APPENDIX I

Biological Opinion

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

February 13, 2004

Memorandum

To: Area Manager, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico (Attn: Jack Garner)

From: State Supervisor, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

Subject: Biological Opinion on the Effects of Actions Associated with the AProgrammatic Biological Assessment (BA) for the City of Albuquerque Drinking Water Project

This document transmits the U.S. Fish and Wildlife Service=s (Service) biological opinion on the effects of actions associated with the AProgrammatic Biological Assessment (BA) for the City of Albuquerque Drinking Water Project.@ This assessment concerns the effects of the action on the endangered Rio Grande silvery minnow *(Hybognathus amarus)* (silvery minnow) and its designated critical habitat, the endangered southwestern willow flycatcher *(Empidonax traillii extimus)* (flycatcher), and the threatened bald eagle (*Haliaeetus leucocephalus)*. Your request for formal consultation, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 531 *et seq*.), was received on November 13, 2002. The Bureau of Reclamation (Reclamation) is the lead Federal agency for this consultation, the City of Albuquerque (City) is an applicant, and the U.S. Army Corps of Engineers (Corps) is a cooperating agency.

Reclamation requested concurrence with the determination of Amay affect, is not likely to adversely affect@ for the bald eagle and the flycatcher. The Service concurs with Reclamation=s determination of Amay affect, is not likely to adversely affect@ the bald eagle and flycatcher for the following reasons:

The operation of the City=s project will not directly affect the bald eagle. There is no known breeding habitat for the bald eagle in the action area. Potential direct and indirect effects on riparian vegetation are not likely to be significant for the bald eagle. Existing habitat in the action area will sustain bald eagles into the future.

The November 12, 2002, BA describes environmental commitments for the bald eagle and flycatcher. These measures include the following:

(1) If a bald eagle is present within 0.25 mile (mi) (0.40 kilometers [km]) upstream or downstream of the active project site in the morning before construction activities start, or following breaks in the activity, the contractor will suspend all activity until the bird leaves of its own volition, or the Reclamation biologist, in consultation with the Service, determines that the potential for harassment is minimal. If a bald eagle arrives during construction activities or if a bald eagle is beyond that distance, construction need not be interrupted;

(2) The City will be responsible for identifying and reporting the presence of all cottonwoods (seedlings through mature trees) remaining in the construction site to the City=s Open Space Division. The City will plant 3 new plants for each plant removed smaller than 6 inches (in) (15.24 centimeters [cm]) in diameter, and 10 new plants for each removed plant larger than 6 in (15.24 cm) in diameter within City=s Open Space. These replacement ratios will apply to native vegetation within those areas directly damaged by construction.

(3) Construction activities will not occur in the Rio Grande or bosque during the flycatcher nesting and breeding seasons.

If these environmental commitments for the bald eagle and flycatcher are not implemented, Reclamation must contact the Service to determine if further consultation is necessary. If bald eagles or flycatchers are found in the immediate project area during the construction period, Reclamation should contact the Service to determine whether further consultation is necessary.

The remainder of this biological opinion will deal with the effects of implementation of the proposed action on the silvery minnow and its critical habitat. Reclamation has determined that the proposed action Amay affect, and is likely to adversely affect@ the silvery minnow and Amay adversely modify@ its designated critical habitat.

Consultation History

This biological opinion is based on information provided in the November 12, 2002, BA; the June 2002, draft environmental impact statement (DEIS) for the project, meetings with Reclamation and the City, e-mail and telephone conversations between our staffs; data in our files; literature review; and other sources of information. Informal consultation for this project began in 1998 after the City adopted the Albuquerque Water Resources Management Strategy. During the informal consultation period, the Service met with the City and Reclamation on several occasions, attended a town hall meeting on alternatives for the Drinking Water Project, attended a public meeting for the DEIS issued for this project, and reviewed the draft BA. Formal consultation for this project began on January 13, 2003; however, due to clarification of language contained in the BA and changes in the proposed action, the Service continued to receive information on this project from the City through September 2004. A draft Biological Opinion was issued to Reclamation and the City on October 9, 2003. Reclamation and the City responded with comments and several meetings took place to discuss these comments in December 2003 and January 2004.

BIOLOGICAL OPINION

I. Description of the Proposed Action

Background

Historically, the City and other municipal and industrial water users in Bernalillo County have relied solely on ground water for drinking water and other uses, such as industrial or turf irrigation (Reclamation 2002b). This water has been drawn from the Albuquerque Basin Aquifer. Aquifer characterization and water supply studies conducted during the 1950s and 1960s indicated that the aquifer was extensive, and that flows in the Rio Grande recharged the aquifer sufficiently to allow ground water withdrawals without affecting the aquifer's long-term ability to supply water. Recent studies have shown that the hydrologic connection between the Albuquerque Aquifer and the Rio Grande is not as transmissive as previously assumed, and it is estimated that the aquifer is being depleted at a rate that is twice that of the recharge to the aquifer from the Rio Grande and other sources. The imbalance between limited and declining recharge and increasing withdrawals is causing ground water levels around the City pumping centers to drop (Reclamation 2002b).

Continued sole reliance on ground water resources would lead to serious environmental problems in the region, including water quality degradation, irreversible damage to the aquifer, and land surface subsidence. In response to this issue, the City proposes to release and divert water imported from the Colorado River system via the San Juan-Chama Project. Congress authorized the San Juan-Chama Project in 1962 under the Colorado River Basin Storage Project Act. Subsequently, Congress authorized the project to be constructed by the Department of the Interior. The San Juan-Chama Project consists of facilities that divert water from the San Juan Basin (Colorado River Basin) in southern Colorado using 26 miles of tunnels through the Continental Divide to Willow Creek, a tributary of the Rio Chama in the Rio Grande Basin, in New Mexico. The firm yield of the San Juan-Chama project has been calculated at 96,200 ac-ft/yr. In 1963, the City contracted for 53,200 acre-feet per year (ac-ft/yr) of imported San Juan-Chama water. In 1965, the City relinquished 5,000 ac-ft/yr of San Juan-Chama water for the Cochiti recreation pool, thereby reducing its contracted amount to 48,200 ac-ft/yr. After accounting for seepage and evaporation losses, as determined by the Office of the State Engineer (OSE), the amount of the City's San Juan-Chama water available for beneficial use is 47,000 ac-ft/yr. Under the terms of the 1965 contract, the City owns the 48,200 ac-ft/yr in perpetuity (Reclamation 2002b).

Action Area

The BA defines the action area as being portions of the Rio Chama and Rio Grande, from the outlet works of Heron Reservoir on the Rio Chama, downstream to the headwaters of Elephant Butte Reservoir. For the purposes of this biological opinion, the Service has determined the action area is narrower in scope and extends from the outlet works of Heron Reservoir to the San Acacia Diversion Dam. The rationale for this modification to the action area is as follows:

1. According to the BA, the only effects downstream of the Southside Water Reclamation Plant will be increased flows (as compared to current operations/baseline conditions) in low-flow and extended drought years due to the delayed effects of pumping on river seepage. Although the modeling information used in the BA states that the increased flows associated with delayed seepage will be realized at the Isleta, San Acacia, and San Marcial gages, the Service believes that the potential for increased flows may only affect a small portion of the Isleta Reach.

2. Adverse effects to the silvery minnow population in the Angostura Reach (Angostura Diversion Dam to Isleta Diversion Dam) and specifically in the 15-mi (24-km) stretch of river between the Paseo del Norte diversion dam and the Southside Water Reclamation Plant (Albuquerque Sub-reach), could affect population densities in the Isleta Reach due to the pelagic spawning strategy of the silvery minnow. As described in the March 17, 2003, Programmatic Biological Opinion on the Effects of Actions Associated with the U.S. Bureau of Reclamation=s, U.S. Army Corps of Engineers=, and non-Federal Entities= Discretionary Actions Related to Water Management on the middle Rio Grande (March 17, 2003, Middle Rio Grande Water Operations Programmatic Biological Opinion), water management downstream from Isleta Diversion Dam, is the significant effect on silvery minnow in the San Acacia Reach and would completely dilute any potential effect by the City=s proposed action.

Standard Proposed Action

The Drinking Water Project, as proposed, will involve construction and operation of: (1) A new surface diversion dam north of Paseo del Norte Bridge, (2), conveyance of untreated water from the point of diversion to the new water treatment plant, (3) a new water treatment plant on Chappell Road NE, (4) transmission of treated (potable) water to residential and commercial customers throughout the Albuquerque metropolitan area, and (5) aquifer storage and recovery. During typical operations, the project will divert a total of 94,000 acre-feet per year (ac-ft/yr) of raw water from the Rio Grande (47,000 ac-ft/yr of City San Juan-Chama water and 47,000 ac-ft/yr of Rio Grande native water) at a near constant rate of about 130 cubic-feet per second (cfs) (3.68 cubic-meters per second [m;s]). Peak diversion operations will consist of up to 103,000 ac-ft/yr being diverted at a rate of up to 142 cfs (4.02 m;s). Water will normally be diverted continuously, although there will be some monthly fluctuations. The diverted river water will be conveyed to a new water treatment plant and upon treatment, transmitted to residential, commercial, institutional, and industrial customers. The City will reclaim half of the diverted water (47,000 ac-ft/yr) and release it back into the Rio Grande at the Southside Water Reclamation Plant in the form of treated effluent. The 47,000 ac-ft/yr of San Juan-Chama water will be used consumptively.

A new water treatment plant with a normal operating rate of 84 million gallons per day (mgd) (381.9 million liters per day [mld]) and a peaking capacity of about 92 mgd (418.2 mld) or 142 cfs (4.02 m;s) will be constructed as part of the proposed action. Diversion and conveyance facilities will be sized for a peak hydraulic capacity of up to 120 mgd (545.5 mld) or 186 cfs (5.27 m;s). Although this will provide flexibility in operation and the

ability
to respond to unusual, short demands, it may also allow for continuous operation in the future at 120 mgd (545.5 mld).

The Drinking Water Project includes an aquifer storage and recovery program intended to supplement the aquifer for peak demands and drought reserve and to improve the possibilities for conjunctive use of surface and groundwater resources. During low demand periods (October through March), the aquifer will be recharged using treated City water for injection into existing and possibly new wells.

CONSTRUCTION ACTIVITIES

Paseo del Norte Diversion Dam

The Paseo del Norte diversion facility will consist of a low-head, adjustable-height dam to be constructed north of the Paseo del Norte Bridge at approximately river mile (RM)192 that is approximately 2.5 B 3.5 feet (ft) (0.76 B 1.1 meters [m]) in height. The approximately 600 ft (182.88 m) long dam may consist of up to 15, 40 ft (12.19 m) sections (crest gates) that could be raised and lowered by inflatable bladder structures mounted on a concrete base that will be built across the active river channel. The existing island that crosses the proposed dam location will be removed for construction and operation of the diversion dam. The bladder dam crest gates will likely be raised from 2 B 3 ft (0.61 B .91 m) above river bottom for a large portion of each year. The gates will probably only lay flat (about 0.5 ft (0.15 m) above river bottom) for a 30 B 45 day period when flows are greater than 3,000 cfs (84.95 m;s). The crest gates on the east side of the dam will route water to an inlet structure, on top of which will be a pump station. However, the pump station may be located out of the bosque and riverine corridor. The diversion dam will include fish screen and fish passage facilities designed to protect the silvery minnow. Construction of the bladder dam will result in the temporary loss of 1.6 acres (ac) (0.65 hectare [ha]) of aquatic habitat. The Service will assist in minimizing the effect of this temporary loss by salvaging and relocating any fish stranded by construction activities, maintaining an open channel with a velocity of less than 3 feet per second (ft/sec) (0.91 meters per second [m/sec]) to facilitate fish passage around the construction area, and implementation of conservation measures to minimize the discharge of sediment into the river. Approximately 0.2 ac (0.08 ha) of aquatic habitat will be permanently lost due to the construction of the bladder dam. This permanent loss will be offset with 0.2 ac (0.08 ha) of higher value aquatic habitat that will consist of bank lowering, bank destabilization, bank terrace cuts, or oxbow re-establishment. Operational and construction details for this diversion dam are presented in Table 1.

The sluice channel (diversion channel) will be constructed of reinforced concrete, and will be approximately 36 ft (10.97 m) wide at the upstream end, 5 ft (1.52 m) wide at the downstream end, and about 6.5 ft (1.98 m) deep. An adjustable-height control gate located at the downstream side of the sluice channel will be used in concert with the bladder dam crest gates to control the water-surface elevation in the sluice channel as well as the bypass flow rate through the sluice channel (Reclamation 2002b).

The surface water intake will be constructed along the east side of the sluice channel, and will consist of 10 intake compartments, each of which will be covered with a fish screen panel, as described below.

TABLE 1
CONCEPTUAL DESIGN AND OPERATIONAL SPECIFICATIONS FOR THE PASEO DEL NORTE DIVERSION (CH2M HILL 2001)

Item	Design Specifications	Operating Requirements
River Location	Between Alameda and Paseo del Norte, Albuquerque Reach	---
Length of Conveyance Corridor to water treatment plant	Approximately 5.5 mi	---
Distance to Southside Water Reclamation Plant outfall	Approximately 15 mi	---
Delivery Capabilities	---	94,000 ac-ft/yr (or 130 cfs)
Fishway Area	5.5 ac	1.7 ac
Fishway Flow Rate	---	50 cfs
Fish Screen Area	0.8 ac	0.2 ac
Fish Screen Flow Rate	---	0.2 cfs
Conveyance Pipeline Depth	4 ft to top of crown	---
Low-head, Adjustable Height Diversion Dam Area	1.8 ac	0.2 acre
Pumping Station Area	4 ac	2.3 ac

As noted in the Drinking Water Project Conceptual Design Report (CH2M Hill 2001) concepts presented for the fishway and fish screens are provisional; adjustments may be necessary during final design to incorporate new findings from the ongoing fish passage and fish swim speed studies being conducted by the City and Reclamation. Downstream fish passage through the sluiceway will be designed so fish are funneled into a Aplunge pool@ energy dissipating structure, such that the force of the drop does not injure the fish. Design elements of the sluice chennal must consider energy dissipation over the range of operational flows (currently estimated at 20 cfs (0.57 m;s) at low flows and 30 cfs (0.85 m;s) at high flows) (Reclamation 2002b).

Fish Screens

Fish screens are a design element of the diversion facility. Fish screens are of several types and combinations, including high velocity, low velocity, fixed and traveling (Miller and Laiho 1997). Using the Miller and Laiho (1997) definitions, fish screens for the Paseo del Norte Diversion, as currently envisioned, will be fixed, high velocity, (over 0.5 ft/sec [0.15 m/sec]) and designed with an air burst type scrubber to remove debris. Fish screens at the diversion facility are a conservation measure designed to prevent silvery minnow and other fishes from entrainment in the water diversion works. As noted, all design elements are presently conceptual. The final design of the fish screens will be to function as barriers to prevent loss of fishes from the river channel (Reclamation 2002b).

The intake will consist of 10 reinforced-concrete intake compartments. A 7.1 ft (2.16 m) wide by 10 ft (3.05 m), stainless steel fish-screen panel with 0.07-in (1.75 millimeter [mm]) openings will be installed across the entrance to each compartment. The screens will be angled (1.5 ft) (0.46 m) horizontal per foot of rise) to provide sufficient surface area across the intake openings (Reclamation 2002b). If an improved fish screen structure is identified during the design, the City will work with the Service to incorporate this into the project (J. Stomp, City, *pers. comm.* 2003).

The fish screens are designed for a maximum approach velocity of 0.2 ft/sec (0.06 m/sec) at the peak diversion rate of 142 cfs (4.02 m;s) to avoid pinning fish against the screens. The sluice channel will narrow from the upstream end to the downstream end in order to maintain a sweeping velocity through the fish screens of at least five times the normal approach velocity (approach velocity of the water entering the screens). A compressor located in the pump station will provide air to spargers (screen cleaning mechanisms) located behind the fish screens. The spargers will be used to backwash the fish screens to remove debris that collects against the screens. Thirty-inch (76.2 cm) diameter intake pipelines, located at the back of each of the intake compartments, will convey the raw river water to one of two intake headers, which in turn will convey the water to the pump station wet well (Reclamation 2002b).

Fishway

Operation of the proposed new surface dam will directly affect both upstream and downstream movements of aquatic species if the dam creates a hydraulic effect in either the up or down position. Downstream movement of fish also will be affected by potential entrainment in the diversion works. Effects on upstream fish movement will be aided by the construction and operation of a fishway on the western shore of the project.

The fishway will allow upstream and downstream passage of aquatic species and is a design element of the Paseo del Norte Diversion. This fishway will be constructed through the riparian area on the west side of the river; adjacent to the bladder dam to allow fish to swim upstream and downstream when the adjustable-height crest gates are raised. Concepts presented for the fishway are provisional; adjustments will be made as appropriate during final design to incorporate any new findings. This conservation measure will help to protect the silvery minnow and other fishes (Reclamation 2002b).

The fishway will be a 50-ft (15.24 m) wide, low gradient, >V=-shaped, roughened channel constructed of riprap laid on filter fabric. The high boundary roughness resulting from the riprap channel combined with rock boulders located along the channel will create flow conditions suitable for fish passage. The slope of the fishway along the channel is 0.4 percent slope. A 250-ft (76.2 m) long by 100-ft (30.48 m) wide Abackwater@ area will be located at the center of the fishway. Average water depth at the center of the channel will be approximately 1.6-ft (0.49 m) (Reclamation 2002b). The average water velocity through the fishway will be approximately 2 ft/sec (0.6 m/sec) at an average flow rate of 50 cfs (1.42 m;s), providing attractant flow when the dam is raised and in operation. Requirements for attractant flows for the silvery minnow will be discussed with the Service (J. Stomp, City, *pers. comm.* 2003). Current operational plans call for flows of 50 cfs (1.42 m;s) through the fishway. Exact placement and operational aspects of the fishway, and the attractant flows are not yet defined but will be incorporated into the final design of the project. Attractant flow will be provided in the sense that the 50 cfs (1.42 m;s) from the fishway will be provided in addition to flows over the dam or through the east side sluiceway. Effects on downstream migrants will be minimized by the fishway and a sluiceway incorporating fish screens, designed with the diversion facility on the east shore. Construction of the fishway will result in the creation of aquatic habitat from an area that is currently riparian vegetation. This fishway is a design-specific conservation measure for the surface diversion dam. A gravel access road will be constructed from the west side levee to the fishway for maintenance activities (Reclamation 2002b). Although the fish passageway is located on the west side of the river in the schematics contained within the BA, the final design may result in the fish passageway being placed on the east side of the river (J. Stomp, City, *pers. comm.* 2003).

The City, working with Reclamation, will construct and test a physical model of the diversion dam. Information derived from this modeling effort will be used to further develop the design criteria for the diversion dam and associated features. The City commits to coordinate the design of the diversion dam, fish screens, intake structure and fish passageway with the Service. If an improved diversion dam, fish screen intake structure, or fish passage is identified by the City during the design, the City will work with the Service to incorporate this into the project (Reclamation, *in litt.* 2003).

Pump Station

The pump station will be constructed on earth fill adjacent to the levee on the east side of the river. The floor of the pump station will be located at the top of the levee to prevent flooding during high river flows. The pump station wet well will be about 21 ft (6.4 m) deep to allow water to flow into the wet well by gravity from the intake structure. Included within the 110-ft (33.53 m) by 100-ft (30.48 m) pump building will be eight pumps, electrical equipment, compressors, a surge tank, and ancillary equipment. Water from the river will enter the pump station from the intake through the two 60-in (152.4 cm) headers. Compressors located at the pump station will provide compressed air for the inflatable crest gate bladders, the fish-screen backwash air spargers, and the surge tank (Reclamation 2002b).

The physical effects of construction include the permanent removal of 6.6 ac (2.68 ha) of riparian vegetation for the construction of access roads, the sluice channel, fishway, and pumping station. The city is examining locating the pump station outside of the bosque to reduce overall operation effects. Locating the pump station outside of bosque would reduce the permanent removal of riparian vegetation to 4.2 acres. Planting native vegetation near the disturbance area at a ratio of 1 native for every exotic species removed and 2 natives for every native plant removed will mitigate this loss of riparian vegetation associated with these construction activities. An additional 8.1 ac (3.29 ha) of riparian vegetation will be temporarily lost due to diversion construction activities. Upon completion of the construction activities, the area will be re-vegetated using native vegetation (Reclamation 2002b).

<u>Conveyance from Diversion to Water Treatment Plant</u>

The raw water will be conveyed through a new pipeline approximately 6.0 mi (9.66 km) from the pump station to the water treatment plant to be located near Chappell Drive (Reclamation *in litt.* 2003). The conveyance pipeline will be built through disturbed urban areas. From the pump station, it will run approximately 0.5 mi (0.80 km) south along the drain road to Paseo del Norte, east along Paseo del Norte for about 2.5 mi (4.02 km) to the Albuquerque Metropolitan Area Flood Control Authority=s North Diversion Channel, then south for about 2.5 mi (4.02 km) within the North Diversion Channel right-of-way to the proposed water treatment plant on Chappell Drive (Reclamation 2002b).

<u>Water Treatment Plant</u>

The water treatment plant will be used to treat the City=s water to drinking water standards prior to transmission to the City=s potable distribution system. The proposed water treatment plant will have a treatment capacity initially of 92 mgd (227 mld) and ultimately of 120 mgd (546 mld). The land area for the proposed water treatment plant is approximately 110 ac (44.72 ha). Land use in this area is industrial, and the plant location is currently the site of a gravel-mining operation where pit recovery, crushing, sizing, and stockpiling of gravel occur (Reclamation 2002b).

Transmission Corridor from Water Treatment Plant to Water Users

The purpose of the potable-water transmission facilities will be to carry treated water in pipelines from the water treatment plant to City residential and business users. More than 12 potential pipeline alignments for the transmission of purified water from the treatment-plant site to the existing potable distribution system were evaluated (Reclamation, *in litt*. 2003). The City=s existing water-distribution system consists of a series of major trunk lines that transport water from lower pressure zones to the upper pressure zones. The trunks generally lay in an east-west alignment. The selected transmission corridors will permit the optimum use of existing hydraulic gradients and in-place City water lines. The pipeline will cross the Rio Grande near Campbell Road (Reclamation 2002b).

Initially, approximately 30 percent of the purified water from the plant will be used on the West Side, and 70 percent on the East Side. By 2040, the City predicts that 60 percent of the purified water from the plant will be used on the West Side, and 40 percent on the East Side. However, the flow distribution may vary from year to year due to demand, water quality (arsenic), aquifer storage and recovery, or other operational considerations (Reclamation 2002b). Because the aquifer is more limited on the west side; the presence of higher average arsenic concentrations; the need for aquifer storage and recovery; and the potential for higher demands in the future, the transmission lines on the west side will be sized for an ultimate capacity of 120 mgd, and lines on the east side will also be sized for an ultimate capacity of 120 mgd (Reclamation *in litt.* 2003).

Approximately 2.4 ac (0.98 ha) of riparian habitat will be temporarily lost during the construction of the treated pipeline crossing. Upon completion of construction activities, this acreage will be re-vegetated with native vegetation. Installation of the transmission pipeline under the active river channel will also result in the temporary loss of 1.5 ac (0.61 ha) of aquatic habitat (Reclamation 2002b).

PROJECT OPERATIONS

Operations of the proposed Drinking Water Project for City San Juan-Chama water will include releases from Heron Reservoir outlet works and conveyances through the Rio Chama and Rio Grande and El Vado, Abiquiu and Cochiti Reservoirs and Dams. An operational plan for this water delivery is discussed below. The general operating plan for the project will involve releases of the City=s San Juan-Chama water from Heron Reservoir and temporary storage (or flow through) at Abiquiu Reservoir (Reclamation 2002b). Water will be released from Heron Reservoir outlet works and conveyed to Abiquiu Reservoir so as to assist with providing flows for fisheries in this portion of the Rio Grande to the extent practicable. The water will then be temporarily stored in Abiquiu Reservoir. Following storage, a constant flow of about 67 cfs (1.9 m;s) of City San Juan-Chama water will be released from Abiquiu Reservoir. After incurring conveyance losses between Abiquiu and Albuquerque, approximately 65 cfs (1.84 m;s) of San Juan-Chama water (on average) will reach the proposed new surface water diversion facility north of Paseo del Norte (Reclamation 2002b). During normal operations, the City=s Drinking Water Project will result in, on average, an additional year-round annual flow of approximately 65 cfs (1.84 m;s), relative to current operations, from the outlet works at Abiquiu to the diversion point at Paseo del Norte. During full curtailment, this additional flow will not be released.

During the first two decades of the Drinking Water Project, considerably more than an annual average of 67 cfs (1.9 m;s) of San Juan-Chama water will be released from Abiquiu by the City to compensate for residual seepage into the aquifer because of past aquifer drawdowns and less ground water will be discharged to the river in the form of return flow at the Southside Water Reclamation Plant (CH2M Hill 2002). The portion of San Juan-Chama water that is in excess of the 65 cfs (1.84 m;s) diversion requirements will flow past the diversion dam to offset the depletions associated with the lingering effects of past pumping.

The City will attempt to follow the historical practice to the extent practicable of taking delivery of their water from Heron (and/or used in trading arrangements with the Middle Rio Grande Conservancy District) at a time that helps facilitate winter flows for the fishery in the Rio Chama below El Vado. These minimum flows have varied between 185 cfs (5.24 m;s) in "average years" to about 100 cfs (2.83 m;s) in "dry years." The City has also assisted in providing "pulse" flows in summer for recreational rafting on the Rio Chama. Typically, these releases occur about 7 weeks per year, with flows maintained at 600 cfs (17 m;s) on weekdays and 1,000 cfs (28.3 m;s) on weekends (Reclamation 2002b). The City will minimize early or "non-normal" releases of San Juan-Chama water from Heron Reservoir to avoid evaporative losses when water is stored in downstream reservoirs. Water stored in Abiquiu Reservoir is subject to more evaporative losses than water stored in Heron (Reclamation 2002b).

To maintain a consistent pool above the proposed Drinking Water Project dam, the dam crest height will adjust with changing Rio Grande flows. The shifting sand bed nature of the river at the diversion site will require operational adjustments regarding dam height vs. flow in any given year. However, in general, as river flow increases, the dam will be lowered and as river flow decreases, the dam will be raised. For example, at flows of approximately 3,000 cfs (84.95 m;s), the dam will be completely lowered, but not flat (Reclamation *in litt.* 2003). Likewise, the dam will probably be fully raised (2.9 ft [0.88 m]) when flows approach 200 B 400 cfs (5.66 B 11.33 m;s) (Reclamation 2002a).

At the proposed surface diversion dam location north of Paseo del Norte, the City=s 65 cfs (1.84 m;s) of San Juan-Chama water will be diverted with an equal amount of native flow for a total of 130 cfs (3.68 m;s). There will also be a provision that 50 cfs (1.42 m;s) will be available to flow through the fishway and 20 cfs (0.57 m;s) will be available to flow through the sluiceway during normal operations. Under normal operations, the City will bypass 130 cfs (3.68 m;s), which includes 50 cfs (1.42 m;s) in the fishway, 20 cfs (0.57 m;s) in the sluiceway, and 60 cfs (1.7 m;s) in the main channel (Reclamation 2002b). When total flows above the diversion are 260 cfs (7.36 m;s) or greater, the City will fully operate the project. When total flows above the diversion are less than 260 cfs (7.36 m;s), the City will decrease or Acurtail@ the amount of native water diverted to ensure that 130 cfs

(3.68 m;s) is bypassed. When the total flows above the diversion reach 195 cfs (5.52 m;s) (65 cfs [1.84 m;s] of City San Juan-Chama water and 130 cfs (3.68 m;s) of bypass flows), the City will cease diversions (full curtailment). As a result, there are two operational scenarios.

Normal Operations

Under a constant release and diversion scenario, the total flow above the diversion will be at least 260 cfs (7.36 m;s) based on the following operation assumptions:

1. A diversion rate of 130 cfs (3.68 m;s) (65 cfs [1.84 m;s] of San Juan-Chama water and 65 cfs [1.84 m;s] of native water);
2. A fishway bypass flow of 50 cfs (1.42 m;s) on the west side of the river; and
3. A bypass flow of 20 cfs (0.57 m;s) at the outlet of the sluiceway on the east side of the river to provide for downstream movement of sediment and fish past the intake screens.
4. A total bypass flow of 130 cfs (3.68 m;s) below the diversion intended to provide 100 cfs (2.83 m;s) at the Central Bridge gage and accounting for potential transport and evapotranspiration loses of about 30 cfs (0.85 m;s).

Thus, under normal operations, the total flow needed to fully operate the Drinking Water Project at 130 cfs (3.68 m;s) is 260 cfs (130 cfs [3.68 m;s] for the diversion and a minimum bypass flow of 130 cfs [3.68 m;s]).

A constant diversion of 130 cfs (3.68 m;s) will occur throughout the year as long as flows equal or exceed the specified "threshold flow" of 260 cfs (7.36 m;s) above the diversion point. The 65 cfs (1.84 m;s) of San Juan-Chama water will be consumptively used within the City=s water service area. The 65 cfs (1.84 m;s) of >native= water will be returned to the river at the Southside Water Reclamation Plant outfall (Reclamation 2002b). The return flows will consist of both native flows returned from the Paseo del Norte diversion as well as groundwater returns. It is estimated that the total annual returns at the Southside Water Reclamation Plant will be 60,000 ac-ft and consist of approximately 47,000 ac-ft of native diversion returns and 13,000 ac-ft of groundwater returns (Reclamation *in litt.* 2003).

Low Flow or Curtailment Operational Scenario

When river flows above the diversion point are less than 260 cfs (7.36 m;s), the City will adjust operations of the surface diversion dam and begin curtailing diversion amounts to minimize depletion effects downstream. When flows just above the diversion point fall below 260 cfs (7.36 m;s), at the surface diversion dam, the City will begin curtailing the quantity of the native (non-San Juan-Chama water) water diverted by reducing the diversion amount by 1 cfs (0.03 m;s) for each 1 cfs (0.03 m;s) reduction of native flow, but will continue to release and divert the full 65 cfs (1.84 m;s) of its San Juan-Chama water. When native flow reaches 130 cfs (3.68 m;s) (195 cfs [5.52 m;s] total flow) just above the diversion, all raw water diversions and San Juan-Chama water releases will be suspended (100 percent curtailment), the adjustable height dam will be completely lowered (about 0.5 ft [.15 m] above the river bottom). During periods of curtailment, the City will offset decreases in the amount of raw water diverted by increasing the amount of ground water pumped for potable use. During periods of complete shut down of river diversions, the City=s water service area will be supplied entirely from ground water wells (Reclamation 2002b) and the City=s San Juan-Chama water will be stored in Abiquiu for later release as part of the groundwater storage and recovery program (Reclamation 2002a). The operation and discharge from the Southside Water Reclamation Plant will not change as a result of the Drinking Water Project. Currently about 60,000 ac-ft/yr is discharged as treated effluent to the river below Rio Bravo Bridge. Based on population trends and current estimates of 46 percent of the water being used consumptively, return flow to the river is projected to increase to nearly 92,000 ac-ft/yr by 2040 and 110,000 ac-ft/yr by 2060 (Reclamation 2002b).

Alternatively, at the City=s option, the entire diversion could be shut down rather than reducing the diversions over time as described above (J. Stomp, City, *pers. comm.* 2003).

Peak Diversion Operations

During curtailment years, the City may be releasing and diverting additional San Juan-Chama water for an Aquifer Storage and Recovery program. For example, if the City were to curtail diversions during the months of July and August, the City will increase diversions from 130 B 142cfs (3.68 B 4.02 m;s) during the months of November through March. The additional 12 cfs (0.34 m;s) of the City=s San Juan-Chama water released during peak diversion will be stored in the aquifer to restore the additional groundwater taken during the curtailment period of July and August. Another example of the City increasing the diversion for peak operations will be during a wet year. During a wet year, the City may divert 142 cfs (4.02 m;s) throughout the entire year. The additional San Juan-Chama water that will be released and diverted will be water the City leases, payback from other San Juan-Chama contractors or San Juan-Chama water stored by the City in Abiquiu Reservoir. During that wet year, the maximum amount diverted will be 142 cfs (4.02 m;s), comprised of 71 cfs (2.01 m;s), of native water and 71 cfs (2.01 m;s) of San Juan-Chama water. An alternative operation scenario may be that the city diverts 65 cfs (1.84 m;s) native water and 77 cfs (2.18 m;s) San Juan-Chama water to meet demands and provide for aquifer storage and recovery (Reclamation *in litt.* 2003). As with all operational scenarios, the native water will be returned to the river at the Southside Water Reclamation Plant (Reclamation 2002b).

River Depletions associated with Project Operations

Because the City=s groundwater pumping results in river depletions due to the drawdown of the aquifer, the 65 cfs (1.84 m;s) that will be diverted at the Paseo del Norte diversion does not accurately reflect the actual depletion in flows. The City=s groundwater pumping currently results in reduced river flows; therefore, the change in river flows associated with the proposed action are calculated as being those reductions that are in excess of what will occur under the City=s current operations. The City offsets the effects of groundwater pumping through return flows from the Southside Water Reclamation Plant (Reclamation *in litt.* 2003).

Through 2060, river flows in the reach between the Paseo del Norte diversion dam and the Southside Water Reclamation Plant, as measured at the Albuquerque gage, will be, on average, 27 cfs (0.76 m;s) less than the flows that will be expected under current operations. The hydrologic model for the proposed action shows that the 65 cfs (1.84 m;s) diversion of native flows will result in a 0.1 B 0.3 ft (0.03 B 0.09 m) reduction in water depth in the Albuquerque Reach, a velocity reduction of 0.1 B 0.2 ft/s (0.03 B 0.06 m/s), and a 20 B 30 ft (6.1 B 9.14 m) reduction of wetted stream width in narrow sections of the river. The operational effect on river flows will vary under different hydrologic scenarios and is described as predicted changes in flow at the San Felipe, Albuquerque, Isleta, San Acacia, and San Marcial gages (CH2M Hill 2002).

Normal Year (modeled after the hydrology of 1988): The proposed action will result in flows that are approximately 60 cfs (1.7 m;s) higher at the San Felipe gage upstream of the diversion and approximately 30 cfs (0.85 m;s) lower at the Albuquerque gage. Streamflow at the Isleta, San Acacia, and San Marcial gages will not be affected.

Under normal flow conditions, 65 cfs (1.84 m;s) of the City=s San Juan-Chama water, plus 65 cfs (1.84 m;s) of native Rio Grande flow will be diverted from the river. Current groundwater pumping activities will cause a depletion of 68 cfs (1.93 m;s) for the same typical year, or about 5 percent of the historic mean flow; therefore, the difference between the proposed action and no action is roughly two percent (City 2002). Generally, this will represent a flow that was 20 B 30 cfs (0.57 B 0.85 m;s) lower than that occurring under current operations (CH2M Hill 2002).

Low-Flow Year (modeled after the hydrology of 1977): The proposed action will result in flows that are approximately 65 cfs (1.84 m;s) higher at the San Felipe gage, with the exception of the September-October period when low flows at the Albuquerque gage will result in full curtailment. Under full curtailment, the flows at the San Felipe gage will be the same as under current operations. Flows at the Albuquerque gage will be approximately 25 B 28 cfs (0.71 B 0.79 m;s) lower under the proposed action. Exceptions will be during periods of curtailment in April-May and September-October. Flows will be 5 B 15 cfs (0.14 B .42 m;s) higher in April-May and 10 B 40 cfs (0.28 B 1.13 m;s) higher in September-October. Streamflow at the Isleta, San Acacia, and San Marcial gages is expected to be the same under the proposed action as they will be under current operations (CH2M Hill 2002).

Extended Drought (modeled as three consecutive years like the hydrology of 1972): The proposed action will result in flows generally 65 cfs (1.84 m;s) higher above the Drinking Water Project diversion dam, except in the May-August period when the Drinking Water Project release and diversions are curtailed because of low flow in the Albuquerque reach. Flows in the Albuquerque reach will be approximately 5 B 35 cfs (0.14 B 0.99 m;s) lower, except in the May-August period when they will be 5 B 15 cfs (0.14 B 0.42 m;s) higher. The Isleta, San Acacia, and San Marcial flows will be approximately 5 B 15 cfs (0.14 B 0.42 m;s) higher under the proposed action, however the flows at San Acacia and San Marcial will be at or near zero during May and June for all three of the drought years (CH2M Hill 2002).

During the curtailment periods experienced during the low-flow and extended drought scenarios, there will be an increased reliance on groundwater pumping. During these periods, additional ground water is returned to the river through the Southside Water Reclamation Plant outfall. Increased seepage of the Rio Grande into the aquifer as a result of the additional pumping will generally not occur in the year of increase, but later, resulting in the river being Asurcharged with water.@ This will result in slight increases in flow at the Isleta, San Acacia, and San Marcial gages during the curtailment periods(CH2M Hill 2002).

Aquifer Storage and Recovery

The Drinking Water Project will include an aquifer storage and recovery program intended to supplement the aquifer for peak demands and drought reserve and to improve the possibilities for conjunctive use of surface and ground water resources. The water treatment plant will run at an essentially constant rate of 84 mgd (381.9 mld) or 130 cfs (3.68 m;s), with a peak capacity of 92 mgd (418.2 mld) or 142 cfs (4.02 m;s). In early years of the project (e.g., 2006 B 2010) peak summer City water demands should be about 160 B 170 mgd (727.4 B 772.8 mld). Thus, during summer months a number of existing City wells will help meet demands. During low demand periods, typically October through March, the water treatment plant will be producing sufficient water to allow the wells to be turned off. During such low demand periods, recharge to the aquifer will be done by transmission of treated City water in the existing distribution system for injection into existing (and possibly some new) City wells. The water available for recharge will be highest (about 10,000 B 15,000 ac-ft/yr) during early project years (2006 B 2010), and gradually decline to zero in later years (Reclamation 2002a). Fifteen to 20 existing wells may be required. Although small relative to overall City water demands, the aquifer storage and recovery water could accumulate over time and provide a >banked= reserve important in drought or emergency situations (Reclamation 2002b).

The overall layout of the aquifer storage and recovery program awaits a demonstration project and an evaluation to select optimal wells for recharge. Because many of the existing City wells produce water that is relatively high in arsenic, the new EPA arsenic standard and possible need for blending low arsenic river water with well water will also be a factor in the selection of aquifer storage and recovery wells.

Release of San Juan-Chama Water to Offset the Past Effects of Pumping

When the Drinking Water Project begins operation in 2006, there will still be a lingering effect of historic City pumping on the river (i.e., river water will continue to seep into the adjacent aquifer because of past pumping induced drawdowns). The City currently offsets this depletion by returning treated wastewater to the river through the Southside Water Reclamation Plant outfall. However, once the Drinking Water Project is operational, not as much ground water will be returned to the river as in the past. These two factors will result in a surface water deficit of approximately 30,000 ac-ft in the early years of the project. The City will completely mitigate this deficit with additional (or supplemental) releases of San

Juan-Chama water (some 90,000 ac-ft in total) from storage in Abiquiu Reservoir during the first 10 years of the project. As the effects of historic City pumping on the river are dissipated, and under much reduced levels of pumping under the Drinking Water Project, the seepage rate and deficit will decline such that additional releases of San Juan-Chama water will no longer be needed after about 2016 (Reclamation 2002a).

Water Accounting

The City will create, maintain, and update an accounting system that will identify the location(s) and quantities of water diverted from the river, and the amount returned to the river. The City will also provide annual reports to the State Engineer with copies to the Service showing the timing of releases of San Juan-Chama water and diversion and return flow amounts. If curtailment of diversion of San Juan-Chama water were necessary during any year due to streamflow conditions, this will also be reported (J. Stomp, City, *pers. comm.* 2003).

CONSERVATION MEASURES

Past and Ongoing Voluntary Conservation Measures

The following conservation measures, initiated by the City are ongoing:

1. The City, working with the Service, developed and implemented a captive rearing and breeding facility for the silvery minnow. The City has provided personnel, equipment, administration, and operation and maintenance of the captive rearing and breeding facility at the Albuquerque Zoo and Naturalized Refugium for more than 3 years and will continue to support these activities for 10 years from the date this consultation is completed.

2. The City signed an Interim Memorandum of Understanding with Federal, state, and local entities to continue to support the development and implementation of the long-term program entitled the ESA Workgroup Collaborative Program. The City has assisted in obtaining significant federal funding for short and long-term conservation measures via their participation in the Collaborative Program.

3. The City has a revised water conservation goal of a 40 percent reduction in demand compared to the baseline established in 1995. The timeframe for the implementation of the new goal will be ten years starting in 2005 and ending in 2014. This goal supplements the original 30 percent reduction goal that is projected to be achieved in 2005.

4. The City has provided personnel and funding for silvery minnow monitoring and habitat surveys in the Middle Rio Grande during late 1999, early 2000, and 2002. In addition, the City completed a flycatcher survey during May, June, and July 2001. The City has committed to conducting annual winter fish monitoring surveys for the

first 10 years of the project. After 10 years, the need for additional fish monitoring will be assessed and, if deemed necessary by mutual agreement between the City and the Service, may continue.

5. The City is supporting and funding ongoing research to increase the understanding of the silvery minnow life cycle at the Albuquerque Zoo and Naturalized Refugium. These studies will contribute to the understanding of spawning behavior, swimming capabilities, and habitat needs. If additional information becomes available prior to completion of the final design of the project, it can be used in the design of facilities and more effective monitoring strategies.

6. The City has an agreement to provide personnel, operation and maintenance costs, and other construction improvements for the Naturalized Refugium project at the Albuquerque Biopark. The refugium will expand the current captive rearing and breeding program, including the construction of a natural habitat for the fish. This project is intended to supplement populations of the silvery minnow by approximately 25,000 fish per year.

7. The City is committed to improving the bosque and the Rio Grande Valley State Park and will coordinate annual programs with the Service. These programs, which include removing non-native plant species, will continue throughout the life of the project. In addition, the City began an extensive program in the fall of 2002 to remove non-native species from the riparian area within Albuquerque over the next five years. The City has already invested about $650,000 for equipment in this endeavor.

8. A habitat mapping technical report has been developed to supplement the City=s ongoing conservation measures to include opportunities for additional aquatic and riparian projects in the Albuquerque Reach of the river. This report included extensive field surveys, mapping and ranking of potential sites within the Middle Rio Grande. Field efforts for this project were conducted in cooperation with the Service during February 2002.

9. In 2003, the City organized and coordinated silvery minnow egg collection efforts for the purposes of propagation.

10. Implementation of the Drinking Water Project will include the construction of a fish passage and fish screens. In addition, the City is committed to working with the Service to develop an operational program to protect the silvery minnow during spawning.

Minimization Measures for Construction Effect

The City is responsible for the following minimization measures:

1. Replace removed exotic vegetation with native vegetation that will provide habitat for the flycatcher. This may occur in coordination with other projects proposed by others. In addition, there may be opportunities to combine silvery minnow habitat restoration activities with flycatcher habitat restoration.

2. During construction in the river, the City will regularly monitor river flow changes so that any silvery minnows stranded by construction of the coffer dam can be relocated to a different portion of the river. The Service has agreed to be available to move silvery minnows that are isolated from the main river channel due to construction activities.

3. During installation of the Drinking Water Project diversion facility, require the construction contractor to maintain an open channel (velocity less than 3 ft/sec) in the Rio Grande for fish passage around the construction site at all times.

4. Construct the water diversion facility during the river=s winter low-flow period (September through March) to avoid, to the extent possible, the spring snow melt and summer monsoon seasons of high flows in the river, and to comply with Clean Water Act Section 404 permit special conditions. Construction activities during the months of April through August will only occur if approved by the Service and other Federal agencies, including the Corps.

5. During installation of the water diversion facility, require the construction contractor to take appropriate measures to minimize and contain the discharge of suspended sediments into the Rio Grande.

6. A plan to monitor the turbidity levels during in-river construction will be established. This plan will be submitted to the Service for approval prior to construction activities taking place.

7. The City will implement necessary spill prevention and containment methods. The City will train appropriate personnel prior to construction and in the long-term operation and maintenance of facilities.

8. Temporary materials and equipment-staging areas at the water-diversion facility construction area will be reclaimed and revegetated with woody trees and shrubs that are native to the area.

9. The size and location of project facilities to be located in the riparian corridor will be designed to minimize the loss of cottonwoods and other native vegetation.

10. The City will restore the bosque and Rio Grande in the areas temporarily affected by the

construction of the project or complete environmental enhancements at an offsite location. During development of the technical plans and specifications for restoration of the Rio Grande channel, the City will coordinate with Reclamation, Corps, the Service, and the ISC to design a channel section that could provide potential habitat for the silvery minnow and flycatcher. If permits and approvals could be obtained, the City will construct the channel to match the existing section, as approved.

11. If an eagle is observed within 0.25 mi (0.40 km) of the active project site every morning before construction starts, or following breaks in construction activity, the contractor will be required to suspend all activity until the bird departs the area on its own volition. However, if an eagle arrives during construction activities or if an eagle is observed at a distance greater than 0.25 mi (0.40 km) from the construction area, construction need not be interrupted.

12. Project pipeline alignments have been routed primarily in developed public rights-of-way to minimize activity in undisturbed areas. Those undeveloped areas that are disturbed during construction will be replanted with appropriate native upland vegetation.

13. The City will develop an adaptive management plan as soon as practicable after the first monitoring periods for the restoration sites and fish monitoring. The adaptive management plan will address modifications of the minimization plan and outline monitoring schedules. This plan will be based on the results from the initial monitoring efforts.

14. Specific tasks that the City has committed to do during project construction/ restoration include:

    a) Construction site visits
    b) Map and document with photos or drawings construction progress and compliance with minimization and monitoring requirements
    c) Training and explanation of environmental requirements to contractors and designers
    d) Progress meetings and completing progress memos
    e) Assist and train field monitoring personnel
    f) Insure compliance with permits and stipulations of the EIS for minimization and monitoring
    g) Maintain minimization plan checklist and update periodically by verification
    h) Collection and analysis of environmental data as needed to insure minimization and monitoring steps are accurate and completed in a timely manner
    i) Development and implementation of adaptive management procedures
    j) Monthly and annual reporting to the Service and Reclamation.

<u>Minimization Measures for Operational Effects</u>

The City is responsible for the following minimization measures:

1. Continued support for the silvery minnow Naturalized Refugium for 10 years from the date of this biological opinion. This may consist of rearing, research, and maintenance of experimental populations. In the year 2002, the City provided $150,000 to the Albuquerque Aquarium for construction, staffing, and monitoring of silvery minnow rearing facilities to raise eggs to the young-of-year (YOY) stage before the fish are released to transplant locations upstream from the San Acacia Diversion Dam.

2. The City will conduct egg collection activities upstream of the Paseo del Norte diversion, near the water intake point, to estimate and reduce the amount of silvery minnow eggs entrained in the diversion structure. This egg collection will consist of 1 egg collector for 2 hours per day from May 1 B 31 each year for the first 10 years of the project. After the first 10 years of the project, the need for continued egg collection will be assessed and may continue for an additional time period if the Service and City cooperatively agree that it is necessary.

3. The proposed fishway for Paseo del Norte Diversion will be constructed to allow fish movement around the new surface dam at Paseo del Norte. Design of the fishway will be coordinated with the Service.

4. The sluice channel for Paseo del Norte Diversion will be equipped with fish screens.

5. Monitor habitat restoration efforts, other minimization measures, diversion impacts, and fish and wildlife enhancement measures for success and suspend unsuccessful projects/practices. This will be an adaptive process with evaluation of methods and practices that are successful and unsuccessful. This monitoring will be carried out for five years upon completion of each minimization or restoration effort.

6. The City will participate in an interagency group that includes Reclamation, the Service, Office of the State Engineer (OSE), the New Mexico Department of Game and Fish, and the Interstate Stream Commission to monitor and manage the effectiveness of both current and long-term environmental enhancement measures described above. This group will identify and recommend to the City and the Service necessary management changes to address environmental issues that are uncertain or unforeseen as a result of operating the Drinking Water Project.

7. The City will create, maintain, and update an accounting system that will document the proposed project effects on the flow regime of the Rio Grande.

8. When flows are low due to drought, the City may, in coordination with the Service, decide to shut the diversion off during the entire summer to avoid impacts to the environment.

9. The City will conduct minimization measures with a coordinated sediment management

element. Sediment management will include elements of concern with respect to flood control and compact delivery requirements. The City will seek to coordinate and facilitate appropriate sediment management actions with respect to Jemez Reservoir, Cochiti Reservoir, Galisteo Reservoir, irrigation diversion dams, and Albuquerque Metropolitan Area Flood Control Authority facilities.

10. If existing river gages are incapable of measuring the flows, the City will install appropriate stream gauging.

11. The City will install meters in the pump station at the diversion structure to continuously measure the amount of water diverted. Gauging information related to the City=s Drinking Water Project will be made available to the Service on a real-time basis.

12. When developing release schedules for San Juan-Chama water, the City will work with Reclamation, the Service, OSE, the New Mexico Department of Game and Fish, and the Interstate Stream Commission so that releases can benefit stream fisheries above the diversion. However, the City=s releases must be consistent with state and federal laws, and must be approved by OSE. The City=s San Juan-Chama water will be released from storage in upstream reservoirs in accordance with the conditions set forth in the approved OSE permit. The application for diversion of the City=s San Juan-Chama water for this project was submitted to the OSE in May 2001. As of the date of this opinion, the City=s permit has not been approved. Upon approval, the City will provide a copy of the permit to the Service. The final release schedule will be determined by the City under the conditions of the permit.

13. The proposed location for the habitat restoration minimization activities is south of Paseo del Norte on the west side of the river and currently includes 160 ac (65 ha) of mixed bosque and 48 acres (19 ha) on the Montaño Oxbow. The work will include mechanical clearing of non-native vegetation to promote native species re-generation. The restoration of native vegetation will be done by either planting or re-establishing hydrologic connectivity. Individual cottonwood poles and willow whips, willow bundles/mats, individual shrubs, reseeding, or other planting methods at a density of 120 plant units per acre are potential methods that may be used to enhance flycatcher habitat.

14. An overbank project of 10 ac (4 ha) will be created that will provide refuge for aquatic organisms, restoration or riparian vegetation, and re-establishment of a river channel/floodplain interaction. The newly created terraces will be placed in areas where the channel is relatively incised and the potential for overbank flows is minimal.

15. Two high-flow side channels will be constructed to provide aquatic habitat at flows greater than 1,500 cfs (42.48 m;s) and 2,000 cfs (56.63 m;s), respectively. The functional purpose of the side channels is to provide backwater and slower velocity areas for aquatic and terrestrial species and increase the potential for overbank flooding and native species regeneration.

16. Channel widening and bank destabilization will be promoted by the removal of 120 jetty jacks. Removal of the jetty jacks, in combination with clearing vegetation and bank lowering, will encourage native species reestablishment and the creation of shallower, slower velocity habitats for the silvery minnow.

17. Two river bars will be enhanced by a combination of non-native species vegetation clearing, lowering, and pilot channel work. This project will also promote the creation of shallower, slower velocity habitats for the silvery minnow.

18. Flow will be reestablished to the Montaño Oxbow by the construction of an additional high side flow channel and non-native vegetation removal. This project will be designed to provide back-water and side channel habitat adjacent to, and connected to the river channel for silvery minnow habitat and restoration of native riparian vegetation.

19. To determine whether these projects are successful, baseline data will be collected, and both short-term and long-term objectives will be established. Examples of parameters that will be assessed under each of these categories are illustrated as follows:

    <u>Initial/Baseline Date</u>
    a. Number of acres in non-native vegetation
    b. Number of acres in native vegetation
    c. Number of acres in non-restored burned condition
    d. Initial plant, insect, and mammal species composition

    <u>Immediate/Short-term Objectives</u>
    a. Number of acres planted into native species or restored
    b. Number of cottonwood pole plantings, willow whips, or shrubs
    c. Acreage of burned area cleared
    d. Acreage of bank-lowering completed
    e. Length of side-channels created
    f. Number of jetty jacks removed
    g. Changes in species composition

    <u>Ongoing/Long-term Measures</u>
    a. Percent survival rate of cottonwood plantings
    b. Size of overbank lowering reclaimed to natural conditions
    c. Survival rate of native species within overbank areas
    d. Presence or increase of endangered or delivered species in restoration areas
    e. Presence or indicator species showing habitat improvement
    f. Overall improvements in water or soil quality

In addition to these specific habitat restoration projects, the City will carry out the following minimization activities:

1. The City will continue to provide funds for utilities, staffing, and equipment for the captive breeding program at the Albuquerque Aquarium for a period of ten years beginning on the date of this biological opinion. The program has been expanded, in partnership with the Interstate Stream Commission, to include a naturalized refugium. Funding will be provided in the amount of no more than $165,000 per year. Silvery minnows raised from the captive breeding program will be reintroduced to the wild in coordination with the New Mexico Fishery Resources Office (NMFRO) and the New Mexico Ecological Services field Office (NMESFO).

2. The City will provide funding to continue to monitor and improve the Albuquerque Water Resources Management Strategy minimization measures program, including continuation of mammal, avian, and human-use studies for the bosque. Additional monitoring of amphibian/reptile populations and vegetation is needed in Rio Grande Valley State Park. Permanent transects have been established at 12 sites throughout the Rio Grande Valley State Park to monitor these populations. The Bosque Action Plan mandates that these transects be monitored for changes every 3 to 5 years.

3. For the first 10 years of the project, as determined and requested by the Service, the City will cease operations of the diversion during a 24-hour period once a year during the silvery minnow spawn to reduce the take of eggs. After 10 years, the need for this conservation measure will be assessed and if deemed necessary by mutual agreement, may continue. This requirement does not apply if the City=s diversion is not in operation during the spawn. The Service will notify the City in writing within one week of the requested shutdown when flows are managed to manufacture the spawn. For natural spawning flows, the Service will coordinate closely with the City to determine when the benefits to the silvery minnow from the 24-hour operational shutdown can be maximized, realizing that: (1) The City needs at least 48 hours to shutdown, and (2) natural flow spikes cannot be predicted.

Reporting and Coordination

The City commits to ongoing coordination with the Service on a number of activities described within the proposed action. The following reporting and coordination will take place during the implementation of this project.

XThe City will meet with the Service to discuss their Annual Operating Plan for the Drinking Water Project by May 15 of each year.

XThe City will provide the Service with an annual report on water accounting for the previous year by February 15 of each year. The City=s accounting system will identify the locations and quantities of water depletion from the river, the amount returned to the river, and the amount of water that will be consumed through beneficial use.

XThe City will provide the Service with an annual report describing the status of the proposed conservation measures by February 15 of each year. This report will describe activities carried out during previous years and projects planned for the upcoming year(s).

XThe City will provide the Service with an annual report describing egg collection directly upstream of the diversion dam by September 1 of each year.

XThe City will coordinate with the Service when developing and implementing the habitat restoration projects described in the proposed action.

XThe City will notify the Service in writing regarding any changes in operations related to curtailment of increases of diversions.

II. Status of the Species

Rio Grande Silvery Minnow

Species Description

The silvery minnow was federally listed as endangered under the ESA on July 20, 1994 (Service 1994). The species is listed by the State of New Mexico as an endangered species. Primary reasons for listing the silvery minnow involved a number of factors, described later in the Status and Distribution section, which contributed to a collapse of population numbers throughout its historic range. The final recovery plan for the silvery minnow was released in July 1999 (Service 1999). The primary objectives are to increase numbers of the silvery minnow, enhance its habitat in the Middle Rio Grande valley, and expand its range by reestablishing the species in at least three other areas within its historic range.

The silvery minnow is a stout minnow, with moderately small eyes, a small, subterminal mouth, and a pointed snout that projects beyond the upper lip (Sublette *et al.* 1990). The back and upper sides of the silvery minnow are silvery to olive, the broad mid-dorsal stripe is greenish, and the lower sides and abdomen are silver. Maximum length attained is about 3.5 in (90 mm). The only readily apparent sexual dimorphism is the expanded body cavity of ripe females during spawning (Bestgen and Propst 1994).

The silvery minnow has had an unstable taxonomic history, and in the past was included with other species of the genus *Hybognathus* due to morphological similarities. Phenetic and phylogenetic analyses corroborate the hypothesis that it is a valid taxon, distinctive from other species of *Hybognathus* (Cook *et. al.* 1992, Bestgen and Propst 1994). It is now recognized as one of seven species in the genus *Hybognathus* in the United States and was formerly one of the most widespread and abundant minnow species in the Rio Grande basin of New Mexico, Texas, and Mexico (Pflieger 1980, Bestgen and Platania 1991). Currently, the silvery minnow is the only remaining endemic pelagic spawning minnow in the Middle Rio Grande. The speckled chub (*Extrarius aestivalus*), Rio Grande shiner (*Notropis jemezanus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus simus*) have gone extinct or have been extirpated from the Middle Rio Grande (New Mexico Department of Game and Fish 1998b, Bestgen and Platania 1991).

Critical Habitat

Critical habitat was proposed for the silvery minnow on June 6, 2002 (67 FR 39205) and was finalized on February 19, 2003 (68 FR 8088). The critical habitat designation went into effect on March 21, 2003. The critical habitat designation extends from Cochiti Dam, Sandoval County, New Mexico downstream to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County, New Mexico, a total of approximately 157 mi (252 km). Although the final rule designates the Jemez River from Jemez Canyon Dam in New Mexico to the upstream boundary of Santa Ana Pueblo as part of the critical habitat designation, a correction notice has been drafted for publication in the Federal Register to remove this reach from the designation. As discussed in the final rule the Pueblo of Santa Ana was excluded from the critical habitat designation. It was determined that the Jemez river below Jemez Canyon Dam is owned by the Pueblo of Santa Ana. The critical habitat designation defines the lateral extent (width) as those areas bounded by existing levees or, in areas without levees, 300 ft (91.4 m) of riparian zone adjacent to each side of the bankfull stage of the Middle Rio Grande. The Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta within this area are not included in the critical habitat designation. Except for these areas, the final remaining portion of the silvery minnow=s occupied range in the Middle Rio Grande in New Mexico is designated as critical habitat (68 FR 8088).

Some developed lands within the 300-ft (91.4-m) lateral extent are not considered critical habitat because they do not contain the primary constituent elements and they are not essential to the conservation of the silvery minnow. Lands located within the exterior boundaries of the critical habitat designation, but not considered critical habitat, include: developed flood control facilities; existing paved roads; bridges; parking lots; dikes; levees; diversion structures; railroad tracks; railroad trestles; water diversion and irrigation canals outside of natural stream channels; the low flow conveyance channel; active gravel pits; cultivated agricultural land; and residential, commercial, and industrial developments. These developed areas do not contain any of the primary constituent elements and do not provide habitat or biological features essential to the conservation of the silvery minnow.

The Service determined the primary constituent elements of critical habitat for the silvery minnow based on studies on their habitat and population biology (68 FR 8088). The primary constituent elements of critical habitat for the silvery minnow include:

1. A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats, such as, but not limited to the following: backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels, pools (that portion of the river that is deep with relatively little velocity compared to the rest of the channel), eddies (a pool with water moving opposite to that in the river channel), and runs (flowing water in the river channel without obstructions) of varying depth and velocity B all of which are necessary for each of the particular silvery minnow life-history stages in appropriate seasons (e.g., the silvery minnow requires habitat with sufficient flows from early spring (March) to early summer (June) to trigger

spawning, flows in the summer (June) and fall (October) that do not increase prolonged periods of low or no flow, and a relatively constant winter flow (November through February)); The presence of eddies created by debris piles, pools, or backwaters, or other refuge habitat within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities;

2. The presence of eddies created by debris piles, pools, or backwaters, or other refuge habitat within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities;
3. Substrates of predominantly sand or silt; and
4. Water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 ^{o}C (35 ^{o}F) and less than 30 ^{o}C (85 ^{o}F) and reduce degraded conditions (e.g., decreased dissolved oxygen, increased pH).

The primary constituent elements identified above provide for the physiological, behavioral, and ecological requirements of the silvery minnow. The first primary constituent element provides water of sufficient flows to reduce the formation of isolated pools. We conclude this element is essential to the conservation of the silvery minnow because the species cannot withstand permanent drying (loss of surface flow) of long stretches of river. Water is a necessary component for all silvery minnow life-history stages and provides for hydrologic connectivity to facilitate fish movement. The second primary constituent element provides habitat necessary for development and hatching of eggs and the survival of the silvery minnow from larvae to adult. Low-velocity habitat provides food, shelter, and sites for nursery habitat, which are essential for the survival and recruitment of silvery minnows (68 FR 8008). The third primary constituent element provides appropriate silt and sand substrates (Dudley and Platania 1997; Remshardt *et al.* 2001), which we believe are important in creating and maintaining appropriate habitat and life requisites such as food and cover. The final primary constituent element provides protection from degraded water quality conditions. We conclude that when water quality conditions degrade (e.g., water temperatures are too high, pH levels are too high, and dissolved oxygen concentrations are too low), silvery minnows will likely be injured or die.

The following analysis (i.e., the determination whether an action destroys or adversely modifies critical habitat) for this opinion will evaluate whether the loss, when added to the environmental baseline, is likely to appreciably diminish the capability of the critical habitat to satisfy essential requirements of the silvery minnow. In other words, activities that may destroy or adversely modify critical habitat include those that alter the primary constituent elements (defined above) to an extent that the value of the critical habitat for the conservation of the silvery minnow is appreciably reduced (50 CFR 402.02).

Life History

The silvery minnow travels in schools and tolerates a wide range of habitats (Sublette *et al.* 1990), but generally prefers low velocity (< 0.33 ft/sec, 10 centimeters/second [cm/sec]) areas over silt or sand substrate that are associated with shallow (< 15.8 in [40 cm]) braided runs, backwaters or pools (Dudley and Platania 1997). Adults are most commonly found in backwaters, pools, and habitats associated with debris piles; whereas, YOY occupy shallow, low velocity backwaters with silt substrates (Dudley and Platania 1997). A study conducted between 1994 and 1996 characterized habitat availability and use at two sites in the Middle Rio Grande at Rio Rancho and Socorro (Dudley and Platania 1997). Dudley and Platania (1997) reported that this fish species was most commonly found in habitats with depths less than 19.7 in (50 cm). Over 85 percent were collected from low velocity habitats (< 0.33 ft/sec [10 cm/sec]) (Dudley and Platania 1997, Watts *et al.* 2002). Habitat for the silvery minnow includes stream margins, side channels, and off-channel pools where water velocities are low or reduced from main-channel velocities. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by the silvery minnow (Sublette *et. al.* 1990, Bestgen and Platania 1991).

The species is a pelagic spawner that produces 3,000 to 6,000 semi-buoyant, non-adhesive eggs during a spawning event (Platania 1995, Platania and Altenbach 1998). Adults normally spawn in about a one-month period in late spring to early summer (May to June) in response to spring runoff. Platania and Dudley (2000, 2001) found that the highest collections of silvery minnow eggs occurred in mid- to late May. In 1997, Smith (1999) collected the highest number of eggs in mid-May, with lower frequency of eggs being collected in late May and June. These data suggest multiple silvery minnow spawning events during the spring and summer, perhaps concurrent with flow spikes. It is unknown if individual silvery minnows spawn more than once a year or if some spawn earlier and some later in the year. An artificial flow spike of 1,800 cfs (51 m;s) for 24 hours was released from Cochiti Dam on May 19, 1996. This flow spike apparently stimulated a spawning event and resulted in the collection of 49 silvery minnow eggs by researchers at Albuquerque on May 22, the day after the spike passed (Platania and Hoagstrom 1996). A late spawn was documented in the Isleta and San Acacia Reaches on July 24, 25, and 26, 2002, following a high flow event produced by a thunderstorm. This spawn was smaller than the typical spawning event in May, but a significant number of eggs were collected (N = 496) in two hours of effort (J. Smith, Service, *pers. comm.* 2002). In 2002, small spawning events of a few eggs have been documented in all reaches except the Cochiti Reach as late as August 7 (J. Smith, Service, *pers. comm.* 2002).

Platania (2000) found that development and hatching of eggs are correlated with water temperature. Eggs of the silvery minnow raised in 30EC water hatched in about 24 hours while eggs reared in 20 B 24EC water hatched within 50 hours. Eggs were 0.06 in (1.6 mm) in size upon fertilization, but quickly swelled to 0.12 in (3 mm). Recently hatched larval fish are about 0.15 in (3.7 mm) in standard length and grow about 0.005 in (0.15 mm) in size per day during the larval stages. If eggs and larvae are not trapped in backwater habitats or eddies and remain in the main current, they have been estimated to remain in the drift for 3

B 5 days, and could be transported from 134 B 223 mi (216 B 359 km) downstream depending on river flows. About three days after hatching the larvae move to low velocity habitats where food (mainly phytoplankton and zooplankton) is abundant and predators are scarce. Young-of-year attain lengths of 1.5 B 1.6 in (39 B 41 mm) by late autumn (Service 1999). Age 1 fish are 1.8 B 1.9 in (45 B 49 mm) by the start of the spawning season. Most growth occurs between June (post spawning) and October, but there is some growth in the winter months. In the wild, maximum longevity is about 25 months, but very few survive more than 13 months (Service 1999). Captive fish have lived until Age 4 (C. Altenbach, City, *pers. comm.* 2003).

Platania (1995) suggested that historically the downstream transport of eggs and larvae of the silvery minnow over long distances was likely beneficial to the survival of their populations. This behavior may have promoted recolonization of reaches impacted during periods of natural drought (Platania 1995). The spawning strategy of releasing floating eggs allows the silvery minnow to replenish populations downstream, but the current presence of diversion dams (Angostura, Isleta, and San Acacia Diversion Dams) prevents recolonization of upstream habitats (Platania 1995). As populations are depleted upstream, and diversion structures prevent upstream movements, isolated extirpations of the species through fragmentation may occur (Service 1999). Adults, eggs, and larvae are also transported downstream to Elephant Butte Reservoir. It is believed that none of these fish survive because of poor habitat and predation from reservoir fishes (Service 1999).

The silvery minnow is herbivorous (feeding primarily on algae); this is indicated indirectly by the elongated and coiled gastrointestinal tract (Sublette *et al.* 1990). Additionally, detritus, including sand and silt, is filtered from the bottom (Sublette *et al.* 1990, Service 1999).

<u>Population Dynamics</u>

The majority of spawning silvery minnows are one year old. Two year old fish comprise less than 10 percent of the spawning population. High silvery minnow mortality occurs during or subsequent to spawning, consequently very few adults are found in late summer. By December, the majority (greater than 98 percent) of individuals are YOY (Age 0). This population ratio does not change appreciably between January and June, as Age I fish usually constitute over 95 percent of the population just prior to spawning. Generally, the population consists of only two age classes (Service 1999).

Platania (1995) found that a single female in captivity could broadcast 3,000 eggs in eight hours. Females produce 3 B 18 clutches of eggs in a 12-hour period. The mean number of eggs in a clutch is approximately 270 (Platania and Altenbach 1998). In captivity, silvery minnows have been induced to spawn as many as four times in a year (C. Altenbach, City, *pers. comm.* 2000). It is not known if they spawn multiple times in the wild. The high reproductive potential of this fish appears to be one of the primary reasons that it has not been extirpated from the Middle Rio Grande. However, the short life span of the silvery minnow increases the population instability. When two below-average flow years occur consecutively, a short-lived species such as the silvery minnow can be impacted, if not completely eliminated from the dry reaches of the river (Service 1999).

Although only limited data are available it appears that natural recruitment and survival of YOY in 2002 and 2003 was poor when compared to 2000 and 2001. In August 2003, 30 YOY were caught within the 20 permanent sites sampled by Dudley and Platania (http://msb-fish.unm.edu/rgsm2003/pdf/03rgaug.pdf) as part of their on-going population monitoring study. In August 2002, a total of 14 silvery minnow YOY were caught from 20 sites. In August 2001, 714 silvery minnow YOY were caught from 19 sites; and, in August 2000, 219 YOY were caught from 18 sites (calculated from data present on website http://www.uc.usbr.gov/progact/rg/rgsm2002/).

Numbers of silvery minnow from the October sampling period represent those fish that survived through the summer and are likely to contribute to the spawning population in the spring. The number of silvery minnow caught in October of 2000, 2001, 2002, and 2003 were 36, 112, 11, and 2, respectively (http://www.uc.usbr.gov/progact/rg/rgsm2002/, http://msb-fish.unm.edu/rgsm2003/pdf/03rgoct.pdf). In comparing numbers of YOY caught in August (representing recruitment) and all ages of silvery minnows caught in October, after the higher numbers caught in 2001 were recorded, as compared to 2000 or 2002, egg salvage efforts in the subsequent year (2002) resulted in considerably higher numbers of eggs caught than in 2001 or 2003. Results from population monitoring in August and October of 2003 indicate that the number of silvery minnows available for spawning in the Rio Grande in 2004 may be low.

Status and Distribution

Historically, the silvery minnow occurred in 2465 mi (3967 km) of rivers in New Mexico and Texas. They were known to have occurred from Española upstream from Cochiti Lake; in the downstream portions of the Chama and Jemez Rivers; throughout the Middle and Lower Rio Grande to the Gulf of Mexico; and in the Pecos River from Sumner Reservoir downstream to the confluence with the Rio Grande (Sublette *et al.* 1990, Bestgen and Platania 1991). The silvery minnow population has been declining since 1986, and has dropped precipitously since 1999 (Dudley and Platania 2002). There was a slight increase in the number of silvery minnows caught in 2001; however, catch rate declined again in 2002 and 2003 (Dudley and Platania 2002, Platania et al. 2003, http://msb-fish.unm.edu/rgsm2003/#data).

The construction of mainstem dams, such as Cochiti Dam and irrigation diversion dams have contributed to the decline of the silvery minnow. The construction of Cochiti Dam in particular has affected the silvery minnow by reducing the magnitude and frequency of flooding events that help to restore and maintain habitat. In addition, the construction of Cochiti Dam has resulted in changes to silvery minnow habitat below the dam. Flow in the river below Cochiti Dam is now generally clear, cool, and free of sediment. There is relatively little channel braiding, and areas with reduced velocity and sand or silt substrates are uncommon. Substrate immediately downstream of the dam is often armored cobble (rounded rock fragments generally 3 B 12 in [8 B 30 cm] in diameter). Further downstream the riverbed is gravel with some sand material. Ephemeral tributaries including Galisteo Creek and Tonque Arroyo occasionally transport sediment into the lower sections of this reach, and some of this is transported downstream with higher flows (Service 2001a; 2003; 1999). Recovering from the degradation imposed by Cochiti Dam, the Rio Grande gains sediment below Angostura Dam and becomes a predominately sand bed river with low, sandy banks in the downstream portion of the reach. The construction of Cochiti Dam created a barrier between silvery minnow populations. As recently as 1978, the silvery minnow was collected upstream of Cochiti Reservoir; however surveys since 1983 suggest that the fish is now extirpated from this area (Service 1999).

Surveys indicate a continued decline of silvery minnows in the entire Middle Rio Grande (Bestgen and Platania 1991, Platania 1993, Platania and Dudley 1997, Dudley and Platania 2002). Historically, the density of silvery minnows increased from upstream (Angostura Reach) to downstream (San Acacia Reach). This is a result of the silvery minnow eggs and larvae being carried downstream in the current and the inability of the adults to repopulate upstream reaches because the diversion dams are barriers. This distributional pattern has been observed since 1994 (Dudley and Platania 2002) (Appendix D, Figure 3). In 1997, it was estimated that 70 percent of the silvery minnow population was found in the reach below San Acacia Diversion Dam (Dudley and Platania 1997). During surveys in 1999, over 98 percent of the silvery minnows captured were downstream of San Acacia Diversion Dam (Dudley and Platania 2002). This area represents 2.4 percent of the historical range. Surveys indicate a dramatic decline in the number of silvery minnows in this reach (Dudley and Platania 2002). The San Acacia Reach has had the greatest number of fish caught in surveys, however, a marked decline in numbers caught in this lower reach has been observed in the past few years. The extensive drying in the Isleta and San Acacia Reaches in recent years and the increased level of silvery minnow augmentation in the Angostura Reach during 2002 and 2003 may result in changes in previously documented distributional patterns. In the Angostura Reach, catch rates indicated that silvery minnows were more widely distributed in 2001 and 2002, as compared to 1999 and 2000 (Dudley and Platania 2002, Dudley et al. 2003). Salvage operations in which silvery minnows were moved to the Angostura Reach from areas that were drying in the Isleta and San Acacia Reaches may have contributed to these results.

Results from egg monitoring indicate that spawning may have increased in the Angostura Reach between 1999 and 2003. Dudley and Platania (2000) only collected a total of 4 eggs at 2 sites in the Angostura Reach during their periodicity study in 1999. In 2003, the Service sampled for eggs at two locations in the Angostura Reach (Alameda and Rio Bravo) from April 21 through June 9, 2003. The peak egg collection occurred from May 15 B 20, 2003, and coincided with a release of water to create a spawning pulse that increased flows from 550 cfs (15.57 m;s) to approximately 1000 cfs (28.32 m;s) at the sampling locations. The Service collected over 1,697 eggs at 2 sites within the Angostura Reach in 2003. Although the sites within the Angostura Reach were geographically different between the two studies, the lower most sites for each study were within 2 miles of each other. The lower site was where Platania and Dudley (2000) collected the four eggs in their study. The

Service collected 294 eggs at the lower site during a single hour peak near this location in 1999. This information is not directly comparable and should be considered with caution because Platania and Dudley (2000) did not sample on weekends and a short peak in spawning could have been missed in 1999. The Service will be conducting egg monitoring activities in the Angostura reach again in 2004.

In addition to the long-term population monitoring program carried out by Dudley and Platania, other agencies including the NMFRO and Reclamation have conducted monitoring and collection activities associated with specific projects such as the silvery minnow augmentation program, habitat use studies, habitat restoration efforts, and other population studies. Collection activities associated with these efforts have provided additional insights and information regarding the status of the silvery minnow. During October 2003, the NMFRO collected 27 silvery minnows in the Angostura Reach during their augmentation monitoring. Of these fish, 11 were marked and 16 were unmarked. Of the unmarked fish, 13 were YOY (Remshardt, NMFRO, *in litt.* 2003).

Drying of the Rio Grande has led to extensive losses of silvery minnows, especially in the San Acacia Reach where they were once most abundant (Dudley and Platania 2002). The effect of river drying was evident in the months of June and July, 2002 (Dudley et al. 2003). In June, an abnormally high catch rate occurred because fish were trapped in small, isolated pools that were easy to seine. By July these pools were dry and no fish were present at these sites. The total number of fish caught for the remainder of 2002 remained low. In October, November, and December 2002, a total of 11, 36, and 15 silvery minnows, respectively, were caught from the 20 permanent sites. The total area seined in these months ranged from 13,648 B 14,205 m^2 (3.4 B 3.5 ac) (http://www.uc.usbr.gov/progact/rg/rgsm2002/). As of the date of this opinion, final catch rate data for 2003 was not available.

In 1996, at least 36 river miles in the San Acacia Reach were dry for 128 days and the San Marcial gage, located at the lower end of this reach had 0 cfs reading for 180 days. The Service conducted an emergency salvage of silvery minnows trapped in drying pools downstream of Isleta Diversion. Approximately 10,000 silvery minnows were salvaged, transported, and released in a perennial reach of the Rio Grande near Albuquerque (Arritt 1996). Additional salvages of silvery minnows occurred between 1997 and 2002. In 1997, at least 16 river miles were dry for approximately five to seven days. Approximately 16 river miles were dry for 28 days in 1998 (Smith 1999). The river was dry in 1999 for four to five days for at least 28 river miles (Platania and Dudley 1999). Mortality of silvery minnows was documented in 1996, 1997, and 1999 in isolated pools during river intermittency (Smith and Hoagstrom 1997, Smith 1999, Dudley and Platania 1999). Smith and Hoagstrom (1997) and Smith (1999) focused on the relative size of the isolated pools (i.e., estimated surface meters and maximum depth) in relation to pool longevity (i.e., number of days pool existed) and fish community. Smith (1999) found that the typical isolated pools found during intermittent conditions usually only lasted 48 hours. Those that persisted longer lost greater than 81 percent of their estimated surface area and more than 26 percent maximum depth in 48 hours. Because of poor water quality (high water temperatures, low dissolved oxygen) and exposure to predators, mortality of all trapped silvery minnows is expected when drying exceeds 48 hours. These small isolated pools are very different in character from the large, deep oxbow lakes and sloughs that once occurred along the river and sustained fish populations through periods of drought.

Drying occurred in 2000 for less than a week in late July (Dudley and Platania 2001). Approximately 8 B 10 mi (12.9 B 16.1 km) of river dried in 2001, with the period of intermittency usually lasting less than two days (Service 2002). Predatory birds have been seen hunting and consuming fish from isolated pools during river intermittence (J. Smith, NMESFO, *pers. comm.* 2003). Though the number of fish present in any pool is unknown, it must be assumed that many of the fish preyed upon in these pools are silvery minnows. Thus, while some dead silvery minnows were collected during the shorter drying events, it is assumed that many more mortalities occurred than were documented.

In 2002, the Service increased salvage efforts in response to river drying. River drying occurred during the 2002 irrigation season in the Isleta and San Acacia Reaches. Between June and August, 2002, approximately 15.75 mi (25.3 km) of river in the San Acacia Reach and 11 mi (17.7 km) in the Isleta Reach dried. These reaches of river dried and re-wetted several times due to rainstorm events. During these drying events, the Service=s silvery minnow salvage crews captured and relocated 3,639 adult silvery minnows to the Angostura and Isleta Reaches, and documented 249 dead silvery minnows that counted toward the Incidental Take Statement in the June 29, 2001, programmatic biological opinion, as clarified in an August 1, 2002, memorandum to Reclamation (NMESFO, *in litt.* 2002). Approximately 98 percent of the salvaged silvery minnows were released at Central Bridge in Albuquerque, with the remainder released in the upper portions of the Isleta Reach. Re-wetting from storm runoff and the subsequent drying of the river in areas that were previously dry led to the death of additional silvery minnows (< 100) that did not count toward the incidental take statement of the June 29, 2001, programmatic biological opinion. These silvery minnows were not considered as take under the June 29, 2001, programmatic biological opinion because an Aact of nature@ caused the river to re-wet and subsequently dry, rather than the actions of Federal agencies (J. Smith, Service, *pers. comm.* 2003).

In 2003, the Service performed 54 individual silvery minnow salvages within the Isleta and San Acacia Reaches. Approximately 35.5 river miles in the Isleta and 35.1 river miles in San Acacia Reaches were salvaged. Due to periodic rewetting from thunderstorm events, a total of approximately 90 miles of river were salvaged in 2003. From the beginning of June 2003 through mid-October 2003, the Service salvaged 713 silvery minnows from the Isleta and San Acacia Reaches. Generally, the largest number of silvery minnows collected were during the first drying event in each section. The overall number of silvery minnows collected during drying events declined after July of 2003. Age structure of the silvery minnows identified was 57 percent adult and 43 percent YOY. It is likely that some of the unidentified YOY fish collected during salvage events throughout June and early July were also silvery minnows. These fish were not identified due to the difficulties in accurately identifying small silvery minnows at this time of year and the high numbers of YOY fish salvaged during June and July (J. Smith, NMESFO, *pers. comm.* 2003). Most salvaged silvery minnows were transported to either the Rio Bravo or Central Bridges in

Albuquerque, while a small proportion of the salvaged silvery minnows were used in a survivability study (J. Smith, NMESFO, *pers. comm.* 2003).

In 2000, a program was initiated to pump water from the low flow conveyance channel back into the river and minimize river drying to the maximum extent possible. The initial pumping program had a total of three stations in the San Acacia Reach. These pumps augmented flows throughout the reach within and below Bosque del Apache National Wildlife Refuge (Refuge). This program reduced the amount of intermittency in the river in 2000 and 2001. In 2002, the pumping was expanded to five stations located in the San Acacia Reach from about 3 mi (4.8 km) upstream of US 380 to near Old Fort Craig. The pumping stations at the southern boundary of the Refuge and Fort Craig have created approximately 16 mi (25.7 km) of flowing water. A new pumping station located approximately 4 mi (6.4 km) north of the southern boundary of the Refuge will provide approximately 4 mi (6.4 km) of additional flowing water when sufficient water is in the low flow conveyance channel. With these pumping stations, flow can be maintained for approximately 20 continuous miles of river, from near the middle of the Refuge, to Elephant Butte. However, if the pumps fail, the river may become intermittent. Reclamation has contractors that check the pumps, but mechanical failures can go undiscovered for several hours. Unexpected disasters such as engine fires (one occurred in mid-July of 2002) can severely affect the ability of the pumps to deliver water (G. Pargas, Tetra Tech, *pers. comm.* 2002). In 2003, pumping at the South Boundary of the Refuge maintained river flow to Elephant Butte for the majority of the irrigation season.

The silvery minnow was federally listed as endangered for the following reasons:

1. Regulation of stream waters, which has led to severe flow reductions, often to the point of dewatering extended lengths of stream channel;

2. Alteration of the natural hydrograph, which impacts the species by disrupting the environmental cues the fish receives for a variety of life functions, including spawning;

3. Both the streamflow reductions and other alterations of the natural hydrograph throughout the year can severely impact habitat availability and quality, including the temporal availability of habitats;

4. Actions such as channelization, bank stabilization, levee construction, and dredging result in both direct and indirect impacts to the silvery minnow and its habitat by severely disrupting natural fluvial processes throughout the floodplain;

5. Construction of diversion dams fragment the habitat and prevent upstream migration;

6. Introduction of nonnative fishes that directly compete with, and can totally replace the silvery minnow, as was the case in the Pecos River, where the species was totally replaced in a time frame of 10 years by its congener the plains minnow (*Hybognathus placitus*); and

7. Discharge of contaminants into the stream system from industrial, municipal, and agricultural sources also impact the species (Service 1993, 1994).

These reasons for listing continue to threaten the species throughout its currently occupied range in the Middle Rio Grande.

III. Environmental Baseline

For development and implementation of the Albuquerque Water Resources Management Strategy, the City has completed two previous projects that include environmental documentation and associated minimization measures. These measures have included funding for Service support for silvery minnow research and completion of Technical Memorandum I (City of Albuquerque 2000) for the North I-25 Industrial Recycling Project. Minimization associated with the Non-potable Water Reclamation and Reuse, Northeast Heights and Southeast Albuquerque project includes salvage operations during construction of in-river facilities, financial support in 2001 and 2002 for the silvery minnow captive breeding and rearing program, and additional funding to support the Service field research.

Past actions by various parties in the Middle Rio Grande have eliminated and severely altered habitat conditions for the silvery minnow. These actions can be broadly categorized as changes to the natural hydrology of the Rio Grande and changes to the morphology of the channel and floodplain. Other factors that influence the environmental baseline are water quality, the propagation of silvery minnows, on-going research efforts, and past projects in the Middle Rio Grande. Also of importance is the current drought, the expected weather pattern for the near future, and how it may affect flow in the Rio Grande. Each of these topics is discussed below.

Changes in Hydrology

There have been two primary changes in hydrology since the construction of dams on the Rio Chama and Rio Grande that affect the silvery minnow: (1) Loss of water, and (2) changes to the magnitude and duration of peak flows.

Loss of Water

Prior to measurable human influence on the system, up to the fourteenth century, the Rio Grande was a perennially flowing, aggrading river with a shifting sand substrate (Biella and Chapman 1977). There is now strong evidence that the Middle Rio Grande first began drying up periodically after the development of Colorado=s San Luis Valley in the mid to late 1800s (Scurlock 1998). After humans began exerting more influence on the river, there are two documented occasions when the river became intermittent; during prolonged, severe droughts in 1752 and 1861 (Scurlock 1998). The silvery minnow historically survived low-flow periods because such events were infrequent, of lesser magnitude than they are today, there were no diversion dams to block repopulation of upstream areas, the fish had a much greater geographical distribution, and there were oxbow lakes, cienegas, and sloughs that supported fish until the river became connected again.

Lack of water is the single most important limiting factor for the survival of the species. Water management and use has resulted in a large reduction of suitable habitat for the silvery minnow (Service 1999). Agriculture accounts for 90 percent of surface water consumption in the Middle Rio Grande (Bullard and Wells 1992). There are four irrigation diversion points in the action area. The Cochiti, Angostura, and Isleta, diversion structures divert water from the river to a system of canals and laterals that delivers water to the middle Rio Grande Conservancy District for irrigation of cropland. Riverside drains and wasteways collect surface water and shallow ground water, and convey it back to the river at numerous locations. Water withdrawals have not only reduced overall flow quantities, but also caused the river to become locally intermittent and/or dry for extended reaches. Irrigation diversions and drains significantly reduce water volumes in the river (Service 2003a).

Municipalities and non-agricultural industries in the Albuquerque Basin presently depend entirely on groundwater drawn from the Santa Fe Group aquifer. As the population of the City and surrounding communities has grown, groundwater pumping has increased to a degree that will make continued sole-source reliance on this aquifer unsustainable. Increases in population and changes in the socioeconomic and demographic characteristics in the region have resulted in increased water demands. As a result, the diminishing aquifer is not being recharged by the Rio Grande at the same rate of depletion. A U.S. Geological Survey (USGS) computer simulation showed that about half the water pumped from the City=s aquifer is not being replenished (USGS 1995). Even if conservation plans are met (*i.e.*, reduction of water use on a per-capita basis by 30 percent), groundwater pumping is expected to exceed natural replenishment. This imbalance between withdrawal and recharge rates has led to drops in groundwater levels around the City=s pumping centers and could lead to future water shortages, water quality degradation, land subsidence, and permanent damage to the aquifer (Reclamation 1997, S.S. Papadopulos & Associates, Inc. 2000).

Because aquifers in the Middle Rio Grande region are stream-connected, the pumping of groundwater affects the water supply available to the region (Corps and ISC 2000). The approximate current level of pumping in the Albuquerque Basin, as documented in the OSE ground-water model (Barroll 1999), is 156,800 ac-ft/yr. The aquifers of the Middle Rio Grande region have a limited hydrologic connection to the river. In the Albuquerque area, water table elevations have declined due to pumping and are presently below the elevation of the stream. The result of this limited hydrologic connection is that pumping takes water from storage in the aquifer faster than it is removed from the river. Thus, there are declines in water table elevations. Locally, the river and aquifer are disconnected. This local disconnection results in additional delay in the time for pumping effects to be felt by the river, as the distance between the pumping locations and the connected reaches of the stream are increased. While local disconnection is an additional factor affecting the timing of pumping impacts on a stream the characterization of aquifers in the Middle Rio Grande region as stream-connected remains functionally correct (Corps and ISC 2000). In 1956, the

State Engineer recognized that pumping the aquifer effects the quantity of water in the stream. Therefore, the City was required to compensate for these impacts. Based on 2000 data, the OSE calculated that the City=s pumping of 114,000 ac-ft of groundwater reduced flows in the river by 71,700 ac-ft. The City replaced these flows in the Rio Grande by discharging about 58,000 ac-ft of treated effluent from the Southside Water Reclamation Plant and by not using 13,500 ac-ft of its Middle Rio Grande Basin surface water rights.

Since the listing of the silvery minnow in 1994, the river has not dried upstream of the Isleta Diversion Dam. River reaches particularly susceptible to drying, as documented by the Service during the spring and summer of 1996, are immediately downstream of the Isleta Diversion Dam (RM 169), a 5-mi (8-km) reach near Tome (RMs 150 B 155), a 5-mi (8-km) reach near the U.S. Highway 60 Bridge (RM 127 B 132), and an extended 36-mi (58-km) reach from near Brown Arroyo (downstream of Socorro) to Elephant Butte Reservoir. Extensive fish kills, including tens of thousands of silvery minnows, have occurred in these lower reaches when the river has dried (C. Shroeder, Service, *pers. comm.* 2002).

During the past few years, the City and other San Juan-Chama project contractors allowed the use of their San Juan-Chama water for the purpose of providing flows in the river that were crucial for the silvery minnow population in the San Acacia Reach (Service 2001b). Albuquerque intends to fully utilize its San Juan-Chama water for the Drinking Water Project, therefore, this water may not be available for future activities involving conservation of silvery minnow populations.

Water in the active river channel has been reduced with the construction of drains along both banks of the Rio Grande. The majority of the Middle Rio Grande valley has drains paralleling the river. The west side of the Rio Grande has 160 mi (258 km) of drains, including the low flow conveyance channel, in a 180-mi (290 km) stretch between Cochiti Dam and the Narrows at Elephant Butte Reservoir. This represents 89 percent of the total length between Cochiti Dam and Elephant Butte Reservoir.

Changes to Size and Duration of Peak Flows

Water management has also resulted in a loss of peak flows that historically initiated spawning (Service 2003a). The reproductive cycle of the silvery minnow is tied to the natural river hydrograph and a reduction in peak flows and/or improper timing of flows may inhibit reproduction (Platania and Hoagstrom 1996, Service 1999, Dudley and Platania 2001). Lack of a peak flow was especially severe in the spring and summer of 1996 because of drought. The Service was concerned that silvery minnow reproduction might not occur or would be seriously reduced. A moderate flow spike was coordinated with the cooperation of the City. River and habitat conditions prior, during, and following the spike were monitored. This spike was successful in triggering a spawn and temporarily improved habitat conditions (Platania and Hoagstrom 1996).

Again in the spring of 2002, there was concern that silvery minnows would not spawn because of a lack of spring runoff due to an extended drought. Runoff for the year was predicted to be the lowest in 100 years at around 2 percent of normal at San Marcial (National Weather Service 2002). Water was released (1650 cfs [46.72 m;s]) from Cochiti Dam on May 14, 2002, to provide a cue for silvery minnow spawning. In response to the release, a significant silvery minnow spawning event occurred and was documented in all reaches except the Cochiti Reach (S. Gottlieb, UNM, *in litt.* 2002). In the spring of 2003, spring runoff was low once again. On the morning of May 14, 2003, Reclamation began releasing supplemental water to increase flow in the system to trigger silvery minnow spawning. Approximately 3000 ac-ft of supplemental water was released from Abiquiu Reservoir at a near constant rate of 800 cfs (22.65 m;s) for a 48-hour period.

In addition to providing a cue for spawning, flood flows also maintain a channel morphology to which the silvery minnow is adapted. The changes in channel morphology that have occurred from the loss of flood flows are discussed below.

Hydrology in the Albuquerque Area

The City extends approximately from RM 193 to RM 176 (Albuquerque Reach). From 1971 through 1998, annual average flows at the Central gage in the City was 1,410 cfs (39.92 m;s) and ranged from about 500 cfs (14.16 m;s) in dry years, to more than 2,500 cfs (70.79 m;s) in wet years. Approximately 18 cfs (0.51 m;s) of this flow on average (and about 32 cfs [.91 m;s] in the July through October period) has been City San Juan-Chama water, much of which has been used by the Middle Rio Grande Conservancy District for irrigation. On a daily basis, the City wastewater treatment plant receives and treats approximately 80 cfs (2.27 m;s) of wastewater and discharges the effluent to the Rio Grande (CITY BA, J. Stomp, City, *pers. comm.* 2003).

Abiquiu and Cochiti Reservoirs, which provide flood protection from the drainages upstream from the City, have attenuated the historical flows at this location. Mean monthly flows are characterized by low baseline conditions of about 500 B 1,000 cfs (14.16 B 28.32 m;s) from August through February. Sporadically, flows increase briefly during this period in response to storms. Flows increase in association with spring runoff from March through June typically peak above 3,000 cfs (84.95 m;s) in early May. A dry-year flow period can be derived from the 1972 hydrograph at the Albuquerque gage. gage data for 1972 shows that the mean gauged flow for this year was about 550 cfs (15.57 m;s) as compared to a 1,410-cfs (39.92 m;s) average-year mean flow.

The approximate current level of pumping in the Albuquerque Basin, as documented in the OSE ground-water model (Barroll 1999) is 156,800 ac-ft/yr. The aquifers of the Middle Rio Grande region have a limited hydrologic connection to the river. In the Albuquerque area, water table elevations have declined due to pumping and are presently below the elevation of the stream. The result of this limited hydrologic connection in the Albuquerque area is that pumping takes water from storage in the aquifer faster than it is removed from the river. Thus, there are declines in water table elevations. Locally, the river and aquifer are disconnected. This local disconnection results in additional delay in the time for pumping effects to be felt by the river, as the distance between the pumping locations and the connected reaches of the stream are increased. While local disconnection is an additional factor affecting the timing of pumping impacts on a stream, the characterization of aquifers in the Middle Rio Grande region as stream-connected remains functionally correct (Corps and ISC 2000).

Changes in Channel Morphology

Historically, the Rio Grande was sinuous, braided, and freely migrated across the floodplain. Changes in natural flow regimes, narrowing and deepening of the channel, and restraints to channel migration (i.e., jetty jacks) adversely affect the silvery minnow. These effects result directly from constraints placed on channel capacity by structures built in the floodplain. These environmental changes have and continue to degrade and eliminate spawning, nursery, feeding, resting, and refugia areas required for the silvery minnow=s survival and recovery (Service 1993).

The active river channel through the reaches where the silvery minnow persists in the Angostura Reach is being narrowed by the encroachment of vegetation, resulting from continued low flows and the lack of overbank flooding. The lack of flood flows has allowed non-native riparian vegetation such as saltcedar (*Tamarix* sp.) and Russian olive (*Elaeagnus angustifolio*) to encroach on the river channel (Reclamation 2001). These non-native plants are very resistant to erosion, resulting in it narrowing (Reclamation 2001). When water is confined in a narrower cross-section, its velocity increases, which gives it more power. Fine sediments such as silt and sand are carried away leaving coarser bed materials such as gravel and cobble. Habitat studies during the winter of 1995 and 1996 (Dudley and Platania 1996), demonstrated that a wide, braided river channel with low velocities resulted in higher catch rates of silvery minnows, and narrower channels resulted in fewer fish captured. The availability of wide, shallow habitats that are important to the silvery minnow is decreasing. Narrow channels have few backwater habitats with low velocities that are important for silvery minnow fry and juveniles.

Where the silvery minnow now persists, human development and use of the floodplain have greatly restricted the width available to the active river channel. Development in the flood plain, makes it difficult, if not impossible, to send large quantities of water downstream that would restore low velocity side channels that the silvery minnow prefers. For example, the railroad bridge at San Marcial is so low, flow releases from Cochiti Dam have been reduced to avoid damage to the bridge. The construction of houses in the flood plain on the east side of the river at Socorro requires that releases from Cochiti Dam are reduced to prevent damage to these homes. These reduced releases decrease the available habitat for the silvery minnow.

Water Quality

The term Awater quality@ is used to refer only to the chemical characteristics of the water column. However, the water quality of a river is reflected in the quality or condition of its associated natural resources (e.g., the water column, sediment, biota). The disadvantage of looking only at the physicochemical characteristics of the water is that they only provide a snapshot in time. Because of dilution and the constant downstream flow of water, significant changes in important water quality characteristics may not be detected because samples were taken too soon or too late or at an inappropriate site. This explains why the results of water quality tests are often highly variable over space and time. However, by examining the results of several studies and reviewing monitoring data from wastewater treatment plants bordering the Rio Grande, we can gain some understanding of important factors that influence water quality and the health of aquatic organisms in the river.

Both point (pollution discharges from a pipe) and non-point (diffuse sources of pollution) sources affect the Middle Rio Grande. Major point sources are Wastewater Treatment Plants. Major non-point sources include agricultural activities (e.g., fertilizer and pesticide application, water diversion), stormwater run off, mining activities, livestock grazing, and feedlots.

Effluents from Wastewater Treatment Plants (under both permitted levels and exceedences of the permit) contain contaminants that may affect the water quality of the river. It is anticipated that Wastewater Treatment Plants effluent may be the primary source of perennial flow in the lower portion of the Angostura Reach during extended periods of intermittency. For that reason the water quality of the effluent is extremely important. In the project area, the largest Wastewater Treatment Plants discharges are from Albuquerque, followed by Rio Rancho, Los Lunas, and Bernalillo, (mean annual discharge flows are 80.4 cfs (2.28 m;s) , 2.5 cfs (0.07 m;s), 0.9 cfs (0.03 m;s), and 0.7 cfs (0.02 m;s), respectively; Bartolino and Cole 2002). Records of effluent discharge are available for the Albuquerque Wastewater Treatment Plants for the time period since 1998 (http://oaspub.epa.gov/enviro/pcs_det_reports.detail_report?npdesid=NM0022250). Since that time, total residual chlorine (chlorine) and ammonia, as nitrogen (ammonia), have been discharged unintentionally at concentrations that exceed protective levels for the silvery minnow. Albuquerque Wastewater Treatment Plants effluent discharge records show that during November 1999, the monthly maximum chlorine concentration in the outfall was 0.49 milligrams per liter (mg/L). Additionally, on February 23, 2003, the concentration of chlorine in the outfall was reported to be 0.70 mg/L (C. Abeyta, Service, *in litt.* 2003; D.S. Dailey, City, *in litt*. 2003). Concentrations of chlorine as low as 0.013 mg/L are harmful to the silvery minnow. Records also show that the monthly maximum concentration of ammonia during July 2001 was 14 mg/L. At pH 8 and a water temperature of 25 EC, concentrations of ammonia as low as 3.1 mg/L are harmful to larval fathead minnow (USEPA 1999). The fathead minnow has been suggested as a surrogate to evaluate the effects of various chemicals on the silvery minnow (Buhl 2002).

Although we do not have complete records for the other Wastewater Treatment Plants, in the summer of 2000, the Rio Rancho Wastewater Treatment Plants released approximately one million gallons of raw sewage into the Rio Grande. Chlorine treatment was maximized in an attempt to reduce the public health risk. Ammonia was reported at 37 mg/L on July 13, 2000, and at 17.1 mg/L on July 27, 2000 (City of Rio Rancho, *in litt.* 2000). Nonetheless, no violations of chlorine or ammonia effluent limits were recorded. This suggests that the averaging of measurements and/or the frequency of water quality measurements is insufficient to detect water quality situations that would be toxic to silvery minnows. The Rio Rancho Wastewater Treatment Plants now uses ultraviolet disinfection (Dee Fuerst, City of Rio Rancho, *pers. comm.* 2003) so the release of chlorine should no longer occur. However, high concentrations of ammonia could still be discharged during an upset. The Bernalillo Wastewater Treatment Plants is still operating under a permit issued in 1988 that does not restrict the discharge of lethal concentrations of chlorine to the Rio Grande. The extent of impact from this discharge to the Rio Grande is unknown. A new permit is under review that will regulate chlorine and ammonia discharges, although the risk of accidental discharges will remain.

In addition to chlorine and ammonia, Wastewater Treatment Plants effluents may also include cyanide, chloroform, organophosphate pesticides, semi-volatile compounds, volatile compounds, heavy metals, and pharmaceuticals and their derivatives, which can pose a health risk to silvery minnows when discharged in concentrations that exceed the protective water quality criteria (J. Lusk, Service, *in litt*. 2003). Even if the concentration of a single element or compound is not harmful by itself, chemical mixtures may be more than additive in their toxicity to silvery minnows (Buhl 2002). In the wild, silvery minnows are exposed to many different chemical and physical agents simultaneously, and these cannot be accounted for during traditional water quality sampling regimes. The long-term effects and overall impacts of chemicals on the silvery minnow are not known.

As precipitation falls and exceeds the ability of soils and plants to absorb it, the remainder of the water runs off, usually in a short-lived flood. Large precipitation events wash sediments and pollutants into the river from surrounding lands through storm drains and intermittent tributaries. Although there are contaminant monitoring programs required for stormwater outfalls, there are no criteria established to regulate the quality of stormwater discharges. Contaminants of concern to the silvery minnow that are frequently found in stormwater include the metals aluminum, cadmium, lead, mercury, and zinc, organics such as oils, the industrial solvents trichloroethene and tetracholoroethene (TCE), and the gasoline additive methyl tert-butyl ether (USGS 2001).

Harwood (1995) studied the North Floodway Channel (Floodway) of Albuquerque, which drains an urban area of about 90 square miles and crosses Pueblo of Sandia lands. He found that storm water contributions of dissolved lead, zinc, and aluminum were significant and posed a threat to the water quality of the Rio Grande. Because the Floodway crosses lands of the Pueblo of Sandia and enters their portion of the Rio Grande, the Pueblo requested that the Environmental Protection Agency conduct toxicity tests on water in the Rio Grande collected below the Floodway. Aquatic crustaceans exposed to this water were found to have significant reproductive impairment and mortality when compared with controls.

Additionally, larval fish also experienced significant mortality and/or narcosis when exposed to water and bed sediment collected from this same area on April 22, 2002 (http://oaspub.epa.gov/enviro/pcs_det_reports.detail_report?npdesid=NM0022250). This study indicates that stormwater runoff can impact the water quality of the Rio Grande and the aquatic organisms that live in the river.

Sediment is the sand, silt, organic matter, and clay portion of the river bed, or the same material suspended in the water column. Ong *et al.* (1991) recorded the concentrations of trace elements and organochlorine pesticides in suspended sediment and bed sediment samples collected from the Middle Rio Grande between 1978 and 1988. These data were compared to numerical sediment quality criteria (Probable Effects Criteria [PEC]) proposed by MacDonald *et al.* (2000). According to MacDonald *et al.* (2000) most of the PECs provide an accurate basis for predicting sediment toxicity to aquatic life and a reliable basis for assessing sediment quality in freshwater ecosystems. Although PECs were developed to assess bed (bottom) sediments, they also provide some indication of the potential adverse effects to organisms consuming these same sediments when suspended in the water column. Some concentrations of trace elements and organochlorine pesticides in suspended sediment collected from the Rio Grande floodway at San Acacia and San Marcial exceeded the PECs for copper, chromium, and zinc. The concentrations of trace elements and organochlorine pesticides in bed sediments were much lower than the PECs, suggesting a differential adherence pattern to suspended sediments and bed sediments and dilution by clean sediments. Additional trace elements were elevated in suspended sediments collected from the Rio Grande at San Felipe. The concentrations of contaminants adhered to suspended sediments may pose a health risk to silvery minnows depending on ingestion rates, bioavailability, and the relative sensitivity of this species (Rand and Petrocelli 1985, pp.496B502).

Volatile organic compounds that have been detectable in the Middle Rio Grande at Isleta include chlorpyrifos, and trichlorofluoromethane (Ellis *et al.* 1993). Anderholm *et al.* (1995) described the relationship between the quality of shallow ground water and land use in an urban area in and adjacent to the City. Important sources of recharge that affect shallow ground-water quality in the area include infiltration of surface water, which is used in agricultural land-use areas to irrigate crops, and infiltration of septic-system effluent in residential areas. The presence of synthetic organic compounds (volatile organic compounds and pesticides) in shallow ground water in the study area indicated that human activities have affected shallow ground-water quality. Past spills of TCE and other toxic substances have polluted some of the groundwater in the Albuquerque area. The connection of the surface water quality to the shallow ground water and the exchange of volatile organic compounds is currently being investigated by the USGS.

Semi-volatile organic compounds are a large group of environmentally important organic compounds. Three groups of compounds, polycyclic aromatic hydrocarbons (PAHs), phenols, and phthalate esters, were included in the analysis of bed sediment collected by the USGS (Levings *et al.* 1998). These compounds were abundant in the environment, are toxic and often carcinogenic to organisms, and could represent a long-term source of contamination. The analysis of the PAH data by Levings *et al.* (1998) show one or more PAH compounds were detected at 14 sites along the Rio Grande with the highest concentrations found below the cities of Albuquerque and Santa Fe. Polycyclic aromatic hydrocarbons and other semi-volatile compounds affect the sediment quality of the Rio Grande and may affect silvery minnow behavior, habitat, feeding, and health.

Pesticide contamination occurs from agricultural activities, as well as from the cumulative impact of residential and commercial landscaping activities. The presence of pesticides in surface water depends on the amount applied, timing, location, and method of application. Water quality standards have not been set for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time. Roy *et al.* (1992) reported that DDE, a degradation product of DDT, was detected most frequently in whole body fish collected throughout the Rio Grande. He suggested that fish and their predators in the lower Rio Grande may be accumulating DDE in concentrations that may be harmful. In a study at the Refuge, Ong *et al.* (1991) found detectable levels of DDE in American coot (*Fulica americana*) and carp (*Cyprinius carpio*). Carter (1997) reported that sediment collected and analyzed in the Rio Grande had detectable concentrations of DDE, but that no other organochlorine insecticides or polychlorinated biphenyls were detected. Whole-body fish samples were also collected at the site of sediment collection and analyzed for organic compounds. Organic compounds were reported more frequently in samples of fish, and more types of organic compounds were found in whole-body fish samples than in bed-sediment samples. Concentrations of DDE, polychlorinated biphenyls, cis-chlordane, trans-chlordane, trans-nonachlor, and hexachlorobenzene were also detected in whole-body samples of fish. The presence of DDT and its metabolites, DDD and DDE, in bed sediment and whole-body fish confirms the persistence of this pesticide in the Rio Grande. Although DDT applications have stopped and concentrations in fish tissue have declined dramatically, DDT compounds may still pose adverse health risks to fish species when bioaccumulated from contaminated environments (Rand and Petrocelli 1985, p. 336).

In addition to the compounds discussed above, several other constituents are present and affect the water quality of the Rio Grande. These include nutrients such as nitrates, nitrites, and phosphorus, total dissolved solids (salinity), and radionuclides. Each of these also has the potential to affect the aquatic ecosystem and health of the silvery minnow. As the river dries, pollutants will be concentrated in the isolated pools. Even though these pollutants do not cause the immediate death of silvery minnows, the evidence suggests that the amount and variety of pollutants present in the Rio Grande, could compromise their health and fitness (Rand and Petrocelli 1985).

Silvery Minnow Propagation

Fish species have been propagated and cultured for more than one hundred years in the United States and other countries. The United States began species propagation in 1871, when a bill was passed in Congress that acknowledged the Federal government=s role in natural resource management (Springer 2002). The resolution stated AThe most valuable food fishes of the coast and the lakes are rapidly diminishing in number, to the public injury and so as materially to affect the interests of trade and commerce@ (Springer 2002). One year later, the first national fish hatchery was established in California. At that time, and for more than 100 years since, fish hatcheries existed to rear game fishes, restore stocks, and introduce sport fishes to new areas (Springer 2002).

The ESA requires Federal agencies to use their authorities to conserve endangered species (ESA, section 7(a) (1)). The current role of the Service in this stewardship is that of lead authority and protector of threatened and endangered fish in the United States. This includes protection of the habitats upon which these species depend, as well as recovery of populations that have been diminished due to habitat degradation, excessive harvesting, water quality issues, or other factors (Edwards and Nickum 1993). With the passage of the ESA, the National Fish Hatchery System not only had to change its methods of operation, but its philosophy as well. The first step in this new direction was taken at Dexter National Fish Hatchery (Hatchery). The Hatchery, a 40-year-old warm water facility originally designed to breed largemouth bass (*Micropterus salmonoides*) and channel catfish (*Ictalurus punctatus*) for New Mexico, was transformed into an endangered fish-rearing facility and technology center.

The Hatchery has been a leader in the development of captive propagation techniques and has reared some of the rarest fish in the country. These include the Colorado pike minnow *(Ptychocheilus lucius*), as well as the Gila topminnow (*Poeciliopsis occidentalis*). There are at least 15 species of threatened or endangered fish being cultured at the Hatchery. These species include the silvery minnow and many other cyprinids such as the bandtail chub (*Gila elegans*), Pahranagat roundtail chub (*Gila robusta jordani*), chihuahua chub (*Gila nigrescens*), Virgin River chub (*Gila robusta seminuda*), woundfin (*Plagopterus argentissimus*), and the Guzman beautiful shiner (*Cyprinella formosa formosa*).

Propagation of minnows in the United States began in the early 1930s with the culture of bait fish to support sport fisheries. Golden shiners (*Notemigonus crysoleucas*), bluntnose minnows (*Pimephales notatus*), fathead minnow (*Pimephales promelas*), and eastern silvery minnow (*Hybognathus regius*) were propagated to provide bait for game fish (Markus 1934, Raney 1941). Many aspects of culturing bait fish in ponds were described as early as 1938. The silvery minnow has been difficult to raise in captivity. The greatest success has occurred at the Hatchery, while other facilities have experienced high levels of mortality (J. Brooks, Service, *in litt.* 2001).

In 1999, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow (Service 1999). Consistent with Service policy (65 FR 183), captive propagation is conducted in a manner that will, to the maximum extent possible, preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations.

In 2000, adult wild silvery minnows from the San Acacia Reach and eggs from San Marcial were collected for a pilot propagation and augmentation program. Wild gravid adults were successfully spawned in captivity at the City=s propagation facilities. Approximately 500 silvery minnows were induced to spawn producing approximately 203,600 eggs (Platania and Dudley 2001). These eggs were raised for 2 B 3 days and released as larval fish at Bernalillo (91,600) and Los Lunas (112,000) (Platania and Dudley 2001).

Since 2000, silvery minnow eggs have been salvaged from the Rio Grande to supplement the captive population. Generally, the majority of eggs observed and collected during the spawn are at or below San Marcial. In 2000, an estimated 41,498 silvery minnow eggs were collected in three days just below the San Marcial Railroad Bridge (J. Smith, Service, *in litt.* 2000). The eggs were transported to the City of Albuquerque=s propagation facilities where they were raised to adults. It was estimated that the eggs would have an estimated five to 10 percent survivorship which would result in approximately 2,075 B 4,150 adult silvery minnows (C. Altenbach, City, *pers. comm.* 2002). However, because the project was only designed to rear 1,000 adult silvery minnows from 10,000 eggs, approximately 2,500 juvenile silvery minnows were released in the Angostura Reach of the Rio Grande in July of 2000 to provide space in the facilities to grow out remaining juveniles to a larger size.

During spring runoff in mid-May, 2001, approximately 89,500 wild eggs were collected near the headwaters of Elephant Butte Reservoir (Platania and Dudley 2002). From May 17 B 19, 2002, the catch of silvery minnow eggs collected for captive propagation is conservatively estimated to be 922,000 (Platania and Dudley 2003). These eggs were transported to captive propagation units where they were raised to sub-adults and adults for release back into the wild. In 2003, the City coordinated egg collection activities associated with silvery minnow propagation and broodstock. Egg collection activities at San Marcial and the "white gate" location on May 19 – 20, 2003, produced approx. 298,000 eggs. Egg collection activities at Rio Bravo Bridge, North Socorro Diversion, South Boundary of the Refuge, San Marcial, and the "white gate" on May 28 – 30, 2003, produced approx. 128,000 eggs (C. Altenbach, City, *pers. comm.* 2003).

Silvery minnow adults were induced to spawn in captivity using hormones in 2001 and into early 2002. In April of 2002, the City=s propagation facilities spawned silvery minnows in captivity for the first time without the use of hormones (C. Altenbach, City, *pers. comm.* 2002). Silvery minnows are currently housed at five facilities in New Mexico. The New Mexico facilities are: the Hatchery; New Mexico State University Coop Unit (Las Cruces); Rock Lake State Fish Hatchery; the NMFRO, and the City=s propagation facilities. These facilities are actively propagating and rearing silvery minnows or are available for propagation. In 2000, the total combined capacity of these facilities was approximately 175,000 silvery minnow juveniles and adults (J. Brooks and J. Landye, Service, *in litt*. 2000). New facilities are being constructed at the City, the Hatchery, and at NMFRO that will increase the total capacity of all facilities to approximately 500,000 juveniles and adults. Silvery minnows are also held in South Dakota at the U.S. Geological Survey, Biological Resources Division (USGS-BRD) Lab, but there is no active spawning program at this facility. As of January 2004, approximately 139,000 silvery minnows are held in various facilities (Dexter, NMFRO, Albuquerque Biopark, NMFRO-Las Cruces). These fish will be used for augmentation into the Rio Grande, broodstock, and research (J. Brooks, in litt. 2004).

Ongoing Research

There is on-going research by the NMFRO and UNM to examine the movement of silvery minnows. The fish are marked with a visible fluorescent elastomer tag and released in large numbers in a few locations. After fish are released, crews sample intensively upstream and downstream from the release site in an attempt to capture the marked fish. In January 2002, approximately 13,000 silvery minnows were released by UNM into the San Acacia Reach. In June 2002, 2,082 silvery minnows were released by NMFRO 1,640 ft (500 m) above the Alameda Bridge in the City; in December 2002, 41,500 silvery minnows were released in Rio Rancho; and in January 2003, approximately 61,000 silvery minnows were released in Bernalillo. The last three releases were made by NMFRO. On April 7, 2003, 22,266 silvery minnows were released by the NMFRO and personnel from the Pueblo of Sandia=s Water Resources Department in the Rio Grande within Sandia Pueblo=s boundary. In addition to providing information on movement, these releases will augment the wild population.

Preliminary results indicate that the majority of silvery minnows dispersed. Monitoring within 48 hours after the release of the 41,500 silvery minnows resulted in the capture of 937 fish. Of these, 928 were marked and 927 were collected downstream of the release point. One individual was captured 15.7 mi (25.3 km) upstream from its release site (S. Platania, UNM, *pers. comm.* 2003). The results of this study are preliminary.

Due to the increased efforts in captive propagation, recent studies have been developed by UNM on the genetic composition of the silvery minnow. Recent research indicates that the net effective population size (Ne) (the number of individuals that contribute to maintaining the genetic variation of a population) of the silvery minnow in the wild is between 60 B 250 fish (T. Turner, UNM, *pers. comm*. 2003). It has been suggested that a Ne of 500 fish is needed to retain the long-term adaptive potential of a population (Franklin 1980). No significant genetic differences have been found in populations isolated in the different reaches of the Rio Grande (D. Alo UNM, *pers. comm*. 2002). Because the number of wild fish in the river appears to be low, the addition of thousands of silvery minnows raised in captivity could impact the genetic structure of the population. The propagation effort should be sufficient to maintain 100,000 B 1,000,000 fish in the wild (T. Turner, UNM, *pers. comm.* 2003). For instance if it were determined that 50,000 silvery minnow were in the wild, a minimum of 50,000 adult fish should be in propagation facilities. We do not know how many fish are in the wild so it is difficult at this time to determine the exact number needed in propagation facilities. However, to insure against a catastrophic event in which nearly all wild fish are lost, it is suggested that 100,000 B 1,000,000 silvery minnow are kept in propagation facilities to maintain a sufficient amount of genetic variability for propagation efforts (T. Turner, UNM, *pers. comm*. 2003). Propagation will be carefully managed to ensure the long-term viability of the species. Research projects investigating the genetic fitness of the species will continue to be conducted.

The Service in coordination with New Mexico State University have initiated a study to assess the survivability of silvery minnows that are salvaged and relocated during river drying events. The purpose of the study is to assess the direct effects (do the adults survive the short and long term effects of salvage) and indirect effects (body condition and susceptibility to disease and parasites) associated with salvage activities. Conditions from which the salvaged fish were collected for this study are carefully recorded (i.e time, water temperature, air temperature, pH, conductivity, dissolved oxygen, size of pool). Salvaged fish used in the experiment are handled exactly the same as all other salvaged fish (i.e., transport time, time of collection, etc.).

Permitted and/or Authorized Take

Table 2 outlines silvery minnow take authorized by section 10 and incidental take permitted under section 7. These permits and/or authorizations are issued by the Service. Applicants for section 10 permits must also acquire a permit from the State to Atake@ or collect silvery minnows. Many of the permits issued under section 10 allow take for the purpose of collection and salvage of silvery minnows and eggs for captive propagation. Eggs, larvae, and adults are also collected for scientific studies to further our knowledge about the species and how best to conserve the silvery minnow. Since 2000, the Service has reduced the amount of take permitted for voucher specimens as a result of the increasingly precarious status of the species in the wild. The only incidental take authorized under section 7 consultation for silvery minnows within the action area is associated with the March 17, 2003, Middle Rio Grande Water Operations Programmatic Biological Opinion.

Agency	**Purpose**	**Time period**	**Take Permitted**
NMESFO (Sec 10)	Captive propagation and salvage	Per year	Unlimited
NMFRO (Sec 10)	Collection for captive propagation	Per year	500,000 eggs or larvae
	Collection for spawning and brood stock	Per year	1000 adults
	Captive propagation	Per year	1,000,000 eggs or
	Maintain in captivity at NMFRO and Bosque del Apache Refuge	Per year	20,000 juveniles or adults
	Stock into river	Per year	500,000
	Provide minnows to other facilities	Per year	5,000
Corps (Sec 10)	Salvage (coordinated with Service)	Per year	Unlimited
	Collection for voucher specimens	Per year	50
Reclamation (Sec 10)	Maintain in captivity for scientific investigations	Per year	500 (200 may be killed)

	Collection for voucher specimens	Per year (June 1 B August 31)	100 per site
		Per year (September 1 B May 31)	100
City of Albuquerque (Sec 10)	Collection for voucher specimens	Per year	100
	Captive propagation	Per year	Unlimited
NMDGF (Sec 10)	Collection for voucher specimens	Per year	1,000 per site
	Captive propagation	Per year	50,000 (20,000 may be killed)
NMSU Coop Unit (Sec 10)	Captive propagation and scientific investigations	Per year	50,000 (20,000 may be killed)
UNM (Sec 10)	Collection for voucher specimens	Per year (May 1 B August 31)	500 per site
		Per year (September 1 B April 31)	100 per site
	Collection for quantification during spawning	Per year	100,000 eggs
	Collection for controlled propagation	Per year	Unlimited eggs
	Collection for spawning and brood stock	Per year	2,000
	Collection for genetic purposes	Per year	300 (30 may be killed) 1000 larval fish
Yankton USGS-BRD (Sec 10)	Maintain in captivity for scientific investigations (toxicity testing)	Per year	5,000 (2,000 may be killed)
Multiple agencies (Sec 7)	2001 Programmatic Water Operations Biological Opinion	2001 B 2003	100,000 (500 adults found dead; 750 juveniles found
Multiple agencies (Sec 7)	2003 Programmatic Water Operations Biological Opinion	2003 B 2013	38,000 adults, unlimited number of juveniles

Table 2. Silvery minnow take associated with current section 10 and section 7 permits.

Other Projects

On the Middle Rio Grande, the following past and present Federal, State, private, and other human activities, in addition to those discussed above, have affected the silvery minnow and its critical habitat:

1. <u>Release of Carryover Storage from Abiquiu Reservoir to Elephant Butte Reservoir</u>: The Corps consulted with the Service on the release of water during the winter of 1995. Ninety-eight thousand ac-ft of water was released from November 1, 1995, to March 31, 1996, at a rate of 325 cfs (9.2 m;s). This discharge is above the historic winter flow rate. Substantial changes in the flow regime that do not mimic the historic hydrograph can be detrimental to the silvery minnow. For example, during the winter release habitat study, Dudley and Platania (1996) observed an apparent increase in flow between two winter sampling trips, January 19 B 26, 1996, and February 3 B 5, 1996, resulting in a decrease in low-velocity and side-channel habitats favored by silvery minnows.

2. <u>Corrales, Albuquerque, and Belen Levees</u>: These levees contribute to floodplain constriction and habitat degradation for the silvery minnow. Levees at these sites contribute to the degradation of the environmental baseline by reducing the amount and quality of suitable habitat for the silvery minnow.

3. <u>Santa Ana River Restoration Project</u>: In August 1999, Reclamation submitted a biological assessment to the Service to proceed with a restoration project located on Santa Ana Pueblo in an area where the river channel was incising and eroding into the levee system. This project includes components such as, a Gradient Restoration Facility (GRF), channel re-alignment, bioengineering, riverside terrace lowering, and erodible banklines. The primary component of the Santa Ana Restoration Project is a GRF which will provide control of the river hydraulics upstream of its location and also river bed control. The GRF was designed to: (1) Store more sand sediments at a stable slope for the current sediment supply; (2) decrease the velocities and depths and increase the width in the river channel upstream; (3) be hydraulically submerged at higher flows while simultaneously increasing the frequency and duration of overbank flows upstream; (4) provide velocities and depths suitable for passage of the silvery minnow through the structure; and (5) halt or limit further channel degradation upstream of its location. The channel re-alignment involves moving the river away from the levee system and over the grade control structure, and involves excavation of a new river channel and floodplain. Another significant component of the Santa Ana Restoration project is riverside terrace lowering for the creation of a wider floodplain. The bioengineering and deformable banklines are also involved to assist in establishing the new channel bank and re-generating native species vegetation in the floodplain. The Service concurred that different aspects of this project were not likely to adversely affect the silvery minnow on August 4, 1999, March 15, 2000, and February 6, 2002.

4. <u>Cochiti Fish Screens:</u> This Corps project involved the reparation of fish screens located on the headworks of the Sile and Cochiti Eastside Main Canals in the stilling basin of Cochiti Dam in November 1999. The repair work took approximately six hours per work day for 4 days and involved reducing outflow from Cochiti Dam to approximately 100 cfs (2.83 m;s) during the six hours of work each day. Conditions that had to be met for the work to progress included: (1) A minimum 700 cfs (19.82 m;s) release prior to and following the release reduction to 100 cfs (2.83 m;s) for repairs; (2) the release reduction could not occur before 9:00 AM and could last for a maximum duration of six hours; (3)

drawdown to 100 cfs (2.83 m;s) for six hours could be undertaken only for 2 consecutive days, and additional repair and release reduction would be deferred to no more than 2 consecutive days the following week if needed; and (4) all repairs had to be completed prior to December 1, 1999, to minimize disturbance of bald eagles.

5. Silvery Minnow Augmentation: The Service completed an intra-Service section 7 consultation on the salvage and controlled propagation of silvery minnows in 2000. This consultation covered the collection of free floating silvery minnow eggs below the San Marcial Railroad Bridge and the collection of wild adult silvery minnows for spawning. This consultation provides guidance to limit silvery minnow mortality during collection and rearing.

6. Salvage of Silvery Minnows: The Service completed an intra-Service section 7 consultation of the salvage of silvery minnows from isolated pools in 2000. This consultation provides guidance to limit silvery minnow mortality during collection.

7. Creation of a Conservation Pool for Storage of Native Water in Abiquiu and Jemez Canyon Reservoirs and Release of a Spike Flow: The City created space (100,000 ac-ft) in Abiquiu Reservoir and the Corps created space in Jemez Canyon Reservoir to store Rio Grande Compact credit water for use in 2001, 2002, and 2003 for the benefit of listed species. The conservation pool was created with the understanding that the management of this water would be decided in later settlement meetings or during water operations conference calls. In addition, a supplemental release (spike) occurred in May 2001 to accommodate movement of sediment as a part of habitat restoration and construction on the Rio Grande and Jemez River on the Santa Ana Pueblo.

8. Programmatic Biological Opinion on the Effects of Actions Associated with the U. S. Bureau of Reclamation=s, U.S. Army Corps of Engineers=, and non-Federal Entities= Discretionary Actions Related to Water Management on the Middle Rio Grande: The Service completed this biological opinion on June 29, 2001, determining the effects of water management by the applicants on the silvery minnow and flycatcher. This biological opinion had one RPA with several elements. These elements set forth a flow regime in the Middle Rio Grande and described habitat improvements necessary to alleviate jeopardy to both the silvery minnow and flycatcher.

9. Los Lunas Habitat Restoration Project: On February 6, 2002, the Service completed this consultation, which tiered from the programmatic biological opinion on water management on the Middle Rio Grande issued June 29, 2001. This project is intended to partially meet element J of the Reasonable and Prudent Alternative from the programmatic biological opinion to conduct habitat/ecosystem restoration projects in the Middle Rio Grande to benefit the silvery minnow and flycatcher. Approximately 37 ac of native riparian and 40 ac of aquatic habitat are being created by this project. This project includes side-channels resulting in increased inundation frequency and will result in inundation of the area at flows greater than or equal to 2,500 cfs (70.79 m;s). A variety of substrate elevations will also allow inundation of some areas when flows are less than 2,500 cfs (70.79 m;s).

10. March 17, 2003, Programmatic Biological Opinion on the Effects of Actions Associated with the U.S. Bureau of Reclamation=s, U.S. Army Corps of Engineers=, and non-Federal Entities= Discretionary Actions Related to Water Management on the middle Rio Grande: This biological opinion resulted from the reinitiation of consultation for the June 29, 2001 biological opinion. The March 17, 2003, Middle Rio Grande Water Operations Programmatic Biological Opinion determined the effects of water management by the applicants and other water users in the Middle Rio Grande Basin on the silvery minnow and flycatcher. This biological opinion had one RPA with several elements. These elements describe a flow regime in the Middle Rio Grande, and habitat improvements, population management, and water quality actions necessary to alleviate jeopardy to both the silvery minnow and flycatcher.

Summary

In summary, the remaining population of the silvery minnow is restricted to about 5 percent of its historic range. Every year since 1996, there has been at least one drying event in the river that has further reduced the silvery minnow population. During 1996, approximately 27 percent of the occupied range of the silvery minnow was dry for several days. In the San Acacia Reach, where the majority of the silvery minnow population occurred, approximately 60 B 64 percent of the reach dried (Reclamation 2001). Although the consequences of the 1996 mortality event are unknown in terms of the total number of silvery minnows or percentage of the population that perished, the species= status and long-term recovery potential were adversely affected (Platania and Dudley 1999). Dead silvery minnows were documented during channel drying events in 1999, 2000, 2001, 2002, and 2003 (Platania and Dudley 1999; J. Smith, NMESFO, *pers. comm.* 2002; Service 2002; J. Smith, NMESFO, *pers. comm*. 2003).

Data collected during the summers of 2000, 2001, and 2002 indicate a near-absence of Age 0 silvery minnows in the Middle Rio Grande, suggesting that the population has dramatically decreased since 1999 (Smith and Jackson 2000, Hoagstrom and Brooks 2000, Dudley and Platania 2002). There was a slight increase in silvery minnow abundance in the Angostura and Isleta Reaches in 2001; however, it appears these slight gains were lost in 2002 (Dudley and Platania 2002). [Update with 2003 data will be in final BiOp]. The population is unable to expand its distribution, because three diversion dams currently block upstream movement and Elephant Butte Reservoir blocks downstream movement (Service 1999). Augmentation of silvery minnows with captive-reared fish will continue, however continued monitoring and evaluation of these fish is necessary to obtain information regarding the survival and movement of individuals.

Water withdrawals from the river and water releases from dams severely limit the survival of silvery minnows. The consumption of shallow groundwater and surface water for municipal, industrial, and irrigation uses continues to reduce the amount of flow in the Rio Grande and eliminate habitat for the silvery minnow (Reclamation 2002b). However, under state law, the municipal and industrial users are required to offset the effects of groundwater pumping on the surface water system. The City, for example, has been offsetting their surface water depletions with 60,000 ac-ft/yr (Reclamation 2002b). The combined effect of water withdrawals and the drought mean that discharge from Wastewater Treatment Plants and irrigation return flows will have greater importance to the silvery minnow and a greater impact on water quality. Lethal levels of chlorine and ammonia have been released from the Wastewater Treatment Plants in the last several years (Service 2003b). In addition, a variety of organic chemicals, heavy metals, nutrients, and pesticides have been documented in the river and contribute to the overall degradation of water quality (Service 2003b).

IV. Effects of the Action

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, which will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

The primary effects of the proposed action on the silvery minnow are related to the construction and operation of the low head diversion dam near Paseo del Norte. The proposed action is to construct a low head dam for the diversion of the City=s San Juan-Chama water and a like amount of Anative@ Rio Grande water. During typical operations, the project will divert a total of 94,000 ac-ft/yr of raw water from the Rio Grande (47,000 ac-ft/yr of City San Juan-Chama water and 47,000 ac-ft/yr of Rio Grande native water) at a near constant rate of about 130 cfs (3.68 m;s). Peak diversions of 103,000 ac-ft/yr (51,500 ac-ft/yr of San Juan-Chama water and 51,500 ac-ft/yr of Rio Grande native water) will be diverted at a rate of 142 cfs (4.02 m;s). These peak diversions will only occur after periods of curtailment when the City will want to release increased amounts of San Juan-Chama water for the aquifer storage and recovery component of their proposed action, or in wet years if the City is able to lease additional San Juan-Chama water from other contractors. The City will store San Juan-Chama water in either Heron or Abiquiu Reservoir on the Rio Chama and deliver the water to the Paseo del Norte diversion dam on a continuous basis when diversion operations are occurring. The delivery of this water will result in an increase of flows on the Rio Chama and Rio Grande above the diversion point, with a continuous increase in flows of approximately 65 cfs (1.84 m;s) from Abiquiu Dam to the Paseo del Norte diversion dam. This increase in flows will not adversely affect the silvery minnow or its critical habitat in areas above the diversion dam and may provide beneficial effects during times of low flow.

Direct Effects

Construction Effects

The construction of a new surface dam and transmission pipeline (crossing at Campbell Boulevard) will adversely affect the silvery minnow by redirecting portions of the river and operating heavy equipment within the channel. Construction activities associated with the installation of the bladder dam will result in the temporary loss of approximately 1.8 acres of aquatic habitat and installation of the transmission pipeline at Campbell Road will result in the temporary loss of 1.5 acres of aquatic habitat. These temporary losses of habitat will be the result of the installation of coffer dams to dewater areas where construction activities will take place. The temporary dewatering of the river will result in the formation of isolated pools immediately after the coffer dams have been installed. Dewatering causes direct mortality to silvery minnows when the pools in which they are trapped dry up. Mortality can also occur before complete drying of the pools if the combination of dissolved oxygen level (too low) and water temperature (too high) becomes lethal. Changes in pH, salinity, carbon dioxide, and ammonia levels can make the fish more vulnerable to changes in dissolved oxygen or can be lethal on their own. Fish trapped in pools are easy prey for both terrestrial and avian predators and may also be eaten by predatory fish if they are trapped in the same pool (Tramer 1977).

Because the dewatered area is a construction site, it is also likely that silvery minnows could be crushed or killed by the heavy equipment that is operated within the river channel. The adverse affects to the silvery minnow associated with these in-channel construction activities will be minimized by having Service personnel on site to salvage and move fish as the construction area is dewatered. As described in the Conservation Measures section of the proposed action, the Service will salvage and move silvery minnows from pools that have formed as a result of the dewatering. The immediate response to the dewatering will reduce the likelihood of direct or indirect mortality associated with the dewatering event.

It is unknown what effect salvage operations have on short or long-term (post release to three months) silvery minnow survival. Water quality conditions in isolated pools can deteriorate quickly, stressing the fish. The fish are then seined, handled, transported, and introduced into a new location in the river. Sigismondi and Weber (1988) found that handling lengthened the time required for chinook salmon to seek cover and that each successive handling experience added to the time needed to reach cover. Although cyprinids in general are a hardy fish, it is unknown how the stress of salvage operations affects the survival of silvery minnows released into a new location in the river.

Construction activities within the river channel may also result in temporary turbidity effects downstream from construction sites and contamination from equipment fluids. Increased turbidity or contamination as a result of a spill could result in direct or indirect mortality to silvery minnows. As a part of the conservation measures that the City will be undertaking for this project, they will develop a plan to monitor the turbidity levels in the river during in-river construction and will implement necessary spill prevention and containment methods and training during construction and in the long term operations and maintenance of facilities. These activities will reduce the likelihood that adverse turbidity or contamination levels will occur and minimize the effect of spill events by establishing containment methods for toxic chemicals.

Approximately 0.2 ac (0.08 ha) of aquatic habitat will be permanently altered as a result of the bladder dam construction. This permanent alteration is associated with the installation of operational structures such as the bladder dam and associated fish screens. This will result in the net loss of silvery minnow habitat and increase riverine fragmentation. Diversion dams on the Rio Grande prevent the movement of fish into upstream reaches and have contributed to the decline of the silvery minnow. However, the City has committed to developing a fishway to allow for fish passage around the Paseo del Norte diversion dam and monitoring its success. This fishway will be developed in coordination with the Service and will incorporate design features that are beneficial to the silvery minnow. In addition, the City has committed to creating and restoring silvery minnow habitat within the vicinity of the Paseo del Norte diversion dams. These habitat restoration activities will minimize the effects associated with the net loss in habitat by providing other suitable habitats for the silvery minnow in the project area.

Operational Effects

The hydrologic model (CH2M Hill 2002) for the proposed action was deemed as the best scientific information available and is used as the basis for this effects analysis. Therefore, this analysis assumes that the key assumptions used in the model prediction are accurate. The model simulated monthly river flows for the proposed action, as well as the current action (groundwater pumping) based on an adjusted hydrologic baseline generated for the 1971 to 1998 time period.

The effects on river flows will vary over the 2006 B 2060 time period due to the interplay between ground-water pumping, the lingering effects of past pumping, wastewater returns, the quantities of groundwater in wastewater returns, and the amounts of San Juan-Chama water released over time. The magnitude and interaction of all or some of these factors will affect the surface flows and thus, habitat availability for the silvery minnow at any given time. In addition to these operational factors, climatic conditions such as drought and other water development activities can have an additive effect on the riverine hydrology of the Rio Grande.

During normal diversion operations, there will be a 60 B 70 cfs (1.7 B 1.98 m;s) increase in flows between Abiquiu Reservoir and the Paseo del Norte diversion. This increase in flows will result from City San Juan-Chama water being released on a continuous basis for diversion near Paseo del Norte. This increase in flows, may benefit the silvery minnow and it=s habitats in the river reach between Cochiti Dam and the Paseo del Norte diversion. The majority of the effects to the silvery minnow and it habitats is expected to occur in the 15-mi (24.14 km) stretch between the diversion structure and the return flows at the Southside Water Reclamation Plant.

Reclamation and the City estimate that the proposed diversion of surface water will result in a reduction in flows measured at the Albuquerque gage, that will be, on average, 27 cfs (0.76 m;s) less than the flows that will be expected under current operations. The hydrologic model for the proposed action shows that the proposed diversion of native flows will result in a 0.1 B 0.3 ft (0.03 B 0.09 m) reduction in water depth in the dewatered reach between the Paseo del Norte diversion dam and the Southside Water Reclamation Plant. In addition, velocity reduction of 0.1 B 0.2 ft/s (0.03 B 0.06 m/s) and a 20 B 30 ft (6.1 B 9.14 m) reduction of wetted stream width in narrow sections of the dewatered reach. While the anticipated decrease in flows will only be a small portion of the annual base flow at the Albuquerque gage, the most significant effects to the silvery minnow will occur due to decreases in flow during critical low flow periods. With the exception of high flow events associated with spring runoff and rainstorm events, river flows tend to be lowest at the Albuquerque gage during the late spring and summer months of April through October. In 1988, the reference year used for the Normal Year analysis, the median flow for the year was 1,210 cfs (34.26 m;s) at the Albuquerque gage, however the average monthly flows during July, August, and October of that year were less than half of the yearly average (592 cfs [16.76 m;s], 514 cfs [14.55 m;s], and 408 cfs [11.55 m;s], respectively). During low-flow and extended drought years, river flows could be so low in the Albuquerque Reach during the spring and summer months that operation of the surface water diversion will have to be curtailed. Although low flow conditions have been observed in the 15-mi (24.14 km) stretch between the diversion structure and the Southside Water Reclamation Plant, diversion of surface water will increase the magnitude and duration of low flow events during all hydrologic scenarios. The reduction in flows will result in less habitat available

for the silvery minnow but will not result in river drying within the 15-mi (24.1 km) reach between the diversion structure and the Southside Water Reclamation Plant.

The diversion of flows during the silvery minnow spawn will likely result in the entrainment of silvery minnow eggs and larvae into the water intake structures. Silvery minnow eggs at extrusion are approximately 0.04 in (1 mm) and rapidly swell to 0.12 in (3 mm) in diameter. Post-larval silvery minnows grow rapidly, but have a very limited swimming ability. Adults range to over 3 in (76.2 mm) (Platania and Altenbach 1998). The proposed fish screens will not completely exclude eggs and larvae from being entrained into the Drinking Water Project water intake structure. Eggs and larvae greater than 0.07 in (1.7 mm) in size may be trapped against the fish screens and be mortally wounded. Adult fish should be capable of avoiding the 0.2 ft/sec (0.06 m/sec) impingement velocities.

During the 2003 silvery minnow spawn, eggs were collected upstream of the proposed diversion, near Alameda Bridge (Jude Smith, NMESFO, *pers. comm.* 2003*)* and the Service expects spawning to continue in the area upstream of the diversion dam throughout the life of this project. Eggs and larvae that are entrained will die when they are transported to the wastewater treatment plant. The City has proposed two conservation measures to reduce potential impacts to eggs and larvae.

1. During the spawning period, the City will monitor and collect silvery minnow eggs. This egg collection will consist of 1 egg collector for 2 hours per day from May 1 B 31 each year for the first 10 years of the project. The monitoring and collection sites will be identified in coordination with the Service and should be located near the diversion structure (either in the sluice channel or directly upstream of the water intake structures) to reduce the amount of entrainment associated with the diversion of flows and to more accurately monitor incidental take.

2. The City has proposed to cease their river diversions for a 24 hour period each year in coordination with the Service in an effort to reduce incidental take of silvery minnow eggs during peak spawning periods.

The proposed conservation measures will reduce the likelihood of entrainment associated with diversion of flows, but will not eliminate it completely. Take of silvery minnow eggs and larvae is anticipated to occur under the proposed action (see Incidental Take Statement).

Indirect Effects

The indirect effects of low flow events on the silvery minnow have not been investigated but based on knowledge of stream ecology and fish biology, several indirect effects can be predicted. Fish typically function best within a relatively narrow range of water quality characteristics such as water temperature, pH, dissolved oxygen, and salinity. When fish are subjected to conditions outside their preferred range it causes physiological stress (Schreck 1990). The longer the fish is subjected to unfavorable conditions the greater the stress (Barton *et al.* 1986). Consequences of physiological stress are typically a decrease in fitness (lowered reproductive success) (Donaldson 1990) and an increased susceptibility to disease (Anderson 1990). Fish can be afflicted by viral, bacterial, and fungal infections and internal and external parasites. Disease can cause death or lead to decreased fitness. Water quality degradation in the 15-mi reach below the Paseo del Norte diversion may occur if low flow conditions persist for a prolonged period of time. In addition, the silvery minnow will be negatively affected if a spill of toxic material or a peak in ammonia or chlorine discharge occurs when flows at the Albuquerque gage are not sufficient to dilute the chemical contaminants associated with spills or accidental discharges.

Operation of the Paseo del Norte diversion structure will affect sediment transport directly downstream of the diversion structures. Appropriate silt and sand substrates (Dudley and Platania 1997; Remshardt *et al.* 2001) are important in creating and maintaining appropriate habitat and life requisites for the silvery minnow, such as food and cover. Larger sized particles in the medium sand sized range and some of the finer-sized suspended and bed material, will tend to settle out and accumulate in the 1,000 B 2,000-ft (304.8 B 609.6 m) long pool behind the dam. However, because the dam will be lowered to river bottom elevation during high flows, much of this deposited material will be resuspended and moved downstream. In addition, localized sediment accumulations on either side of the diversion dam in the immediate upstream pool can be flushed by lowering individual sections of the adjustable dam face. The capability to operate the diversion dam in a manner that allows for sediment transport will reduce changes in channel bed morphology and substrate composition. However, temporary changes to substrate and sediment transport could have temporary effects on silvery minnow habitat.

The dam will be an impediment to silvery minnow movement during average and low flow periods when it is raised. Although the fish passage structure will facilitate movement of silvery minnow around the diversion, it is unlikely that it will provide the same amount of movement by silvery minnows as would occur under natural conditions. The fish passage structure should facilitate habitat and population connectivity above and below the dam and prevent the creation of isolated populations of silvery minnow in the Angostura Reach. Our analysis in this opinion is based upon the successful and regular use of the fish passage structure by the silvery minnow to move both upstream and downstream. Specific studies and monitoring programs will be developed by the City of Albuquerque to assess silvery minnow use of the fish passage structure and evaluate population connectivity within the Angostura Reach.

Effects on Designated Critical Habitat

Approximately 7.6 ac (3.1 ha) of designated critical habitat will be permanently altered by the construction activities associated with the proposed action. This area will consist of 1 ac (0.4 km) of aquatic habitat that will be permanently altered by the installation of the dam and the diversion equipment and 6.6 ac (2.7 ha) of riparian area designated as critical habitat will be permanently altered by the construction of the water intake channels, pump station, roads and other permanent structures. All four of the primary constituent elements will be adversely affected within the 1 ac (0.4 km) of aquatic habitat associated with the installation of the bladder dam and associated structures. However, this area represents less than one percent of the designated critical habitat. As a result, the permanent alterations associated with the construction activities for the proposed project will not result in adverse modification of critical habitat.

Adverse effects associated with the operational activities for the proposed action will occur within the 15-mi (24.1 km) stretch of river between the Paseo del Norte diversion structure and the outfall of the wastewater treatment plant. This area represents approximately 9 percent of the designated critical habitat. Because the proposed action will not result in river drying and diversions will be ceased when a flow of 106 cfs (3 m;s) at the Albuquerque gage occurs, sufficient flowing water will be available for the silvery minnow during all of its critical life stages as described in the first primary constituent element.

The second primary constituent element is the presence of eddies created by debris piles, pools, or backwaters, or other refuge habitat within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities. The depletion associated with the proposed action, along with the effects of groundwater pumping, represents a 7 percent average annual reduction in the mean annual flow for a typical year midway through the project (2030) in the Rio Grande at the Albuquerque gage. This flow reduction between the drinking water plant diversion and the Southside Water Reclamation Plant will result in the encroachment of exotic plant species, such as saltcedar and Russian olive (Howe and Knopf 1991, Crawford *et al.* 1993) within the 15-mi (24.1 km) river stretch that are not part of the minimization and conservation activity projects outlined in the proposed action. It has been hypothesized that channel narrowing has accelerated the decline of silvery minnow populations.

Encroachment of non-native vegetation, such as Russian olives and salt cedar, into the river channel and resultant channel narrowing can be additional indirect effects of river dewatering on designated critical habitat. Such channel narrowing can cause downcutting and limit overbank flooding, reducing the potential for recruitment of native riparian vegetation, especially cottonwoods and willows (Reclamation 2003). Overbank flooding is needed to restore shallow, low velocity backwaters that are a component of silvery minnow critical habitat. Channel narrowing by encroachment of non-natives will reduce both the quantity and quality of silvery minnow critical habitat. Bank lowering and the creation of a side channel will provide additional areas of silvery minnow habitat within proposed habitat restoration activity areas.

Operation of the Paseo del Norte diversion structure will affect sediment transport directly downstream of the diversion structure by trapping sediment behind the dam when it is raised, and then flushing the trapped sediment below the dam when it is lowered. The change in sediment transport is only expected to have effect extending 1 mi (1.6 km) downstream from the diversion dam. In addition, localized sediment accumulations on either side of the diversion dam in the immediate upstream pool can be flushed by lowering individual sections of the adjustable dam face. Therefore, the proposed action will not result in adverse modifications to the third primary constituent element related to the presence of substrates of predominantly sand or silt.

The final primary constituent element provides protection from degraded water quality conditions. Wastewater exceedence at the wastewater treatment plants could have an adverse affect on water quality if the amount of flow in the river at the point of discharge was insufficient to dilute the wastewater and maintain the necessary water quality parameters for the silvery minnow. However, the effects of a water quality exceedence will be temporary and will not result in the permanent adverse modification of critical habitat.

The Service has determined that the proposed action will not appreciably diminish the value of primary constituent elements essential to the species= conservation and therefore will not result in the adverse modification of critical habitat.

V. Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Cumulative effects include:

- Increases in development and urbanization in the historic floodplain that result in reduced peak flows to prevent flooding. Development in the floodplain makes it more difficult, if not impossible, to transport large quantities of water that would overbank and restore low velocity habitats preferred by the silvery minnow. Development in the floodplain also reduces the acreage available for overbank flooding.

- Increased urban use of water, including municipal and private uses. Further use of groundwater from both the shallow and deep aquifers and surface water from the Rio Grande will reduce river flow and decrease available habitat for the silvery minnow. This will result in a gradual change in river morphology resulting from the encroachment of vegetation into the floodplain and active river channel during more frequent low flow periods. Silvery minnow larvae require shallow, low velocity habitats for development. Encroachment of vegetation into the floodplain can affect river channel morphology by contributing to the armoring of banks, channel narrowing, and island formation. These changes in channel morphology can result in a decrease in silvery minnow habitats such as side channels, backwaters, and other shallow, low velocity habitats.

- Contamination of the water (i.e., sewage treatment plants, runoff from feed lots, dairies, and residential, industrial, and commercial development). A decrease in water quality could adversely affect the silvery minnow and its critical habitat by creating habitat conditions that are intolerable by the silvery minnow (i.e. increased pH, excessive nitrates or chlorine, high water temperatures, etc.)

- Farming and grazing in the Middle Rio Grande floodplain and terraces, and water removal from the river. Human activities that may adversely impact the silvery minnow by decreasing the amount and suitability of habitat include dewatering the river for irrigation; increased water pollution from non-point sources; adverse effects from increased recreational use, and removal of large woody debris.

The Service anticipates that these types of activities will continue to threaten the survival and recovery of the silvery minnow by reducing the quantity and quality of habitat through continuation and expansion of habitat degrading actions.

VI. Conclusion

The Service has analyzed the full spectrum of water management options described in the November 13, 2003, final biological assessment and additional documentation provided by the City. After reviewing the current status of the silvery minnow, the environmental baseline for the action area, the effects of the City=s proposed drinking water project, and the cumulative effects, it is the Service=s biological opinion that the City=s Drinking Water Project, as proposed in the November 13, 2002, BA and supporting documents, is not likely to jeopardize the continued existence of the silvery minnow, and will not adversely modify its critical habitat.

The silvery minnow will be adversely affected by the City=s Drinking Water Project via construction and operation of a new dam and transmission pipeline and by newly proposed water operations. The construction of a new surface dam and transmission pipeline will adversely affect the silvery minnow by temporarily dewatering 3.3 acres of aquatic habitat, creating isolated pools with poor water quality and increased predator access to silvery minnow, which could result in mortality of silvery minnow. Approximately 0.2 ac (0.08 ha) of aquatic habitat will be permanently altered as a result of the bladder dam construction. This will result in the net loss of silvery minnow habitat, increase riverine fragmentation, and potentially prevent the movement of fish into upstream reaches. Construction activities within the river channel with heavy equipment use in the river may crush or kill silvery minnow. Construction activities will result in temporary turbidity effects downstream from construction sites and could result in contamination from equipment fluids. Increased turbidity or contamination as a result of a spill could result in direct or indirect mortality to silvery minnows.

The most significant operational effects to the silvery minnow will occur due to decreases in flow during critical low flow periods. During low-flow and extended drought years, river flows could be so low in the Albuquerque Reach during the spring and summer months that operations will have to be curtailed. Although low flow conditions have been observed in the 15-mi (24.14 km) stretch between the diversion structure and the Southside Water Reclamation Plant, operation of the Drinking Water Project will increase the magnitude and duration of low flow events during all hydrologic scenarios. The reduction in flows will result in less habitat being available for the silvery minnow but will not result in river drying within the 15-mi (24.1 km) reach between the diversion structure and the Southside Water Reclamation Plant.

Operation of the newly constructed dam and diversion facility will adversely affect the silvery minnow. The diversion of flows during the silvery minnow spawn will likely result in the entrainment of silvery minnow eggs and larvae into the water intake structures. Eggs and larvae that are entrained will die when they are transported to the wastewater treatment plant. Additionally, the dam will be an impediment to silvery minnow movement during average and low flow periods when it is raised. Operation of the Paseo del Norte diversion structure will affect sediment transport and deposition directly downstream of the diversion structures and will temporarily adversely affect silvery minnow by reducing the amount of available habitat.

Although the proposed action will adversely affect the silvery minnow, several measures are being proposed by the City to minimize these effects. The adverse affects to the silvery minnow associated with these in-channel construction activities will be minimized and the likelihood of direct or indirect mortality will be decreased by minimization measures, including silvery minnow salvage and development and implementation of spill prevention and containment methods. The City has committed to developing a fishway to allow for fish passage around the Paseo del Norte diversion dam and monitoring its success. In addition, the City has committed to creating and restoring silvery minnow habitat within the vicinity of the Paseo del Norte diversion dams. These habitat restoration activities will minimize the effects associated with the net loss in habitat by providing other suitable habitats for the silvery minnow in the project area.

The City has proposed two conservation measures to reduce potential impacts to eggs and larvae, including monitoring and capture of silvery minnow eggs during spawning and cessation of diversions for a 24 hour period each year in coordination with the Service in an effort to reduce incidental take of silvery minnow eggs during peak spawning periods. The proposed conservation measures will reduce the likelihood of entrainment associated with diversion of flows, but will not eliminate it completely. Take of silvery minnow eggs and larvae is anticipated to occur under the proposed action.

The fish passage structure will facilitate some movement of silvery minnow around the diversion. The capability to operate the diversion dam in a manner that allows for sediment transport will reduce changes in channel bed morphology and substrate composition.

In combination, the adverse effects to the silvery minnow described above, combined with measures proposed to minimize them, are not likely to jeopardize the continued survival and recovery of the silvery minnow.

Effects on Designated Critical Habitat

Approximately 7.6 ac (3.1 ha) of designated critical habitat will be permanently altered by the construction activities associated with the proposed action. This area will consist of 1 ac (0.4 km) of aquatic habitat that will be permanently altered by the installation of the dam and the diversion equipment and 6.6 ac (2.7 ha) of riparian area designated as critical habitat will be permanently altered by the construction of the water intake channels, pump station, roads and other permanent structures. All four of the primary constituent elements will be adversely affected within the 1 ac (0.4 km) of aquatic habitat associated with the installation of the bladder dam and associated structures. However, this area represents less than one percent of the designated critical habitat. The Service has determined that the proposed action will not appreciably diminish the value of primary constituent elements essential to the species= conservation and therefore will not result in the adverse modification of critical habitat.

VII. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be undertaken by the City so that they become binding conditions of any Federal grant or permit issued to the City, as appropriate, for the exemption in section 7(o)(2) to apply. The Federal agencies have a continuing duty to regulate the activity covered by this incidental take statement. If the Federal agencies: Fail to assume and implement the terms and conditions the protective coverage of section 7(o) (2) may lapse. In order to monitor the impact of incidental take, the Federal agencies must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR '402.14(i) (3)]

Amount or Extent of Take Anticipated

The Service anticipates that up to 20 silvery minnows (greater than 30 mm [1.2 in]) may be taken due to construction actions described and analyzed in this biological opinion. Under the effects of the action, the Service estimates a temporary loss of of 6,475 m5 (69,696 ft5) of aquatic habitat as a result of construction activities. Silvery minnow surveys completed in 2003 by the NMFRO provide density estimates of 0.3 fish per 100 m5 (1076 ft5). Based on this density estimate, the Service anticipates that no more than 20 silvery minnows greater than 30 mm [1.2 in] (6,475 m5 (69,696 ft5)/ 100 m5 = 64.75 m5 x 0.3 fish) will be taken during construction activities associated with the proposed action. Therefore, if more than 20 silvery minnows greater than 30 mm (1.2 in) are found dead, the level of anticipated take will have been exceeded. This take will be in the form of kill and harm. Rescued silvery minnows will count toward the Service=s Regional Director=s 10(a) (1) (A) permit.

The majority of silvery minnow take will be associated with the entrainment of eggs and larvae as a result of operational activities. The Service anticipates that no more than 25,000 silvery minnows eggs each year will be taken through entrainment at the diversion facility. Take of eggs will occur in the form of harm, wound, and kill.

The Service anticipates that no more than 7,000 larval silvery minnow (less than 30 mm (1.2 in)) may be taken in any year due to the operational activities described and analyzed in this biological opinion. Take of larval silvery minnow will occur in the form of harm, wound, and kill.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the silvery minnow or destruction or adverse modification to critical habitat.

REASONABLE AND PRUDENT MEASURES

The City has proposed to implement several conservation measures that will minimize the amount of incidental take associated with the proposed action and will serve as the Reasonable and Prudent Measures (RPMs) for the anticipated take. The Service believes the following RPMs are necessary and appropriate to minimize impacts of incidental take of the silvery minnow. The specific conservation measures that will serve as RPMs are:

1. During construction in the river, salvage any fish stranded by construction of the coffer dam and relocate them to a different portion of the river. By agreement, Service staff will be available to move individual specimens of the silvery minnow if they inadvertently become separated from the main river channel due to construction activities.
2. The City will implement necessary spill prevention and containment methods training during construction and in the long term operations and maintenance of facilities.
3. The City will conduct egg collection activities upstream of the diversion, near the water intake point to reduce the amount of silvery minnow entrained in the diversion structure. This egg collection will consist of 1 egg collector for two hours per day from May 1 B 31 each year for the first 10 years of the project. After the first 10 years of the project, the need for continued egg collection will be assessed and may continue for an additional time period if deemed necessary.
4. The sluice channel for the Paseo del Norte Diversion will be equipped with fish screens.
5. During the peak spawning period, the City will monitor silvery minnow eggs and cease diverting from the river during a 24 hours period each year in coordination with the Service to reduce take of silvery minnow eggs.

<u>Terms and Conditions</u>

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. The salvage of silvery minnows (eggs, larvae, and adults) requires an ESA section 10(a) (1) (A) permit from the Service and such take is not covered by this incidental take statement.

To implement RPM 1, the City shall

1.1) Coordinate with the Service when isolated pools form during installation of the coffer dam and seine isolated pools as the river recedes. The sampling protocol developed by NMESFO will be used. The Service will coordinate data collection, and salvage/rescue of the silvery minnows. This will minimize take by rescuing silvery minnows to the maximum extent practicable.

To implement RPM 2, the City shall

2.1) Provide the Service with a copy of the spill prevention and containment plan for the proposed action prior to construction beginning. Notify the Service of any spills or contamination associated with construction or maintenance of Drinking Water Project facilities within one hour of the occurrence. The Service will determine whether silvery minnow salvage is appropriate, water quality testing is necessary, and assess the effects of the spill on the silvery minnow.

2.2) Ensure that all construction workers have received spill prevention and containment training prior to construction beginning.

To implement RPM 3, the City shall

3.1) Conduct egg collection activities just upstream of the Paseo del Norte diversion dam or in the sluice channel using sampling protocols developed by the Service. All silvery minnow eggs collected during the spawn will either be released downstream of the Paseo del Norte diversion dam or transported to a propagation facility. The determination of where collected eggs will be moved will be made in coordination with the Service. The City will collect eggs in accordance with the methods and schedule described in the Minimization Measures for Operation Effects section of this BO. The reporting date for egg collection activities associated with this RPM will be during the annual report of minimization activities or by September 1 of each year as directed under the Reporting and Coordination section of this opinion.

To implement RPM 4, the City shall

4.1) Maintain fish screens at all times. Any structural or mechanical failures associated with the fish screens shall be reported to the Service within one hour from when the problem is identified.

To implement RPM5, the City shall

5.1) The City shall coordinate with the Service beginning April 15 of each year to determine when the diversion facility will curtail or cease operations.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The City will work with the Service to specifically define the time of study, list of parameters to be studied, data collection, short- and long-term monitoring, and other requirements for the studies that are listed below.

1) Research the effects of turbidity and suspended sediment on silvery minnow.

2) Determine the effects of sediment toxicity on silvery minnow.

3) Conduct studies of silvery minnow diet and sediment ingestion.

4) Conduct studies to determine how effluents from the Wastewater Treatment Plants mix with water from the Rio Grande at various discharges.

5) Provide for citizen education and outreach regarding prevention of pollution to water resources and the effects that pollution has on river ecosystems.

6) Sponsor voluntary citizen water quality monitoring of the Rio Grande.

7) Monitor/study silvery minnow spawning throughout the irrigation season in the Angostura Reach.

8) Continue to work collaboratively to develop and implement a long-term plan to benefit the recovery of the silvery minnow and flycatcher.

9) Monitor fluctuations of groundwater in the shallow and deep aquifers to better understand the groundwater/surface water relationship.

10) Use adaptive management and conservation of water to benefit listed species.

11) In accordance with State and Federal law, secure storage space in Abiquiu reservoir to create a permanent conservation pool to benefit endangered species.

12) Provide funding to determine the habitat preferences of the silvery minnow.

13) In addition to other monitoring efforts, conduct monthly monitoring for the silvery minnow at additional, currently un-monitored sites within the Angostura Reach.

14) Take advantage of opportunities to limit encroachment of permanent dwellings into the 10,000 cfs (283.2 m;s) floodplain.

15) Develop a study to investigate silvery minnow predation and competition relationships.

<u>Reinitiation Notice</u>

This concludes formal consultation on the action(s) outlined in the November 12, 2002, request. This consultation is valid until December 31, 2060. As provided in 50 CFR ' 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1)

The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the fish passage structure does not provide consistent upstream and downstream movement of silvery minnow within the Angostura Reach; (4) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. Consultation must be reinitiated prior to the expiration of this biological opinion to ensure continued compliance with sections 7 and 9 of the ESA. Additionally, consultation must be reinitiated if any one (or more) of the following occurs: (1) All biological information collected and analyzed on an annual basis suggest population declines. This includes, but is not limited to, minnow salvage, egg collections, and density estimates; or (2) the OSE permit for this project is violated or amended. In instances where the amount or extent of incidental take is exceeded, any Federal operations causing such take must cease pending reinitiation.

In future correspondence on this project, please refer to consultation number 2-22-03-F-0146. Please contact Lyle Lewis of our New Mexico Ecological Services Field Office at 505-761-4714, if you have any questions or would like to discuss any part of this biological opinion.

/s/ Joy E. Nicholopoulos

Attachment

cc: (w/o atch)
City of Albuquerque, Albuquerque, New Mexico (Attn: John Stomp)

LITERATURE CITED

Anderholm, S.K., M.J. Radell, and S.F. Richey, 1995. Water-Quality Assessment of the Rio Grande Valley Study Unit, Colorado, New Mexico, and Texas B Analysis of Selected Nutrient, Suspended-Sediment, and Pesticide Data. U.S. Geological Survey.

Anderson, D. P. 1990. Immunological Indicators: Effects of Environmental Stress on Immune Protection and Disease Outbreaks. Pages 38B50 in S. M. Adams (editor) Biological Indicators of Stress in Fish. American Fisheries Symposium 8. Bethesda, Maryland.

Arritt, S. 1996. The Rio Grande Silvery Minnow: Symbol of an Embattled River. Partners Conserving Endangered Species, a publication of the Conservation Services Division, New Mexico Department of Game and Fish. 1:5B16.

Barton, B. A., C.B. Schreck, and L.A. Sigismondi. 1986. Multiple Acute Disturbances Evoke Cumulative Physiological Stress Responses in Juvenile Chinook Salmon. Transactions of the American Fisheries Society. 115:245B251.

Biella, J., and R. Chapman (eds.). 1977. Archeological Investigations in Cochiti Reservoir, New Mexico. Vol. 1: A Survey of Regional Variability. Report submitted to the National Park Service, Santa Fe, for the U.S. Army Corps of Engineers, Albuquerque, New Mexico.

Bestgen, K. and S.P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow, *Hybognathus amarus*. Southwestern Naturalist 26(2):225B232.

Bestgen, K. and D.R. Propst. 1994. Redescription, geographic variation, and taxonomic status of the Rio Grande silvery minnow, *Hybognathus amarus* (Girard 1856). Contribution 69. Larval Fish Laboratory, Colorado State University.

Buhl, K. J. 2002. The Relative Toxicity of Waterborne Inorganic Contaminants to the Rio Grande Silvery Minnow (*Hybognathus amarus*) and Fathead Minnow (*Pimephales promelas*) in a Water Quality Simulating that in the Rio Range, New Mexico. Final Report to the U.S. Fish and Wildlife Service, Study No. 2F33B9620003. U.S. Geological Survey, Columbia Environmental Research Center, Yankton Field Research Station, Yankton SD.

Bullard, T.F., and S.G. Wells . 1992. Hydrology of the Middle Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service Research Publication 179.

Carter, L.F. 1997. Water-quality Assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas: Organic Compounds and Trace Elements in Bed Sediment and Fish Tissue, 1992-93. U.S. Geological Survey Water-Resources Investigations Report 97-4002. 23 pp.

CH2M Hill. 2002. Hydrologic Effect of the Proposed City of Albuquerque Drinking Water Project on the Rio Grande and Rio Chama Systems. Prepared for the City of Albuquerque: Final Report. May.

Cook, J.A., K.R. Bestgen, D.L. Propst, and T.L. Yates. 1992. Allozymic divergence and systematics of the Rio Grande silvery minnow, *Hybognathus amarus* (Teleostei: Cyprinidae). Copeia 1992(1): 36B44.

Donaldson, E. M. 1990. Reproductive Indices as Measures of the Effects of Environmental Stressors in Fish. Pages 109B122 in S. M. Adams (editor) Biological Indicators of Stress in Fish. American Fisheries Symposium 8. Bethesda, Maryland.

Dudley, R.K. S. J. Gottlieb, and S.P. Platania. 2003. 2002 Population Monitoring of Rio Grande silvery minnow, Hybognathus amarus. Fianl report. Submitted to U.S. Bureaus of Rclamation, Albuquerque Area Office, 10 June, 2003. 53 pp.

Dudley, R.K. and S.P. Platania. 1997. Habitat use of the Rio Grande silvery minnow. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 88 pp.

Dudley, R.K., and S.P. Platania. 1999. Draft Summary of Aquatic Conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad Bridge Crossing for the period 14 through 26 April 1999. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 15 pp.

Dudley, R.K. and S.P. Platania. 2002. Summary of population monitoring of Rio Grande silvery minnow (1994B2002). Report to New Mexico Ecological Services Field Office, September 10, 2002, Albuquerque, New Mexico. 14pp.

Edwards, G.B., and J.G. Nickum. 1993. Use of Propagated Fishes in Fish and Wildlife Service Programs. *In* M.R. Collie and J.P. McVey, eds. 1993. Proceedings of the 22nd U.S. B Japan Aquaculture Panal Symposium, Homer, Alaska: Interactions between Cultured Species and Naturally Occurring Species in the Environment.

Ellis, S.R., G.W. Levings, L.F. Carter, S.F. Richey, and M.J. Radell. 1993. Rio Grande Valley, Colorado, New Mexico, and Texas. *In* Leahy, P.P., B.J. Ryan, and A.I. Johnson, eds. American Water Resources Association Monograph Series no. 19. pp. 617-646.

Harwood, A.K. 1995. The Urban Stormwater Contribution of Dissolved Trace Metals from the North Floodway Channel, Albuquerque, NM, to the Rio Grande. University of New Mexico, Water Resources Program, Professional Project Report.

Hoagstrom, C., and J. Brooks. 2000. Memorandum to Joy Nicholopoulos, Supervisor, New Mexico Ecological Services Field Office from New Mexico Fishery Resources Office, entitled *Rio Grande silvery minnow recovery priorities*. August 14, 2000. 10 pp.

Levings, G.W., D.F. Healy, S.F. Richey, and L.F. Carter. 1998. Water Quality in the Rio Grande Valley, Colorado, New Mexico, and Texas, 1992-95. U.S. Geological Survey Circular 1162. Http://water.usgs.gov/pubs/circ1162 (viewed on May 18, 1998) .

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Toxicology and Chemistry 39:20B31.

Markus, H.C. 1934. The Fate of our Forage Fish. Transactions American Fisheries Society 64:93-96.

Miller, W.J. and D. Laiho. 1997. Final Report: Upper Colorado River Basin Recovery Implementation Program Feasibility Evaluation of Non-Native Fish Control Structures. Prepared for Colorado River Conservation District. Glenwood Springs, CO.

National Weather Service and Natural Resources Conservation Service. 2003. Water supply forecast, March 2003. Http://www.nm.nrcs.usda.gov/snow/forecast/wy03/mar/nr0303.htm (Viewed 10 March 2003).

New Mexico Department of Game and Fish. 1998b. Rio Grande silvery minnow monitoring in 1997. Sante Fe, New Mexico.

Ong, K., T.F. O'Brien, and M.D. Rucker. 1991. Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Middle Rio Grande and Bosque del Apache National Wildlife Refuge in New Mexico 1988B89: U.S. Geological Survey Water-Resources Investigations Report 91-4036, Albuquerque, New Mexico.

Pflieger, W. 1980. *Hybognathus nuchalis* Agassiz, pp.177. *In* D. lee, C. Gilbert, C. Hucutt, R. Jenkins, McCallister, and J. Stauffer, eds., Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina.

Platania, S. 1993. The Fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and Their Habitat Associations. U.S. Bureau of Reclamation, Albuquerque, New Mexico. 188 pp.

Platania, S.P. 1995. Reproductive biology and early life-history of Rio Grande silvery minnow, *Hybognathus amarus*. U.S. Army Corps of Engineers, Albuquerque, New Mexico. 23 pp.

Platania, S. P. 2000. Effects Of Four Water Temperatures Treatments On Survival, Growth, and Developmental Rates of Rio Grande silvery minnows, Hybognathus amarus, Eggs and Larvae. Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Platania, S.P. and C. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande basin cyprinids. Copeia 1998(3): 559B569.

Platania, S.P., and R. Dudley. 1997. Monitoring the Status, Habitat Association, and Seasonal Occurrence of Rio Grande Silvery Minnow in the Vicinity of the Montaño Bridge. American Southwest Ichthyological Consulting, Albuquerque, New Mexico.

Platania, S.P. and R. Dudley. 1999. Draft summary of aquatic conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad bridge crossing for the period 14 through 26 April 1999. Prepared for the Bureau of Reclamation and New Mexico Ecological Services Field Office.

Platania, S.P. and R. Dudley. 2001. Summary of population monitoring of Rio Grande silvery minnow (21B27 February 2001). Report to the Bureau of Reclamation and Corps of Engineers. Albuquerque. 7pp.

Platania, S.P., and R. Dudley. 2002. Spawning Periodicity of Rio Grande Silvery Minnow during 2001. Http://www.uc.usbr.gov/progact/rg/rgsm2002/egg_salvage/wrg/aop/rgo/progact/rg/rgsm2002/progact/rg/rgsm2002/index.html.

Platania, S.P., and R. Dudley. 2003. Spawning Periodicity of Rio Grande Silvery Minnow, *Hybognathus amarus*, During 2002. Draft final report submitted to the U. S. Bureau of Reclamation, January 22, 2003. 49 pp.

Platania, S.P., and C.W. Hoagstrom. 1996. Response of Rio Grande Fish Community to an Artificial Flow Spike: Monitoring Report Rio Grande Silvery Minnow Spawning Peak Flow. New Mexico Ecological Services State Office, Albuquerque, New Mexico.

Rand, G.M., and Petrocelli, S.R. 1985. Fundamentals of Aquatic Toxicology B Methods and Applications. Hemisphere Publishing Corporation, New York. 666 pp.

Raney, E.C. 1941. Propagation of the Silvery Minnow (*Hybognathus nuchalis regius Girard*) in Ponds. American Fisheries Society 71:215-218.

Remshardt, W. J., J. R. Smith, and C. W. Hoagstrom. 2001. Fishes of the Mainstem Rio Grande, Bernalillo to Ft. Craig, New Mexico. June 1999 B June 2001. Draft Report Submitted to U.S. Army Corps of Engineers, Albuquerque District and the City Albuquerque.

S.S. Papadopulos & Associates, Inc. 2000. Middle Rio Grande Water Supply Study. Boulder, CO: August 4, 2000.

Schreck, C.B. 1990. Physiological, Behavioral, and Performance Indicators of Stress. Pages 29B37 in S.M. Adams (editor) Biological Indicators of Stress in Fish. American Fisheries Symposium 8. Bethesda, Maryland.

Scurlock, D. 1998. From the Rio to the Serria: An Environmental History of the Middle Rio Grande Basin. USDA Rocky Mountain Research Station, Fort Collins, Colorado, 80526.

Sigismondi, L.A., and L.J. Weber. 1988. Changes in Avoidance Response Time of Juvenile Chinook Salmon Exposed to Multiple Acute Handling Stresses. Transactions of the American Fisheries Society. 117:196B201.

Smith, J.R. 1999. Summary of Rio Grande investigations for FY1997. Draft. U.S. Fish and Wildlife Service Report Submitted to the U.S. Bureau of Reclamation, Albuquerque, New Mexico.

Smith, J.R., and C.W. Hoagstrom. 1997. Fishery Investigations on the Low Flow Conveyance Channel Temporary Outfall Project and on Intermittency in the Rio Grande. Progress Report, 1996 to Bureau of Reclamation, Albuquerque, New Mexico.

Smith, J.R., and J.A. Jackson. 2000. Draft memorandum from the New Mexico Fishery Resources Office to the New Mexico Ecological Services Field Office, U.S. Bureau of Reclamation and U.S. Army Corps of Engineers. Preliminary 1999 Rio Grande Collections of Rio Grande Silvery Minnow Only. January 5, 2000.

Springer, C. 2002. Creation of the Fisheries Program. *In* M. Durham and N. Throckmorton, eds. 2002. Fish and Wildlife News: March/April/May 2002. U.S. Fish and Wildlife Service.

Sublette, J., M. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. 393 pp.

Tramer, E.J. 1977. Catastrophic Mortality of Stream Fishes Trapped in Shrinking Pools. The American Midland Naturalist 97(2):469B478.

U. S. Bureau of Reclamation. 1997. Middle Rio Grande Water Assessment: Land use trends and their effect on water use and the hydrologic budget in the Albuquerque Basin, NM. Supporting Document Number 14.

U.S. Bureau of Reclamation. 2001. U.S. Bureau of Reclamation=s Discretionary Actions Related to Water Management, U.S. Army Corps of Engineers Water Operations Rules, and Non-Federal Actions Related to Ordinary Operations on the Middle Rio Grande, New Mexico: June 30, 2001, through December 31, 2003. June 8, 2001.

U.S. Bureau of Reclamation. 2002a. Draft Environmental Impact Statement for the City of Albuquerque Drinking Water Project. June.

U.S. Bureau of Reclamation. 2002b. Final Biological Analysis for the City of Albuquerque Drinking Water Project. November.

United States Environmental Protection Agency. 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia U.S. Environmental Protection Agency, Office of Water Report EPA-822-R-99-014, Washington, D.C.

U.S. Fish and Wildlife Service. 1993. Proposal Rule to List the Rio Grande Silvery Minnow as Endangered, with Critical Habitat. Federal Register 58: 11821B11828.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; final rule to list the Rio Grande silvery minnow as an endangered species. Federal Register 59:36988B37001.

U.S. Fish and Wildlife Service. 1999. Rio Grande Silvery Minnow *(Hybognathus amarus)* Recovery Plan. Region 2, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 138 pp.

U.S. Fish and Wildlife Service. 2001. Programmatic Biological Opinion on the Effects of Actions Associated with the U.S. Bureau of Reclamation=s, U.S. Army Corps of Engineers=, and non-Federal Entities= Discretionary Actions Related to Water Management on the Middle Rio Grande, New Mexico, 29 June 2001.

U.S. Fish and Wildlife Service. 2002. Report to the Rio Grande Compact Commission, U.S. Fish and Wildlife Service Activities in the Rio Grande Basin Calendar Year 2001. Prepared for the Rio Grande Compact Commission by the New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; final rule for the designation of critical habitat for the Rio Grande silvery minnow. Federal Register 68:8088B8135.

U.S. Fish and Wildlife Service. 2003b. Programmatic Biological Opinion on the Effects of Actions Associated with the U.S. Bureau of Reclamation=s, U.S. Army Corps of Engineers=, and non-Federal Entities= Discretionary Actions Related to Water Management on the Middle Rio Grande, New Mexico, 17 March 2003.

U.S. Geologic Survey. 1995. Simulation of Flow in the Albuquerque Groundwater Basin, New Mexico, 1901-1994, with Projections to 2020. Prepared in cooperation with the City of Albuquerque Public Works Department. Albuquerque, NM.

U.S. Geologic Survey. 2001. Selected Findings and Current Perspectives on Urban and Agricultural Water Quality by the National Water-Quality Assessment Program, FS-047-01. http://water.usgs.gov/pubs/FS/fs-047-01//pdf/fs047-01.pdf

Watts, H.E., C.W. Hoagstrom, and J.R. Smith. 2002. Observations on habitat associated with Rio Grande silvery minnow, *Hybognathus amarus* (Girard). Submitted to U.S. Army Corps of Engineers, Albuquerque District and City of Albuquerque Water Resources Division on June 28, 2002.