irrigation system is likely rare. Direct and Indirect – The operation of diversions are not likely to adversely affect adult silvery minnow.</td></tr>
<tr><td>Summer (June–Sept)</td><td></td><td></td><td colspan="3" rowspan="2">MRGCD diversions decrease the available habitat for silvery minnow in reaches downstream of Isleta Dam in some years. Drying can cause mortality in silvery minnow. Releases from drains and outfalls may provide areas of refuge for silvery minnow during low-flow periods. Direct and Indirect – Diversions are likely to adversely affect silvery minnow in summer and fall periods.</td></tr>
<tr><td>Fall (Sept–Nov)</td><td></td><td></td></tr>
<tr><td>Winter (Dec–March)</td><td></td><td></td><td></td><td></td><td>MRGCD does not divert water in the winter. Direct – Diversions have no direct effect to winter survival of adult silvery minnow.

Indirect – Body condition of fish may be reduced going into winter months due to increased low-flow periods.</td></tr>
<tr><td colspan="6">Critical Habitat PCEs</td></tr>
<tr><td colspan="6">Hydrologic Regime</td></tr>
<tr><td>A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.</td><td colspan="5">MRGCD diversions increase the number of river miles dried in some years in reaches downstream of Isleta Dam. Releases from drain and wasteway outfalls may maintain wetted habitat within reaches, or may provide areas of refuge for silvery minnow during low-flow periods. Direct and Indirect – Diversions are likely to adversely affect the hydrology and maintenance of silvery minnow critical habitat within the MRG.</td></tr>
<tr><td>Presence of a diversity of habitats for all life history stages</td><td colspan="5">Direct and Indirect – Diversions are not likely to adversely affect the presence of diversity of habitats for all life history stages within the MRG.</td></tr>
</table>

Table II-34. Effect of operation of MRGCD diversions on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Sufficient flows from early spring (March) to early summer (June) to trigger spawning	The Proposed Action may cause minor decreases in high flows, and this is not expected to have an effect on successful spawning. **Direct and Indirect –** ***MRGCD operations are not likely to adversely affect silvery minnow critical habitat for spawning of silvery minnow.***				
Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow	MRGCD diversions increase the number of river miles dried in some years downstream of Isleta Dam. Releases from drain and wasteway outfalls may maintain wetted habitat within reaches, or may provide areas of refuge for silvery minnow during low-flow periods. **Direct and Indirect –** ***MRGCD operations are likely to adversely affect silvery minnow critical habitat during summer and fall periods.***				
Constant winter flow					MRGCD diversions are not operated during the winter. **Direct and Indirect –** ***MRGCD operations are not likely to adversely affect winter critical habitat for adult silvery minnow.***
Unimpounded stretches of river with a diversity of habitats and low-velocity refuge areas					
River reach length	San Acacia and Angostura Dams are barriers to upstream fish passage, regardless of operation. Isleta Dam may be passable by silvery minnow under certain gate configurations. Cochiti, Angostura, and San Acacia Dams are not passable under any gate configuration. In general, ***operation of Diversion Dams is not likely to adversely affect river reach length within critical habita, with the exception of Isleta Dam while in operation to divert water.***				
Habitat "quality" in each reach and refugial habitats.	Ongoing geomorphic trends will continue under the current operations. The formation of a two-stage channel within the MRG set by the high- and low-flow condition causes habitat availability for silvery minnow to not increase linearly with flow increases and is set to base flow levels. The ongoing vegetation encroachment and narrowing trends are supported by the natural low flows and monsoonal inputs, and the contributions of the Proposed Water Management Actions to these trends are indistinguishable from the natural and other anthropogenic effects. Drain outfalls may provide backwater and refuge habitats. ***Return flows from drains and wasteways may have positive effects to habitat quality.*** Effects from reductions in flows are addressed in the hydrologic regime element above.				

Table II-34. Effect of operation of MRGCD diversions on life history elements and PCEs of silvery minnow

	Spawning	Eggs	Larval	Juvenile	Adult
Substrate of sand or silt					
Substrates of predominantly sand or silt	Diversion dams have some effect on sediment transport within the MRG in the immediate vicinity of the diversion dam. The ongoing trends will continue within the reaches above and below diversion dams. ***Diversions are likely to adversely affect sediment transport within critical habitat.***				
Water quality					
Temp >1°, < 30°C DO > 5 mg/L pH (6.6–9.0)	Water temperature, DO, and pH within the MRG may be affected during low-flow conditions especially in intermittent areas. Return flows from drains and wasteways and increased flows in the Albuquerque Reach may have positive effects to water quality. **Direct and Indirect – *The operation of Diversions is likely to adversely affect water quality due to low flows in reaches downstream of Isleta Dam*.**				
Other contaminants	Drain and irrigation return water has the potential to have poor water quality, but recent studies (Buhl 2011) found no elevated levels of contaminants in the tested wasteway water. River water entering the irrigation canal system can carry high nutrient concentrations, but concentrations of nitrate, ammonium, and phosphate re-entering the river from these tributary return flows are consistently low (Zeglin and Dahm 2006). The operation of MRGCD diversions reduces the amount of water that is available to dilute contaminants that are introduced to the river from outside sources. This lack of dilution ***may have indirect effects but is not likely to adversely affect silvery minnow.***				

2.4.4.3.2 Flycatcher

Diversions may have different effects on the flycatcher. When natural flows are below the overbanking threshold in a reach, diversions cannot affect overbank flooding. At that threshold and above, diversions can decrease the amount of overbank flooding that occurs or at some times, diversions may cause flow levels to drop below the threshold. However, the flow threshold at which overbank flooding occurs varies in each reach. Also, diversions increase the potential for drying the river and have the potential to affect groundwater levels that would have impacts to native vegetation health. Canals and drains may also help keep groundwater levels stable in some areas, which may benefit the flycatcher.

For a reach-based analysis of these effects of diversions, MRGCD has developed a more refined model for the middle valley between Cochiti and RM 60. The MRGCD's spreadsheet flow model was developed to fully assess the hydrologic impacts of MRGCD operation through the MRG. The MRGCD's complete description of the methods and hydrologic impacts from the MRGCD model are included in Appendix H, and the anticipated effects of the MRGCD's Proposed Actions on the flycatcher are provided below in Table II-35.

Table II-35. Effect of MRGCD Proposed Actions on life history elements and PCEs of flycatchers

	Migration (April-June and July–September)	Arrival to Territories/Territory Establishment/ Nest Building (May–July)	Egg Laying/Incubation/ Nestling/ Fledgling (June–August)
Breeding Season (April–September)	The Proposed Action would ***not likely adversely affect*** flycatcher stopover locations during migration because flycatchers will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect flycatcher habitat on a negligible level***. Because the Proposed Action, when compared to No Action, would decrease the potential of overbank flooding and decrease the overall water available for vegetation, this could cause a decline in territory recruitment and canopy cover/plant health/seed establishment and ***could potentially adversely affect flycatcher habitat,*** particularly in periods of drought. However, it should be noted that the decrease in water between the two scenarios is a relatively small amount.	Territory recruitment at this stage is no longer an issue as flycatchers are more invested in their territories and less likely to abandon nests should conditions dry or decline in value. However, if vegetation does not have adequate water resources, canopy cover likely will decrease and predation and/or parasitism likely would be more prevalent. Because the Proposed Action would result in less water in the system, there would be an increased possibility of vegetation not having adequate water to maintain health, and therefore ***could adversely affect flycatcher habitat and potential nest success,*** again particularly in times of drought. However, canals and drains may also help keep groundwater levels stable in some areas, which may benefit the flycatcher.
Critical Habitat PCEs			
Riparian Vegetation	Riparian habitat in a dynamic successional environment to be used for nesting, foraging, migration, dispersal, and shelter. Dense tree or shrub vegetation in close proximity to open water or marsh areas. With a decrease in the water amount reaching flycatcher suitable habitat patches, the Proposed Action could ***potentially adversely affect flycatcher riparian vegetation***.		
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. The minimal difference between the No Action and the Proposed Action ***may affect, but is not likely to adversely affect the insect prey populations***. It is also important to note that a dry river does not impact insect populations when ponded water and adjacent drains are present.		

2.4.4.3.3 Cuckoo

Diversions may have different effects on the cuckoo. When natural flows are below the overbanking threshold in a reach, diversions cannot affect overbank flooding. At that threshold and above, diversions can decrease the amount of overbank flooding that occurs or at some times, diversions may cause flow levels to drop below the threshold. However, the flow threshold at which overbank flooding occurs varies in each reach. Also, diversions increase the potential for drying the river and have the potential to affect groundwater levels that would have impacts to native vegetation health. Canals and drains may also help keep groundwater levels stable in some areas, which may benefit the cuckoo.

For a reach-based analysis of these effects of diversions, the MRGCD has developed a more refined model for the middle valley between Cochiti and RM 60. The MRGCD's spreadsheet flow model was developed to fully assess the hydrologic impacts of MRGCD operation through the MRG. The MRGCD's complete description of the methods and hydrologic impacts from the MRGCD model are included in Appendix H, and the anticipated effects of the MRGCD's Proposed Actions on the cuckoo are provided in Table II-36.

The methodologies described in Section 2.4.4.6, Effect of MRGCD Water Management Actions on Flycatcher, and Section 2.4.3.4, Effect of El Vado Dam Operation on Flycatcher, used to determine the relative change in the potential for overbank flooding can also be used for cuckoos. Please refer to those sections for additional details.

Table II-36. Effect of MRGCD Proposed Action on life history elements and PCEs of cuckoos

	Migration (May–June and August–September)	**Arrival to Territories/Territory Establishment/Nest Building (June)**	**Egg Laying/Incubation/ Nestling/Fledgling (July–August)**
Breeding Season (June–August)	The Proposed Action would **not likely adversely affect** cuckoo stopover locations during migration because cuckoos will use habitat that is less suitable during this time and farther away from water sources.	The Proposed Action may ***indirectly affect cuckoo habitat on a negligible level***. Because the Proposed Action, when compared to No Action, would decrease the potential of overbank flooding and decrease the overall water available for vegetation, this could cause a decline canopy cover/plant health/seed establishment and ***could potentially adversely affect cuckoo habitat,*** particularly in periods of drought. However, it should be noted that the decrease in water between the two scenarios is a relatively small amount.	If vegetation does not have adequate water resources, canopy cover likely will decrease and predation likely would be more prevalent. Because the Proposed Action would result in less water in the system, there would be an increased possibility of vegetation not having adequate water to maintain health, and therefore ***could adversely affect cuckoo habitat and potential nest success,*** again particularly in times of drought. However, canals and drains may also help keep groundwater levels stable in some areas, which may benefit the cuckoo.
Critical Habitat PCEs			
Riparian Woodlands	Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats. With a decrease in the water amount reaching cuckoo habitat patches, the Proposed Action could ***potentially adversely affect riparian woodlands***.		

Table II-36. Effect of MRGCD Proposed Action on life history elements and PCEs of cuckoos

	Migration (May–June and August–September)	Arrival to Territories/Territory Establishment/Nest Building (June)	Egg Laying/Incubation/ Nestling/Fledgling (July–August)
Adequate Prey Base	Presence of a prey base consisting of large insect fauna (e.g., cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas. The insignificant difference between the No Action and the Proposed Action indicates that this action ***may affect, but is not likely to adversely affect the insect prey base,*** particularly because the cuckoo diet is so variable.		
Dynamic Riverine Processes	River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old. With a decrease in the water amount as well as the decrease in probability of overbank flooding reaching cuckoo habitat patches, the Proposed Action is ***likely to adversely affect dynamic riverine processes that help to sustain cuckoo habitat***.		

2.4.4.3.4 Jumping Mouse

For an evaluation of the effects of the MRGCD's proposed action on the jumping mouse, see Table II-16.

2.4.5 Effects Analysis of Non-Federal Proposed Actions: State

The State Proposed Actions are analyzed for their hydrologic impacts to the river system and their effects on the listed species.

2.4.5.1 Hydrologic Impact Analysis of the State's Proposed Actions

The hydrologic impact analysis of the proposed actions uses an analytical approach that assumes full impact on the river (i.e., groundwater pumping has 100 percent impact on the river instantaneously). In doing so, the analysis shows impacts that are greater than what is probably occurring in reality. In addition, URGWOM was used to estimate the expected credit water relinquishment for the next 10 years.

2.4.5.1.1 Allocation of Relinquishment Credit Under Administration of the Rio Grande Compact, and Storage and Release of Relinquished Water (Primarily With Storage in El Vado)

The ISC proposes to continue its Compact related activities, specifically including administering relinquishment of New Mexico Credit water and allocation of relinquished compact credit. Analysis of the URGWOM simulations used in development of the Reclamation current BA indicates that relinquishment of New Mexico accrued credit water, and the related ability to store relinquishment water upstream during the snowmelt runoff and release it later by MRG water users and Reclamation, allows an extended MRG irrigation season and provides storable water to help Reclamation and the Corps meet their 2003 BO flow targets.

Article VII of the Compact restricts storage of native Rio Grande water in reservoirs upstream of Elephant Butte Reservoir constructed after 1929 when there is less than 400,000 AF of Usable Water in Rio Grande Project Storage in Elephant Butte and Caballo Reservoirs. During the period covered by the 2003 BO, New Mexico relinquished credit water several times. If the relinquishments had not occurred, Reclamation and the Corps would have had a more difficult time meeting the flow targets of the 2003 BO and may not have been able to do so under some circumstances.

The URGWOM simulations demonstrate that the frequency and the amount of credit water available for relinquishment depends on the hydrologic sequence simulated. Using the 50% exceedance probability 10-year hydrologic sequence (Roach 2009) model run, the state would be able to propose to relinquish significant amounts of credit water about 50% of the time (Figure II-23). However, given the history of relinquishments since signing the compact and the current litigation with the State of Texas, that scenario likely overestimates the frequency and volume of future relinquishments. Relinquishments would provide water for storage to meet MRG demands when otherwise prohibited by the Compact.

The impacts of the storage and release of the relinquishment water are included in the effect analysis of actions related to El Vado Storage and release by Reclamation and the MRGCD.

Therefore, the effects of the State's proposed actions in administering the Compact are, on the whole, positive as measured by the ability to make relinquishment water available in upstream storage for release to benefit municipal and irrigation needs and to meet flow targets when native water storage would otherwise not be available to do so.

2.4.5.1.2 Administration of Surface and Groundwater Supplies

The NMOSE proposes to continue to administer the surface water and groundwater resources to maintain hydrologic system balance by executing his statutory duties with respect to transfers of valid existing surface water rights and compliance with valid existing state water declarations, permits, licenses, and court adjudications.

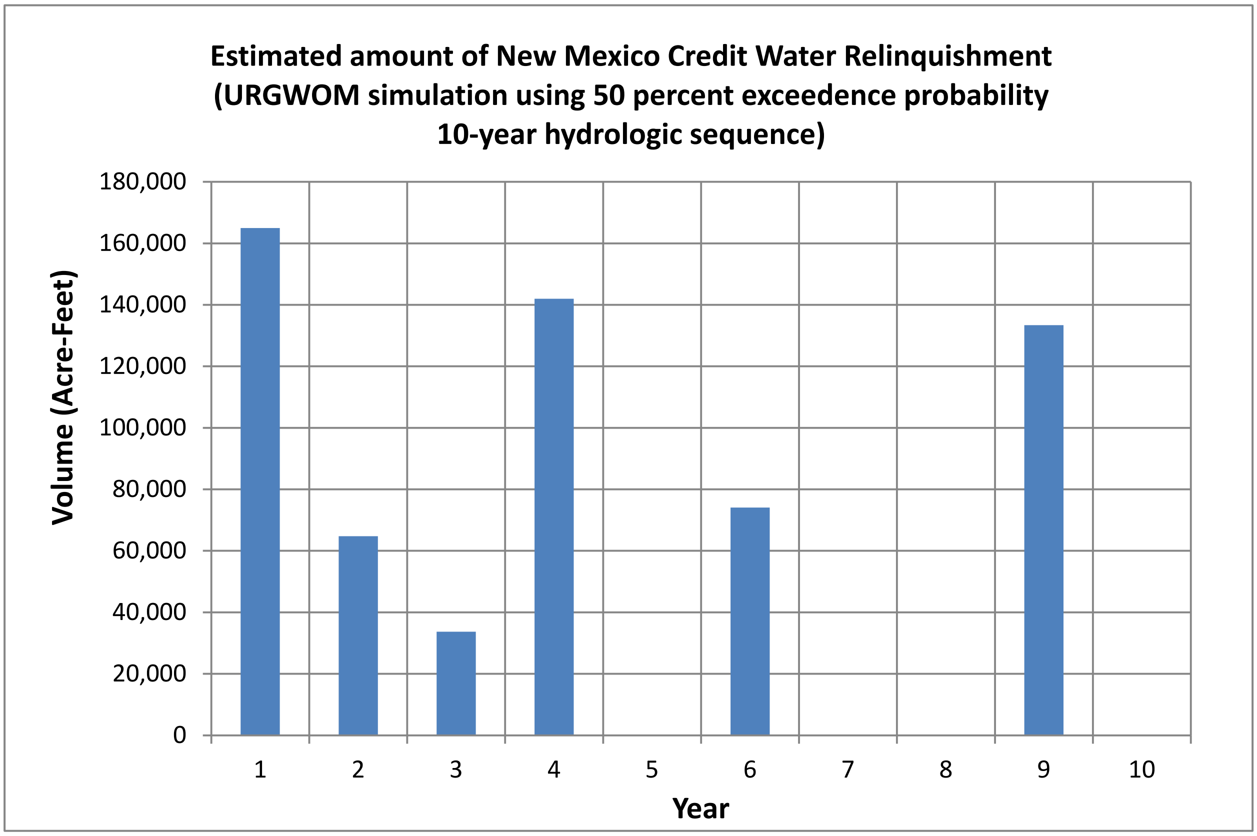

Figure II-23. Estimated amount of New Mexico Credit Water relinquishment (URGWOM simulation using 50% exceedance probability for a 10-year hydrologic sequence)

Between the state line and the Otowi gage (URG), the NMOSE conjunctively administers surface water and groundwater resources to keep total human depletions at or below the 1929 conditions. All depletions occurring as a result of transfer at the move-to location must be offset by a decrease in depletion at the move-from location, return flow, or releases of SJC Project Water. In addition, the NMOSE conducts alternative administration or water rights administration on the Rio Chama below Abiquiu Reservoir, when necessary, as required within the federal court adjudication. Therefore, the hydrologic impacts of the State proposed actions above the Otowi gage (URG) are on the whole neutral, as measured by the effects on the river at the Otowi gage.

Between the Otowi gage and the full pool of Elephant Butte Reservoir (Middle Rio Grande, MRG) the NMOSE conjunctively administers surface water and groundwater to offset pumping impact on the Rio Grande. The NMOSE uses three components of the offset program that result in replacement of permitted groundwater pumping impacts to the river on a real-time basis whenever MRGCD is releasing from storage. The NMOSE evaluates groundwater pumping annually to ensure compliance with the permit and its conditions. The three components are summarized in the following subsections.

Transfer of Senior Water Rights

The total volume of senior water rights transferred to date to offset the effects of permitted groundwater pumping on the river system is about 19,620 AF. This includes senior water rights transferred since the State Engineer's declaration of the Rio Grande Underground Water Basin on November 29, 1956 to offset the effects of permitted groundwater pumping on the river system or, in the instance of the BDD, needed for diversion and consumption. Of that amount, 5,000 AF is held by the ABCWUA and 3,125 AF by the BDD, both of which have coverage under their existing BOs, and are therefore not described further herein. The remainder is 11,495 AF (approximately 340 AF from the Cochiti Division, 1,770 AF from the Albuquerque Division, 6,585 AF from the Belen Division, and 2,800 AF from the Socorro Division). These 11,495 AFY of senior consumptive use rights have been transferred from agricultural use in the MRGCD to municipal and industrial uses. About one-third of these transferred senior water rights are currently needed for offset requirements (NMOSE water rights files). The remaining portion of transferred senior rights is for offset of future impacts. All these historical transfers are included in the baseline conditions; no effect analysis is presented here.

When the purpose of use is changed from irrigation to another use in the MRG, only the consumptive irrigation requirement (CIR) of the water right is transferred. The CIR portion of the water right in the MRG is 2.1 AF per acre, or about one-third of the amount that would normally be diverted from the river (about 7.5 AF per acre) to irrigate those move-from lands. Therefore, for existing transfers that are being used for offset (not being leased back) when the natural flow is greater than MRGCD demand, MRGCD needs to divert less water to meet the demand. As a result, the river flow would increase by the amount of conveyance water that is left in the river as a result of the transfers.

Since 2003, most specifically due to irrigation improvements, MRGCD has reduced its annual river diversions by about 40 percent. As a result, MRGCD is using less natural river flow to meet its irrigation demand, and is leaving water in storage when the natural flows are sufficient to meet its demands. At times when MRGCD is releasing stored water to meet irrigation demand, less water needs to be released to meet demand, which means MRGCD can extend its delivery time period and, indirectly, help meet the Albuquerque gage flow target of the 2003 BO.

The State is expecting that about 5,000 AF of water will be transferred in the next 10 years in the MRG. Using the same historical distribution of the water rights transfer (i.e., 80 percent of the transfers are from Socorro and Belen Divisions to Albuquerque Division), the hydrologic impact for these transfers would result in a reduction of flow at the Albuquerque gage of 0 to 5.5 cfs 10 years later. However, in general, during spring runoff or when MRGCD is releasing stored water, transfer of a senior water right has a *de minimis* effect on river flow. During the winter months the river flow is continuous, however transfers may have a small impact on river flows due to continuing groundwater pumping at the move-to location. During summer months, transfers have an impact during periods of low river flows or during periods when MRGCD has no stored water to release. This reduction of the flow is small in comparison to average annual flow at the Central gage, and is within the margin of uncertainty for most flow measurements. In addition, this reduction of the flow assumes that all the consumptive rights are currently needed for offset, and ignores the benefits of the non-transferable portion of the right staying in the river system.

During low-flow time periods, MRGCD routinely diverts almost all of the water required for its Belen and Socorro Divisions at the Isleta Diversion Dam. Thus, transfers of senior surface water rights from these divisions upstream into the Albuquerque Division have no impact on the river below the Isleta Diversion Dam during those time periods.

In summary, the impact of water rights transfers on river flow varies in relation to the amount of flow in the river and whether the transfer is to an upstream or downstream point of diversion. In general, during periods of higher flow such as during winter months and spring runoff, transfer of a senior water right for offset of historical and ongoing pumping impacts at either an upstream or downstream point of diversion has a *de minimis* effect on river flow. During lower natural flow periods when the MRGCD is releasing water from storage, transfer of a senior water right for offset to either an upstream or downstream point of diversion most likely will have a small positive impact on the river due to retention of irrigation system conveyance flows resulting from the transfers remaining in reservoir storage. During low-flow periods when the MRGCD has no stored water to release, transfer of a senior water right for offset to either an upstream or downstream point of diversion will have a small negative impact on the river. Therefore, the overall hydrologic impacts of the State action of permitting transfers of senior water rights is minimal as measured by the effects on the river flow.

The NMOSE routinely provides the MRGCD with geospatial data that identify all those lands from which pre-1907 surface water rights have been severed, and coordinates with the MRGCD to monitor the status of lands from which senior consumptive use rights have been transferred.

Return Flow Component

NMOSE groundwater permits allow permitted users to use return flow to offset their river impact pursuant to an approved return flow plan. Offset credit for return flow can only be obtained by application and permit based on a return flow plan acceptable to the NMOSE (see baseline section). Return flow occurs simultaneously with diversions throughout the course of the year. Therefore, return flows provide a real-time offset of the effect of groundwater pumping on the river. Currently about 67,000 AFY of water is returned directly into the river between the Otowi gage and Elephant Butte Dam. Of this quantity, about 58,000 AFY consists of ABCWUA direct returns. Because the ABCWUA has its own existing BO for all its water management activities, ABCWUA actions are not evaluated as part of the state actions and are not included in the state’s hydrologic impact analysis. In certain instances, return flows exceed required offsets such that the river flow is augmented because groundwater pumping impacts are less than the return flows.

The hydrologic impacts of the State action approving return flow plans are in the whole neutral, as measured by the effects on the river, and may even have some positive effects due to the augmentation.

The Letter Water Program

For each groundwater pumper that has SJC Project water in storage for use as an offset, the NMOSE periodically provides Reclamation with letters requesting release or exchange of stored SJC Project water by certain dates to offset a portion of the permitted pumping impact. The impacts are quantified by the NMOSE as cumulative effects on Elephant Butte Reservoir (and therefore to New Mexico's deliveries under the Compact) and cumulative effects on the Rio Grande due to impacts in the MRG below the Otowi gage.

Impacts that occur during the irrigation season when MRGCD is releasing stored water to meet demand are considered effects on the MRG and are replenished by exchange of the SJC Project water in storage to MRGCD, which holds that water for release when needed to meet demand. As such, it provides a near real-time offset of the groundwater pumping effects on the river system except during times when MRGCD is not releasing water from storage. These conditions have occurred for portions of three irrigation seasons in the last 10 years and not at all in the 20 preceding years. When it has occurred, it has been during the months of September and October. The maximum amount of SJC Project water that has been exchanged to MRGCD (excluding by the ABCWUA) was about 350 AF in 2007. The State is expecting a total of 350 AFY of future SJC exchange during summer months, which would equate to a reduction of the flow of about 1.5 cfs during September and October.

Impacts that occur during the months of November through March are considered effects on Elephant Butte Reservoir (and therefore to New Mexico's delivery under the Rio Grande Compact). The maximum amount needed for offset (again excluding the ABCWUA) was 870 AF in 2005. This SJC Project water is generally released to the Rio Grande in the winter for delivery to Elephant Butte Reservoir. While there is some flexibility in when the water is delivered to Elephant Butte, it cannot be depleted in the middle valley.

In general, the amount of the letter water currently utilized in the Offset Program (excluding ABCWUA) has an insignificant effect on river flows as measured at the Albuquerque gage. Letter water, including the SJC Project water that is stored by exchange in Nichols and McClure Reservoirs by the City of Santa Fe, has little or no effect on the river flow during spring runoff, when MRGCD is releasing stored water, or during winter months. During summer months, letter water can have a small impact at low river flows, especially when MRGCD has no stored water to release. Therefore, the hydrologic impacts of the State letter water component of the MRG offset program are limited to certain periods and overall are minimal, as measured by the impacts on the river flow.

Water operations associated with the Letter Water Program are also described by Reclamation in this BA and are included in the URGWOM simulations used in development of the BA.

In summary, the hydrologic impacts of the State's proposed actions in administering surface and groundwater supplies is calculated as a reduction of flow in the Albuquerque Reach of about 1.5 cfs at the beginning of the consultation increasing to 7 cfs after 10 years. In addition, the State proposes to add 3 cfs of possible additional flow reduction at the Albuquerque gage after 10 years as part of the consultation. The addition is specific to the State's intent for the RIP to afford broad coverage for New Mexico water users into the future.

2.4.5.1.3 Administration of Domestic, Municipal, Livestock and Temporary Uses

The NMOSE is required by statute to grant permits for domestic wells—that is, this action is a non-discretionary action. The current NMOSE policy is to grant permits up to 1 AFY for watering livestock, irrigation of trees lawn or garden, and household or domestic use. In the Nambe, Tesuque, Pojoaque Basin, requirements for domestic wells are more restrictive. The total estimated diversion amount of domestic use in the URG is about 4,400 AFY (Longworth et al. 2008) distributed as follows: 1,480 AFY in Taos County, 2,320 AFY in Rio Arriba County, and 600 AFY in Santa Fe County. All these historical diversions and their effects are included in the baseline. The NMOSE is expected to issue about 1,000 AFY of domestic well diversion permits in the URG over the next 10 years. Assuming about 50 percent of total domestic well diversions is returned to the hydrologic system, the impact on the river at the Otowi gage is a reduction of flow about 500 AFY or about 0.7 cfs. This amount is insignificant and will not have any impact on the spring runoff at Central gage or during low-flow periods. In addition, the NMOSE conjunctively administers surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (1929 conditions). The hydrologic impacts of the domestic well uses in the URG are on the whole neutral, as measured by the effects on the river.

In the MRG, the total estimated historical diversion amount of domestic and livestock uses is about 18,300 AFY (Longworth et al. 2008) distributed as follows: 2,425 AFY in Santa Fe County, 2,880 AFY in Sandoval County, 6,415 AFY in Bernalillo County, 4,835 AFY in Valencia County, and 1,715 AFY in Socorro County. Effects of these historical groundwater uses are included in the baseline. For the purposes of this assessment, the NMOSE assumes it will issue about 5,000 AFY of domestic well permits in the MRG over the next 10 years (we have intentionally overestimated the number of domestic permits to be issued), and that the effects of those wells will be distributed similar to the current distribution. Assuming 50 percent of total domestic well diversions return to the hydrologic system, the total impact on the river is a reduction of flow of about 2,500 AF, or about 3.5 cfs at the headwaters of Elephant Butte Reservoir. The expected impact at the Albuquerque gage is a reduction of flow of about 2.25 cfs after 10 years. The State recognizes it does not have any ESA responsibility for the non-discretionary actions; rather, the State proposes to implement Conservation Measures for them as part of its effort to confirm broad coverage for legal uses of water in the MRG.

2.4.5.2 Species Effects of the State's Proposed Actions

The following is an assessment of the effects of actions proposed by the State of New Mexico (State's actions) for the federally listed species: silvery minnow, flycatcher, cuckoo, jumping mouse, and sunflower.

In summary, effects determinations for the State action's are (1) no effect for the Pecos sunflower, (2) may affect, but not likely to adversely affect for the flycatcher, cuckoo, and jumping mouse, and (3) may affect and likely to adversely affect for the silvery minnow (Table II-37).

Table II-37. Summary of effects determination for the State's Proposed Actions.

Species	Effects Determination
Rio Grande silvery minnow (*Hybognathus amarus*)	May affect and likely to adversely affect
Southwestern willow flycatcher (*Empidonax traillii extimus*)	May affect, but not likely to adversely affect
Yellow-billed cuckoo (*Coccyzus americanus*)	May affect, but not likely to adversely affect
New Mexico meadow jumping mouse (*Zapus hudsonius luteus*)	May affect, but not likely to adversely affect
Pecos sunflower (*Helianthus paradoxus*)	No effect

The effects determinations for each of the species listed above by action category are described in the following subsections. Because the State's action may change over time, the effects determinations are based on maximum effect even though it may occur in the latter part of the 10-year consultation period. At the beginning of this consultation (based on the environmental baseline), the total combined impact of the administration of surface water and groundwater supplies is negligible (1.5 cfs). As time moves through the 10-year consultation period, various transactions take place and water is used in new and different places, and hydrologic impacts begin to occur on the river.

An assumption used in this evaluation is that the uses affect the river system linearly in time, at about one additional cfs each year. Therefore, the total calculated effect increases over 10 years from 1.5 cfs at the start to about 7 cfs in 30 percent of years during September-October in the Albuquerque Reach. Similarly, administration of domestic, municipal, and livestock uses is expected to increase linearly over the 10-year period to 2.25 cfs at the Albuquerque gage and to 3.5 cfs at the headwaters of Elephant Butte Reservoir.

These flow reductions are a small amount of hydrologic impact in the MRG, given a river with flow that ranges from 600–800 cfs in winter (November–March), 800–6,000 cfs in spring (April into June), and 250 to 700 cfs in summer (June–October). Given these anticipated water transactions, the effects determination reflects changes in hydrology through time. Hence, there is no effect initially; may affect, but not likely to adversely affect after 5 years; and may affect, but not likely to adversely affect after 10 years, except under very specific natural low-flow conditions when there may be an adverse effect. Because of the anticipated effect of flow reduction in the latter years of this consultation, we determine that the State's administration of water supplies does not adversely affect the listed species, except possibly for the silvery minnow.

2.4.5.2.1 Rio Grande Silvery Minnow

Summary of Effects on the Silvery Minnow

A summary of hydrologic impacts of the State's actions by category and associated direct and indirect effects to the silvery minnow is provided in Table II-38. The first State action category allows other entities to store water during the spring runoff to meet water needs at other times of the year, and relinquished New Mexico credit provides opportunity for water during low-flow periods to help maintain river flow and provide more wetted habitat. In summary, the administration of the Rio Grande Compact may affect, but is not likely to adversely affect the silvery minnow or adversely affect critical habitat. This action category is likely to benefit all life stages of the silvery minnow and its critical habitat.

Administration of surface water and groundwater supplies, and administration of domestic, municipal, livestock, and temporary uses may affect, and are likely to adversely affect the silvery minnow or adversely affect critical habitat. This determination is based on flow reduction during low-flow periods that could contribute to habitat reduction and possibly river drying. The magnitude of flow reduction from these action categories is small and immeasurable during spring peak flows and will have an insignificant effect on the silvery minnow and its critical habitat.

Table II-38. Summary of direct and indirect effects of the State's actions on the Rio Grande silvery minnow

Action Category	Summary of Hydrologic Impact	Summary of Effects to Silvery Minnow
Administration of Rio Grande Compact	• Allocation of New Mexico relinquished credit for irrigation, M&I and environmental uses is beneficial to the ecosystem because it provides more water to the system during low-flow periods. • The effect of storing and releasing the water is analyzed with the El Vado storage action above.	• This action allows other entities to store water almost exclusively during the spring runoff to meet water needs at other times of the year. Providing relinquished New Mexico credit water during low natural flow periods helps to maintain river flow and provide more wetted habitat. This action may affect, but is not likely to adversely affect the Rio Grande silvery minnow or adversely affect its critical habitat. This action is likely to benefit the silvery minnow.
Administration of Surface Water and Groundwater Supplies	• Upper Rio Grande: There is no hydrologic impact to the middle Rio Grande from the Upper Rio Grande because of the State Engineer's continued administration of surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (1929 conditions). • Middle Rio Grande: The total hydrologic impact of administering surface water and groundwater supplies is calculated as a reduction of flow in the Albuquerque Reach of about 1.5 cfs at the beginning of the consultation increasing to 10 cfs after 10 years.	• The continued administration of surface water and groundwater supplies above the Otowi gage has no effect on the Rio Grande silvery minnow or its critical habitat. • A flow reduction of 1.5 cfs in the MRG is part of the SJC offset program and is small and immeasurable. • A flow reduction of up to 7-10 cfs could occur in the Albuquerque Reach during times when the MRGCD is not releasing water from storage (about 30% of years for about 2–3 months (Aug-Oct timeframe) resulting in a reduction of wetted habitat for a short time period in some dry years in the Albuquerque Reach only. • In total, this action may affect, and is likely to adversely affect the Rio Grande silvery minnow or adversely affect its critical habitat in the Albuquerque Reach only.
Administration of Domestic, Municipal, Livestock and Temporary Uses	• Upper Rio Grande: There is no hydrologic impact to the middle Rio Grande from the Upper Rio Grande because of the NMOSE's continued administration of surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (1929 conditions). • Middle Rio Grande: The total hydrologic impact of administering domestic, municipal, livestock and temporary uses is estimated to be zero cfs at the beginning of the consultation period increasing to about 2.25 cfs at the Albuquerque gage and 3.5 cfs at the headwaters of Elephant Butte Reservoir after 10 years.	• The continued administration of surface water and groundwater supplies above the Otowi gage has no effect on the Rio Grande silvery minnow or its critical habitat. • A flow reduction ranging longitudinally from 2.25 cfs at the Albuquerque gage to 3.5 cfs at the headwaters of Elephant Butte Reservoir is small and immeasurable during spring peak flows; however, during low-flow periods, this flow reduction (in addition to 1.5 cfs reduction from the offset program) could contribute to river drying in the Isleta and San Acacia Reaches during extremely low flows. This action may affect, and is likely to adversely affect the Rio Grande silvery minnow or adversely affect its critical habitat.

Effects on the Silvery Minnow by Action Category

A summary of the hydrologic impact of the State's action by category is presented in Table II-38. This section describes the direct and indirect effects of each action category on life stages and primary constituent elements of critical habitat of the silvery minnow.

Administration of the Rio Grande Compact. The effects of the State's administration of the Rio Grande Compact on the silvery minnow are on the whole positive, as measured by the ability of making relinquished New Mexico credit water available in upstream storage for release to fulfill municipal, irrigation, and environmental needs and when native water storage would otherwise not be available (Table II-39). Water stored during snowmelt runoff and released during low-flow periods provides a higher frequency of continuous flow in the MRG that benefits the silvery minnow by maintaining habitat for all life stages, especially in summer. Low-flow periods are particularly critical to the silvery minnow as the river may become intermittent or dry in some portions. Providing water during low-flow events reduces the frequency, duration, or magnitude of drying and provides more persistent habitat. The silvery minnow lives only 2–4 years and all adult year classes participate in spawning (including fish reaching 1 year of age), so maintaining river habitat, especially during dry periods is beneficial by sustaining the reproductive stock and maintaining population self-sustainability.

Helping to maintain flow during low-flow periods also helps to protect the primary constituent elements of critical habitat for the silvery minnow, including space for individual and population growth, food, water quantity and quality, cover or shelter, sites for breeding, reproduction, or rearing of offspring, and habitats that are protected from disturbance or are representative of the historical geographical and ecological distributions of the species. Continuous summer flow helps to maintain habitat, including water depth, temperature, and quality, as well as food production.

In summary, the State's administration of the Rio Grande Compact may affect, but is not likely to adversely affect the Rio Grande silvery minnow or adversely affect its critical habitat. Providing relinquished credit water during low-flow periods is likely to benefit the species by maintaining river flow and providing continuous wetted habitat.

Table II-39. Direct and indirect effects of the State's administration of the New Mexico credit water and allocation of relinquished Compact credits on life stages and critical habitat of the Rio Grande silvery minnow

	Life Stage				
	Spawning	**Eggs**	**Larval**	**Juvenile**	**Adult**
Spring (March–May)	There is no effect to spring peak flow from this action and no effect on spawning, eggs, or larval life stages of the silvery minnow.			There is no effect to spring peak flow from this action and no effect on juvenile or adult life stages of the silvery minnow.	
Summer (June–August)	The amount of spawning that may occur in summer is small and inconsequential; this action provides more water during low-flow periods, and is likely to benefit spawning, egg, and larval life stages of the silvery minnow.			This action provides more water during low-flow periods in summer, fall, and winter, and is likely to benefit juvenile and adult life stages of the silvery minnow.	
Fall (September–November)	Spawning, egg, and larval life stages of the silvery minnow do not normally occur in fall or winter.				
Winter (December–February)					
Primary Constituent Elements (PCEs)					
A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.	Water released during low-flow periods provides more flowing water that helps to maintain a diversity of aquatic habitats for all life stages of silvery minnow; this action is likely to enhance this PCE of critical habitat for the silvery minnow.				
Presence of a diversity of habitats for all life history stages					
Sufficient flows from early spring (March) to early summer (June) to trigger spawning	There is no effect on flows from March to June from this action and no effect on spawning triggers for the silvery minnow.				
Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow	Water released during low-flow periods (Jun-Oct) provides more flowing water that reduces the periods of low or no flow; this action is likely to enhance this PCE of critical habitat for the silvery minnow.				
Constant winter flow	Water released in winter will help to maintain constant flows and provide persistent habitat for fish, especially in deepened pools and around instream woody debris; this action is likely to enhance this PCE of critical habitat for the silvery minnow.				
River reach length	Water released during low-flow periods helps to maintain river continuity and reach length; this action is likely to enhance this PCE of critical habitat for the silvery minnow.				
Habitat "quality" in each reach and refugial habitats	Water released during low-flow periods helps to maintain habitat quality in each reach and habitats where fish can take refuge during extremely low flows; this action is likely to enhance this PCE of critical habitat for the silvery minnow.				
Substrates of predominantly sand or silt	This action does not affect sediment transport or substrate composition of the river.				

Table II-39. Direct and indirect effects of the State's administration of the New Mexico credit water and allocation of relinquished Compact credits on life stages and critical habitat of the Rio Grande silvery minnow

	Life Stage				
	Spawning	**Eggs**	**Larval**	**Juvenile**	**Adult**
Primary Constituent Elements (PCEs) (cont.)					
Temp >1° - <30°C DO > 5 mg/L pH (6.6–9.0) Other contaminants	Water released during low-flow periods helps to maintain river flow, dilution, and circulation that benefits water quality; this action is likely to enhance these PCEs of critical habitat for the silvery minnow.				

Administration of Surface Water and Groundwater Supplies. This action category includes administration of surface water and groundwater supplies above and below the Otowi gage, including transfer of senior water rights and the letter water program. The NMOSE administers surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (i.e., 1929 conditions). Administering water supplies above the Otowi gage results in a discountable effect on the silvery minnow as the gage is located far upstream of occupied or critical habitat.

The State is expecting that about 5,000 AF of water will be transferred through senior water rights in the next 10 years in the MRG. In general, during spring runoff or when the MRGCD is releasing stored water, transfer of a senior water right has a *de minimis* effect on river flow. During winter months, river flow is continuous, however, and transfers have a small impact on flow due to continuing pumping at the move-to location. During summer months, transfers have an impact during periods of low river flows or when MRGCD has no stored water to release. These conditions have occurred about three times in September and October of the last 10 years (i.e., 30% of years) and not at all in the 20 preceding years. The impact of senior water rights transfers from the Isleta and Socorro Divisions to the Albuquerque Reach would result in a flow reduction of 0 cfs at the Central gage (Albuquerque Reach) increasing linearly to 5.5 cfs after 10 years. This flow reduction is small in comparison to average annual flow, and is within the margin of uncertainty for flow measurement. However, in years of extremely low flow, this reduction could adversely affect habitat and the silvery minnow in the Albuquerque Reach only (Table II-40).

In general, the amount of letter water has an insignificant effect on river flows as measured at the Central gage (1.5 cfs). Letter water has no effect on river flow during spring runoff, or when MRGCD is releasing stored water or during winter months. The letter water program is likely to have little effect on the silvery minnow and its critical habitat. The letter water program provides a near real-time offset of the groundwater pumping effects on the river system, except during times when MRGCD is not releasing water from storage. These conditions have occurred about three times in September and October of the last 10 years and not at all in the 20 preceding years. Total effect of administering surface water and groundwater supplies in the action area is a flow reduction in the Albuquerque Reach of about 1.5 cfs increasing linearly to 7 cfs after 10 years. In addition, the State proposes to add 3 cfs of possible additional flow reduction at the Albuquerque gage after 10 years as part of the evaluation. The addition is specific to the State intent for the RIP to afford broad coverage for New Mexico water users into the future.

In summary, the State's Administration of surface water and groundwater supplies in the middle Rio Grande may affect and is likely to adversely affect the silvery minnow or adversely affect its critical habitat. Flow reduction in years of extremely low flow could adversely affect habitat and the silvery minnow in the Albuquerque Reach only.

Table II-40. Direct and indirect effects of the State's administration of surface water and groundwater supplies in the middle Rio Grande on life stages and critical habitat of the Rio Grande silvery minnow

<table>
<tr><th rowspan="2"></th><th colspan="5">Life Stage</th></tr>
<tr><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (March-May)</td><td colspan="5">Flow reduction of 1.5 cfs in the MRG and increasing to 7 cfs in the Albuquerque Reach only is small and immeasurable compared to snowmelt spring runoff and the effect on all life stages of silvery minnow is likely to be insignificant.</td></tr>
<tr><td>Summer (June-August)</td><td colspan="3">Flow reduction of 1.5–10 cfs in the Albuquerque Reach could reduce flow stability and habitat for spawning, egg, and larval life stages of the silvery minnow, but the effect is expected to be inconsequential because there is little spawning in summer.</td><td colspan="2" rowspan="3">• Flow reduction of 1.5 cfs river-wide is immeasurable and would have an insignificant effect on the silvery minnow.
• Flow reduction of 1.5–10 cfs in the Albuquerque Reach could increase periods of low flow and reduce fish habitat in summer, fall, and winter; this action is likely to adversely affect juvenile and adult life stages of the silvery minnow in the Albuquerque Reach only.</td></tr>
<tr><td>Fall (September-November)</td><td colspan="3" rowspan="2">Spawning, egg, and larval life stages of the silvery minnow do not normally occur in fall or winter.</td></tr>
<tr><td>Winter (December-February)</td></tr>
<tr><td colspan="6">Primary Constituent Elements (PCEs)</td></tr>
<tr><td>A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.</td><td colspan="3" rowspan="2">Flow reduction of 1.5 cfs in the MRG and increasing to 10 cfs in the Albuquerque Reach after 10 years is small and immeasurable compared to snowmelt spring runoff and the effect on the hydrologic regime and habitat diversity for spawning, egg, and larval life stages of silvery minnow is likely to be insignificant.</td><td colspan="2" rowspan="2">• Flow reduction of 1.5 cfs river-wide is immeasurable and would have an insignificant effect on the silvery minnow.
• Flow reduction of 1.5–10 cfs in the Albuquerque Reach may have a small effect on the hydrologic regime during low-flow periods and reduce habitat diversity in summer, fall, and winter; this action is likely to adversely affect these PCEs of critical habitat for juvenile and adult life stages of the silvery minnow in the Albuquerque Reach only.</td></tr>
<tr><td>Presence of a diversity of habitats for all life history stages</td></tr>
<tr><td>Sufficient flows from early spring (March) to early summer (June) to trigger spawning</td><td colspan="5">Flow reduction of 1.5 cfs in the MRG and increasing to 10 cfs in the Albuquerque Reach is small and immeasurable during runoff in early spring (March–April), but could adversely affect habitat during low-flow periods that can occur in May or June in the Albuquerque Reach; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow in the Albuquerque Reach only.</td></tr>
<tr><td>Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow</td><td colspan="5">Flow reduction of 1.5–10 cfs in the Albuquerque Reach could prolong periods of low flow during Jun-Oct; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow in the Albuquerque Reach only.</td></tr>
</table>

Table II-40. Direct and indirect effects of the State's administration of surface water and groundwater supplies in the middle Rio Grande on life stages and critical habitat of the Rio Grande silvery minnow

	Life Stage				
	Spawning	**Eggs**	**Larval**	**Juvenile**	**Adult**
Primary Constituent Elements (PCEs) (cont.)					
Constant winter flow	Flow reduction of 1.5–10 cfs in the Albuquerque Reach would not be expected to affect the constancy of flow in winter; this action is not likely to adversely affect this PCE of critical habitat for the silvery minnow.				
River reach length	Flow reduction of 1.5–10 cfs in the Albuquerque Reach would not be expected to affect river reach length; this action is not likely to adversely affect this PCE of critical habitat for the silvery minnow.				
Habitat "quality" in each reach and refugial habitats	Flow reduction of 1.5 cfs is immeasurable and would not prolong periods of low or no flow in the Isleta or San Acacia Reaches; flow reduction of 1.5–10 cfs in the Albuquerque Reach could prolong periods of low flow and reduce habitat quality and availability of refuge habitats; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow in the Albuquerque Reach only.				
Substrates of predominantly sand or silt	This action does not affect sediment transport or substrate composition of the river.				
Temp >1° - <30°C DO > 5 mg/L pH (6.6–9.0) Other contaminants	Flow reduction of 1.5 cfs is immeasurable and would not affect water temperature, DO, pH, or contaminants in the Isleta or San Acacia Reaches; flow reduction of 1.5–10 cfs in the Albuquerque Reach could prolong periods of low flow and affect water temperature, DO, pH, or contaminants; this action is likely to adversely affect these PCEs of critical habitat for the silvery minnow in the Albuquerque Reach only.				

Administration of Domestic, Municipal, Livestock and Temporary Uses. The NMOSE administers surface water and groundwater supplies for the purpose of domestic, municipal, livestock, and temporary uses in the State of New Mexico. This includes administration of water supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (i.e., 1929 conditions), which has a discountable effect on the silvery minnow as the gage is located far upstream of occupied or critical habitat.

The State is expecting about 5,000 AF of domestic well permits in the MRG over the next 10 years and that the effects of those wells will be distributed similar to the current distribution. Assuming 50% of total domestic well diversions return to the hydrologic system, the total impact on the river is a reduction of flow of about 2,500 AF or about 3.5 cfs at the headwaters of Elephant Butte Reservoir. The expected impact at the Albuquerque gage is a reduction of flow of about 2.25 cfs after 10 years.

This amount of flow reduction is small and immeasurable during snowmelt spring runoff and the effect of this reduction on the silvery minnow is expected to be insignificant (Table II-41). However, flow reduction of 2.25 cfs at Albuquerque to 3.5 cfs at the headwaters of Elephant Butte could prolong periods of low or no flow in the Isleta and San Acacia Reaches and adversely affect the silvery minnow and its habitats.

In summary, the State's Administration of domestic, municipal, livestock and temporary uses in the middle Rio Grande may affect and is likely to adversely affect the Rio Grande silvery minnow or adversely affect its critical habitat. Flow reduction during low-flow periods could prolong periods of low or no flow and adversely affect the silvery minnow and its habitat.

Table II-41. Direct and indirect effects of the State's administration of domestic, municipal, livestock and temporary uses in the middle Rio Grande on life stages and critical habitat of the Rio Grande silvery minnow

<table>
<tr><th rowspan="2"></th><th colspan="5">Life Stage</th></tr>
<tr><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td>Spring (March–May)</td><td colspan="5">The magnitude of flow reduction (2.25 cfs at Albuquerque to 3.5 cfs at the headwaters of Elephant Butte) is small and immeasurable compared to snowmelt spring runoff and the effect on all life stages of silvery minnow is likely to be insignificant.</td></tr>
<tr><td>Summer (June–August)</td><td colspan="3">Flow reduction of 2.25-3.5 cfs could reduce flow stability and habitat for spawning, egg, and larval life stages of the silvery minnow, but the effect is expected to be discountable because there is little spawning in summer.</td><td colspan="2" rowspan="3">Flow reduction of 2.25–3.5 cfs could increase periods of low flow and reduce fish habitat in summer, fall, and winter; this action is likely to adversely affect juvenile and adult life stages of the silvery minnow.</td></tr>
<tr><td>Fall (September–November)</td><td colspan="3" rowspan="2">Spawning, egg, and larval life stages of the silvery minnow do not normally occur in fall or winter.</td></tr>
<tr><td>Winter (December–February)</td></tr>
<tr><td colspan="6">Primary Constituent Elements (PCEs)</td></tr>
<tr><td>A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats.</td><td colspan="3" rowspan="2">The magnitude of flow reduction (2.25-3.5 cfs) is small and immeasurable compared to snowmelt spring runoff and the effect on the flow regime and habitat diversity for spawning, egg, and larval life stages of silvery minnow is likely to be insignificant.</td><td colspan="2" rowspan="2">Flow reduction of 2.25–3.5 cfs could have a small effect on the hydrologic regime during low-flow periods and reduce habitat diversity in summer, fall, and winter; this action is likely to adversely affect these PCEs of critical habitat for juvenile and adult life stages of the silvery minnow.</td></tr>
<tr><td>Presence of a diversity of habitats for all life history stages</td></tr>
<tr><td>Sufficient flows from early spring (March) to early summer (June) to trigger spawning</td><td colspan="5">Flow reduction of 2.25–3.5 cfs is small and immeasurable during runoff in early spring (Mar-Apr), but could adversely affect habitat during low-flow periods that can occur in May or June; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
<tr><td>Flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow</td><td colspan="5">Flow reduction of 2.25–3.5 cfs could prolong periods of low flow during Jun-Oct; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
<tr><td>Constant winter flow</td><td colspan="5">Flow reduction of 2.25–3.5 cfs would not be expected to affect the constancy of flow in winter; this action is not likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
<tr><td>River reach length</td><td colspan="5">Flow reduction of 2.25–3.5 cfs could affect river reach length in the Isleta or San Acacia Reaches; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
<tr><td>Habitat "quality" in each reach and refugial habitats</td><td colspan="5">Flow reduction of 2.25–3.5 cfs could prolong periods of low or no flow and reduce habitat quality and availability of refuge habitats; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
<tr><td>Substrates of predominantly sand or silt</td><td colspan="5">This action does not affect sediment transport or substrate composition of the river.</td></tr>
<tr><td>Temp >1˚ - <30˚C
DO > 5 mg/L
pH (6.6-9.0)
Other contaminants</td><td colspan="5">Flow reduction of 2.25–3.5 cfs could prolong periods of low flow and affect water temperature, DO, pH, or contaminants; this action is likely to adversely affect this PCE of critical habitat for the silvery minnow.</td></tr>
</table>

2.4.5.2.2 Southwestern Willow Flycatcher

Summary of Effects on the Flycatcher

In summary, the State's actions may affect, but are not likely to adversely affect the flycatcher or adversely affect its critical habitat. Flow reductions from administration of water supplies and other uses are small in magnitude compared to snowmelt-spring runoff and early summer when the birds are nesting and fledging, and most effects are either discountable or insignificant (Table II-42). Administration of the Rio Grande Compact and surface water and groundwater supplies generally help to provide water during low natural flow periods that offset groundwater depletions and maintain flow during conveyance. These actions help to provide more reliable river flow and help reduce the frequency, duration, or magnitude of drying. These actions also maintain water in the river that helps to sustain the overall river ecosystem and riparian areas used by the flycatchers for nesting, feeding, and stopover.

Effects on the Flycatcher by Action Category

A summary of the hydrologic impact of the State's action by category is presented in Table II-42. This section describes the direct and indirect effects of each action category on life stages and primary constituent elements of critical habitat of the flycatcher.

Administration of the Rio Grande Compact. The effects of the State's administration of the Rio Grande Compact are on the whole, insignificant or slightly beneficial as measured by the ability of making relinquished credit water available in upstream storage for release to fulfill municipal, irrigation and environmental needs and when native water storage would otherwise not be available. Water stored during runoff and released during low-flow periods provides a higher frequency of continuous flow in the MRG that could benefit the flycatcher by providing a more stable riparian vegetative community (Table II-43).

The flycatcher uses some sites of the MRG for nesting and rearing in spring and early summer, and at other times of the year there are either few birds in the area or the birds of all ages are mobile and move to necessary feeding and resting sites. The release of the relinquished water during spring runoff has immeasurable impact on peak flow and is expected to have insignificant effect on the flycatcher.

This action may affect, but is not likely to adversely affect the flycatcher or its critical habitat.

Table II-42. Summary of direct and indirect effects of the State's actions on the flycatcher

Action Category	Summary of Hydrologic impact	Summary of Effects to Flycatcher
Administration of Rio Grande Compact	• Allocation of New Mexico relinquished credit for irrigation, M&I and environmental uses is beneficial to the ecosystem because it provides more water to the system during low-flow periods. • The effect of storing and releasing the water is analyzed with the El Vado storage action above.	This action allows other entities to store water almost exclusively during the spring runoff to meet water needs at other times of the year. Providing relinquished NM credit water during low natural flow periods helps to maintain river flow and provide more wetted habitat. This action may affect, but is not likely to adversely affect the flycatcher or adversely affect its critical habitat. This action is likely to benefit the flycatcher.
Administration of Surface Water and Groundwater Supplies	• Upper Rio Grande: There is no hydrologic impact to the middle Rio Grande from the Upper Rio Grande because of the NMOSE's continued administration of surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (1929 conditions). • Middle Rio Grande: The total hydrologic impact of administering surface water and groundwater supplies is calculated as a reduction of flow in the Albuquerque Reach of about 1.5 cfs at the beginning of the consultation increasing to 7 cfs after 10 years. • The State proposes to add 3 cfs of possible additional flow reduction as part of the evaluation. The addition is specific to the State intent for the RIP to afford broad coverage for New Mexico water users into the future. The intent is to set the foundation for potential projects not already address elsewhere, for future streamlined consultation through the RIP.	• The continued administration of surface water and groundwater supplies above the Otowi gage has no effect on the flycatcher or its critical habitat. • A flow reduction of 1.5 cfs is part of the San Juan-Chama offset program and is small and immeasurable; however, a flow reduction of up to 7 cfs could occur in the Albuquerque Reach in Sep–Oct during times when MRGCD is not releasing water from storage (about 30% of years). This flow reduction would increase over the 10-year period, but it occurs after the birds have nested and fledged and would have no effect on the more mobile juveniles and adults. This action may affect, and is not likely to adversely affect the flycatcher or adversely affect its critical habitat. • If the additional flow reduction occurs, an additional depletion of 3 cfs would result in total flow depletion of 4.5 cfs and up to 10 cfs after 10 years in the Albuquerque Reach in Sep-Oct when MRGCD is not releasing water from storage. This could result in additional river drying, and it is still anticipated that this action may affect, but is not likely to adversely affect the flycatcher or adversely affect its critical habitat.
Administration of Domestic, Municipal, Livestock and Temporary Uses	• Upper Rio Grande: There is no hydrologic impact to the middle Rio Grande from the Upper Rio Grande because of the NMOSE's continued administration of surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (1929 conditions). • Middle Rio Grande: The total hydrologic impact of administering domestic, municipal, livestock and temporary uses is estimated to be zero cfs at the beginning of the consultation period increasing to about 2.25 cfs at the Albuquerque gage and 3.5 cfs at the headwaters of Elephant Butte Reservoir after 10 years.	• The continued administration of surface water and groundwater supplies above the Otowi gage has no effect on the flycatcher or its critical habitat. • A flow reduction ranging longitudinally from 2.25 cfs at the Albuquerque gage to 3.5 cfs at the headwaters of Elephant Butte Reservoir is immeasurable during spring peak flows and the effect on nesting and fledging flycatchers would be insignificant; during low-flow periods, this flow reduction (in addition to 1.5 cfs reduction from the offset program) would occur after the birds have nested and fledged and would have no effect on the more mobile juveniles and adults. This action may affect, but is not likely to adversely affect the flycatcher or adversely affect its critical habitat.

Table II-43. Direct and indirect effects of administration of the New Mexico credit water and allocation of relinquished Compact credits on life stages and critical habitat of the flycatcher

Life Stage	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April to September)	This action would have no effect on flycatcher stopover locations during migration due to the fact that flycatchers will use habitat that is less suitable and farther away from water sources during this time.	This action could provide a more reliable continuous river flow, but the effect is expected to be negligible to flycatchers establishing territories and building nests during spring when river flow is otherwise high; water released during low-flow periods is likely to be a small benefit to the species.	Nesting flycatchers are in their territories and less likely to abandon nests if conditions dry or decline in value; water released during low-flow periods is likely to be a small benefit to the species.
Primary Constituent Elements (PCEs)			
Riparian Vegetation	Riparian habitat is in a dynamic successional environment to be used for nesting, foraging, migration, dispersal and shelter. Dense tree or shrub vegetation are in close proximity to open water or marsh areas. This action, on the whole, is slightly beneficial as measured by the ability of making relinquished water available for more river flow; this action is likely to benefit or have insignificant effect on this PCE of critical habitat of the flycatcher.		
Insect Prey Populations	A variety of insect prey populations is found in close proximity to riparian floodplains or moist environments. Water released during low-flow periods may enhance aquatic insect populations, but this beneficial effect is expected to be insignificant on this PCE. Many insect populations are found in ponded water or low-lying areas or drains adjacent to the river.		

Administration of Surface Water and Groundwater Supplies. This action category includes administration of surface water and groundwater supplies above and below the Otowi gage, including transfer of senior water rights and the letter water program. The NMOSE administers surface water and groundwater supplies above the Otowi gage to maintain the status quo of the hydrologic system balance (i.e., 1929 conditions). Administering water supplies above the Otowi gage results in a discountable effect on the flycatcher, as the gage is located far upstream of occupied or critical habitat.

Flow reductions of 1.5 cfs riverwide and 1.5–10 cfs in the Albuquerque Reach are not expected to affect migration, establishment of territories, nesting, or fledging of flycatchers (Table II-44). This flow reduction is of small magnitude and should not decrease the potential for overbank flooding or overall water availability for vegetation; it should not cause a decline in territories or canopy cover/plant health/seed establishment.

This action may affect, but is not likely to adversely affect the flycatcher or its critical habitat.

Table II-44. Direct and indirect effects of administration of surface water and groundwater supplies in the MRG on life stages and critical habitat of the flycatcher

Life Stage	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April to September)	This action would have no effect on flycatcher stopover locations during migration due to the fact that flycatchers will use habitat that is less suitable and farther away from water sources during this time.	Flow reduction of 1.5–10 cfs is not expected to be of large enough magnitude to affect establishment of territories or nest building; this flow reduction should not decrease the potential for overbank flooding or overall water availability for vegetation, and it should not cause a decline in territories or canopy cover/plant health/seed establishment.	Nesting flycatchers are in their territories and less likely to abandon nests if conditions dry or decline in value; flow reductions of 1.5 cfs river-wide and 1.5–10 cfs in the Albuquerque Reach are not expected to reduce availability of nesting sites or feeding areas for fledging of young.
Primary Constituent Elements (PCEs)			
Riparian Vegetation	Riparian habitat is in a dynamic successional environment to be used for nesting, foraging, migration, dispersal and shelter. Dense tree or shrub vegetation are in close proximity to open water or marsh areas. Flow reductions of 1.5 cfs riverwide and 1.5–10 cfs in the Albuquerque Reach are not expected to reduce availability of riparian vegetation; this action is expected to have little or negligible effect on this PCE of critical habitat of the flycatcher.		
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. Flow reductions of 1.5 cfs river-wide and 1.5–10 cfs in the Albuquerque Reach are not expected to adversely affect availability of insect prey populations; this action is expected to have negligible effect on this PCE. Many insect populations are found in ponded water or low-lying areas or drains adjacent to the river.		

Administration of Domestic, Municipal, Livestock and Temporary Uses. The NMOSE will continue to issue permits for small domestic, livestock and temporary uses as required by NMSA 1978 Sections 72-12-1.1 through 72-12-1.3, in accordance with the NMOSE 2006 Rules and Regulations Governing the Use of Public Underground Waters for Household and Other Domestic Use.

The State is expecting about 5,000 AF of domestic well permits in the MRG over the next 10 years and that the effects of those wells will be distributed similar to the current distribution. Assuming 50 percent of total domestic well diversions return to the hydrologic system, the total impact on the river is a reduction of flow of about 2,500 AF or about 3.5 cfs at the headwaters of Elephant Butte Reservoir. The expected impact at the Albuquerque gage is a reduction of flow of about 2.25 cfs after 10 years.

This amount of flow reduction is small and immeasurable during snowmelt spring runoff and the effect of this reduction on the flycatcher is expected to be insignificant (Table II-45). The magnitude of flow reduction of 2.25 cfs at Albuquerque to 3.5 cfs at the headwaters of Elephant Butte is within the margin of measurement error for base flow and the effect to the flycatcher is expected to be insignificant.

This action may affect, but is not likely to adversely affect the flycatcher or its critical habitat.

Table II-45. Direct and indirect effects of administration of domestic, municipal, livestock, and temporary uses in the MRG on life stages and critical habitat of the flycatcher

Life Stage	Migration (April–June and July–September)	Arrival to Territories/Territory Establishment/Nest Building (May–July)	Egg Laying/Incubation/ Nestling/Fledgling (June–August)
Breeding Season (April to September)	This action would have no effect on flycatcher stopover locations during migration because flycatchers will use habitat that is less suitable during this time and farther away from water sources.	Reductions in flow of 2.25–3.5 cfs in the MRG would have an insignificant effect on snowmelt runoff. This action is not expected to decrease the potential of overbank flooding or decrease the overall water available for vegetation, and no decline in territory recruitment and canopy cover/plant health/seed establishment is expected.	Flycatchers during nesting are in their territories and less likely to abandon nests if conditions dry or decline in value.
Primary Constituent Elements (PCEs)			
Riparian Vegetation	Riparian habitat is in a dynamic successional environment to be used for nesting, foraging, migration, dispersal and shelter. Dense tree or shrub vegetation are in close proximity to open water or marsh areas. Flow reductions of 2.25–3.5 cfs in the MRG are not expected to reduce availability of riparian vegetation; this action is expected to have an insignificant effect on this PCE of critical habitat of the flycatcher.		
Insect Prey Populations	A variety of insect prey populations found in close proximity to riparian floodplains or moist environments. Flow reductions of 2.25–3.5 cfs in the MRG are not expected to adversely affect availability of insect prey populations; this action is expected to have an insignificant effect on this PCE. Many insect populations are found in ponded water or low-lying areas or drains adjacent to the river.		

2.4.5.2.3 Yellow-Billed Cuckoo

The western distinct population segment of the yellow-billed cuckoo was listed as threatened in October 2014 (79 FR 59992). The geographical breeding range of the cuckoo in western North America includes suitable habitat within the low- to moderate-elevation areas west of the crest of the Rocky Mountains in Canada, Mexico, and the United States, including the URG, MRG, and other western river basins. The Middle and Lower Rio Grande are also used as a migration corridor by the species. The alteration of riparian systems in western river basins through changes in hydrologic function and the introduction of nonnative plants, like tamarisk, have negatively impacted the nesting, roosting, and feeding habitat of the cuckoo. There is currently a low occurrence of the cuckoo in the MRG, and effects of the State's actions are expected to be discountable or insignificant because effects on river flows due to the proposed State actions are within the margin of uncertainty for flow measurement.

The entire MRG from below Cochiti Dam to Elephant Butte Reservoir has been proposed as critical habitat for the cuckoo (79 FR 48548). This is based on the number of cuckoo breeding pairs identified in the area, the amount of habitat available, and the relationship and importance of the Elephant Butte Reservoir and Rio Grande to other cuckoo habitat in New Mexico and the southwest. Other areas of proposed critical habitat are located along the Rio Grande upstream and downstream of the MRG, but these are too removed from the action area as to be affected by the State's action as described in this biological assessment. For the proposed critical habitat within the action area, flow reductions by the State are small and would have insignificant effects on habitat of the cuckoo.

The State's action may affect, but is not likely to adversely affect the cuckoo or its proposed critical habitat.

2.4.5.2.4 New Mexico Meadow Jumping Mouse

The jumping mouse was listed as endangered throughout its range in Arizona, Colorado, and New Mexico in June 2014 (79 FR 33119). The jumping mouse has exceptionally specialized habitat requirements to support these life-history needs and maintain adequate population sizes. Habitat requirements are characterized by tall (averaging at least 61 cm), dense riparian herbaceous vegetation (plants with no woody tissue) primarily composed of sedges and forbs. This suitable habitat is found only when wetland vegetation achieves full growth potential associated with perennial flowing water. The historical distribution of the jumping mouse is the Rio Grande Valley from Española to the BDA. The species is currently found only along the irrigation ditches and canals in the area of the wildlife refuge and managed by the refuge.

Three areas of historical habitat are included in proposed critical habitat for the jumping mouse (78 FR 37328): the Isleta Marsh on land owned by the Isleta Pueblo, the Ohkay Owingeh Marsh on land owned by the Ohkay Owingeh Tribe, and the BDA canal administered by the Service. Only the last area is currently occupied by the species. Because the jumping mouse is found in the MRG in lateral drains and canals that are some distance from the river, the State's actions are removed from the immediate management of these laterals and effects are considered discountable and insignificant with respect to the State administration of water.

The State's action may affect, but is not likely to adversely affect the jumping mouse or its proposed critical habitat.

2.4.5.2.5 Pecos Sunflower

One of seven populations of the Pecos sunflower occurs near the Rio Grande in New Mexico. The main population presently exists within the La Joya WMA, a unit of the Ladd S. Gordon Waterfowl Complex, managed by NMDGF. The La Joya WMA was excluded from critical habitat designation for the species because of the development of a habitat management plan that adequately protects the species. In 2010, the population was extended to a ditch (cleared of tamarisk and seeded with Pecos sunflowers) that delivers water between ponds within the La Joya WMA.

The Pecos sunflower in the MRG is limited to the areas described above within the La Joya WMA The State's actions have little effect on the area occupied by the Pecos sunflower and on the canals that transfer water from ponds within the La Joya WMA.

The State's actions will have no effect on the Pecos sunflower.

2.5 Interrelated and Interdependent Actions

In addition to activities authorized, funded, or carried out by federal agencies, section 7 consultation regulations also require agencies to analyze the effects of interrelated and interdependent actions along with the direct and indirect effects of the proposed action. Interdependent actions are those having no independent utility apart from the Proposed Action (defined in 50 CFR §402.02). Interrelated actions are those actions that are part of a larger action and depend on the larger [proposed] action for their justification (defined in 50 CFR §402.02). The Proposed Action model runs also include the interrelated and interdependent actions of the Corps as described below.

2.5.1 The Corps Actions Related to the SJC Project

Reclamation has determined that the following components of the Corps' actions are interrelated and interdependent with Reclamation's actions:

1. Storage of SJC Project water in Abiquiu Reservoir.
2. Use of SJC Project water to offset evaporation and other depletions occurring at the Cochiti Reservoir recreational pool.

2.5.1.1 Storage for SJC Project Contractors at Abiquiu Reservoir

The Corps stores up to approximately 180,000 AF of SJC Project water in Abiquiu Reservoir, pursuant to agreements with SJC Project contractors. The contractors take ownership of their SJC Project water upon release from Heron Dam by Reclamation and can elect to deliver this water to Abiquiu Reservoir for storage.

As discussed in the following Effects Analysis, the transport of SJC Project water within the Rio Grande Basin is beneficial to listed species and designated and proposed critical habitat because it increases both the discharge rate and volume above that of natural flow. Water stored by non-federal entities in Abiquiu Reservoir also has been used, at their discretion, to offset groundwater depletions or has been made available for purchase or lease by others, including Reclamation for its Supplemental Water Program. Reclamation expects these uses to continue in the future.

No listed species or designated critical habitat occurs between Heron Dam and Abiquiu Dam; therefore, the discretionary storage of SJC Project water in Abiquiu Reservoir will have no effect on the silvery minnow, flycatcher, cuckoo, or jumping mouse, or proposed or designated critical habitat of these species. The related release of such water—at the discretion of other entities—is benign or beneficial to the silvery minnow, flycatcher, cuckoo, and jumping mouse and their proposed or designated critical habitat. There is no effect on Pecos sunflower.

2.5.1.2 Use of SJC Project Water for Cochiti Recreation Pool Replacement Water

The Corps uses SJC Project water at the end of spring runoff and during the winter months to replace water that has evaporated from the Cochiti Recreation Pool. The elevation of the recreation pool increases approximately 1–1.5 feet with partial delivery of replacement water, and up to 3 feet after all replacement water is delivered in a given year. The Corps follows recommendations from a multi-agency biological advisory group to maximize the benefits of the replacement water to the wetlands in the delta area of Cochiti Lake (Allen et al. 1993). The use of water for the recreation pool does not change the hydrograph downstream from Cochiti Dam.

The silvery minnow does not occur between Heron Dam and Cochiti Lake; nor does designated critical habitat for this species.

Designated critical habitat for flycatcher does not occur between Heron Dam and Cochiti Lake. Flycatchers are known to use the river corridor upstream of Cochiti Lake during spring migration (Reclamation 2010) and are presumed to be similarly present during fall migration. The annual replenishment of evaporation losses at Cochiti Lake maintains existing riparian and wetland habitat immediately upstream of the permanent pool. Therefore, the use of recreation pool replacement water would have no effect on flycatcher. This action may have an indirect, beneficial effect by maintaining riparian habitat used by migrating flycatchers and potentially cuckoos.

The jumping mouse historically occurred on Ohkay Owingeh Pueblo in areas to the north and south of the confluence of the Chama River and Rio Grande. During surveys performed in 2012, no jumping mice were found on the Pueblo. The historical jumping mouse habitat located on the Rio Grande approximately 1.5 miles south of the confluence may have been indirectly and beneficially affected by this replacement water by maintaining wetland and riparian habitat used by jumping mice.

There is no effect on Pecos sunflower.

2.6 Summary Effects Analysis of Proposed Water Management Actions

2.6.1 Summary of the Effects of Reclamation’s Actions

The analyses show that Reclamation’s ability to affect the timing and distribution of flows in the MRG is extremely limited. Reclamation’s actions affect only imported SJC Project water and the portion of the native flows of the Rio Chama, a tributary to the Rio Grande, that are stored in El Vado Reservoir. Reclamation has no ability to affect the flows of the Rio Grande main stem that comprise a strong majority of the flow in the MRG.

Although Reclamation's discretionary actions have limited impact on flows in the MRG, model simulations demonstrate that these limited influences are, on the whole, positive, as measured by the ability to maintain summertime flows in the MRG. Additionally, because Reclamation's storage of water in the springtime only diminishes flows of the Rio Chama in the reach between El Vado Dam and Abiquiu Reservoir, Reclamation's actions have very little influence on the size and timing of the spring snowmelt runoff. The primary spring runoff, which has been correlated with the spring spawn of the silvery minnow, comes from the main stem of the Rio Grande and is larger, longer in duration, and later in time than the runoff from the Rio Chama. Flows on the Rio Chama are limited to 1,800 cfs by the Corps' flood control operations at Abiquiu Dam; therefore, the Rio Chama on its own, with or without operation of Reclamation's Projects, cannot cause a flow in the MRG of greater than 1,800 cfs.

The water that the MRGCD diverts consists of the natural flows of the main stem of the Rio Grande and its tributaries, as well as native Rio Grande water released from El Vado Reservoir and imported SJC water from Reclamation's SJC Project. About 90% of the flows in the MRG are composed of natural flow that is native to the basin and has not been regulated by reservoirs. These natural flows provide 79.2% of the MRGCD's diversion demand, which is used to meet the needs of the Six MRG Pueblos, MRGCD irrigators, and BDA. Only 5.9% of the MRGCD diversion demand is met with water released from storage at El Vado Reservoir. Reclamation's operation of Heron Dam under the SJC Project accounts for approximately 6.7% of the MRGCD diversion demand.

2.6.2 Summary of the Effects of MRGCD's Water Management Actions

The MRGCD's permit from the NMOSE to divert flows of the Rio Grande allows the MRGCD to divert up to 100% of the available natural flow in the MRG. The MRGCD has been diverting flows from the Rio Grande to serve irrigated acreages at and above the current level since the early 1930s. The MRGCD system replaced a pre-existing, acequia-based diversion and irrigation system that had been in place for hundreds of years, with a maximum irrigated acreage of 180,000 acres in the late 1800s.

These diversions have the effect of reducing Rio Grande flows during the irrigation season. During times of high flows, the impact may be minor. During times of lower flow, the effect may be significant and may result in river drying. However, it should be noted that, in most years, the natural flow of the Rio Grande is insufficient to sustain riparian evapotranspiration and open water evaporation of the MRG, so that drying likely would occur in the absence of MRGCD diversions. During those times, MRGCD submits requests to Reclamation to release stored water from El Vado Reservoir (when available) to augment the natural flow of the Rio Grande to the level required for MRGCD diversion works to function. During full irrigation system operations, this results in continuous flow as far downstream as Isleta Diversion Dam. The MRGCD can supply irrigation water to all of its members with no flow downstream from the Isleta Diversion Dam, as the needs of the Socorro Division (otherwise served by the San

Acacia Diversion Dam) can be met by return flows from the Belen Division, transported between divisions using the Unit 7 Drain, a State drain, as a conveyance.

The effect of MRGCD diversions is to reduce flow in the Rio Grande downstream from those diversions during the irrigation season. However, the effect of operations of El Vado Reservoir, which support these diversions, is to increase flows upstream of those diversions during the same time period. Significant river drying could still occur in the MRG without the combined effects of El Vado operations and irrigation diversions. Flows from MRGCD drains and wasteways can increase flows in critical reaches, especially in the Albuquerque and Isleta Reaches.

2.6.3 Summary of Effects on Species

2.6.3.1 Silvery Minnow

The Proposed Action may have adverse effects to spawning and recruitment due to reduction of peak flows, and to juvenile and adult survival due to reduced flow in some reaches and drying. Effects are minor on spawning and recruitment due to timing of storage and releases, origin of flows, and magnitude of MRG water use relative to spring flow. There is little difference between the Proposed Action and No Action scenarios in the duration of flows high enough to have channel altering capacity, so there is little direct effect to current silvery minnow habitat features within the MRG.

Reclamation's Proposed Action is specific to storage and later release of water from SJC Project water from Heron Reservoir and native Rio Chama water from El Vado Reservoir. The water then passes through two other reservoirs, operated by the Corps, prior to reaching occupied silvery minnow habitat. Stored SJC Project water is released for contractors as additional water to the Rio Grande and is beneficial to the silvery minnow.

MRGCD operations of existing diversions (with releases and return flows) have a complex effect on silvery minnow by decreasing the amount of water in the river during some years while increasing the amount in other years, depending on reach. Diversion of water from the river can decrease available habitat for silvery minnow at some locations, while return flow can increase available habitat at other locations. In the majority of years, MRGCD must supplement naturally occurring inflows to the MRG, which increases flow through upstream reaches. Reaches below Isleta Dam may be affected by storage releases through return flow, but may experience regular drying either with or without MRGCD diversions. While highly variable year to year, MRGCD diversion on average reduces the amount of available habitat, which may be a factor in population size. Additionally, diversion structures cause fragmentation of silvery minnow population and habitat.

A summary of the action-by-action analysis is listed below.

- Reclamation's operation of Heron Dam

  - Provides a potential benefit to silvery minnow and designated critical habitat by adding imported water to the system and decreasing the likelihood of summer drying especially in the Angostura Reach upstream of Isleta Diversion Dam.

- Actions by Reclamation and MRGCD related to the operation of El Vado Dam

  - Limited decrease in duration and magnitude of spring peak flow in silvery minnow designated critical habitat may adversely affect silvery minnow spawning and recruitment.

  - Provides a potential benefit to silvery minnow and silvery minnow designated critical habitat by releasing stored water later in the irrigation season and decreasing summer drying.

- MRGCD's water management actions:

  - Diversions decrease the amount of water at some places, and at some times, within the river during the irrigation season, which may adversely affect the silvery minnow and designated critical habitat by reducing the amount of available habitat.

  - Diversions result in flows from MRGCD drains and wasteways which can increase flows in certain reaches, especially in the Albuquerque and Isleta Reaches.

  - Diversion, return flow, and system operation result in a redistribution of habitat through the critical habitat area, changing the natural pattern of drying from linear (perennial only in upstream reaches) to patches in multiple reaches.

  - Operation of Isleta Dam creates a barrier to upstream movement of fish and affects the geomorphology of the river, which is likely to adversely affect silvery minnow and designated critical habitat.

  - Operation of Diversion Dams may adversely affect the silvery minnow through entrainment of adults, juveniles, and eggs into irrigation canals, although monitoring has indicated effects are generally minor.

2.6.3.2 Flycatcher

Overall, the Proposed Actions of storage and release of water from Heron and the combined operation of El Vado Reservoirs by Reclamation and MRGCD is beneficial or likely to not adversely affect flycatchers or flycatcher critical habitat. The Proposed Action, of diversion dam operation may remove water from the river near where flycatchers establish territories, increasing flows through canals and drains which may also be near flycatcher territories. Return flows to the river from drains and wasteways may produce a redistribution of water through the critical habitat area, keeping some areas wet that might otherwise dry. A summary of the action-by-action analysis is listed below:

- Reclamation's operation of Heron Dam
  - Provides a potential benefit to flycatchers and flycatcher designated critical habitat by decreasing summer drying.
- Actions by Reclamation and MRGCD related to the operation of El Vado Dam
  - Provides a potential benefit to flycatchers and flycatcher designated critical habitat by decreasing summer drying.
- MRGCD's Water Management Actions
  - Diversions may decrease the amount of water available for riparian vegetation used by flycatchers, which may adversely affect the species and designated critical habitat.
  - Diversions decrease the amount of inundated habitat in higher flow years, which may have adverse effects for territory establishment of flycatchers. Effects are variable depending on magnitude of spring runoff.
  - Flows from MRGCD drains and wasteways can increase flows in critical reaches, especially in the Albuquerque and Isleta Reaches.
  - MRGCD irrigation operation redistributes water through the MRG, causing some areas to experience increased drying, while maintaining other areas as wetted that might otherwise be dry.

2.6.3.3 Cuckoo

Overall, Reclamation's Proposed Actions of storage and release of water from Heron Reservoir and the combined operation of El Vado Reservoir by Reclamation and MRGCD is mainly beneficial or likely to not adversely affect cuckoos or proposed cuckoo critical habitat. The MRGCD proposed actions, however, are generally more negative in nature as the process of diverting water within the river during irrigation season removes water from the river system where cuckoos establish territories. A summary of the action-by-action analysis is listed below:

- Reclamation's operation of Heron Dam
  - Provides a potential benefit to cuckoos and proposed cuckoo critical habitat by decreasing summer drying.
- Actions by Reclamation and MRGCD related to the operation of El Vado Dam

  - Provides a potential benefit to cuckoos and proposed cuckoo critical habitat by decreasing summer drying.

- MRGCD's Water Management Actions

  - Diversions may decrease the amount of water available for riparian vegetation used by cuckoos, which may adversely affect the species and proposed critical habitat.

  - Diversions decrease the amount of inundated habitat in higher flow years, which may have adverse effects for territory establishment of cuckoos. Effects are variable depending on magnitude of spring runoff.

  - Flows from MRGCD drains and wasteways can increase flows in critical reaches, especially in the Albuquerque and Isleta Reaches.

  - MRGCD irrigation operation redistributes water through the MRG, causing some areas to experience increased drying, while maintaining other areas as wetted that might otherwise be dry.

2.6.3.4 Jumping Mouse

Overall, Reclamation's Proposed Actions of storage and release of water from Heron, the combined operation of El Vado Reservoirs by Reclamation and MRGCD, the MRGCD's water management actions, and the State of New Mexico's water management actions are beneficial, have no effect, and/or are not likely to adversely affect jumping mouse or proposed jumping mouse critical habitat. A summary of the action-by-action analysis is provided below:

- Reclamation's operation of Heron Dam:

  - Results in no effect to jumping mouse and proposed critical habitat.

- Actions by Reclamation and MRGCD related to the operation of El Vado Dam

  - Results in a potential benefit to jumping mouse and proposed critical habitat by decreasing summer drying; hence, this action may affect, but is not likely to adversely affect the jumping mouse and its proposed critical habitat.

- MRGCD's Water Management Actions

  - Diversions may have a beneficial effect to jumping mouse and proposed critical habitat by making the amount of water in the irrigation canals and ditches more reliable and consistent, even in drought, to support the wetland and riparian vegetation used by jumping mice. MRGCD activities may have a direct beneficial effect through delivery of water to the BDA and the Isleta and Okhay Owingeh Pueblos.

2.6.3.5 Pecos Sunflower

The Proposed Action is beneficial to Pecos sunflower within the La Joya WMA due to delivery of water.

- Reclamation’s Proposed Action that is specific to storage and later release of SJC water from Heron is not likely to adversely affect Pecos sunflower.
- The combined Reclamation and MRGCD operation of El Vado Reservoir that is specific to storage and release of water is not likely to adversely affect Pecos sunflower and may have some beneficial effects due to delivery of water to the La Joya WMA.
- MRGCD activities have a direct beneficial effect on the Pecos sunflower through beneficial delivery of water to the La Joya WMA.
- The newly established Rhodes population may be affected by actions that decrease overbank flows such as storage and diversion of spring flows, but effects of the Proposed Action are insignificant, and are therefore not likely to adversely affect Pecos sunflower.