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**FINAL ECONOMIC ANALYSIS  
OF CRITICAL HABITAT DESIGNATION  
FOR THE RIO GRANDE SILVERY MINNOW**

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## EXECUTIVE SUMMARY

1. The purpose of this report is to identify and analyze the potential economic impacts that would result from the critical habitat designation for the Rio Grande silvery minnow (*Hybognathus amarus*). This report was prepared by Industrial Economics, Incorporated and Brookshire, McIntosh, and Associates for the U.S. Fish and Wildlife Service's Division of Economics.
2. Section 4(b)(2) of the Endangered Species Act (Act) requires the Service to designate critical habitat on the basis of the best scientific data available, after taking into consideration the economic impact, and any other relevant impact, of specifying any particular area as critical habitat. The Service may exclude areas from critical habitat designation when the benefits of exclusion outweigh the benefits of including the areas within critical habitat, provided the exclusion will not result in extinction of the species.
3. The focus of this economic analysis is on section 7 of the Act, which requires Federal agencies to insure that any action authorized, funded, or carried out will not likely jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. Federal agencies are required to consult with the Service whenever they propose a discretionary action that may affect a listed species or its designated critical habitat. Aside from the protection that is provided under section 7, critical habitat does not provide other forms of protection to designated lands. Because consultation under section 7 only applies to activities that involve Federal permits, funding or involvement, the designation of critical habitat will not afford any additional protections for species with respect to such strictly private activities.
4. In November 2000, the U. S. District Court for the District of New Mexico ordered the Service to repropose critical habitat for the Rio Grande silvery minnow (silvery minnow). The Service decided to conduct a new economic analysis in light of the Court's order. With regard to the silvery minnow critical habitat designation, this analysis considers:
  - Economic impacts on Federal agencies whose actions within or in the vicinity of the Middle Rio Grande designated critical habitat unit may be affected by implementation of section 7 of the Act;
  - Economic impacts on Federal agencies whose actions within other areas essential to the conservation of the silvery minnow may be affected by implementation of section 7 of the Act. These areas include the middle Pecos River from immediately downstream of Summer Reservoir Dam to Brantley Reservoir Dam, New Mexico and the Lower Rio Grande from the

upstream boundary of Big Bend National Park to the Terrell/Val Verde County line, Texas. The Service is not including these areas in the critical habitat designation; however, as explained below, this analysis considers the economic impacts on Federal agencies in these areas;

- C Economic impacts on non-Federal entities whose actions within or in the vicinity of the three areas covered in this analysis may be affected by implementation of section 7 of the Act;
- C The "opportunity cost"<sup>1</sup> of diverting water from current uses to maintain instream flow in the stretches of the Middle Rio Grande and Pecos River in New Mexico, which is considered one of the most significant potential impacts of section 7 of the Act. This report presents an estimate of the total economic cost of this effect, measured as the opportunity cost of the water diverted from other current uses to this use; and
- C Secondary economic effects of such water diversions and other impacts of critical habitat designation, including any expected changes in regional employment, wages, and income.

### **Key Findings**

5. One measure of the economic cost of an environmental protection program is the opportunity cost of the resources allocated to the program. In this case, the principal resource in question is water, as required to maintain sufficient flows to support the silvery minnow and its habitat. Water in New Mexico is fully allocated; thus, any use of water for supplemental flow will result in a lost opportunity to use that water for some existing purpose (e.g., for farm irrigation), although it also may result in new or increased opportunities for those who benefit from increased instream flow.

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<sup>1</sup> The opportunity cost of any decision is foregone value of the next best alternative that is not chosen. Definition from Baumol, William and Alan S. Blinder. *Economics: Principles and Policy*, Fifth Edition, Harcourt Brace Jovanovich, Inc., New York, 1991.

## **Critical Habitat Areas**

6. The critical habitat designation for the silvery minnow encompasses the Middle Rio Grande in New Mexico from Cochiti Dam to the to the approximate spillway crest elevation of Elephant Butte Reservoir, Socorro County.<sup>2</sup> The lateral boundaries of the critical habitat stretch 300 feet from the bankfull width of the river channel. In addition, the designation breaks the Middle Rio Grande unit into five reaches: Cochiti Reach, Jemez Canyon Reach, Angostura Reach, Isleta Reach, and San Acacia Reach. This analysis provides estimates of economic impact at the reach level for the Middle Rio Grande in Appendix D, although the accuracy of these estimates are limited by the availability of data.
  
7. In the critical habitat designation for the silvery minnow, the Service determined that a river reach in the Lower Rio Grande stretching from the upstream boundary of Big Bend National Park to the Terrell/Val Verde County line, Texas, and a river reach in the middle Pecos River, New Mexico, from Sumner Dam to Brantley Dam in De Baca, Chaves, and Eddy Counties, New Mexico, are essential to the conservation of the silvery minnow. However, based on the Service's analysis under section 4(b)(2) of the Act, defined above, these areas have been excluded from the final designation of critical habitat for the silvery minnow. These two areas are included in this economic analysis because the Service believes that they are essential to the conservation of the species and it is important for the Service to consider all economic and other relevant information concerning these areas when making its determination under section 4(b)(2) of the Act.

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<sup>2</sup> The final critical habitat designation for the silvery minnow encompasses the Middle Rio Grande in New Mexico from Cochiti Reservoir downstream to the utility line crossing the Rio Grande at UTM 13-311474E, 3719722 N. The lateral boundaries of the final critical habitat designation stretch 300 feet from the bankfull width. The proposed critical habitat designation also included the lands of six Pueblos. However, the Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta are not included in the final designation. This analysis is consistent with the designation as described in the proposed rule. Where possible, this analysis identifies potential changes to the estimates that could be associated with changes to critical habitat areas in the final rule.

8. The primary constituent elements (PCEs) of critical habitat for the silvery minnow are defined as those habitat components that are essential for the conservation of the species. For the silvery minnow, these PCEs include<sup>3</sup>:

"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 all of which are necessary for each of the particular silvery minnow life-history stages in appropriate seasons. 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 to February); The presence of low-velocity habitat (including eddies created by debris piles, pools, or backwaters, or other refuge habitat (e.g., connected oxbows or braided channels)) within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variety of habitats with a wide range of depth and velocities; Substrates of predominantly sand or silt; and Water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 °C (35 °F) and less than 30 °C (85 °F) and reduce degraded water quality conditions (decreased dissolved oxygen, increased p.H., etc.)."

### **Hydrological Analysis**

9. This economic analysis identifies economic costs and benefits that may result from the designation of critical habitat for the silvery minnow. These impacts are closely associated with providing or maintaining PCEs, such as sufficient flow. The critical habitat rule for the silvery minnow does not identify quantitative estimates of specific minimum thresholds (e.g., minimum flows or depths) needed for these PCEs, because these thresholds may vary seasonally and annually. The Service states that specific thresholds are appropriately enumerated through section 7 consultations (e.g., see Service 2001 and Service

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<sup>3</sup> A complete list of PCEs for the silvery minnow is included in Section 1.4 of this report.



2002).<sup>4</sup> Thus, this analysis uses 50 cubic feet per second (cfs) as a basis from which to calculate the opportunity costs associated with providing sufficient flowing water to prevent formation of isolated pools for the silvery minnow.<sup>5</sup> The 50 cfs standard was chosen because it was the best available estimate of a target flow and was set forth in the Service's "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" (programmatic opinion).<sup>6</sup> The requirements set forth in the 2001 programmatic opinion include providing a minimum flow of 50 cfs in the Middle Rio Grande. An explanation of the derivation of the 50 cfs minimum flow standard is presented in Appendix A.

10. Although the Service has not drafted a biological opinion for the silvery minnow on the Pecos River or in the Lower Rio Grande, this analysis assumes that the minimum flow requirement of 50 cfs described above will also apply to those areas. The Service has indicated that a 50 cfs standard may be higher than what is necessary for the silvery minnow outside of the main stem of the Middle Rio Grande (i.e., in the Pecos River and Lower Rio Grande as well as in the Jemez Reach of the Middle Rio Grande unit).<sup>7</sup> Thus, the opportunity cost of providing 50 cfs to these river segments are likely to be upper bound estimates (i.e., actual opportunity costs may be lower than these estimates).
11. Both the Middle Rio Grande and the Pecos River in New Mexico have periodically experienced intermittent flows in select locations during dry, low-flow periods. As a result, existing instream flows would require supplemental water to meet a target flow of 50 cfs. Because the total amount of water available for consumption within each stretch of river is

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<sup>4</sup> Written communication, U.S. Fish and Wildlife Service, Ecological Services Field Office and Regional Office, Albuquerque, NM, December 17, 2001.

<sup>5</sup> In the Middle Rio Grande, the biological opinion suggests a winter requirement of 50 cfs flow at the San Marcial Railroad Bridge and a summer requirement of 50 cfs at San Acacia Dam. This assumption was used in the hydrological modeling included in this analysis. See Appendix B for details.

<sup>6</sup> U.S. Fish and Wildlife Service, Region 2. "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." June 29, 2001. P. 107.

<sup>7</sup> Written communication with Biologist, U.S. Fish and Wildlife, Ecological Services Office, Albuquerque, NM, December 17, 2001.

limited by legal agreements such as the Rio Grande Compact of 1938 and the Pecos River Compact of 1948 (see Section 3) as well as by weather, this analysis recognizes that any additional water for instream flow must come from the existing supply that is currently used for other purposes. The estimated specific quantities and distribution of water would be necessary to fulfill a target flow of 50 cfs are described in detail in Section 4 of this report.

12. The Lower Rio Grande along and below Big Bend National Park in Texas generally does not experience the intermittent flow described above.<sup>8</sup> National Park Service staff state that the river flow averages between 250 and 650 cfs, with over 95 percent of daily flows since 1936 exceeding the target flow of 50 cfs.<sup>9</sup> They also state that the river does not run dry in the area considered important for the silvery minnow.<sup>10</sup> In addition, flow in this stretch of the Rio Grande is determined primarily by the quantity of water contributed to the Rio Grande by the Rio Conchos in Mexico. Because current and historical flow has been sufficient, and because authority for water flow regulation lies outside of State or Federal jurisdiction, this analysis assumes that flow in the Lower Rio Grande along and below Big Bend National Park is sufficient for the purposes of providing a target flow of 50 cfs for the silvery minnow. Thus, this analysis assumes that there is no need for supplemental water in this area. As a result, the sections of this report that characterize the legal framework and market through which water rights are traded (Section 3) and the analysis of the direct and indirect economic effects of supplementing flows (Sections 4 and 5), do not address the Lower Rio Grande. Estimated costs of the designation of critical habitat related to section 7 consultations in this area are addressed in Section 6 of this report.
13. The analysis of the direct and indirect economic effects of shifting water from existing uses to instream flow consists of three primary components: (1) a hydrological analysis of the quantity of supplemental water required; (2) an economic analysis of the value of that water; and (3) use of an input/output model to estimate the secondary economic effects on the regional economy of changing the water use. While each component of the analysis serves as an input for the next, each methodology also stands on its own. As a result, any change to the hydrological analysis will result in changes to the other values presented. However, such a change would not alter the methodology used to calculate the economic effects.

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<sup>8</sup> Biologist, Big Bend National Park. Personal communication, September 6, 2001.

<sup>9</sup> Flow data available at: [www.ibwc.state.gov/wad/rio\\_grande.htm](http://www.ibwc.state.gov/wad/rio_grande.htm). Accessed January 24, 2002.

<sup>10</sup> Hydrologist, Big Bend National Park. Personal communication, September 6, 2001.

14. The hydrological analysis used in this report relies on publicly available flow gage data; it does not make use of sophisticated hydrological models of the affected river systems. When it becomes available, the Upper Rio Grande Water Operation Model (URGWOM), is likely to be a useful tool in modeling water requirements for flows in the Middle Rio Grande, as suggested in public comments of the New Mexico Interstate Stream Commission on the proposed rule.<sup>11</sup> Use of this model to estimate the supplemental water required to achieve target flows might result in estimates that differ from those used in this analysis. However, at the time of this analysis, the URGWOM model has not been made publicly available. In addition, the URGWOM Steering Committee itself has recently stated that: 1) the latest version of URGWOM should not be released until it has been tested and is ready for public use; 2) the data and results for various model runs were not totally successful, but furthered model debugging, testing and evaluation; 3) the Middle Rio Grande Valley water depletions are modeled too high; 4) the water planning model is currently simplistic and rough; and 5) water operations modeling is still undergoing troubleshooting, repairs, and enhancements.<sup>12</sup> Thus, in order to provide estimates of the amount of water that would be needed to supplement current instream flows, this analysis uses existing, publicly available data.
15. As discussed later in this report, several assumptions made regarding hydrological requirements and water rights transfers that may be associated with critical habitat designation for the silvery minnow are likely to generate conservative (i.e., more likely to overstate than understate) impact estimates. A brief description of the major assumptions made in this hydrological analysis is provided below. A detailed description of the hydrological analyses of supplemental water needed for the Middle Rio Grande and Pecos rivers are provided in Appendices B and C, respectively.<sup>13</sup>

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<sup>11</sup> “Comments by the State of New Mexico on the Draft Environmental Impact Statement and Proposed Rule published June 6, 2002, regarding Critical Habitat of the Rio Grande silvery minnow,” New Mexico Interstate Stream Commission, October 2, 2002.

<sup>12</sup> Notes from URGWOM Steering Committee Meeting: September 12, 2002: 10 am Corps of Engineers Conference Room and URGWOM Steering Committee Meeting: April 11, 2002: 10 am.

<sup>13</sup> In these analyses, the supplemental water needed is expressed as an average water deficit below the minimum flow requirements in the river.

- As noted in the 2001 biological opinion, providing a target flow of 50 cfs in San Acacia reach may provide more water than is necessary for the silvery minnow in some segments of the critical habitat.<sup>14</sup>
- This analysis values the stream flow need (water deficit in acre-feet) by the number of consumptive use water rights equal to this amount. In fact, if consumptive use rights are traded and used for instream flow, water included as part of those consumptive use rights that previously would have been lost to conveyance in irrigation ditches etc., would no longer be lost. Thus, more water than necessary to fulfill that deficit would be available in the river. In addition, other waters included as part of consumptive use rights, such as return flows, would also become available as a result of such a trade.<sup>15</sup>
- This analysis estimates the quantity of supplemental water needed in the 95th percentile worst-case (e.g., driest) year. In other words, this quantity of water exceeds the amount needed to achieve a flow of 50 cfs in all but five years out of 100.
- If consumptive use rights are held for the 95th percentile driest year, then in other years other management options could be explored, including controlling flow patterns to simulate seasonal pulses in flow or leasing water to other users on a short-term basis to offset costs of managing the river to protect the silvery minnow.

### **Framework for Analysis**

16. This analysis first identifies land use activities within or in the vicinity of the three areas being analyzed for effects under section 7 of the Act. To do this, the analysis evaluates a “without section 7” scenario and compares it to a “with section 7” scenario. The “without section 7” scenario constitutes the baseline of this analysis. It represents the level of protection currently afforded the species under the Act, absent section 7 protective measures, which includes other Federal, State, and local laws. The “with section 7” scenario identifies

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<sup>14</sup> Written communication with Biologist, U.S. Fish and Wildlife, Ecological Services Office, Albuquerque, NM, December 17, 2001.

<sup>15</sup> This point is highlighted in the public comments of Brian McDonald for MRGCD, October 2, 2002. “It appears that the 40,427 acre-feet is a withdrawal need—stream flow—while the \$4,750 per acre feet is for a consumptive right...” Indeed, this analysis makes the withdrawal need equal to the consumptive use right in an attempt to avoid understating costs.

land-use activities likely to involve a Federal nexus that may affect the species or its designated critical habitat, which accordingly have the potential to be subject to future consultations under section 7 of the Act.

17. Economic activities identified as likely to be affected under section 7 and the resulting impacts that section 7 can have on such activities constitute the upper-bound estimate of the critical habitat economic analysis. By defining the upper-bound estimate to include both jeopardy and adverse modification of critical habitat impacts, the analysis recognizes the difficulty in sometimes differentiating between the two in evaluating only the critical habitat effects associated with the rulemaking. This step is adopted in order to ensure that any critical habitat impacts that may occur co-extensively with the listing of the species (i.e., jeopardy) are not overlooked in the analysis.
18. Upon identifying section 7 impacts, the analysis proceeds to consider the subset of impacts that can be attributed exclusively to the three areas being considered in this analysis. To do this, the analysis adopts a “with and without critical habitat approach.” This approach is used to determine those effects found in the upper-bound estimate that may be attributed solely to the designation of critical habitat. Specifically, the “with and without critical habitat” approach considers section 7 impacts that will likely be associated with the implementation of the *jeopardy* provisions of section 7 and those that will likely be associated with the implementation of the *adverse modification* provision of section 7. In many cases, impacts associated with the jeopardy standard remain unaffected by the designation of critical habitat and thus would not normally be considered an effect of a critical habitat rulemaking. The subset of section 7 impacts likely to be affected solely by the designation of critical habitat represent the lower-bound estimate of this analysis.

### **Summary of Section 7 Implementation Impacts**

19. Exhibit ES-1 below summarizes the costs associated with section 7 implementation of the Act, but does not include costs associated with providing supplemental water for the silvery minnow. Costs associated with each of the five designated reaches in the Middle Rio Grande are presented in Appendix D.

<b>Exhibit ES-1</b>					
<b>SUMMARY OF SECTION 7 COSTS OF CRITICAL AND OTHER ESSENTIAL HABITAT FOR THE SILVERY MINNOW: CONSULTATIONS AND PROJECT MODIFICATIONS<sup>a</sup></b>					
<b>River Segment</b>	<b>Consultations Due to Critical Habitat Alone (20 years)</b>	<b>Total Section 7 Costs (20 years)</b>	<b>Present Value of Total Section 7 Costs 3%</b>	<b>Present Value of Total Section 7 Costs 7%</b>	<b>Total Section 7 Costs (annual)<sup>b</sup></b>
Middle Rio Grande	\$5.6 to \$10.8 million	\$20.4 to \$36.3 million	\$15.2 to \$27.0 million	\$10.8 to \$19.1 million	\$1.0 to \$1.8 million
Pecos River	\$12.4 to \$21.5 million	\$12.4 to \$21.5 million	\$9.2 to \$16.0 million	\$6.6 to \$11.4 million	\$620,000 to \$1.1 million
Lower Rio Grande	\$3.9 to \$8.4 million	\$3.9 to \$8.4 million	\$2.9 to \$6.3 million	\$2.1 to \$4.4 million	\$195,000 to \$420,000
<sup>a</sup> This exhibit does not include the opportunity costs to provide supplemental flows in critical habitat areas. Costs associated with providing supplemental water for the silvery minnow are presented in Exhibit ES-2. See ES-4 for total section 7 costs. <sup>b</sup> This estimate uses three and seven percent discount rates to calculate an annualized value.					

**Summary of Opportunity Costs of Supplemental Water Flow and Potential Regional Economic Impacts**

20. Under State law in New Mexico, users of water must hold a water right. Such rights are treated as real property, and traded in a market. Since a competitive market exists for water rights in New Mexico, it is assumed that the price of these rights represents the expected economic benefit of water made available by these rights, in its highest and best use. That is, in paying for water rights, buyers are making clear the implicit value of the water to them.
  
21. This analysis uses the current price of water rights to calculate the opportunity cost associated with providing a target flow of 50 cfs for the silvery minnow.<sup>16</sup> This analysis also considers the regional economic implications of moving water from the agricultural sector to supplement instream flows, as well as the expected cost of compliance with listing and

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<sup>16</sup> Public comments from Brian McDonald for the Middle Rio Grande Conservancy District, October 2, 2002 requested clarification of why the current price of water was used in this analysis. See Section 4.1 for details.

critical habitat consultation provisions.<sup>17</sup> This analysis does not attempt to discuss social and cultural values associated with agriculture in the region, beyond a discussion of the economic impacts likely to be incurred. Please refer to the Designation of Critical Habitat for the Rio Grande Silvery Minnow Final Environmental Impact Statement for a detailed discussion of the social and cultural values of the region.<sup>18</sup>

22. Exhibits ES-2 and ES-3 below summarize the estimated value of water necessary to provide target flows to the silvery minnow and the negative regional economic impacts that could be associated with providing that water. Note that this analysis considers the annual deficit of water below the target flow in the 95th percentile and the 50th percentile worst-case (e.g., driest) years. That is, these volumes should provide sufficient flow in 95 years and 50 years out of 100. This range serves as an estimate of the quantities of water (and cost) likely to be associated with designating critical habitat for the silvery minnow.<sup>19</sup> The estimated regional economic impacts (Section 5) assume voluntary acquisition of water rights from the agricultural sector. The extent and distribution of these impacts may differ if rights are ultimately acquired from a different distribution of sources. Conversely, the broader economic impacts, as reflected in the opportunity cost of water used to assure sufficient in-stream flow, are not expected to change according to the source of the supplemental water.
23. This analysis assumes that water used to supplement instream flow will voluntarily come from that currently held in irrigation water rights, both because of the disproportionate number of rights held by this sector and because of recent trends in the water market.

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<sup>17</sup> Numerous public comments requested more information about why agricultural water rights were modeled, and more specifically why alfalfa rights were modeled. This revised analysis provides more explanation in Section 4.3. In addition, this revised analysis presents an analysis of the effects on an alternate crop, hay, in order to provide better context for the alfalfa model.

<sup>18</sup> Robert Simon (October 2, 2002) and the New Mexico Interstate Stream Commission (October 2, 2002) commented that the Service should consider the social and cultural impacts of the reduction of agriculture on the region.

<sup>19</sup> As stated above, these estimates rely on publicly-available flow gage data.

24. The assumption that water comes from agricultural uses is likely to result in a high-end estimate of the regional economic effects of the reallocation because effects on the farming sector generally ripple through the local economy to a greater extent than they do for many other sectors. It is also important to note that because supplemental flows will represent a transfer of one water use for another, rather than a net gain or loss to the system, negative impacts on water storage facilities are not expected.<sup>20</sup>
25. Finally, while existing water uses consume water to various degrees, instream flow “consumption” is likely to result in a higher return flow to the river than many water uses, such as agriculture, where a typical return flow is 30 percent.<sup>21</sup> Thus, adverse effects on Compact agreements and international treaties are not expected.<sup>22</sup>
26. This analysis does not consider options such as extending water markets to Colorado or Texas, as there is no historical record of such transfers occurring, and such transfers may be difficult to arrange under existing Compact agreements and relevant state water laws. The exhibits below and throughout this analysis present values for both the 95th and 50th percentile flow scenarios.

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<sup>20</sup> Numerous commenters request that this analysis assess the potential impact of critical habitat designation on water storage. For example, comments of the El Paso Public Utilities Board state: “Any imposition of flow maintenance requirements to maintain critical habitat areas will almost certainly affect water administrators’ ability to manage the river system and users’ ability to rely on it. Restrictions on use, timing of use, or available volumes for use, or other constraints imposed by the proposed critical habitat designation will inevitably increase economic costs, both direct costs for the management and operation of such storage, and indirect costs, including increased costs of supply and of alternative supply capacity to users, including outright loss or permanent restriction of supply.”

<sup>21</sup> Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, New Mexico State Engineer Office Technical Report 49, 1997.

<sup>22</sup> Some public commenters request that this analysis more explicitly address impacts of critical habitat designation on Compact agreements and international treaty obligations. See comments of New Mexico Interstate Stream Commission, October 2, 2002; International Boundary and Water Commission, United States and Mexico, August 22, 2002; Timothy Young, on behalf of the El Paso County Water Improvement District, October 2, 2002.



<b>Exhibit ES-2</b>							
<b>ESTIMATED OPPORTUNITY COSTS TO MEET MINIMUM INSTREAM FLOW FOR SILVERY MINNOW CRITICAL AND OTHER ESSENTIAL HABITAT</b>							
<b>River Segment</b>	<b>Unit Price (\$ per acre/foot)</b>	<b>Transaction Costs (\$ per acre/foot)<sup>a</sup></b>	<b>Estimated Annual Water Deficit (acre-feet/year)<sup>b</sup></b>	<b>Estimated Total Opportunity Cost (2001\$)</b>	<b>Estimated Present Value 20 Year Opportunity Cost (3%)</b>	<b>Estimated Present Value 20 Year Opportunity Cost (7%)</b>	<b>Estimated Annual Opportunity Cost<sup>c</sup></b>
<i>95th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	40,427	\$205.5 million	\$91.7 million	\$152.4 million	\$6.2 to \$14.4 million
Pecos	\$1,750	\$183	24,463	\$47.3 million	\$21.1 million	\$35.1 million	\$1.4 to \$3.3 million
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<i>50th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	5,635	\$28.6 million	\$12.8 million	\$21.2 million	\$0.9 to \$2.0 million
Pecos	\$1,750	\$183	16,431	\$31.8 million	\$14.2 million	\$23.6 million	\$1.0 to \$2.2 million
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<sup>a</sup> Average of transaction cost estimates from Easter et al (1999) and <a href="http://www.waterbank.com/Agreements/Agency%20Agreement.htm">http://www.waterbank.com/Agreements/Agency%20Agreement.htm</a> <sup>b</sup> See Appendices B and C for detailed calculation of these volumes. <sup>c</sup> This estimate uses three and seven percent discount rates to calculate an annualized value.							

<b>Exhibit ES-3</b>				
<b>SUMMARY TABLE OF REGIONAL ECONOMIC EFFECTS OF PROVIDING A TARGET FLOW OF 50 CFS IN SILVERY MINNOW CRITICAL AND OTHER ESSENTIAL HABITAT</b>				
<b>River Segment</b>	<b>Value of Forgone Crop Production (2001\$)</b>	<b>Effect on Regional Output <sup>a</sup> (2001\$)</b>	<b>Effect on Regional Employment (persons)</b>	<b>Effect on Regional Tax Revenue (2001\$)</b>
	<i>Direct Effect</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>
<i>95th Percentile Scenario</i>				
Middle Rio Grande	\$6.0 million	\$8.4 million	362	\$1.4 million
Pecos	\$4.2 million	\$6.2 million	158	\$0.6 million
<i>50th Percentile Scenario</i>				
Middle Rio Grande	\$0.8 million	\$1.2 million	51	\$0.2 million
Pecos	\$2.8 million	\$4.2 million	106	\$0.4 million
<sup>a</sup> Note that the effects on regional output, employment, and tax revenue include both the direct effect used as an input to the model (see Section 5.2.1) and the modeled indirect or secondary effects on the economy of the study area.				

27. Exhibit ES-4 presents the annualized costs associated with section 7 of the Act. This includes section 7 consultation and technical assistance costs, (from Exhibit ES-1) as well as the estimated opportunity cost of providing a target flow of 50 cfs (from Exhibit ES-2), which this analysis considers to be the most significant potential cost of section 7 implementation. Exhibit ES-4 presents the 95th and 50th percentile flow values as the basis for high and low-end cost estimates, in combination with the range of values presented in Exhibit ES-1.
28. Note that the estimated regional economic effects presented in Exhibit ES-3 are an entirely different measure of impact than the annualized and 20-year estimates included in ES-1, 2 and 4. The regional economic impacts measure distributional impact rather than the efficiency impacts measured by in ES-1, 2 and 4. As such, they are not comparable to and cannot be summed with the section 7 cost estimates presented in ES-4. That is, these are both important, but distinct measures of impact.

<b>Exhibit ES-4</b>			
<b>SUMMARY OF ANNUALIZED COSTS ASSOCIATED WITH CRITICAL AND OTHER ESSENTIAL HABITAT: CONSULTATIONS, PROJECT MODIFICATIONS, AND TARGET FLOWS</b>			
<b>River Segment</b>	<b>Consultation and Project Modification Costs (2001\$)</b>	<b>Opportunity Cost to Provide Target Flows (2001\$)</b>	<b>Total Annualized Costs<sup>a</sup> (2001\$)</b>
Middle Rio Grande	\$1.0 to \$1.8 million	\$0.9 <sup>b</sup> to \$14.4 <sup>c</sup> million	\$1.9 to \$16.2 million
Pecos	\$0.6 to \$1.1 million	\$1.0 to \$3.3 million	\$1.6 to \$4.4 million
Lower Rio Grande	\$0.2 to \$0.4 million	\$0	\$0.2 to \$0.4 million
<sup>a</sup> Total annualized costs are calculated by adding the total annual consultation and project modification costs presented in Exhibit ES-1 to the annual opportunity costs presented in Exhibit ES-2. This table does not include regional economic effects. <sup>b</sup> Low estimate is based on the low estimate of the 50 <sup>th</sup> percentile costs in Exhibit ES-2. <sup>c</sup> High estimate is based on the high estimate of the 95 <sup>th</sup> percentile costs in Exhibit ES-2.			

**Summary of Potential Benefits**

29. To estimate the benefits of critical habitat designation for the silvery minnow, this report focuses on the benefits associated with the primary goal of species recovery and, to a lesser extent, the secondary benefits associated with the habitat protection required to achieve this primary goal. While no published literature has estimated values for the specific *marginal* changes afforded by section 7 protections for endangered species, this report considers existing literature to the extent that it informs the broader decision-making process by providing values associated with the species and habitat in question.
  
30. Specifically, drawing upon results from two stated-preference valuation studies of instream flow protection programs on the Middle Rio Grande, this report estimates the total present value of perpetual welfare benefits expected to result from silvery minnow habitat protection to be approximately \$80 to \$100 million (\$2001). This range reflects the range of welfare values from the two studies, as well as discounting at both a three and seven percent rate. Alternatively, the present value of these perpetual benefits accrued only over the next 20 years would be \$36 to \$74 million at the same rates.
  
31. The range of values represents the benefits associated with maintaining instream flow on the Middle Rio Grande for the primary purpose of silvery minnow protection. However, these benefits necessarily reflect a variety of environmental changes. As described to survey participants, coincident changes in environmental quality include enhanced riparian vegetation, improved recreational and viewing opportunities, improved

water quality, and improved habitat for fish and wildlife— particularly for 10 other threatened and endangered fish species found in the Middle Rio Grande. It is not possible to identify what portion of the public’s stated willingness to pay corresponds specifically to the increase in the probability of silvery minnow recovery. Therefore, these total values are not consistent with the *marginal* benefits to the silvery minnow of designating an additional unit of critical habitat. The estimated aggregate values (i.e., \$36 to \$100 million) are not directly comparable to the costs described in other sections, but rather reflect the benefits of instream flow and species protection generally.

<b>Exhibit ES-5</b>		
<b>CAVEATS TO THE ECONOMIC ANALYSIS</b>		
<b>Analysis</b>	<b>Assumption</b>	<b>Effect on Cost Estimate</b>
Hydrological Analysis	Historic water flow data offer an accurate picture of future water needs.	?
	No policy can guarantee flow at all times and so this analysis relies on historical data to estimate the quantity of water needed to achieve an instream flow of 50 cfs in the 95th percentile driest year, rather than an average supplemental value.	+
	The hydrological model accurately predicts water volume needed for silvery minnow.	?
Value of Water/ Market Analysis	The value of water in perpetuity is a reasonable representation of the value of water within the 20-year time horizon of this analysis.	+
	Contingent water markets do not exist.	+
	Inter-state transfers of water are not feasible.	+
Regional Economic Analysis	Farmers who trade water rights will retire acreage rather than switch to more efficient technology or less water-intensive crops.	+
	Water removed from irrigation for instream flow will come from alfalfa crops.	+
	The structure of the economy will be static over time.	+
Consultation and Project Modification Costs	Historic patterns of consultations and project modifications are good predictors of future consultation behavior.	?
	Consultation rates will not decrease over time.	+
	The presence of other species (i.e., bluntnose shiner, flycatcher) has no influence on consultation/project modification costs.	+
? : unknown effect - : underestimates costs + : overestimates costs		

## INTRODUCTION AND BACKGROUND

## SECTION 1

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32. In June 2002, the U.S. Fish and Wildlife Service (Service) proposed designating critical habitat for the Rio Grande silvery minnow (*Hybognathus amarus*) on approximately 214 river miles of the Middle Rio Grande in New Mexico. Two other areas, the Middle Pecos River and the Lower Rio Grande, are considered essential to the conservation of the silvery minnow and are included in this analysis. The purpose of this report is to identify and analyze the potential economic impacts that would result from the designation of the Middle Rio Grande (the only area included in the Service's final rule) as critical habitat as well as the other two areas considered essential to the conservation of the silvery minnow. This report was prepared by Industrial Economics, Incorporated and Brookshire, McIntosh and Associates for the Service's Division of Economics.
33. Section 4(b)(2) of the Endangered Species Act (the Act) requires the Service to designate critical habitat based on the best scientific and commercial data available, after taking into consideration the economic impact, and any other relevant impact, of specifying any particular area as critical habitat. The Service may exclude areas from critical habitat designation when the benefits of exclusion outweigh the benefits of including the areas within critical habitat, provided the exclusion will not result in extinction of the species.
34. In November 2000, the U. S. District Court for the District of New Mexico ordered the Service to repropose critical habitat for the Rio Grande silvery minnow. With regard to the silvery minnow critical habitat designation, this analysis considers:
- C Economic impacts on Federal agencies whose actions within or in the vicinity of the Middle Rio Grande critical habitat unit may be affected by implementation of section 7 of the Act;

- Economic impacts on Federal agencies whose actions within other areas essential to the conservation of the silvery minnow may be affected by implementation of section 7 of the Act. These areas include the middle Pecos River from immediately downstream of Summer Reservoir Dam to Brantley Reservoir Dam, New Mexico and the Lower Rio Grande from the upstream boundary of Big Bend National Park to the Terrell/Val Verde County line, Texas. The Service is not designating these areas as critical habitat; however, as explained below, this analysis considers the economic impacts on Federal agencies in these areas;
- C Economic impacts on non-Federal entities whose actions within or in the vicinity of the three areas covered in this analysis may be affected by implementation of section 7 of the Act;
- C The "opportunity cost<sup>23</sup>" of diverting water from current uses to maintain instream flow in the stretches of the Middle Rio Grande and Pecos River in New Mexico, which is considered one of the most significant potential impacts of section 7 of the Act. This report presents an estimate of the total economic cost of this effect, measured as the opportunity cost of the water diverted from other current uses to this use; and
- C Secondary economic effects of such water diversions and other impacts of critical habitat designation, including any expected changes in regional employment, wages, and income.

## **1.1 Framework for Analysis**

35. After the listing of a species, section 7(a)(2) of the Act requires Federal agencies to consult with the Service to ensure that activities they fund, authorize, permit, or carry out are not likely to jeopardize the continued existence of the species. For designated critical habitat, section 7(a)(2) also requires Federal agencies to consult with the Service to ensure that activities they fund, authorize, permit, or carry out do not result in destruction or adverse modification of critical habitat.

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<sup>23</sup> Opportunity cost is defined as the cost in terms of foregone alternatives.

36. This analysis first identifies land use activities within or in the vicinity of the three areas being analyzed for effects under section 7 of the Act. To do this, the analysis evaluates a “without section 7” scenario and compares it to a “with section 7” scenario. The “without section 7” scenario constitutes the baseline of this analysis. It represents the level of protection currently afforded the species under the Act, absent section 7 protective measures, which includes other Federal, State, and local laws. The “with section 7” scenario identifies land-use activities likely to involve a Federal nexus that may affect the species or its designated critical habitat, which accordingly have the potential to be subject to future consultations under section 7 of the Act.
37. Economic activities identified as likely to be affected under section 7 and the resulting impacts that section 7 can have on such activities constitute the upper-bound estimate of the critical habitat economic analysis. By defining the upper-bound estimate to include both jeopardy and adverse modification of critical habitat impacts, the analysis recognizes the difficulty in sometimes differentiating between the two in evaluating only the critical habitat effects associated with the rulemaking. This step is adopted in order to ensure that any critical habitat impacts that may occur co-extensively with the listing of the species (i.e., jeopardy) are not overlooked in the analysis.
38. Upon identifying section 7 impacts, the analysis proceeds to consider the subset of impacts that can be attributed exclusively to the three areas being considered in this analysis. To do this, the analysis adopts a “with and without critical habitat approach.” This approach is used to determine those effects found in the upper-bound estimate that may be attributed solely to the designation of critical habitat. Specifically, the “with and without critical habitat” approach considers section 7 impacts that will likely be associated with the implementation of the *jeopardy* provisions of section 7 and those that will likely be associated with the implementation of the *adverse modification* provision of section 7. In many cases, impacts associated with the jeopardy standard remain unaffected by the designation of critical habitat and thus would not normally be considered an effect of a critical habitat rulemaking. The subset of section 7 impacts likely to be affected solely by the designation of critical habitat represent the lower-bound estimate of this analysis.

## **1.2 Methodological Approach**

39. Critical habitat may potentially affect private, State, Federal, and Tribal landowners and water users in areas designated as critical habitat in the Middle Rio Grande and the other two areas considered important for the conservation of the silvery minnow. First and foremost, this analysis addresses potential impacts on water users that may be associated with critical habitat. This analysis also assesses how implementation of section 7 of the Act for the silvery minnow may affect current and planned land uses and activities in the three

areas under consideration in this analysis over the next 20 years. This report relies on a sequential methodology and focuses on distilling the salient and relevant aspects of potential economic impacts of critical habitat designation. The methodology consists of:

- C Determining the current and projected economic activity within and around the area designated as critical habitat and the other two areas considered important for the conservation of the silvery minnow;
- C Considering how current and future activities that take place or will likely take place on the Federal and private land could adversely affect designated critical habitat and the other two areas considered important for the conservation of the silvery minnow;
- C Identifying whether such activities taking place on privately-owned property within the designated critical habitat boundaries and the other two areas considered important for the conservation of the silvery minnow are likely to involve a Federal nexus (Section 6);
- C Evaluating the likelihood that identified Federal actions and non-Federal actions having a Federal nexus will require consultations under section 7 of the Act and, in turn, that such consultations will result in modifications to projects (Section 6);
- C Estimating costs of expected section 7 consultations, project modifications and other economic impacts associated with activities in or adjacent to areas designated as critical habitat and the other two areas considered important for the conservation of the silvery minnow (Sections 4, 5 and 6);
- C Estimating the upper bound of total costs associated with the designation (including costs that may be attributed co-extensively with the listing of the species) and the other two areas considered important for the conservation of the silvery minnow and the lower bound of costs (i.e., costs attributable solely to critical habitat) (Section 6);
- C Determining the benefits that may be associated with the designation of critical habitat (Section 8); and
- C Assessing the extent to which critical habitat designation will create costs for small businesses and/or affect property values as a result of modifications or delays to projects (Section 8).



40. For non-Federal lands, section 7 consultations and resulting modifications to land uses and activities can only be required when a Federal nexus, or connection, exists. A Federal nexus arises if the activity or land use of concern involves Federal permits, Federal funding, or another form of Federal involvement. Section 7 consultations are not required for activities on State, county, Tribal, and private land that do not involve a Federal nexus. However, section 9 prohibitions still exist for these lands.
41. This report estimates impacts of critical habitat designation on activities that are "reasonably foreseeable," including, but not limited to, activities which are currently authorized, permitted, or funded, or for which proposed plans are currently available to the public. For the analysis of impacts that may arise directly from section 7 consultation, this analysis considers activities that are likely to occur within a 20-year time horizon. This is because population forecasts as well as local and regional planning documents use similar time horizons. In addition, forecasting consultations activities and behavior of Action agencies and the Service beyond 20 years becomes very difficult. To assess the opportunity costs of shifting water from present uses to instream flow, the water rights are valued at current market prices, which carry a value into perpetuity. Values for section 7 implementation (including water values) are then presented as annualized values, as well as 20-year estimates. Regional impacts are calculated as a one time change in the regional economy to employment, crop production, regional output, and regional effect on tax revenue.

### **1.3 Description of Species and Habitat**

42. The silvery minnow is a fish that is silvery to olive in color on the back and upper sides with a broad, greenish mid dorsal stripe and silver lower sides and abdomen. It has a maximum length of approximately 3.5 inches, with small eyes and a pointed snout that projects beyond the upper lip.
43. The silvery minnow currently inhabits a 170-mile stretch of the Rio Grande between Cochiti Dam and Elephant Butte Reservoir, an area equivalent to five percent of its historic range. The historic range stretched from the Rio Grande near Espanola, upstream of the Cochiti Dam in New Mexico, to the Gulf of Mexico. It also included the Pecos River from Sumner Reservoir to the river's confluence with the Rio Grande in Texas. The silvery minnow's short life span, usually one year, causes populations to vary greatly from year to year.

#### 1.4 **Designated Critical Habitat**

44. The critical habitat designation for the silvery minnow encompasses the Middle Rio Grande in New Mexico from Cochiti Dam to the approximate spillway crest elevation of Elephant Butte Reservoir.<sup>24</sup> The lateral boundaries of the critical habitat stretch 300 feet from the center of the river channel. In addition, the designation breaks the Middle Rio Grande unit into five reaches according to the following distinctions:

- C *Cochiti Reach* - 21 river miles downstream of Cochiti Reservoir Dam, ending at Angostura Diversion Dam.
- C *Jemez Canyon Reach* - five river miles downstream of Jemez Canyon Reservoir, ending at the confluence of Jemez and the Rio Grande.
- C *Angostura Reach* - 38 river miles downstream of Angostura Diversion Dam, ending at Isleta Diversion Dam.
- C *Isleta Reach* - 56 river miles downstream of Isleta Diversion Dam, ending at San Acacia Diversion Dam.
- C *San Acacia Reach* - 47 river miles downstream of San Acacia Diversion Dam, to the approximate spillway crest elevation of Elephant Butte Reservoir, Socorro County.<sup>25</sup>

This analysis provides estimates of economic impact at the reach level for the Middle Rio Grande in Appendix D, although the accuracy of these estimates is limited by the availability of data.

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<sup>24</sup> The final critical habitat designation for the silvery minnow encompasses the Middle Rio Grande in New Mexico from Cochiti Reservoir downstream to the utility line crossing the Rio Grande at UTM 13-311474E, 3719722 N. The lateral boundaries of the final critical habitat designation stretch 300 feet from the bankfull width. The proposed critical habitat designation also included the lands of six Pueblos. However, the Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta are not included in the final designation. This analysis is consistent with the designation as described in the proposed rule. Where possible, this analysis identifies potential changes to the estimates that could be associated with changes to critical habitat areas in the final rule.

<sup>25</sup> See above footnote. This analysis is consistent with the designation as described in the proposed rule.

45. Other areas essential to the conservation of the silvery minnow include the middle Pecos River from immediately downstream of Summer Reservoir Dam to Brantley Reservoir Dam, New Mexico and the Lower Rio Grande from the upstream boundary of Big Bend National Park to the Terrell/Val Verde County line, Texas. The Service is not including these areas in the final designation of critical habitat; however, as explained in the Executive Summary, these areas are included in this economic analysis.
46. The primary constituent elements (PCEs) of critical habitat for the silvery minnow are defined as those habitat components that are essential for the conservation of the species. For the silvery minnow, these PCEs are:
- C 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 all of which are necessary for each of the particular silvery minnow life-history stages in appropriate seasons. 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 to February);
  - C The presence of low-velocity habitat (including eddies created by debris piles, pools, or backwaters, or other refuge habitat (e.g., connected oxbows or braided channels)) within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variety of habitats with a wide range of depth and velocities;
  - C Substrates of predominantly sand or silt; and

- C Water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 °C (35 °F) and less than 30 °C (85 °F) and reduce degraded water quality conditions (decreased dissolved oxygen, increased p.H., etc.).<sup>26</sup>

## 1.5 Hydrological Analysis

47. This economic analysis identifies economic costs and benefits that may result from the designation of critical habitat for the silvery minnow. These impacts are closely associated with the PCEs described above, such as providing sufficient flow. The critical habitat rule for the silvery minnow does not identify quantitative estimates of specific minimum thresholds (e.g., minimum flows or depths) needed for these PCEs, because these thresholds may vary seasonally and annually. The Service states that specific thresholds are appropriately enumerated through section 7 consultations (e.g., see Service 2001 and Service 2002).<sup>27</sup> Thus, this analysis uses 50 cubic feet per second as a basis from which to calculate the opportunity costs associated with providing sufficient flowing water to prevent formation of isolated pools for the silvery minnow.<sup>28</sup> The 50 cfs standard was chosen because it was the best available estimate of a target flow and was set forth in the Service's "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" (programmatic opinion).<sup>29</sup> The requirements set forth in the 2001 programmatic opinion include providing a minimum flow of 50 cfs in the Middle Rio Grande. An explanation of the derivation of the 50 cfs minimum flow standard is presented in Appendix A.

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<sup>26</sup> Final Rule for the Designation of Critical Habitat for the Rio Grande Silvery Minnow. U.S. Fish and Wildlife Service, 2003.

<sup>27</sup> Written communication, U.S. Fish and Wildlife Service, Ecological Services Field Office and Regional Office, Albuquerque, NM, December 17, 2001.

<sup>28</sup> In the Middle Rio Grande, the biological opinion suggests a winter requirement of 50 cfs flow at the San Marcial Railroad Bridge and a summer requirement of 50 cfs at San Acacia Dam. This assumption was used in the hydrological modeling included in this analysis. See Appendix B for details.

<sup>29</sup> U.S. Fish and Wildlife Service, Region 2. "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." June 29, 2001. P. 107.

48. Although the Service has not drafted a biological opinion for the silvery minnow on the Pecos River or in the Lower Rio Grande, this analysis assumes that the minimum flow requirement of 50 cfs described above will also apply to those areas. The Service has indicated that a 50 cfs standard may be higher than what is necessary for the silvery minnow outside of the main stem of the Middle Rio Grande (i.e., in the Pecos River and Lower Rio Grande as well as in the Jemez Reach of the Middle Rio Grande unit).<sup>30</sup> Thus, the opportunity cost of providing 50 cfs to these river segments are likely to be upper bound estimates (i.e., actual opportunity costs may be lower than these estimates).
49. Both the Middle Rio Grande and the Pecos River in New Mexico have periodically experienced intermittent flows in select locations during dry, low-flow periods. As a result, existing instream flows would require supplemental water to meet a target flow of 50 cfs. Because the total amount of water available for consumption within each stretch of river is limited by legal agreements such as the Rio Grande Compact of 1938 and the Pecos River Compact of 1948 (see Section 3) as well as by weather, this analysis recognizes that any additional water for instream flow must come from the existing supply that is currently used for other purposes. The estimated specific quantities and distribution of water would be necessary to fulfill a target flow of 50 cfs are described in detail in Section 4 of this report.
50. The Lower Rio Grande along and below Big Bend National Park in Texas generally does not experience the intermittent flow described above.<sup>31</sup> National Park Service staff state that the river flow averages between 250 and 650 cfs, with over 95 percent of daily flows since 1936 exceeding the target flow of 50 cfs.<sup>32</sup> They also state that the river does not run dry in the area considered important for the silvery minnow.<sup>33</sup> In addition, flow in this stretch of the Rio Grande is determined primarily by the quantity of water contributed to the Rio Grande by the Rio Conchos in Mexico. Because current and historical flow has been sufficient, and because authority for water flow regulation lies outside of State or Federal jurisdiction, this analysis assumes that flow in the Lower Rio Grande along and below Big Bend National Park is sufficient for the purposes of providing a target flow of 50 cfs for the silvery minnow. Thus, this analysis assumes that there is no need for supplemental water in this area. As a result, the sections of this report that characterize the legal framework and

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<sup>30</sup> Written communication with Biologist, U.S. Fish and Wildlife, Ecological Services Office, Albuquerque, NM, December 17, 2001.

<sup>31</sup> Biologist, Big Bend National Park. Personal communication, September 6, 2001.

<sup>32</sup> Flow data available at: [www.ibwc.state.gov/wad/rio\\_grande.htm](http://www.ibwc.state.gov/wad/rio_grande.htm). Accessed January 24, 2002.

<sup>33</sup> Hydrologist, Big Bend National Park. Personal communication, September 6, 2001.

market through which water rights are traded (Section 3) and the analysis of the direct and indirect economic effects of supplementing flows (Sections 4 and 5), do not address the Lower Rio Grande. Estimated costs of the designation of critical habitat related to section 7 consultations in this area are addressed in Section 6 of this report.

51. The analysis of the direct and indirect economic effects of shifting water from existing uses to instream flow consists of three primary components: a hydrological analysis of the quantity of supplemental water required, an economic analysis of the value of that water, and use of an input/output model to estimate the secondary economic effects on the regional economy of changing the water use. While each component of the analysis serves as an input for the next, each methodology also stands on its own. As a result, any change to the hydrological analysis will result in changes to the other values presented. However, such a change would not alter the methodology used to calculate the economic effects.
52. The hydrological analysis used in this report relies on publicly available flow gage data; it does not make use of sophisticated hydrological models of the affected river systems. When it becomes available, the Upper Rio Grande Water Operation Model (URGWOM), is likely to be a useful tool in modeling water requirements for flows in the Middle Rio Grande, as suggested in public comments of the New Mexico Interstate Stream Commission on the proposed rule.<sup>34</sup> Use of this model to estimate the supplemental water required to achieve target flows might result in estimates that differ from those used in this analysis. However, at the time of this analysis, the URGWOM model has not been made publicly available. In addition, the URGWOM Steering Committee itself has recently stated that: 1) the latest version of URGWOM should not be released until it has been tested and is ready for public use; 2) the data and results for various model runs were not totally successful, but furthered model debugging, testing and evaluation; 3) the Middle Rio Grande Valley water depletions are modeled too high; 4) the water planning model is currently simplistic and rough; and 5) water operations modeling is still undergoing troubleshooting, repairs, and enhancements.<sup>35</sup> Thus, in order to provide estimates of the amount of water that would be needed to supplement current instream flows, this analysis uses existing, publicly available data.

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<sup>34</sup>“Comments by the State of New Mexico on the Draft Environmental Impact Statement and Proposed Rule published June 6, 2002, regarding Critical Habitat of the Rio Grande silvery minnow,” New Mexico Interstate Stream Commission, October 2, 2002.

<sup>35</sup> Notes from URGWOM Steering Committee Meeting: September 12, 2002: 10 am Corps of Engineers Conference Room and URGWOM Steering Committee Meeting: April 11, 2002: 10 am.

53. As discussed later in this report, several assumptions made regarding voluntary water rights transfers that may be associated with critical habitat designation for the silvery minnow are likely to generate conservative (i.e., more likely to overstate than understate) impact estimates. A brief description of the major assumptions made in this hydrological analysis is provided below. A detailed description of the hydrological analyses of supplemental water needed for the Middle Rio Grande and Pecos rivers are provided in Appendices B and C, respectively.<sup>36</sup>

- As noted in the 2001 programmatic opinion, providing a target flow of 50 cfs in San Acacia reach may provide more water than is necessary for the silvery minnow in some segments of the critical habitat.<sup>37</sup>
- This analysis values the stream flow need (water deficit in acre-feet) by the number of consumptive use water rights equal to this amount. In fact, if consumptive use rights are traded and used for instream flow, water included as part of those consumptive use rights that previously would have been lost to conveyance in irrigation ditches etc., would no longer be lost. Thus, more water than necessary to fulfill that deficit would be made available in the river. In addition, other waters included as part of consumptive use rights, such as return flows, would also become available as a result of such a trade.<sup>38</sup>
- This analysis estimates the quantity of supplemental water needed in the 95th percentile worst-case (e.g., driest) year. In other words, this quantity of water exceeds the amount needed to achieve a flow of 50 cfs in all but five years out of 100.
- If consumptive use rights are held for the 95th percentile driest year, then in other years other management options could be explored, including controlling flow patterns to simulate seasonal pulses in flow or leasing water to other users on a short-term basis to offset costs of managing the river to

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<sup>36</sup> In these analyses, the supplemental water needed is expressed as an average water deficit below the minimum flow requirements in the river.

<sup>37</sup> Written communication with Biologist, U.S. Fish and Wildlife, Ecological Services Office, Albuquerque, NM, December 17, 2001.

<sup>38</sup> This point is highlighted in the public comments of Brian McDonald for MRGCD, October 2, 2002. “It appears that the 40,427 acre-feet is a withdrawal need—stream flow—while the \$4,750 per acre feet is for a consumptive right...” Indeed, this analysis makes the withdrawal need equal to the consumptive use right in an attempt to not understate costs.

protect the silvery minnow. As a result, this analysis is likely to overstate the negative economic effects of the designation of critical habitat.

54. Finally, the stretch of critical habitat designated in the Middle Rio Grande passes through six Indian Pueblos, each of which hold water rights in the river: Cochiti Pueblo, Isleta Pueblo, San Felipe Pueblo, Sandia Pueblo, Santa Ana Pueblo, and Santo Domingo Pueblo. However, the final rule explicitly excludes the Pueblos of Isleta, Sandia, Santa Ana, and Santo Domingo. Nonetheless, these Pueblos, as well as other Native American Tribes in New Mexico, hold significant rights to water in the Middle Rio Grande basin. Section 2 characterizes the socioeconomic characteristics of these Tribes and section 3 describes potential impacts on Tribes associated with section 7 of the Act.

#### **1.6 Framework for Analysis of Opportunity Costs of Meeting Minimum Flow Requirements**

55. One measure of the economic cost of an environmental protection program is the opportunity cost of the resources allocated to the program. In this case, the principal resource in question is water, as required to maintain sufficient flows to support the silvery minnow and its habitat. Water in New Mexico is fully allocated; thus, any use of water for supplemental flow will result in a lost opportunity to use that water for some existing purpose (e.g., for farm irrigation), although it also may result in new or increased opportunities for those who benefit from increased instream flow.
56. Among other impacts, this analysis estimates the opportunity cost of the water necessary to provide a target flow of 50 cfs for each of the areas being analyzed. Under State law in New Mexico, users of water must hold a water right. Such rights are treated as real property, and trade in a market. Since a competitive market exists for water rights in New Mexico, it is assumed that the price of these rights represents the expected economic benefit of water made available by these rights, in its highest and best use. That is, in paying for water rights, buyers are making clear the implicit value of the water to them.
57. This analysis uses the current price of water rights to calculate the opportunity cost associated with providing a target flow of 50 cfs. This analysis also considers the regional economic implications of voluntarily moving water from the agricultural sector to supplement instream flow, as well as the expected cost of compliance with listing and critical habitat consultation provisions.



58. This analysis focuses on the economic consequences associated with providing a target flow of 50 cfs and other requirements associated with section 7 listing and critical habitat, and does not address the methodology or responsibility for acquisition of this water.
59. As stated above, this analysis assumes because water resources in New Mexico are limited, any water that is provided to the silvery minnow will have to be diverted from another use. To estimate the opportunity cost that may be associated with supplying sufficient instream flow for the silvery minnow, the following framework was applied:
- Estimate the volume of water that is necessary to provide sufficient instream flow for the silvery minnow as a result of critical habitat designation and the listing of the species under the Act (Section 4).
  - Review historical patterns of water transfers in New Mexico and Texas as needed, including sale and purchase of water rights (Sections 3 and 4).
  - Estimate the opportunity cost of maintaining water in the river for target flows using current water rights prices as a measure of the economic value of water (Section 4).
  - Estimate the secondary economic effects of diverting water from current uses on regional economies in New Mexico, including any effects on employment, wages, and income (Section 5).

## SOCIOECONOMIC PROFILE

## SECTION 2

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60. To provide context for the discussion of potential economic impacts within the three areas under consideration in this analysis, it is useful to consider relevant economic and demographic data for counties and Indian Pueblos potentially affected by the designation.<sup>39</sup> The areas surrounding the Middle Rio Grande and the Pecos River encompass a significant portion of New Mexico's irrigated acreage and agriculture. Statewide, water users in New Mexico withdraw over two million acre-feet of surface water each year, 1.9 million of which farmers use for irrigation.<sup>40</sup> Users in Texas withdraw a total of almost 18 million acre-feet of surface water, 3.3 million of which they use for irrigation. Almost one third of New Mexico's surface water withdrawals go to counties that fall within the critical habitat designation and the other two areas considered important for the conservation of the silvery minnow, while less than one percent of Texas' surface water withdrawals go to counties with areas considered essential to the silvery minnow. As a result, any change in the use, distribution, or availability of Rio Grande water is more likely to affect these communities in New Mexico than those in Texas. Nevertheless, this analysis describes present economic conditions of potentially affected counties in both States below.

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<sup>39</sup> A public comment from Defenders of Wildlife/Forest Guardians requests a more complete discussion of the physical environment in critical habitat areas. While this is outside the scope of the economic analysis, a detailed discussion can be found in the Final Environmental Impact Statement for this rule.

<sup>40</sup> One acre-foot of water is the amount of water required to cover one acre with a foot of water. It is equivalent to 43,560 cubic feet or 325,900 gallons.

## 2.1 **Socioeconomic Profile of Affected Counties in New Mexico**

61. This section summarizes key economic and demographic information for the seven counties with areas either designated as critical habitat or considered important for the conservation of the silvery minnow in New Mexico. County level data are provided as context for the discussion of potential economic impacts due to critical habitat designation, and to illuminate trends that may influence these impacts.<sup>41</sup>
62. This analysis does not attempt to discuss social and cultural values of the region. Please refer to the Designation of Critical Habitat for the Rio Grande Silvery Minnow Final Environmental Impact Statement for a discussion of the social and cultural values of the region.<sup>42</sup>

### 2.1.1 **Sandoval**

63. Sandoval County is the northernmost of the affected counties on the Middle Rio Grande, encompassing a total of 3,709 square miles. With 89,908 residents, or 4.9 percent of the total State population, Sandoval is the fifth most populous county in the State. The county's population increased by 42.0 percent between 1990 and 2000, compared to a State average of 20.1 percent. This population is projected to increase an additional 42.8 percent by 2010 and 146.5 percent by 2030.
64. In 1995, the majority (71 percent) of Sandoval residents received water from the municipal supply, 99 percent of which is presently drawn from groundwater. Other water uses include commercial (628 acre-feet per year [af/y]), industrial (1,323 af/y), livestock

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<sup>41</sup> Population summaries are derived primarily from: State of New Mexico, Economic Development Department, *Community Profiles*. Accessed at: <http://www.edd.state.nm.us/COMMUNITIES/counties.htm> on August 16, 2001; U.S. Bureau of Economic Analysis Regional Accounts Data. Accessed at: <http://www.bea.doc.gov/bea/regional/data.htm> on August 16, 2001; and U.S. Geological Survey, *1995 Water Use Data*. Accessed at: <http://water.usgs.gov/watuse/spread95.html> on August 21, 2001.

<sup>42</sup> The Pena Blanca/Sile Irrigation Working Group (October 2, 2002) various other commenters request a more complete discussion of the social and cultural values of the region. While this is outside the scope of the economic analysis, a detailed discussion can be found in the Final Environmental Impact Statement for this rule.

(359 af/y), irrigation (55,501 af/y), and wastewater treatment (returns 605 af/y).<sup>43</sup> Of the water used, 72 percent, or 54,817 af/y was surface water, 99.6 percent of which was used for irrigation.

65. In 1999, Sandoval County had a total personal income of \$1.9 billion, with a per capita personal income (PCPI) of \$20,747.<sup>44</sup> Sandoval's PCPI was five percent lower than the State average (\$21,836) and 27 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 4.6 percent, which is slightly above the average annual growth rate for the State (4.5 percent) and for the nation (4.4 percent).
66. Total earnings of persons employed in Sandoval increased from about \$224 million in 1989 to \$891 million in 1999, an average annual growth rate of 14.8 percent. Services, government, and retail trade were the largest employers in 1999. Farming represents approximately \$1.4 million, or 0.2 percent of the total earnings.

### 2.1.2 Bernalillo

67. Bernalillo County is the second northernmost of the affected counties on the Rio Grande and is the most populous in the State with 556,678 residents in 2000, or 30.6 percent of the total State population. Bernalillo is part of the Albuquerque Metropolitan Area, and experienced a growth of 15.8 percent between 1990 and 2000, compared to a State average of 20.1 percent. This population is projected to increase an additional 11.7 percent by 2010 and 22.1 percent by 2030. Spread over 1,166 square miles, Bernalillo has an average density of 447 people per square mile. In order to meet the water needs of this growing population, the City of Albuquerque anticipates supplementing its current municipal drinking water supply of groundwater with surface water drawn from the Rio Grande and the Rio Chama rivers. Overall, Bernalillo County is urban and suburban, in contrast to the majority of the rest of the State, which is more rural. As a result, its economic and water use patterns differ from that of much of the rest of the State.

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<sup>43</sup> Note that values provided are for withdrawals only and that each user group returns some fraction of the withdrawal to the source. As a result, consumptive use is significantly lower than total withdrawal.

<sup>44</sup> Total personal income includes the earning (wages and salaries, other labor income, and proprietor's income); dividends, interest, and rent; and transfer payments received by the residents of a county.

68. In 1995, the vast majority (96 percent) of Bernalillo residents received water from the municipal supply, which presently consists entirely of groundwater withdrawals. Other water uses include commercial (3,722 af/y), industrial (785 af/y), power generation (258 af/y), mining (348 af/y), livestock (818 af/y), irrigation (69,177 af/y), and wastewater treatment (returns 61,375 af/y). Of these users, only livestock and irrigation draw water from the Rio Grande; all other groups presently rely solely on groundwater.
69. In 1999, Bernalillo had a total personal income of \$14.3 billion, with a per capita personal income of \$27,287. Bernalillo's PCPI was 25 percent higher than the State average (\$21,836) and four percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 4.9 percent, which is above the average annual growth rate for the State (4.5 percent) and for the nation (4.4 percent).
70. Total earnings of persons employed in Bernalillo increased from about \$6.5 billion in 1989 to \$11.5 billion in 1999, an average annual growth rate of 5.8 percent. Services, state and local government, and retail trade maintained their positions as the largest industries in the county during these 10 years. Farming represented approximately \$11.2 million, or 0.1 percent of the total earnings in 1999.

### **2.1.3 Valencia**

71. Valencia County lies just south of Bernalillo County on the Rio Grande, and had a population of 66,152 residents in 2000, or 3.6 percent of the total state population. Valencia experienced a growth of 46.2 percent between 1990 and 2000, compared to a state average of 20.1 percent. This population is projected to increase an additional 32.4 percent by 2010 and 114.8 percent by 2030. Spread over 1,068 square miles, Valencia currently has an average density of 61.9 people per square mile.
72. In 1995, approximately half (49 percent) of Valencia residents received water from a municipal supply, which presently consists entirely of groundwater withdrawals. Other water uses include commercial (1,065 af/y), industrial (34 af/y), livestock (717 af/y), irrigation (191,579 af/y), and wastewater treatment (returns 1,794 af/y). Of these users, a fraction of the livestock and the majority of the irrigation water budgets (3.1 and 95 percent, respectively) are drawn from surface water; all other groups rely solely on groundwater.
73. In 1999, residents of Valencia had a total personal income of \$1.2 billion, with a per capita personal income of \$18,961. Valencia's PCPI was 13 percent lower than the State average (\$21,836) and 34 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 4.1 percent, just below the average annual growth rate for the State (4.5 percent) and for the nation (4.4 percent).

74. Total earnings of persons employed in Valencia County increased from about \$188 million in 1989 to \$387 million in 1999, an average annual growth rate of 7.5 percent. Services, state and local government, and retail trade maintained their positions as the largest industries in the County during those 10 years. Farming represented approximately \$10.7 million, or 2.8 percent of the total earnings in 1999.

#### **2.1.4 Socorro**

75. Socorro County is the southernmost county within the stretch of the Rio Grande that has been designated as critical habitat. Its 18,078 residents comprise 1.0 percent of the total state population. Socorro experienced a growth of 22.4 percent between 1990 and 2000, compared to a state average of 20.1 percent. This population is projected to increase an additional 2.2 percent by 2010 and 19.8 percent by 2030. Spread over 6,646 square miles, Socorro has an average density of 2.7 people per square mile.
76. In 1995, the majority (77 percent) of Socorro residents received water from the municipal supply, which presently consists entirely of groundwater withdrawals. Other water uses include commercial (1,043 af/y), industrial (11 af/y), mining (11 af/y), livestock (964 af/y), irrigation (160,404 af/y), and wastewater treatment (returns 1,132 af/y). Of these users, a fraction of the livestock and the majority of the irrigation water budgets (8.1 and 66 percent, respectively) are drawn from surface water; all other groups rely solely on groundwater.
77. In 1999, residents of Socorro had a total personal income of 262 million, with a per capita personal income of \$15,866. Socorro's PCPI was 27 percent below the State average (\$21,836) and 44 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 3.6 percent, below the average annual growth rate for the State (4.5 percent) and for the nation (4.4 percent).
78. Total earnings of persons employed in Socorro County increased from about \$109 million in 1989 to \$155 million in 1999, an average annual growth of 3.6 percent. Services, state and local government, and retail trade maintained their positions as the largest industries in the County during those 10 years. Farming represented approximately \$9.8 million, or 6.3 percent of the total earnings in 1999.

### 2.1.5 De Baca

79. De Baca County is the northernmost of the affected counties on the Pecos River and had a population of 2,240 residents in 2000, or 0.1 percent of the total state population. De Baca experienced a population loss of 0.5 percent between 1990 and 2000, compared to a state average of 20.1 percent increase. Despite the recent decline, the population is projected to increase by 17.1 percent by 2010 and by 20.2 percent by 2030. Spread over 2,325 square miles, De Baca has an average density of 1.0 people per square mile.
80. In 1995, the vast majority (86 percent) of De Baca residents received water from the municipal supply, which presently consists entirely of groundwater withdrawals. Other water uses include mining (11 af/y), livestock (370 af/y), irrigation (57,967 af/y), and wastewater treatment (returns 135 af/y). Of these users, only livestock and irrigation draw from surface water, while the others are limited to groundwater supplies. Nevertheless, surface water constitutes 76 percent of all water withdrawals for the county due to its heavy use for irrigation.
81. In 1999, residents of De Baca had a total personal income of \$41 million, with a per capita personal income of \$17,268. De Baca's PCPI was 21 percent lower than the State average (\$21,836) and 40 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 3.8 percent, below the average annual growth rate for the State (4.5 percent) and of the nation (4.4 percent).
82. Total earnings of persons employed in De Baca County increased from about \$12.2 million in 1989 to \$21.5 million in 1999, an average annual growth of 5.8 percent. State and local government, farming, and retail trade maintained their positions as the largest industries in the County during those 10 years. Farming represented approximately \$5.2 million, or 24.2 percent of the total earnings in 1999.

### 2.1.6 Chaves

83. Chaves County lies just south of De Baca on the Pecos and had a population of 61,382 residents in 2000, or 3.4 percent of the total state population. Chaves experienced a growth of 6.1 percent between 1990 and 2000, compared to a state average of 20.1 percent. This population is projected to increase an additional 8.7 percent by 2010 and by 15.8 percent by 2030. Spread over 6,071 square miles, Chaves has an average density of 10.1 people per square mile.

84. In 1995, the vast majority (90 percent) of Chaves residents received water from the municipal supply, which presently consists entirely of groundwater withdrawals. Other water uses include commercial (2,489 af/y), industrial (639 af/y), mining (90 af/y), livestock (7,712 af/y), irrigation (294,050 af/y), and wastewater treatment (returns 1,704 af/y). Less than 10 percent of all water used in Chaves County comes from surface water resources.
85. In 1999, residents of Chaves had a total personal income of \$1.2 billion, with a per capita personal income of \$19,356. Chaves' PCPI was 11 percent lower than the State average (\$21,836) and 32 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 3.6 percent, below the average annual growth rate for the State (4.5 percent) and of the nation (4.4 percent).
86. Total earnings of persons employed in Chaves County increased from about \$494 million in 1989 to \$772 million in 1999, an average annual growth of 4.6 percent. Services, farming, and state and local government were the largest industries in the County in 1999. Farming represented approximately \$146 million, or 18.9 percent of the total earnings in 1999.

### 2.1.7 Eddy

87. Eddy County is the southernmost of the Pecos counties and had a population of 51,658 residents in 2000, or 2.8 percent of the total state population. Eddy County experienced a growth of 6.3 percent between 1990 and 2000, compared to a state average of 20.1 percent. This population is projected to increase an additional 17.3 percent by 2010 and by 34.3 percent by 2030. Spread over 4,182 square miles, Eddy has an average density of 12.4 people per square mile.
88. In 1995, the vast majority (93 percent) of Eddy residents received water from the municipal supply, which presently consists almost entirely of groundwater withdrawals. Other water uses include commercial (448 af/y), industrial (661 af/y), mining (11,188 af/y), livestock (717 af/y), irrigation (237,630 af/y), and wastewater treatment (returns 3,598 af/y). Of all the water used, almost half is derived from surface water, nearly all (99.4 percent) of which is devoted to irrigation.
89. In 1999, residents of Eddy had a total personal income of \$1.1 billion, with a per capita personal income of \$19,843. Eddy's PCPI was nine percent lower than the State average (\$21,836) and 30 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 3.7 percent, below the average annual growth for the State (4.5 percent) and of the nation (4.4 percent).



90. Total earnings of persons employed in Eddy County increased from about \$432 million in 1989 to \$700 million in 1999, an average annual growth rate of 4.9 percent. The largest industries in 1999 were mining, services, and state and local government. Farming represented approximately \$26.8 million, or 3.8 percent of the total earnings in 1999.
91. Exhibit 2-1 summarizes the socioeconomic data on the counties presented above.

<b>Exhibit 2-1</b>							
<b>SOCIOECONOMIC CHARACTERISTICS OF COUNTIES IN NEW MEXICO</b>							
<b>Statistic</b>	<b>Sandoval County</b>	<b>Bernalillo County</b>	<b>Valencia County</b>	<b>Socorro County</b>	<b>De Baca County</b>	<b>Chaves County</b>	<b>Eddy County</b>
Population of County (2000)	89,908	556,678	66,152	18,078	2,240	61,382	51,685
Percent of State Population	4.9%	30.6%	3.6%	1.0%	0.1%	3.4%	2.8%
Percent Change in Population (1990-1999)	42.0%	15.8%	46.2%	22.4%	-0.5%	6.1%	6.3%
Total Full and Part time Employment (1999)	31,412	387,363	18,724	7,060	1,134	27,982	25,668
Unemployment Rate (1999)	4.9%	4.5%	5.0%	7.3%	6.5%	7.7%	9.2%
<b>1999 Full/Part Time Employment (Percent of County Total)</b>							
<b>Industry</b>	<b>Sandoval County</b>	<b>Bernalillo County</b>	<b>Valencia County</b>	<b>Socorro County</b>	<b>De Baca County</b>	<b>Chaves County</b>	<b>Eddy County</b>
Farming	400 (1.3%)	616 (0.2%)	818 (4.4%)	593 (8.4%)	334 (29.5%)	1,618 (5.8%)	847 (3.3%)
Agricultural Services	270 (0.9%)	3,181 (0.8%)	(D)	(D)	(D)	534 (1.9%)	331 (1.3%)
Mining	115 (0.4%)	752 (0.2%)	(D)	(D)	(L)	1,016 (3.6%)	2,914 (11.4%)
Construction	2,005 (6.4%)	24,634 (6.4%)	1,520 (8.1%)	255 (3.6%)	71 (6.3%)	1,551 (5.5%)	1,638 (6.4%)
Manufacturing	(D)	21,219 (5.5%)	1,247 (6.7%)	197 (2.8%)	(D)	2,420 (8.6%)	1,072 (4.2%)
Transportation/ Utilities	2,057 (6.5%)	18,083 (4.7%)	1,076 (5.7%)	136 (1.9%)	(D)	998 (3.6%)	1,813 (7.1%)
Wholesale Trade	(D)	18,481 (4.8%)	249 (1.3%)	(D)	(D)	1,048 (3.7%)	570 (2.2%)

Exhibit 2-1							
SOCIOECONOMIC CHARACTERISTICS OF COUNTIES IN NEW MEXICO							
Industry	Sandoval County	Bernalillo County	Valencia County	Socorro County	De Baca County	Chaves County	Eddy County
Retail Trade	5,425 (17.3%)	67,979 (17.5%)	3,887 (20.8%)	972 (13.8%)	159 (14.0%)	5,324 (19.0%)	4,675 (18.2%)
Finance/ Insurance/ Real Estate	2,405 (7.7%)	31,684 (8.2%)	1,266 (6.8%)	269 (3.8%)	29 (2.6%)	1,756 (6.3%)	1,277 (5.0%)
Services	7,909 (25.2%)	137,311 (35.4%)	3,973 (21.2%)	2,122 (30.1%)	177 (15.6%)	6,826 (24.4%)	6,936 (27.0%)
Government	3,897 (12.4%)	63,423 (16.4%)	4,363 (23.3%)	2,339 (33.1%)	256 (22.6%)	4,891 (17.5%)	3,595 (14.0%)
(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals. (L) Less than 10 jobs, but the estimates for this item are included in the totals.							
Sources: State of New Mexico, Economic Development Department, <i>Community Profiles</i> , May 2000. Accessed at: <a href="http://www.edd.state.nm.us/COMMUNITIES/counties.htm">http://www.edd.state.nm.us/COMMUNITIES/counties.htm</a> on August 20, 2001. Regional Accounts Data prepared by the Bureau of Economic Analysis, U.S. Dept. of Commerce. The Bureau of Economic Analysis. Accessed at: <a href="http://www.bea.doc.gov/bea/regional/reis/">http://www.bea.doc.gov/bea/regional/reis/</a> on August 20, 2001.							

## 2.2 Socioeconomic Profile of Counties in Texas

92. This section summarizes key economic and demographic information for the two counties with areas important for the conservation of the silvery minnow in Texas. County level data are provided as context for the discussion of potential economic impacts due to critical habitat designation, and to illuminate trends that may influence these impacts.<sup>45</sup>

### 2.2.1 Brewster

93. Brewster County is the westernmost of the counties on the Lower Rio Grande, encompassing a total of 6,193 square miles. With 8,866 residents, or less than one percent of the total State population, Brewster is the 172nd most populous of the 254 counties in the State. The county population increased by 2.5 percent between 1990 and 2000, compared to a State average of 17.6 percent.

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<sup>45</sup> Population summaries are derived primarily from: U.S. Bureau of Economic Analysis Regional Accounts Data. Accessed at: <http://www.bea.doc.gov/bea/regional/data.htm> on August 16, 2001; and U.S. Geological Survey, *1995 Water Use Data*. Accessed at: <http://water.usgs.gov/watuse/spread95.html> on August 21, 2001.

94. In 1995, the majority (74 percent) of Brewster residents received water from the municipal supply, 86 percent of which is presently drawn from withdrawals of groundwater. Other water uses include commercial (303 acre-feet per year), mining (695 af/y), livestock (897 af/y), irrigation (325 af/y), and wastewater treatment (returns 605 af/y). Of the water used, 12 percent, or 493 af/y was surface water, none of which was used for irrigation.
95. In 1999, Brewster had a total personal income of \$177 million, with a per capita personal income of \$20,111. Brewster's PCPI was 25 percent lower than the State average (\$26,834) and 30 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 5.9 percent, which is slightly above the average annual growth rate for the State (5.1 percent) and for the nation (4.4 percent).
96. Total earnings of persons employed in Brewster increased from about \$59 million in 1989 to \$109 million in 1999, an average annual growth rate of 6.4 percent. Government, services, and retail trade were the largest employers in 1999. The farming industry lost approximately \$4.4 million in 1999.

### **2.2.2 Terrell**

97. Terrell County is the easternmost of the counties on the Lower Rio Grande, encompassing a total of 2,358 square miles. With 1,081 residents, or less than one percent of the total State population, Terrell is the eighth least populous county in the State. The county population decreased by 23 percent between 1990 and 2000, compared to a State average increase of 17.6 percent.
98. In 1995, the majority (76 percent) of Terrell residents received water from the municipal supply, all of which is presently drawn from withdrawals of groundwater. Other water uses include mining (90 af/y), livestock (336 af/y), and irrigation (493 af/y). Of the water used, one percent, or 11 af/y was surface water, none of which was used for irrigation.
99. In 1999, Terrell had a total personal income of \$26.3 million, with a per capita personal income of \$21,887. Terrell's PCPI was 18 percent lower than the State average (\$26,834) and 23 percent lower than the national average (\$28,546). The average annual income growth rate over the past 10 years was 4.4 percent, which is slightly below the average annual growth rate for the State (5.1 percent) and equal to that of the nation (4.4 percent).

100. Total earnings of persons employed in Terrell decreased from about \$16 million in 1989 to \$14 million in 1999, an average annual growth rate of -1.6 percent. Government, transportation and public utilities, and services were the largest employers in 1999. The farming industry lost approximately \$1.2 million in 1999.

101. Exhibit 2-2 summarizes the socioeconomic data on the counties presented above.

<b>Exhibit 2-2</b>		
<b>SOCIOECONOMIC CHARACTERISTICS OF COUNTIES IN TEXAS</b>		
<b>Statistic</b>	<b>Brewster County</b>	<b>Terrell County</b>
Population of County (2000)	8,866	1,081
Percent of State Population	0.04%	0.01%
Percent Change in Population (1990-1999)	2.5%	-23.3%
Total Full and Part time Employment (1999)	5,325	833
Unemployment Rate (1999)	2.5%	4.1%
<b>1999 Full/Part Time Employment (Percent of County Total)</b>		
<b>Industry</b>	<b>Brewster County</b>	<b>Terrell County</b>
Farming	238 (4.5%)	164 (20%)
Agricultural Services	(D)	(D)
Mining	(D)	(D)
Construction	283 (5.3%)	(D)
Manufacturing	112 (2.1%)	(D)
Transportation/ Utilities	308 (5.8%)	(D)
Wholesale Trade	219 (4.1%)	(L)
Retail Trade	1,000 (19%)	55 (6.6%)
Finance/ Insurance/ Real Estate	247 (4.6%)	142 (17%)
Services	1,273 (24%)	120 (14%)
Government	1,544 (29%)	247 (30%)
(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.		
(L) Less than 10 jobs, but the estimates for this item are included in the totals.		
Sources: Regional Accounts Data prepared by the Bureau of Economic Analysis, U.S. Dept. of Commerce. The Bureau of Economic Analysis. Accessed at: <a href="http://www.bea.doc.gov/bea/regional/reis/">http://www.bea.doc.gov/bea/regional/reis/</a> on August 20, 2001 and Texas County Unemployment Data. Accessed at: <a href="http://www.twc.state.tx.us/lmi/lfs/type/unemployment/unemploymenthome.html">http://www.twc.state.tx.us/lmi/lfs/type/unemployment/unemploymenthome.html</a> on February 13, 2002.		

### **2.3 Socioeconomic Profile of Native American Tribes within the Vicinity of Essential Silvery Minnow Habitat**

102. The proposed critical habitat designation included the lands of six Pueblos. The Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta are not included in the final designation. Other tribes not included in critical habitat but discussed in this section include the Jicarilla Apache Nation, the Taos Pueblo, and the San Juan Pueblo. The majority of these tribal lands are located within Sandoval County, while the Isleta Pueblo is in Bernalillo and Sandoval Counties, the Jicarilla Apache Reservation is in Rio Arriba and Sandoval Counties, the Taos Pueblo is in Taos County, and the San Juan Pueblo is in Rio Arriba County. Isleta, Santo Domingo, and San Juan are the largest of the Pueblos with more than 4,000 members enrolled in each; Sandia is the smallest with fewer than 500 enrolled members. The Pueblos differ significantly in their primary economic activities, as described below.
103. Members of the Cochiti Pueblo do not rely heavily on agriculture for their livelihood. The Cochiti Dam Project was constructed between 1965 and 1975 for flood and sediment control with the added intent to enhance area fisheries and wildlife.<sup>46</sup> As a result, the Cochiti Community Development Corporation manages the 600-acre Cochiti Lake residential development, a golf course, marina, recreation center, and commercial center.
104. Farming, ranching, and mineral resources remain major sources of income for members of Santo Domingo Pueblo. The Pueblo also operates a service station on Interstate 25 and benefits from tourism during its annual arts and crafts fair.
105. Farming and ranching are an important source of income for the San Felipe Pueblo, as over fifty percent of the land on this Pueblo is used as farmland. The Pueblo also receives royalties from a sand and gravel permit and profits from tourism, particularly at the time of its annual fiesta. In addition, the Pueblo operates the San Felipe Casino Hollywood and is currently building a race track for cars.
106. The Santa Ana Pueblo earn a significant portion of its income from leasing its land to commercial interests. Agriculture is not a major economic activity for tribe members. The Pueblo's enterprises include a 27-hole golf course and the Hyatt Regency Tamaya Resort and Spa, which is operated by the Hyatt Corporation. In addition, the Pueblo owns and operates the Santa Ana Star, a large casino that also includes bowling lanes, restaurants, and a concert arena. Other Tribal industries include a wholesale nursery and retail garden shop.

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<sup>46</sup> See [www.usace.army.mil/cochiti](http://www.usace.army.mil/cochiti). Accessed April 12, 2002.

107. Members of the Sandia Pueblo gain modest income from agriculture and cattle grazing, both directly and through the leasing of land. The Casino Sandia, a successful gaming enterprise, also provides income and employment for 650 people. The Tribe plans to add a hotel and golf course to the resort and to develop an industrial park on a 1,280 acre parcel of land. In addition, the Tribe administers the public Sandia Lakes Recreation area.
108. Fewer than 10 percent of those employed on the Isleta Pueblo work in agriculture. The Isleta Gaming Palace is one of the largest casinos in New Mexico, providing a significant source of income and employment. The Pueblo has a master plan designed to expand tourism and recreational opportunities, including renovating the casino further into a resort destination complete with a hotel, conference facilities, golf course, and improved camping facilities. The Pueblo is also planning to build a regional park.
109. The most important source of revenue for the Jicarilla Apache Nation is mineral extraction, oil, gas, coal uranium, and geothermal reserves. Ranching is the primary agricultural activity, although crop production is expected to expand.
110. Tourism and recreation represent the major source of revenue for the Taos Pueblo. Ranching and agriculture do not, at present, represent a major source of income for the Pueblo.
111. The Tribal Bingo Facility, operated by the San Juan Pueblo, provides modest employment and revenues. Agriculture does not represent a large source of revenues, much of the agricultural production is consumed within the Pueblo.

<b>Exhibit 2-3</b>			
<b>MEMBERSHIP CHARACTERISTICS OF MIDDLE RIO GRANDE PUEBLOS</b>			
<b>Tribe</b>	<b>Enrolled Membership</b>	<b>American Indian Population on Reservation</b>	<b>Land Base (Acres)</b>
Cochiti	1,175	695	50,681
Santo Domingo	4,041	3,085	71,356
San Felipe	3,157	2,465	48,930
Santa Ana	664	473	76,983
Sandia	420	500	22,890
Isleta	4,812	2,675	301,121
Jicarilla Apache	3,136	2,636	870,580
Taos	2,200	1,700	95,341
San Juan	5,237	5,237	12,237
<b>Total</b>	<b>24,842</b>	<b>19,466</b>	<b>1,550,119</b>

## CHARACTERIZATION OF BASELINE ELEMENTS

## SECTION 3

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112. Because of the State's fundamentally arid climate, development of all types in New Mexico is dependent upon and often limited by water supplies, whether in the residential, agricultural, or industrial sectors. As a result, water and the right to use it are valued highly. As in many other States in the western United States, New Mexico has developed a market for water rights. This is an active market in which water rights move between willing buyers and sellers, within the confines of State and Federal regulations, as described below.

### **3.1 Federal, State and Local Water Law**

113. Under New Mexico State law, water in rivers such as the Rio Grande and Pecos is allocated according to prior appropriation, meaning that the right to use water is established at the first recorded time when water was taken from a river or aquifer and put to beneficial use. This means that right to the use of water is determined by use rather than by proximity to a water source. If the holder of a water right does not use all of the water for a purpose approved by the Office of the State Engineer (OSE), then the OSE may revoke any water rights that are not exercised for appropriate purposes.<sup>47</sup> Essentially, users can only divert water for domestic, municipal, agricultural, industrial, or commercial uses that are deemed beneficial by the OSE. In March 1998, the State Attorney General concluded that the use of water rights for instream flow to benefit "recreational, fish or wildlife, or ecological purposes" may be considered a beneficial use under New Mexico law.<sup>48</sup>

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<sup>47</sup> Water Law: Appropriation and Use of Surface Water. New Mexico Statute §72-5-28.

<sup>48</sup> Attorney General of New Mexico. Opinion No. 98-01. March 27, 1998.



114. Water is the limiting resource for many activities in New Mexico. As a result, there may be more potential users than water supply, especially in dry years with low-flow conditions. Water in both the Rio Grande and Pecos River is allocated according to the age, or priority, of a water right. Ownership of a senior water right imparts a greater assurance of receiving water in years of shortage. As a result, a water right's priority date is a key factor in determining its value, as junior water rights may not "produce" any water in dry years.
115. Water rights held by Indian Pueblos and Tribes (or by the United States on behalf of or in trust for Indian Pueblos and Tribes) under Federal law are generally senior to state law water rights in the Middle Rio Grande Basin, and cannot be impaired by the Rio Grande Compact. Otherwise, senior water rights under state law in the Middle Rio Grande are those with pre-1907 priority dates. At this time, pre-1947 priority dates are considered senior in the Pecos. The stretch of critical habitat designated in the Middle Rio Grande passes through six Indian Pueblos, each of which hold water rights in the river: Cochiti Pueblo, Isleta Pueblo, San Felipe Pueblo, Sandia Pueblo, Santa Ana Pueblo, and Santo Domingo Pueblo. Note that the final rule explicitly excludes the Pueblos of Isleta, Sandia, Santa Ana, and Santo Domingo. Nonetheless, these Pueblos, as well as other Native American Tribes in New Mexico, hold significant rights to water in the Middle Rio Grande basin. In many cases, the volumes of water needed to satisfy Pueblo/Tribal water rights have not been quantified.<sup>49</sup> This analysis considers the economic value of water needed to achieve flows in the Rio Grande and Pecos River sufficient to assure maintenance of critical habitat for the silvery minnow. This analysis does not directly address whether the required water could or would involve lease or purchase of Tribal water rights. In addition, this analysis does not address whether maintenance of sufficient flow in the Rio Grande and Pecos River using water obtained from non-tribal water rights holders could affect the ability of a Tribe to exercise their water rights. Because Tribal water rights are different in nature than non-Tribal water rights, it is possible that if such rights were traded, the type of impacts could differ from those identified in this analysis. However, the broader economic impacts of this rule, as reflected in the opportunity costs of water used to assure in-stream flow, are not expected to change according to the source of supplemental water.

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<sup>49</sup> This point is underscored, for example, in the public comments of the Pueblo of San Juan: "The Pueblo's water rights on the Rio Chama, Rio Santa Cruz, and Rio Grande systems include not only historical and existing uses, but also future use reserved water rights. Although these rights have not yet been quantified in an adjudication, they are valid water rights and as Federal Indian water rights are not subject to loss through non-use." San Juan Tribal Council, "The Pueblo of San Juan's Comments to the U.S. Fish and Wildlife Service on the Proposed Designation of Critical Habitat for the Rio Grande Silvery Minnow," October 2, 2002.

116. Under Department of Interior's Departmental Manual, Part 512 DM 2, Interior is required to "recognize and fulfill its legal obligations to identify, protect, and conserve the trust resources of Federally recognized Indian tribes..." In addition, Department of the Interior Secretarial Order 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act*, clarifies the Service's responsibilities when actions taken under the authority of the Endangered Species Act affect Indian lands and tribal trust resources.<sup>50</sup> As part of Section 3 (C) of the Appendix, the Order states that the Service should, among other efforts, give full consideration to all comments and information received from any affected Tribes in developing reasonable and prudent alternatives for project modifications. Consideration of the impact of this designation on individual Tribes would require detailed information on how the Service will act to achieve target flows. Such an analysis is beyond the scope of this report but is included as part of the Final Environmental Impact Statement for this rule. The economic impact estimated by this report, however, as reflected in the opportunity cost of water used to assure sufficient in-stream flow, is not expected to change according to the source of the supplemental water. However, the distribution of such impacts could differ from those considered in this report.
117. The Rio Grande Compact of 1938 codifies an agreement between Colorado, New Mexico, and Texas regarding the quantities of Rio Grande water that are guaranteed to each State in a given year. The Compact stipulates the amount of flow delivered to each downstream user group based on a percentage of actual flows that fluctuates according to the amount of annual runoff. Thus, Colorado must deliver a minimum quantity of water to New Mexico's northern boundary (effectively the reservoir at Cochiti) and New Mexico must deliver a specified percentage of that water to Texas. Because the Compact supercedes all individual water rights except those held by the Indian Pueblos and Tribes, water in the Middle Rio Grande available for allocation is considered to equal the water delivered to New Mexico by Colorado, less the water New Mexico must deliver to Texas and that held by the Pueblos. This volume may be supplemented by additional stored water. In practice, New Mexico "delivers" its water to Texas at the Elephant Butte Reservoir in south-central New Mexico. Water released from this reservoir is provided to downstream users in southern New Mexico, Texas, and Mexico. Outside of these required deliveries and the Tribal rights, pre-1907 water rights have the highest claim to flows in the Rio Grande and are considered senior under state law.

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<sup>50</sup> Department of the Interior Secretarial Order 3206, "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act," <http://endangered.fws.gov/tribal/Esatribe.htm>, August 29, 2000.

118. Allocation of Pecos River water is subject to similar restrictions to those placed on the Rio Grande.<sup>51</sup> New Mexico and Texas entered into the Pecos River Compact in 1948, establishing minimum obligations for annual water deliveries from New Mexico to Texas. Under a 1988 U.S. Supreme Court decree, the federally-appointed Pecos River Master defines New Mexico's minimum delivery of Pecos River water to Texas each year. In 1991, the Supreme Court found that New Mexico's delivery to Texas was short by an average of approximately 10,000 acre-feet per year and required New Mexico to pay a fine and guarantee an increase in flow at the State line. In order to meet the increased Compact requirements, New Mexico has purchased and leased a significant quantity of water rights on the Pecos in order to retire their consumptive uses and allow the water to flow downstream. Only senior (pre-1947) water rights are eligible for lease or sale.

### **3.2 Institutional Setting of Water Markets In New Mexico**

119. When it was ratified in 1911, the New Mexico State Constitution recognized the water rights that existed prior to statehood, assumed control of all unappropriated rights, and authorized the Legislature to provide a legal setting for the administration of all rights. Effectively, water rights are held in trust for the citizens of New Mexico.<sup>52</sup> The New Mexico legislature has stated that, “all natural water flowing in streams and water courses, whether such be perennial or torrential, within the limits of the State of New Mexico, belong to the public.”<sup>53</sup>
120. New Mexico water law clearly allows the selling and subsequent transfer of water rights. Over the years there have been numerous transfers in river basins in New Mexico. Given that the OSE effectively validates and facilitates the transfer under State law, then State law essentially endorses a market for water. This market has developed over time into what is now recognized as a competitive market within the institutional constraints outlined above. That is, there is a willing buyer and a willing seller, and no one buyer or seller

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<sup>51</sup> While no Indian Pueblos or Tribes and therefore no Indian water rights currently exist on the main stem of the Pecos, such rights would enjoy the status described above should they be established. The Mescalero Tribe does hold water rights in the Pecos River basin.

<sup>52</sup> Article XVI- Irrigation and Water Rights, Constitution of the State of New Mexico, January 1995.

<sup>53</sup> See F. Lee Brown, Charles Dumars, Michelle Minnis, Sue Anderson Smasal, David Kennedy and Julie A. Urban, Transfers of Water Use in New Mexico, Natural Resources Center, University of New Mexico, Volume 2, Chapter 4, p. 1, 1990 or N.M. Stat. Ann. 72-1-1(rep. 1985) as cited in Brown et. al.

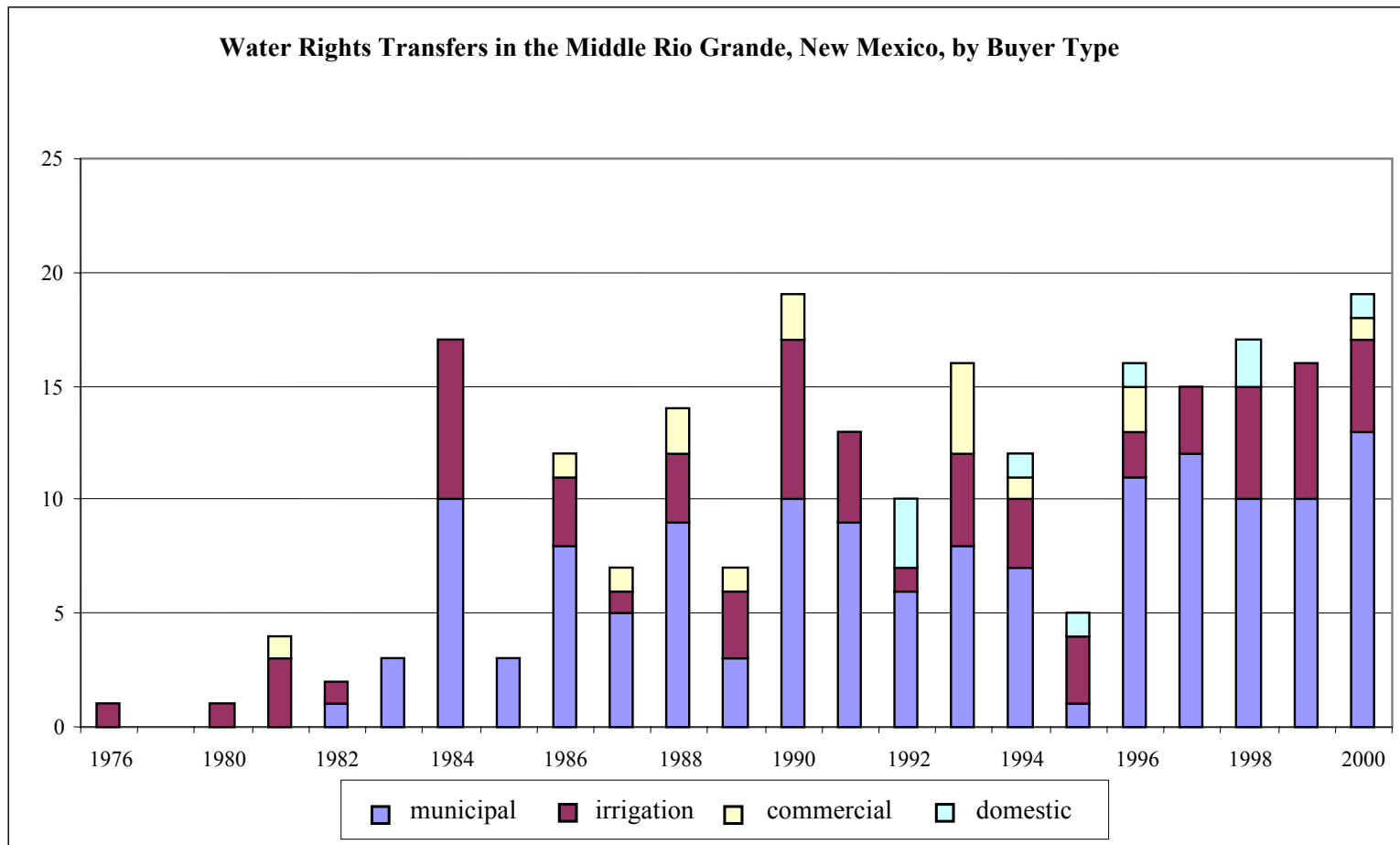
dominates the market. Only in the case of failing to use water for a beneficial use can one lose a water right.

121. The market exchange in the transfer of a water right generates a market (purchase) price for a given quantity of water. In the context of a market demand and supply framework, the prevailing price for a water right reflects the economic value of water on the margin. Price times quantity or the expenditure associated with the water transfer is a reasonable approximation of economic value.<sup>54</sup> Note that in this analysis, the value of a river water deficit are assumed to be equal to the value of consumptive use water rights for this amount. In fact, the purchase of consumptive use rights would clearly produce more water in the river than necessary to fulfill that deficit.
  
122. A number of factors can be considered in testing the notion that the water market in New Mexico is competitive. Exhibits 3-1, 3-2, and 3-3 demonstrate that there are numerous buyers and sellers of water rights, reflecting various sectors of the economy. While purchasers of water rights are generally municipalities, other sectors participate as buyers in this market as well. Sellers of water rights have historically been primarily in agriculture, reflecting the fact that the majority of the water rights (as measured by total volume of water reflected in these rights) are currently held in the agriculture sector.

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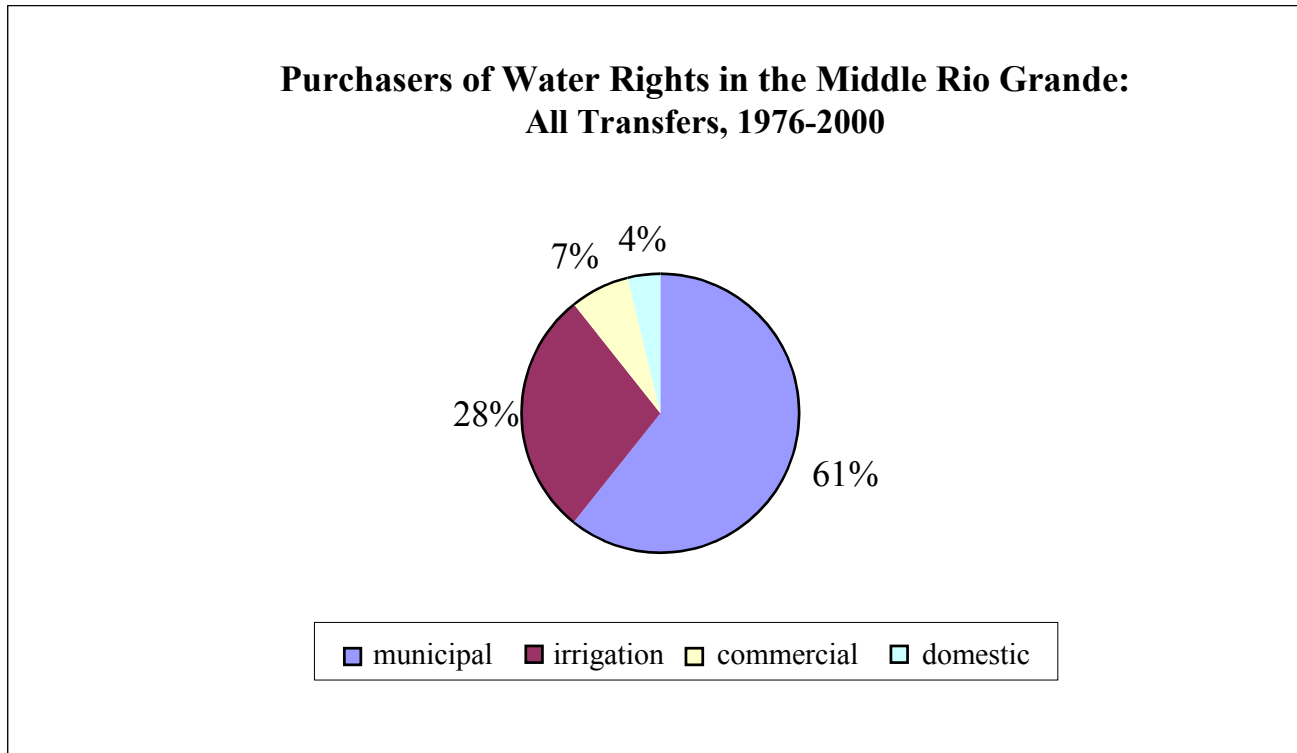
<sup>54</sup> A public comment from the Defenders of Wildlife/Forest Guardians notes that the market price at present does not include values for instream flow. However studies of the marginal value of instream flows do not exist for the Middle Rio Grande. These studies do exist for many Western rivers. Past studies attempting to review streamflow value literature have found that instream flow valued at a range of \$1-25 per af (Brown, 1991) and \$14-24 per af (Loomis, 1987) (1997\$). Brown, Thomas C. "Water for Wilderness Areas: Instream Flow Needs, Protection, and Economic Value," *Rivers*, Vol. 2, No. 4, 1991; Loomis, John, "The Economic Value of Instream Flow: Methodology and Benefit Estimates for Optimum Flows," *Journal of Environmental Management*, Vol. 24, 1987.

Exhibit 3-1



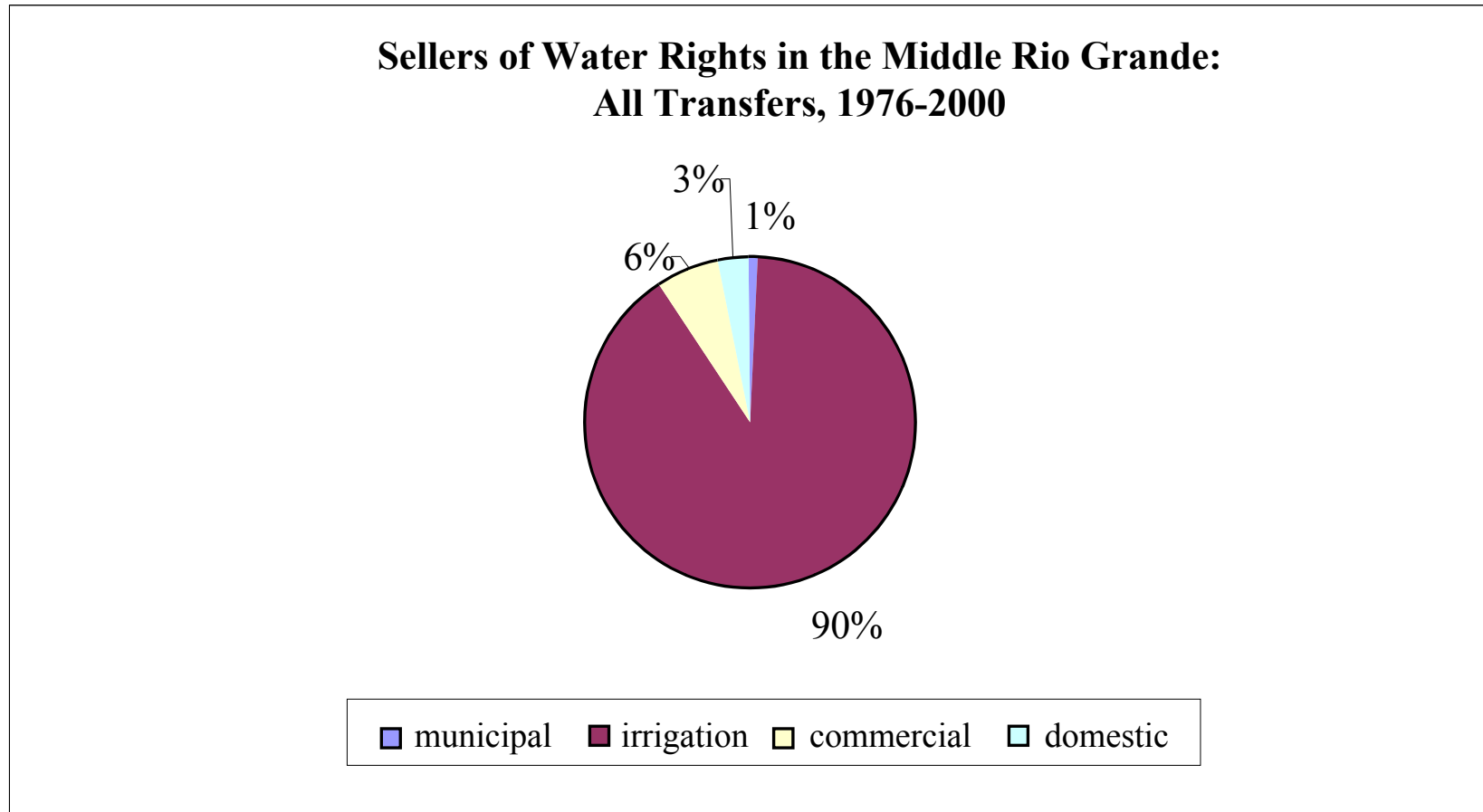
Source: Taken from poster “Western Water Market Prices and the Economic Value of Water” 2002, Presented at SAHRA-*Sustainability of Semi-Arid Hydrology and Riparian Areas*- meeting, David Brookshire, Phillip Ganderton, Joe Little, Mary Ewers. Data for this chart were collected at the Albuquerque division of the State Engineer’s office and include transfers to the city of Albuquerque.

Exhibit 3-2



Source: Taken from poster "Western Water Market Prices and the Economic Value of Water" 2002, Presented at SAHRA-*Sustainability of Semi-Arid Hydrology and Riparian Areas*- meeting, David Brookshire, Phillip Ganderton, Joe Little, Mary Ewers. Data for this chart were collected at the Albuquerque division of the State Engineer's office and include transfers to the city of Albuquerque.

Exhibit 3-3



Source: Taken from poster “Western Water Market Prices and the Economic Value of Water” 2002, Presented at SAHRA-*Sustainability of Semi-Arid Hydrology and Riparian Areas*- meeting, David Brookshire, Phillip Ganderton, Joe Little, Mary Ewers. Data for this chart were collected at the Albuquerque division of the State Engineer’s office and include transfers to the city of Albuquerque.

123. As additional evidence of a competitive market for water rights in New Mexico, it is possible to predict market prices for water rights from expected, underlying economic factors. Specifically, Khoshakhlagh et al. (1977) developed a reduced form price equation to predict the market price of water rights from 1962 to 1975.<sup>55</sup> This equation considered:
1. *The Calculated Price of Water Right (dependent variable: Price).* The authors of this study employed historical data to estimate a time-based trend for prices and then used the predicted values as the dependent variable in their reduced-form price equation.
  2. *Value of Agricultural Output.* This dollar value is obtained from the New Mexico Department of Agriculture. It is calculated for three counties: Bernalillo, Sandoval and Valencia. Values are deflated to real (1967) dollars using the agricultural price index.
  3. *Marginal Price of Land.* Using a sample of sales in Valencia County, the analysis uses the average sale price of an acre of land to measure the opportunity cost of marginal irrigated land. New data were obtained for this series from the Valencia County Clerk's office. The data are deflated to real (1967) values using the Wholesale Price Index.
  4. *Population.* Population for the three-county region was obtained from the New Mexico Statistical Abstracts. The population is squared to capture the rate of population growth.
  5. *Personal Income.* Obtained from the Bureau of Economic Analysis (BEA), this series is deflated to real (1967) dollars using the Consumer Price Index.
  6. *Employment in the Industrial Sector.* Using BEA data, this series reports the employment in mining and manufacturing sectors in the three-county region.

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<sup>55</sup> Khoshakhlagh, R., F. Lee Brown and C. Dumars. "Forecasting Future Market Values." New Mexico Water Resources Research Institute, New Mexico State University. July 1977.



124. It is possible to apply this equation today to predict current water rights prices.<sup>56</sup> As shown in Exhibit 3-4, this model performs well when applied to predict prices today; the predicted price in 1999 was \$5,410 while observed prices in the Middle Rio Grande were approximately \$4,750. The predicted prices for 1990 and 1999 are comparable to those found by Brookshire, Ewers, and Ganderton (2002) for market prices of water right transfers in the Middle Rio Grande basin.<sup>57</sup>

Exhibit 3-4			
PREDICTED WATER RIGHT PRICES IN SELECTED YEARS ACCORDING TO VARIOUS MODELS			
Year	Original predicted price (1976 dollars) <sup>a</sup>	Current data predicted price (1967 dollars)	Current data predicted price (nominal dollars)
1962	\$313	\$302	\$283
1965	\$196	\$135	\$131
1970	\$211	\$470	\$517
1975	\$334	\$354	\$626
1980		\$86	\$239
1985		\$398	\$1,224
1990		\$528	\$1,861
1195		\$1,410	\$5,261
1999		\$1,427	\$5,410

<sup>a</sup> Khoshakhlagh et al. (1977).

125. It can be concluded from this and other information that (1) there is an active market in New Mexico to move water to uses other than the original use; (2) there are multiple buyers and sellers of water rights; and (3) that the price of water rights can be predicted from expected, underlying economic factors. All of these conclusions support the notion that the New Mexico water rights market is competitive, and provides a true, if low-end (i.e., more likely to understate than overstate) measure of the economic value of water.

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<sup>56</sup> Note that, while replication of this model was not simple or free of the need to interpret obscure wording and descriptions, the resulting replication is quite reasonable and the predicted market prices of water rights is consistent with actual prices recently observed.

<sup>57</sup> Brookshire, David S., Mary Ewers, and Philip T. Ganderton. "Western Water Market Prices and the Economic Value of Water." UNM Department of Economics mimeo, January 2002.

126. Because water is already the limiting resource for most development in the Rio Grande and Pecos River basins, any transfer of water to instream flow in those systems will only intensify the existing scarcity of water for consumptive use. All of the water available in these river systems is allocated at this time.<sup>58</sup> As a result, any surface water needed for a new activity must be transferred from an existing use; it is no longer possible to create new water rights. The OSE recognized these conditions in its July 2001 report, stating that "because New Mexico water supplies are finite, the State will develop well-defined water rights markets. As water demands from expanded existing and new uses increase, the marketing of water through the transfer of existing water rights will grow."<sup>59</sup> Such transactions currently take place, with the most senior water rights commanding the highest prices. Recent trends in these transactions in the Rio Grande and Pecos River are described in Section 4.1 below.
127. While active water markets exist in New Mexico, all non-tribal transactions are also subject to the approval of the OSE. Transfers of rights between uses and locations receive particular scrutiny and must continue to meet beneficial use requirements. Once a transfer is approved, then interested parties are free to negotiate prices and trade water rights.

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<sup>58</sup> A river system must be fully adjudicated in order for the OSE to determine (1) the amount of water available for allocation, (2) the amount of water allocated in existing water rights, and (3) the individual hierarchy of those water rights. The New Mexico OSE is currently in the process of adjudicating water rights on the Pecos River and is conducting the preliminary studies of the Middle Rio Grande necessary to adjudicate that river in the near future. As a result, there is no absolute confirmation that these rivers are fully allocated; however, the State Engineer declared the Middle Rio Grande "fully allocated" in 1907 and it is commonly understood that demand outstrips supply under current conditions. See [www.seo.state.nm.us/publications/99-00-annual-report/fnl-apdx-a.html](http://www.seo.state.nm.us/publications/99-00-annual-report/fnl-apdx-a.html).

<sup>59</sup> Turney, Thomas. "New Mexico's Water Supply and Active Water Resource Management," prepared by the Office of the State Engineers and the Interstate Stream Commission, draft, July 23, 2001.

**DIRECT IMPACTS RELATED TO WATER NEEDS  
FOR THE SILVERY MINNOW**

**SECTION 4**

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128. As stated in Section 2, this analysis estimates the opportunity costs associated with providing target flows for the river segment designated as critical habitat in the Middle Rio Grande, as well as the stretch of the Pecos River that is considered essential to the conservation of the silvery minnow. This analysis further assumes that use of the water needed to increase the instream flow of the Rio Grande and Pecos is currently controlled by existing water rights. Retiring water rights from consumptive use can result in more water in the river channel, providing habitat for the silvery minnow. In order to project the value of this water, this analysis uses the current market prices for water rights as a proxy for the value of water in these areas. To do so, the analysis first determines the likely unit price of water based on historical transactions and future expectations and then determines the quantity of water likely required to provide target flows.

**4.1 Water Trades and Price per Acre-Foot**

129. According to data collected by the New Mexico Natural Resource Trustee and professional water trade brokers, prices for water rights have risen steadily in recent years. This analysis uses the recent going price of approximately \$4,750 per acre foot in the Rio Grande and \$1,750 per acre foot in the Pecos River.<sup>60</sup> This purchase price of a water right is used as a proxy for the value of water. It is used to calculate the total value of the water that would be used to supplement instream flows for the silvery minnow. This value is not

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<sup>60</sup> Note that prices for water rights on the Pecos River are given in terms of acre-feet delivered at the Texas State line. As a result, the actual volume released may be greater than that indicated, which would make this unit price a high-end estimate. See William Turner, New Mexico National Resource Trustee. "Value of Water in the Middle Rio Grande and Pecos River Valleys". Memorandum, October 31, 2001.

confined to the 20-year time horizon of the rest of this analysis, but rather represents the value of this water in perpetuity. In other words, using the purchase price for water rights gives the value of that water in perpetuity, not just the value for the next 20 years.<sup>61</sup> To discount and annualize these values, guidance provided by the Office of Management and Budget (OMB) specifies the use of a rate of seven percent, reflecting the social opportunity cost of capital (measured by the before-tax rate of return for private investment.) In addition, OMB recommends sensitivity analysis using other discount rates. One commonly applied rate is three percent, reflecting a social rate of time preference (estimated using average rates on long-term Treasury bonds).<sup>62</sup> This analysis presents results using both of these rates. This results in annual values that range from \$143 to \$333 per acre foot per year in the Rio Grande River, and \$53 to \$123 per acre foot per year in the Pecos River.<sup>63</sup>

130. Recent and historic trends indicate that the value of water in New Mexico is rising and will continue to rise for the foreseeable future. This analysis does not attempt to capture that increase, but rather indicates the total and annualized values under present conditions. As a result, these values may provide low-end estimates of the opportunity cost of water used to supplement instream flow.<sup>64</sup>

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<sup>61</sup> This analysis notes that the State Attorney General concluded that the use of water rights for instream flow to benefit "recreational, fish or wildlife, or ecological purposes" may be considered a beneficial use under New Mexico law. Attorney General of New Mexico. Opinion No. 98-01. March 27, 1998.

<sup>62</sup> U.S. Office of Management and Budget, "Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements," in *Appendix 4: Report to Congress on the Costs and Benefits of Federal Regulations*, March 22, 2000.

<sup>63</sup> Economic theorists argue that these annualized values should approximate current lease prices of water if they capture the true value of the water into perpetuity. In fact, current lease prices in the Middle Rio Grande are selling at \$400 per af, which does approximate the high end estimate of the annualized value of water. William Turner, Wastewater Resources, memorandum "Re: Value of Water in the Middle Rio Grande and Pecos River Valleys," October 31, 2001.

<sup>64</sup> Several public commenters request clarification for why the current price of water is used in this analysis. See comments of Defenders of Wildlife/Forest Guardians, October 2, 2002; John Stomp for City of Albuquerque, October 2, 2002. Today's water price reflects the market's best judgement of the value of water use, and therefore reflects the long-term value of that water. As stated in the comments of F. Lee Brown for MRGCD, "the MRGCD has identified numerous values [other than profit and to maintain legal title] that lie within its stewardship responsibilities including preservation of the riverine environment, the greening of the valley, preservation of diverse cultural farming communities, recreation, aquifer recharge and a host of other values. So, too, may

#### **4.2 Water Volume Required to Sustain a Minimum Flow for the Silvery Minnow**

131. Historically, flows in both the Middle Rio Grande and the Pecos Rivers have been intermittent during the summer months of dry years. The Service has recommended providing a target flow of 50 cfs in the Middle Rio Grande in their 2001 biological opinion.<sup>65</sup> In order to determine the quantity of water needed to supplement existing flows in both rivers so that they do not fall below 50 cfs, a professional hydrologist examined historical flow data dating back to 1936 in the Rio Grande and to 1938 in the Pecos River.<sup>66</sup> He examined the daily deficit of flow at the gages specified by the Service (San Acacia for the Rio Grande and Acme for the Pecos); that is, he examined the difference between the actual flow and the target flow of 50 cfs. By tabulating daily water deficits, the hydrologist calculated the historic annual river flow "deficit" below the minimums desired for the silvery minnow critical habitat.<sup>67</sup> It is understood that no policy can guarantee flow at all times, regardless of the extremity of conditions. As a result, this analysis calculates the annual deficit of water below the required minimum flow in the 95th percentile and the 50th

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individual farmers hold similar values. These additional values are also reflected in the water right supply decisions made by irrigators in the water marketplace and thereby in the prevailing price of water rights." Public comments of F. Lee Brown for MRGCD, "Appendix B. Supplemental Comments on Draft Economic Analysis of Critical Habitat Designation for the Rio Grande Silvery Minnow", October 2, 2002.

<sup>65</sup> More precisely, this analysis does not assess regional impacts for the Lower Rio Grande area, as no changes in the distribution of water rights are anticipated. In the Middle Rio Grande, the biological opinion suggests a winter requirement of 50 cfs flow at the San Marcial Railroad Bridge and a summer requirement of 50 cfs at San Acacia Dam. This assumption was used in the hydrological modeling included in this analysis. See Appendix B for details.

<sup>66</sup> In 1996-2002, Federal officials leased water to supplement instream flow in the Rio Grande to benefit the silvery minnow. As a result of these additions, the years 1996 to the present were excluded from the distribution analysis in order to determine the likelihood of dry conditions independent of such active management.

<sup>67</sup> Note that the Service's biological opinion for the bluntnose shiner in the Pecos River identifies the Near Acme Gage as the point within the river at which minimum flows should be measured (U.S. Fish and Wildlife Service. Biological opinion on Reclamation's 2001 Discretionary Actions Related to Water Management on the Pecos River, New Mexico. New Mexico Ecological Services Field Office. May 21, 2001). This analysis adopts the use of the Near Acme Gage as the measuring point for minimum flow requirements.

percentile worst-case (e.g., driest) year. This calculation results in annual deficits of 40,427 and 5,635 acre-feet/year in the entire Middle Rio Grande unit and 24,463 and 16,431 acre-feet/year in the Middle Pecos.<sup>68</sup> These hydrological analyses are presented in detail in Appendices A and B. Using this simplified approach, this analysis estimates that the provision of these volumes of supplementary water should guarantee a constant flow of at least 50 cfs in 95 and 50 percent of all years, respectively.

132. This analysis provides information on the water needed to maintain target flows in each of the five reaches in Appendix D. Because supplemental water will flow downstream to subsequent reaches, the quantity of water required to achieve the targeted flow is assumed to be cumulative (i.e., to provide a flow of 50 cfs to Angostura Reach, flow must also be provided to Cochiti Reach. To provide flow of 50 cfs to Isleta, 50 cfs must also be provided to Cochiti and Angostura reaches, etc.). Note that the analysis considers the Jemez Canyon Reach in isolation, as it is not part of the main stem of the Middle Rio Grande. Appendix D includes each of the analyses included in Sections 4, 5 and 6, applied on a reach-by-reach basis.

133. The hydrological analysis used in this report relies on publicly available flow gage data; it does not make use of sophisticated hydrological models of the affected river systems. When it becomes available, the Upper Rio Grande Water Operation Model (URGWOM), is likely to be a useful tool in modeling water requirements for flows in the Middle Rio Grande, as suggested in public comments of the New Mexico Interstate Stream Commission on the proposed rule.<sup>69</sup> Use of this model to estimate the supplemental water required to achieve target flows might result in estimates that differ from those used in this analysis. However, at the time of this analysis, the URGWOM model has not been made publicly available. In addition, the URGWOM Steering Committee itself has recently stated that: 1) the latest version of URGWOM should not be released until it has been tested and is ready for public use; 2) the data and results for various model runs were not totally successful, but furthered model debugging, testing and evaluation; 3) the Middle Rio Grande Valley water depletions are modeled too high; 4) the water planning model is currently simplistic and

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<sup>68</sup> This calculation is of the quantity of supplemental water needed for delivery to the San Acacia and Acme gages. As described in detail in Appendices A and B, some water is lost in transit between upstream and downstream points. As a result, a greater quantity of upstream water rights would be needed to deliver the same volume of water to a downstream point. This analysis does not attempt to model the location of water used to supplement instream flow, but rather provides the amount of supplementary water needed at the San Acacia and Acme gages.

<sup>69</sup> New Mexico Interstate Stream Commission, "Comments by the State of New Mexico on the Draft Environmental Impact Statement and Proposed Rule published June 6, 2002, regarding Critical Habitat of the Rio Grande silvery minnow," October 2, 2002.

rough; and 5) water operations modeling is still undergoing troubleshooting, repairs, and enhancements.<sup>70</sup> Thus, in order to provide estimates of the amount of water that would be needed to supplement current instream flows, this analysis uses existing, publicly available data.

134. As discussed later in this report, several assumptions made regarding hydrological requirements and water rights transfers that may be associated with critical habitat designation for the silvery minnow are likely to generate conservative (i.e., more likely to overstate than understate) impact estimates. A brief description of the major assumptions made in this hydrological analysis is provided below. A detailed description of the hydrological analyses of supplemental water needed for the Middle Rio Grande and Pecos rivers are provided in Appendices B and C, respectively.<sup>71</sup>

- As noted in the programmatic opinion, providing a target flow of 50 cfs in San Acacia reach may provide more water than is necessary for the silvery minnow in some segments of the critical habitat.<sup>72</sup>
- This analysis values the stream flow need (water deficit in acre-feet) by the number of consumptive use water rights equal to this amount. In fact, if consumptive use rights are traded and used for instream flow, water included as part of those consumptive use rights that previously would have been lost to conveyance in irrigation ditches etc., would no longer be lost. Thus, more water than necessary to fulfill that deficit would be made available in the river. In addition, other waters included as part of consumptive use rights, such as return flows, would also become available as a result of such a trade.<sup>73</sup>

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<sup>70</sup> Notes from URGWOM Steering Committee Meeting: September 12, 2002: 10 am Corps of Engineers Conference Room and URGWOM Steering Committee Meeting: April 11, 2002: 10 am.

<sup>71</sup> In these analyses, the supplemental water needed is expressed as an average water deficit below the minimum flow requirements in the river.

<sup>72</sup> Written communication with Biologist, U.S. Fish and Wildlife, Ecological Services Office, Albuquerque, NM, December 17, 2001.

<sup>73</sup> This point is highlighted in the public comments of Brian McDonald for MRGCD, October 2, 2002. “It appears that the 40,427 acre-feet is a withdrawal need—stream flow—while the \$4,750 per acre feet is for a consumptive right...” Indeed, this analysis makes the withdrawal need equal to the consumptive use right in an attempt to not understate costs.

- This analysis estimates the quantity of supplemental water needed in the 95th percentile worst-case (e.g., driest) year. In other words, this quantity of water exceeds the amount needed to achieve a flow of 50 cfs in all but five years out of 100.
- If consumptive use rights are held for the 95th percentile driest year, then in other years other management options could be explored, including controlling flow patterns to simulate seasonal pulses in flow or leasing water to other users on a short-term basis to offset costs of managing the river to protect the silvery minnow. As a result, it is likely to overstate the negative economic effects of the designation of critical habitat.<sup>74</sup>

128. Note that the volume of water described above is a key input to the calculation of the opportunity cost of achieving target flows (calculated in Section 4.3) and the regional economic effects of moving that water from irrigation to instream flow (calculated in Section 5.2). The analysis of the direct and indirect economic effects of shifting water from existing uses to instream flow consists of three primary components: a hydrological analysis of the quantity of supplemental water required, an economic analysis of the value of that water, and use of an input/output model to estimate the secondary economic effects on the regional economy of changing the water use. While each component of the analysis serves as an input for the next, each also stands on its own. As a result, any change to the hydrological analysis will result in changes to the other values presented. However, such a change would not alter the methodology used to calculate economic effects.

129. The estimate described above includes several estimates that attempt to avoid understating the effects of this critical habitat designation and its associated requirements. The resulting estimate of approximately 40,000 acre-feet of supplemental water is within the range of other estimates of supplemental water required to maintain instream flow in the Middle Rio Grande. From 1996 to 2002, the U.S. Bureau of Reclamation has leased an average of 43,215 acre-feet of water each year to maintain instream flow during this very dry

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<sup>74</sup> Brian McDonald highlights this point in his comments for MRGCD, October 2, 2002: “Missing is any discussion of alternative ways of preserving the critical habitat. For example, why not obtain water rights for the 50<sup>th</sup> percentile case, then supplement through leasing for those years of drought or below average flow?” Clearly, if rights are held in perpetuity for only the 50<sup>th</sup> percentile case, costs of this designation would be significantly lower than estimated here. However, to be conservative (i.e. be more likely to overstate costs than understate them), this analysis uses the high-end, 95<sup>th</sup> percentile scenario.



period.<sup>75</sup> While these years were uncommonly dry, the average leased amount was comparable to estimates in this analysis. In addition, Balleau Groundwater, Inc. (1999) estimated that it would require 52,600 acre-feet of water released from Cochiti to maintain a flow of 200 cfs at San Acacia in an average year.<sup>76</sup> As stated above, the current analysis estimates that 40,000 acre-feet of water released from Cochiti would provide 50 cfs at San Acacia, suggesting that if Balleau's estimates are correct, these estimates may be an overstatement. Thus, these related and comparable estimates suggest that the values used in this analysis are reasonable. Details of these calculations are provided in Appendices B and C.

#### **4.3 Opportunity Costs of Providing Supplemental Water Flow for the Silvery Minnow**

130. Note that this revised analysis includes transaction costs associated with water transfers as part of total cost estimates.<sup>77</sup> Transaction costs may vary widely, depending on conditions surrounding the lease or sale of a water right and are thus difficult to predict or quantify. A typical brokerage arrangement in the Middle Rio Grande entails a 10 percent commission for completing a lease or sale of a water right.<sup>78</sup> Easter et al. found that the transaction costs associated with the purchase or lease of water rights range from \$17 to \$190 per acre-foot.<sup>79</sup> Based on this information, transaction costs are estimated to be approximately \$333 per af in the Middle Rio Grande on average.<sup>80</sup> This would represent approximately six percent of total opportunity costs, or as much as \$13 million dollars on the Middle Rio Grande. Transaction costs on the Pecos are estimated to range from negligible to \$183 per af, or \$4 million total.

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<sup>75</sup> Based on supplemental release data provided in the "Hydrologic Comments" by the MRGCD in public comments by W. Peter Balleau, October 2, 2002.

<sup>76</sup> Balleau Groundwater, Inc. "Hydrologic Effects of Designating Critical Habitat for the Rio Grande Silvery Minnow." Prepared for the Middle Rio Grande Conservancy District. May 5, 1999.

<sup>77</sup> The City of Albuquerque (October 2, 2002) has commented that this analysis should include transaction costs.

<sup>78</sup> See <http://www.waterbank.com/Agreements/Agency%20Agreement.htm>.

<sup>79</sup> Easter, K. William et al. "Formal and Informal Markets for Water: Institutions, Performance, and Constraints," *The World Bank Research Observer*, vol 14, no. 1. 1999.

<sup>80</sup> To develop an estimate of transaction costs, we average the high-end estimate from Easter et al. and 10 percent of the current af price of a water right in the Middle Rio Grande and Pecos respectively.

131. This analysis does not include the cost of pumping water from the low-flow conveyance channel into the lower part of the Middle Rio Grande, as this cost is not perceived to reflect a portion of the opportunity cost of water diverted for purposes of silvery minnow protection in the context of this analysis.<sup>81</sup>
132. **Middle Rio Grande.** Multiplication of the unit value of water and associated transaction costs by the estimated volume of water needed to meet minimum target flow requirements for the silvery minnow yields a total direct opportunity cost of \$205.5 million for the Middle Rio Grande under the 95th percentile low-flow scenario, as shown in Exhibit 4-1 below.<sup>82</sup>
133. This analysis also presents the cost of holding water rights for the finite time horizon of 20 years. The implied cost of holding these water rights in the Middle Rio Grande for 20 years would range from \$92 million to \$152 million in the 95th percentile scenario. The annualized opportunity costs of reallocating these volumes of water range from \$6.2 million to \$14.4 million in the 95th percentile scenario.<sup>83</sup>

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<sup>81</sup> The Bureau of Reclamation currently pumps water from the low-flow conveyance channel into the main channel of the Middle Rio Grande near San Marcial. The estimated annual cost of this effort is \$1.2 million. Jaci Gould, U.S. Bureau of Reclamation. Memorandum to Judy Flynn-O'Brien. February 8, 2002.

<sup>82</sup> It is interesting to note that F. Lee Brown arrives at comparable estimates, even while assuming a typical annual supplement of 150,000 af, (cited as a “suggestion by Lee Wilson”, which strongly conflicts with the estimates of Peter Balleau, who also “suggests” in this same document, one paragraph earlier, that a 35,000 af supplement could be expected on average). “Conservatively, then, the economic impact in this illustration is a one-time lost market value of \$140,000,000 with additional annual costs up to \$25,000,000 in exceedingly dry years.” Public comments of F. Lee Brown for MRGCD, “Appendix B. Supplemental Comments on Draft Economic Analysis of Critical Habitat Designation for the Rio Grande Silvery Minnow”, October 2, 2002.

<sup>83</sup> The opportunity cost over the 20-year time period (\$92 to \$152 mil.) is calculated by taking the present value of 20 years of annual costs (\$6.2 to \$14.4), as implied by the value of the volume of water rights in perpetuity (i.e., the total opportunity cost, \$205.5 mil. multiplied by the discount rate). The range is established by using both a three and seven percent rate.

134. **Pecos River.** Multiplication of the unit value of water and associated transaction costs by the estimated volume of water needed to meet minimum target flow requirements for the silvery minnow yields a total direct opportunity cost of and \$47.3 million for the Pecos under the 95th percentile low-flow scenario, as shown in Exhibit 4-1 below.
135. As in the Middle Rio Grande, this analysis also presents the cost of holding water rights for the finite time horizon of 20 years. The implied cost of holding these water rights in the Pecos for 20 years would range from \$21 million to \$35 million in the 95<sup>th</sup> percentile scenario and \$14 million to \$24 million in the 50<sup>th</sup> percentile scenario. The annualized opportunity costs of reallocating these volumes of water range from \$1.4 million to \$3.3 million for the Pecos River.
136. Values presented in the text of the rest of this report are for the 95th percentile scenario. Those for the 50th percentile scenario are presented in the summary tables in each section.

Exhibit 4-1							
ESTIMATED OPPORTUNITY COSTS TO MEET MINIMUM INSTREAM FLOW FOR SILVERY MINNOW CRITICAL AND OTHER ESSENTIAL HABITAT							
River Segment	Unit Price (\$ per acre/foot)	Transaction Costs (\$ per acre/foot) <sup>a</sup>	Estimated Annual Water Deficit (acre-feet/year) <sup>b</sup>	Estimated Total Opportunity Cost (2001\$)	Estimated Present Value 20 Year Opportunity Cost (3%)	Estimated Present Value 20 Year Opportunity Cost (7%)	Estimated Annual Opportunity Cost <sup>c</sup>
<i>95th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	40,427	\$205,490,000	\$91,720,000	\$152,390,000	\$6,160,000 to \$14,380,000
Pecos	\$1,750	\$183	24,463	\$47,290,000	\$21,110,000	\$35,067,000	\$1,420,000 to \$3,310,000
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<i>50th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	5,635	\$28,640,000	\$12,780,000	\$21,240,000	\$860,000 to \$2,000,000
Pecos	\$1,750	\$183	16,431	\$31,760,000	\$14,180,000	\$23,550,000	\$950,000 to \$2,220,000
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<sup>a</sup> Average of transaction cost estimates from Easter et al (1999) and <a href="http://www.waterbank.com/Agreements/Agency%20Agreement.htm">http://www.waterbank.com/Agreements/Agency%20Agreement.htm</a> <sup>b</sup> See Appendices B and C for detailed calculation of these volumes. <sup>c</sup> This estimate uses three and seven percent discount rates to calculate an annualized value.							

137. This analysis assumes that water used to supplement instream flow will voluntarily come from that currently held in irrigation water rights, both because of the disproportionate number of rights held by this sector and because of recent trends in the water market. Over 63 percent of the consumptive use of water in the Middle Rio Grande area is used by agriculture, as is 91 percent of the consumptive use in the Pecos River area.<sup>84</sup> In addition, recent trends indicate that water rights are moving from agriculture to municipal and industrial uses (see Exhibits 3-2 and 3-3). Further, the U.S. Bureau of Reclamation notes that, "the most recent trend begins to show an absolute decline in water withdrawal for irrigated agriculture," as demonstrated in Exhibits 3-2 and 3-3 in the previous section of this analysis.<sup>85</sup> In general, water use for irrigation is assumed to have a greater elasticity than that for municipal or commercial uses.
138. The assumption that water comes from agricultural uses is likely to result in a high-end estimate of the regional economic effects of the reallocation because effects on the farming sector generally ripple through the local economy to a greater extent than they do for many other sectors. For example, changing the use of water from irrigation to instream flow will likely result in the removal of land from agriculture, as discussed in Section 5 of this report. In contrast, reallocating water from a municipal use might result in an increase in costs to consumers. This cost could result in decreased household purchasing power.<sup>86</sup> Finally, it is important to note that because supplemental flows will represent a transfer of

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<sup>84</sup> U.S. Geological Survey. 1995 Water Use Data: New Mexico. <http://water.usgs.gov/watuse/spread95/nmco95.txt>. Accessed August 21, 2001.

<sup>85</sup> U.S. Bureau of Reclamation, New Mexico Water Resources Assessment for Planning Purposes, 10, 1976. See also: Chan, Arthur H. "To market or not to Market: Allocating water rights in New Mexico." *Natural Resources Journal*, University of New Mexico, Summer 1989 and "Comments of the Middle Rio Grande Conservancy District regarding the U.S. Fish and Wildlife Service's Proposed Designation of Critical Habitat for the Rio Grande Silvery Minnow," Appendix 3: Comments on the Economic Analysis, May 9, 1999.

<sup>86</sup> Public comments of Brian McDonald for MRGCD state: "In the 95<sup>th</sup> percentile scenario, the total opportunity costs of the value of water in the Middle Rio Grande is estimated at \$192.0 million. But, there is no discussion of who will bear this cost. For example, if the federal government comes up with the money, that \$192 million would go to water right holders and water institutions in the region. The authors have not incorporated the *positive* impact of this injection of \$192 million into the region's economy." McDonald, Brian for MRGCD, "Economic Analysis Comments," October 2, 2002. This analysis assumes, however, that a farmer would not agree to exchange his water right unless he expects to receive adequate compensation for it that reflects his perception of future profits that he might make from the use of that water. That being the case, any outflow of funds to the farmer would simply displace the profits he would have received, and would not result in a net gain to the economy.

one water use for another, rather than a net gain or loss, negative impacts on water storage facilities are not expected.<sup>87</sup>

139. As discussed, the estimated regional economic impacts (as presented in Section 5) assume acquisition of water rights from the agricultural sector. The extent and distribution of these impacts may differ if rights are ultimately acquired from a different distribution of sources. Conversely, the broader economic impacts, as reflected in the opportunity cost of water used to assure sufficient in-stream flow, are not expected to change according to the source of the supplemental water.
140. Finally, while existing water uses consume water to various degrees, instream flow “consumption” is likely to result in more water returned to the river than many water uses, such as agriculture, where a typical return flow is 30 percent.<sup>88</sup> Thus, adverse effects on Compact agreements and international treaties are not expected.<sup>89</sup>
141. This analysis does not consider options such as extending water markets to Colorado or Texas, as there is no historical record of such transfers occurring, and such transfers may be difficult to arrange under existing Compact agreements and relevant state water laws. A table of additional caveats to this analysis is provided in Section 7.

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<sup>87</sup> Numerous commenters request that this analysis assess the potential impact of critical habitat designation on water storage. For example, comments of the El Paso Public Utilities Board state: “Any imposition of flow maintenance requirements to maintain critical habitat areas will almost certainly affect water administrators’ ability to manage the river system and users’ ability to rely on it. Restrictions on use, timing of use, or available volumes for use, or other constraints imposed by the proposed critical habitat designation will inevitably increase economic costs, both direct costs for the management and operation of such storage, and indirect costs, including increased costs of supply and of alternative supply capacity to users, including outright loss or permanent restriction of supply.”

<sup>88</sup> Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, New Mexico State Engineer Office Technical Report 49, 1997.

<sup>89</sup> Some public commenters request that this analysis more explicitly address impacts of critical habitat designation on Compact agreements and international treaty obligations. See comments of New Mexico Interstate Stream Commission, October 2, 2002; International Boundary and Water Commission, United States and Mexico, August 22, 2002; Timothy Young, on behalf of the El Paso County Water Improvement District, October 2, 2002.

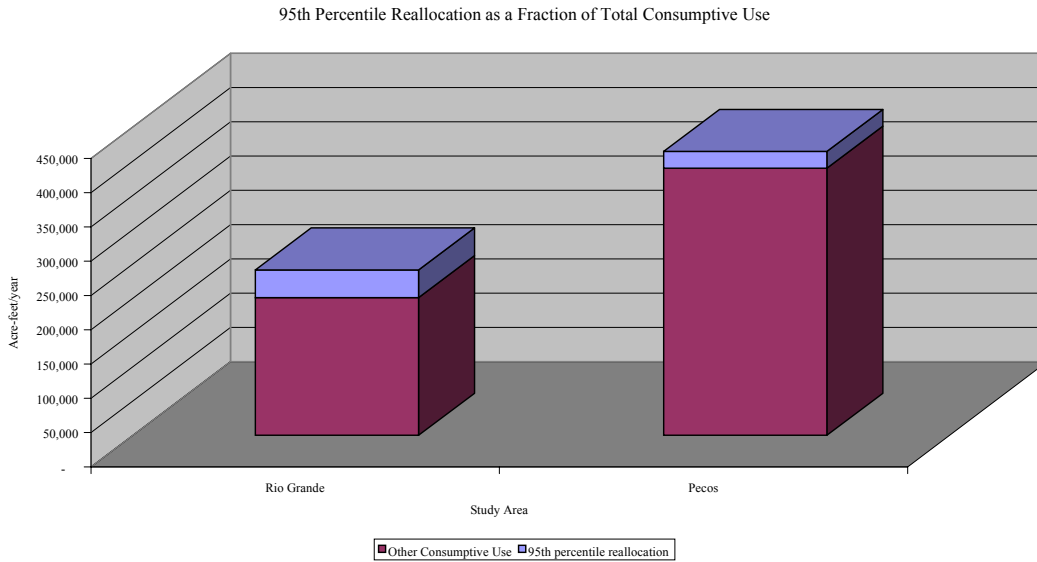
**CULTURAL AND SECONDARY IMPACTS  
ON WATER SELLERS AND COMMUNITIES**

**SECTION 5**

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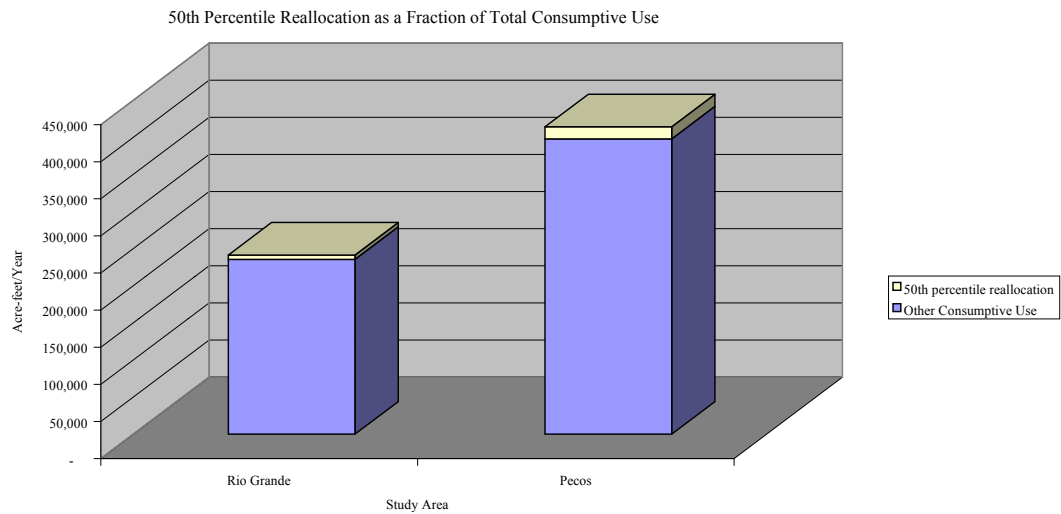
142. As detailed in Appendices B and C, this analysis assumes that approximately 40,000 acre-feet of water in the Middle Rio Grande and 24,000 acre-feet in the Pecos River would need to be reallocated from existing uses to instream flow to provide adequate flow for the silvery minnow. The total levels of consumptive use of water in the areas are approximately 240,000 acre-feet/year on the Rio Grande and 410,000 acre-feet/year on the Pecos River, and so this analysis estimates that approximately 17 and six percent of water currently used for consumptive purposes would be needed to meet target flows for the silvery minnow on the Rio Grande and Pecos River, respectively. Note that this analysis does not estimate the effect of switching from current irrigation techniques to other water efficiency measures, such as drip irrigation which might allow farmers to consume less water per acre of crop, and thus change the existing level of consumptive use for farm irrigation without a change in cropping patterns or output. Whether water rights are purchased or leased is a matter of policy that is beyond the scope of this analysis, which simply examines the economic effects that would be associated with maintaining a target flow of 50 cfs in each river reach. To quantify these effects as completely as possible, this analysis also evaluates the effect that such a change to the water market would have on both farms and farming communities. Exhibits 5-1 and 5-2 present the volume of water necessary to meet target flows for the silvery minnow as a portion of total consumptive use.

### Exhibit 5-1



Source: U.S. Geological Survey, 1995 Water Use Data. Accessed at <http://www.usgs.gov/watuse/spread95.htm> on August 21, 2001.

### Exhibit 5-2



Source: U.S. Geological Survey, 1995 Water Use Data. Accessed at <http://www.usgs.gov/watuse/spread95.htm> on August 21, 2001.



## **5.1 Regional Economic Analysis**

143. To determine the extent of economic activity affected by the reduction in water used for farming, this analysis utilizes regional economic analysis techniques. Regional economic analysis provides a means of estimating the significance of different businesses in a local economy by quantifying contributions to output, employment, and taxes. Because industries in a geographic area are interconnected, the contribution of any one industry will have proportionally larger effects on regional output and employment, a concept referred to as the “multiplier effect.” To fully capture these effects, this analysis enlists a technique referred to as input-output modeling, as discussed below.

### **5.1.1 Overview of Input/Output Modeling**

144. Industries within a given geographic area are interdependent in the sense that they purchase output from other industries and sectors, while also supplying inputs to other businesses. Thus, the contribution of a particular industry or activity to the regional economy is greater than its individual output. A feed store, for example, sells its products to local businesses and individuals and, at the same time, purchases equipment and supplies (e.g., feed and materials) and hires employees. An increase in demand for feed will induce an increase in output and employment in related industries. Likewise, a reduction in demand for feed will likely have greater regional output and employment effects than just those borne by local feed stores.
145. Constructing a regional economic model requires interpretation of the complex relationships between industries. To simplify the analysis, industries that have similar effects on the economy are grouped together in sectors. These sectors are arrayed in an input/output matrix, which demonstrates how the input requirements of each sector are fulfilled by output produced in other sectors. This matrix is the source of values known as multipliers. Multipliers quantify the relationship between the demand for output from a given sector and the resultant output required of the regional economy. For example, an output multiplier of 1.5 associated with the retail sales sector implies that spending \$1.00 for feed generates \$1.50 in total output by the regional economy (i.e., secondary contributions by suppliers, the local labor market, and all other sectors). Thus, the estimated contribution of a given sector to the regional economy is ultimately proportional to the size of its multiplier.
146. Defining the “study area” is an important feature of implementing a regional economic analysis. This area should be drawn broadly enough to include the outer limit of the geographic region through which a change in an activity is expected to reverberate, but not so broadly that impacts become so diffuse as to be indiscernible. Specifically, it should

include the actual site of the impact, the regional location of secondary industries similarly affected, the residential location of the labor force, and relevant pathways through which goods and services flow.

### 5.1.2 Overview of the IMPLAN Model

147. This economic analysis relies upon MicroIMPLAN (IMpact Analysis for PLANning), an input/output model designed by the U.S. Forest Service. IMPLAN is commonly used by State and Federal agencies for policy planning and evaluation purposes. The model draws upon data from several Federal and State agencies, including the Bureau of Economic Analysis and the Bureau of Labor Statistics. To group related industries into sectors, IMPLAN utilizes the categories defined by the U.S. Office of Management and Budget's Standard Industrial Classification (SIC) Code. In addition, this analysis relies upon the New Mexico Cooperative Extension Service's Cost and Return Models to estimate inputs to IMPLAN.<sup>90</sup>

148. Below IMPLAN is used to estimate the regional effects of modifying the water available to the farming industry. To accomplish this, this analysis posits a change in output in the farming sector corresponding to the hypothesized withdrawal of water from the market and the resulting decreases in production and revenues. The model then translates these changes in expenditures and revenues into changes in demand for output from the affected industries and corresponding changes in demand for inputs to those industries, and so on. These effects can be described as *direct*, *indirect*, or *induced*, depending on the nature of the change.

C *Direct effects* represent changes in output attributable to a change in demand or a supply shock. These are specified initially by the modeler.

C *Indirect effects* are changes in output of industries linked to those that are directly affected, as described previously in the context of the livestock feed industry.

C *Induced effects* reflect changes in household consumption arising from changes in employment (which in turn are the result of direct and indirect effects). For example, changes in employment in a region may affect the consumption of certain goods and services.

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<sup>90</sup> Available at <http://agecon.nmsu.edu/jlibbin/2001%20projected/home.html>.

These categories are calculated for all industries and aggregated to determine the regional economic effect of purchasing irrigation water for use in augmenting instream flow.

### 5.1.3 Interpretation of Model Results

149. In the following sub-sections, this analysis reports the regional economic contribution of farming-dependent activities in three categories: output, employment, and tax revenue. These results are presented in tables such as Exhibit 5-3.

Exhibit 5-3			
HYPOTHETICAL EXAMPLE OF IMPLAN MODEL RESULTS			
Change Specified in Model	Contribution to Regional Output (2001\$)	Contribution to Regional Employment (Persons)	Contribution to Tax Revenues (2001\$)
<i>Direct Effect</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>
\$1	\$1.50	<1	\$.50
Source: IEc IMPLAN analysis			

150. The elements of the exhibit are defined as follows:

- C *Change Specified in Model*: These are the initial changes specified by the modeler and are analogous to the *direct effects* described above. In this example, the change specified represents a \$1.00 consumer expenditure on food and beverages.
- C *Contribution to Regional Output (2001\$)*: This figure represents the total economic activity generated by the initial \$1.00 expenditure within the regional economy, as measured by the output of all industries affected (in this case, \$1.50). Output is the value of these industries' production, which includes the direct, indirect, and induced effects. Because IMPLAN model results are reported in 1998 dollars, this analysis uses the GDP implicit price deflator to adjust these amounts to current dollars.

- C *Contribution to Regional Employment*: This figure reflects the number of full-time jobs generated by the initial expenditure in all relevant industries within the regional economy. In this hypothetical example the contribution is negligible.
  
- C *Contribution to Tax Revenues (2001\$)*: This figure reflects the total tax revenue collected by Federal, State, and local governments that the initial expenditure (in this case, \$.50) will generate. It is similarly reported in current dollars.

#### 5.1.4 Caveats to IMPLAN Analyses

151. There are two important caveats relevant to the interpretation of IMPLAN model estimates, generally, and within the context of this analysis. Principally, the model is static in nature and measures only those effects resulting from a specific change at one point in time. Thus, IMPLAN does not account for adjustments that may occur. For example, a reduction in demand for farming-related services may encourage suppliers to diversify their operations and thereby abate reductions in employment and output. In addition, IMPLAN does not acknowledge the re-employment of workers displaced by the original change. In this application, this caveat simply suggests that the long-run net output and employment effects resulting from the hypothetical removal of farmed acres from the local economy would likely be smaller than those estimated by the model. As a result, this estimate should be considered the upper bound of a range of values.
  
152. A second caveat to the IMPLAN analyses is related to the model data. IMPLAN relies upon input/output relationships derived from 1998 data. Thus, the analyses presented in this report assume that this characterization of the affected county economies is a reasonable approximation of current conditions. To the extent that significant changes have occurred, the results may be sensitive to this assumption. However, the magnitude and direction of any such bias is unknown.
  
153. An additional consideration associated with the regional economic analysis is similarly related to data, but not specific to the IMPLAN model. The resultant estimates of economic activity attributable to the farming sector in the affected counties are based on estimates of the value of forgone crop production. Naturally, the accuracy of these estimates of regional economic activity are sensitive to the integrity of these underlying data.

## 5.2 **IMPLAN Analysis**

154. In order to achieve a high-end estimate of the possible economic effects of removing a quantity of water from agricultural use, this analysis makes several assumptions in calculating the direct effects value that serves as an input to the IMPLAN model.

### 5.2.1 **Inputs to the IMPLAN Analysis (*Direct Effects*)**

155. First, this analysis assumes that all farmers who sell water rights will retire the fields to which the forgone water was applied rather than substitute crops or reduce yields. In other words, there will be a direct relationship between the water removed from the market and the acres of field retired from production.<sup>91</sup>
156. This analysis addresses two study areas: one comprised of Sandoval, Bernalillo, Valencia, and Socorro counties surrounding the designated critical habitat in the Middle Rio Grande, and the second comprised of De Baca, Chavez, and Eddy counties along the designated stretch of the Pecos.<sup>92</sup>

### 5.2.2 **Crop Selection<sup>93</sup>**

157. Crops vary in their dependence on water, and so it is necessary to identify how crop acreages will be affected by reductions in available water. Hay (other than alfalfa) and alfalfa together comprise 90 percent of the irrigated acreage in the Middle Rio Grande study area. This analysis assumes that acres retired from planting will be those devoted to alfalfa crop, because this assumption results in a higher estimate of production loss than if the acres

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<sup>91</sup> Public comments from the Defenders of Wildlife/Forest Guardians note that “the analysis assumes that all farmers who sell their water rights will retire the fields to which the forgone water was applied rather than substitute crops or reduce yields...this assumption is too restrictive and results in increasing the [estimated] costs of the reallocation.” While this is a conservative assumption, it is our understanding that the sale of agricultural rights must result in the retiring of agricultural lands under New Mexico law.

<sup>92</sup> This analysis does not assess regional impacts for the Lower Rio Grande area, as no changes in the distribution of water rights are anticipated.

<sup>93</sup> Michelle Henrie (October 2, 2002) has commented that this analysis underestimated cost of forgone production by using alfalfa. This analysis shows that the upper bound impact is derived by calculating the cost of forgone production using alfalfa.

were retired from hay. The following sections provide more detail and a comparison of alfalfa to hay in the model.

158. Alfalfa is the dominant crop in the Rio Grande study area, comprising 56 percent of the total irrigated acreage in the area. An acre of alfalfa production requires a diversion right of 4.45 acre-feet per acre, which is higher than other crops that can be grown in the area. Interviews with local crop scientists on the annual planting cycle and relatively high water requirements of alfalfa, indicate the acres retired from planting will most likely be those devoted to the alfalfa crop.<sup>94</sup>
159. The second most dominant crop in the Rio Grande Study area is hay, other than alfalfa, comprising 34 percent of the total irrigated acreage in the area. An acre of hay production requires a diversion rate of 2.74 acre-feet of water per acre, less than that of alfalfa production. Although this analysis assumes the acres retired from planting will be those devoted to alfalfa, a second calculation using a reduction in hay production is included to provide comparison.<sup>95</sup>

### 5.2.3 Quantification of Forgone Production

160. In order to quantify the changes in agricultural practice and output described above, this analysis relies on models created by the New Mexico Cooperative Extension Service (NMCES) to project costs and returns for the State's farming industry in 2001.<sup>96</sup> These models provide estimates of the quantity of irrigation water required per acre of crop and of yields of crop per acre. Using these estimates and 1999 New Mexico Agricultural Statistics,

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<sup>94</sup> Personal communication with a crop scientist at the New Mexico State University Agricultural Extension, October 15, 2001. This assumption is likely to be conservative and overstate effects on the regional economy when compared to modeling reductions in water available to other crops. Modeling the same reductions in water available to the second most prevalent crop in each study area (pasture hay for the Middle Rio Grande) produces a total value of forgone production that is 12 percent less than that produced by modeling removals from alfalfa.

<sup>95</sup> Public comments from Defenders of Wildlife/Forest Guardians (October 2, 2002) suggest that to gauge better the likely agricultural lands which may be retired (if any), interviews with producers are necessary. However, time and resource constraints preclude such actions for gathering a random sample of such landowners.

<sup>96</sup> Personal communication with crop scientists at the New Mexico State University Agricultural Extension, October 8, 2001 and October 15, 2001. Models available at: <http://agecon.nmsu.edu/jlibbin/2001%20Projected/home.htm>.

it is possible to estimate the value of forgone crop production. The following components contributed to this estimate:

1. Calculate the average quantity of water required per acre of alfalfa/hay in each study area, weighting the values provided for each county by the NMCES model according to the fraction of the total irrigated acres in the study area that fall within that county.
  2. Calculate the acreage retired from production using the total volume of water removed from the market and the water required per acre.
  3. Determine the average yield of alfalfa/hay per acre in each study area, weighting the county-specific modeled values according to the fraction of the total irrigated area that falls within that county.
  4. Use the acres retired and the average yield per acre to calculate the tons of alfalfa/hay production forgone.
  5. Apply the average 1999 price of alfalfa/hay to the tons of production forgone to calculate a total dollar value of production forgone.
161. The calculations described above and summarized in Exhibit 5-4 result in an estimate of \$6.0 million in forgone production in the Rio Grande study area and \$4.2 million in the Pecos study area that will occur as a result of land retirement due to shifting water from irrigation to instream flow. These figures constitute the *direct effects* of the water trading anticipated described in this section.

<b>Exhibit 5-4</b>		
<b>ESTIMATED VALUE OF FORGONE PRODUCTION OF RIO GRANDE STUDY AREA: INPUTS TO THE IMPLAN MODEL (<i>Direct Effects</i>)</b>		
<b>Variable</b>	<b>Alfalfa<sup>a</sup></b>	<b>Hay<sup>a</sup></b>
Water Removed from Market	40,427 acre-feet/year (5,635)	40,427 acre-feet/year (5,635)
Water Usage <sup>b</sup>	4.45 acre-feet/acre of crop	2.88 acre-feet/acre of crop
Acres Removed from Production	9,094 acres	14,037 acres
Yield per Acre per Year <sup>b</sup>	5.67 tons/acre	3.97 tons/acre
Tons of Forgone Production	51,546 tons	55,775 tons
Unit Price <sup>c</sup>	\$116 /ton	\$94 /ton
<b>Value of Forgone Production</b>	<b>\$5,979,390 (\$833,450)</b>	<b>\$5,242,880 (\$730,790)</b>
<p><sup>a</sup> Values in the table are calculated based on the 95th percentile scenario with volumes of water and values of foregone production under the 50th percentile scenario included in parentheses. Note that the values presented in this table may have been rounded and so calculations may appear imprecise.</p> <p><sup>b</sup> Water usage is measured as acre feet per acre of water rights. Source: New Mexico Cooperative Extension Service Crop Models. Available at: <a href="http://agecon.mnsu.edu/jlibbin/2001%20projected/hane.edu">http://agecon.mnsu.edu/jlibbin/2001%20projected/hane.edu</a>.</p> <p><sup>c</sup> State of New Mexico. New Mexico Agricultural Statistics 1999. New Mexico Agricultural Statistics Service, Department of Agriculture, 1999.</p>		

162. The New Mexico Interstate Stream Commission (October 2, 2002) and Middle Rio Grande Conservancy District (October 2, 2002) commented that this analysis erroneously assumes following an acre of alfalfa would yield 4.45 acre-feet of water; thus, they believe this analysis overestimates the water made available from fallowing an acre of cropland. This analysis assumes that each alfalfa farmer faces the same constraints. Contained in a diversion requirement of 4.45 acre-feet per acre is the assumption that 30 percent (or 1.34 acre-feet per acre) is returned to the system (i.e. 70 percent (or 3.12 acre-feet per acre) is consumed and/or lost to the system).<sup>97</sup> Thus, the diversion of 40,427 acre-feet of instream flow would result in 28,299 acre-feet consumed and 12,128 acre-feet returned to the system. Approximately 42 percent of the diversion requirement (or 1.87 acre-feet per acre) is the consumptive irrigation requirement for alfalfa, and 28 percent (or 1.25 acre-feet per acre) are other farm losses. Given these assumptions, 42 percent (16,979 acre-feet) of the anticipated water deficit would be consumed by 9,094 acres of alfalfa production. Thus, the consumptive requirement of alfalfa is not 4.45 but 1.87, and this analysis correctly estimates the number of acres removed from alfalfa production.

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<sup>97</sup> Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, New Mexico State Engineer Office Technical Report 49, 1997.



<b>Exhibit 5-4</b>	
<b>ESTIMATED VALUE OF FORGONE PRODUCTION OF PECOS STUDY AREA: INPUTS TO THE IMPLAN MODEL (<i>Direct Effects</i>)</b>	
<b>Variable</b>	<b>Alfalfa<sup>a</sup></b>
Water Removed from Market	24,463 acre-feet/year (16,431)
Water Usage <sup>b</sup>	4.19 acre-feet/acre of crop
Acres Removed from Production	5,839 acres
Yield per Acre per Year <sup>b</sup>	6.22 tons/acre
Tons of Forgone Production	36,314 tons
Unit Price <sup>c</sup>	\$116 /ton
<b>Value of Forgone Production</b>	<b>\$4,212,436 (\$2,829,356)</b>
<sup>a</sup> Values in the table are calculated based on the 95th percentile scenario with volumes of water and values of foregone production under the 50th percentile scenario included in parentheses. Note that the values presented in this table may have been rounded and so calculations may appear imprecise. <sup>b</sup> Water usage is measured as acre feet per acre of water rights. Source: New Mexico Cooperative Extension Service Crop Models. Available at: <a href="http://agecon.mnsu.edu/jlibbin/2001%20projected/hane.edu">http://agecon.mnsu.edu/jlibbin/2001%20projected/hane.edu</a> <sup>c</sup> State of New Mexico. New Mexico Agricultural Statistics 1999. New Mexico Agricultural Statistics Service, Department of Agriculture, 1999.	

#### 5.2.4 Background Conditions for the IMPLAN Analysis

163. Results generated by IMPLAN should be considered in the context of modeled existing conditions. Exhibit 5-5 below provides background data on the regional output, employment, and tax revenue for both the Middle Rio Grande and Pecos River study areas. These values reflect current conditions, absent any changes in water policy.

<b>Exhibit 5-5</b>			
<b>EXISTING REGIONAL ECONOMIC CONDITIONS</b>			
<b>River Segment</b>	<b>Output</b>	<b>Employment</b>	<b>Tax Revenue</b>
Middle Rio Grande	\$32.4 billion	446,524	\$1.4 billion
Pecos	\$5.3 billion	57,168	\$200 million
<b>Total</b>	<b>\$37.7 billion</b>	<b>503,692</b>	<b>\$1.6 billion</b>
Source: IMPLAN analysis.			

### 5.2.5 Results of IMPLAN Analysis

164. Exhibit 5-6 below summarizes the regional economic effects of the changes to the water markets described above. These changes result in an estimate of \$8.4 million in economic impacts to the output of the Rio Grande study area and \$6.2 million in the Pecos study area under the 95th percentile scenario. Note that these changes in output include the direct impact of forgone crop production estimated in Section 5.2.1 above. The removal of these quantities of water from their current use for irrigation would result in a loss of 520 jobs across both study areas and a total reduction of \$2.0 million in State and Federal taxes, annually. In context, these values represent a decrease of 0.17 percent, 0.10 percent, and 0.13 percent in output, employment, and tax revenue, respectively. The 50th percentile scenario would result in a \$1.2 million reduction to regional output in the Rio Grande and \$4.2 million in the Pecos. It also would result in a loss of 157 jobs and \$610,000 of tax revenue across both study regions. Other effects under the 50th percentile scenario are presented in Exhibit 5-6. This analysis does not attempt to discuss social and cultural values associated with agriculture in the region, beyond a discussion of the economic impacts likely to be incurred. Please refer to the Designation of Critical Habitat for the Rio Grande Silvery Minnow Final Environmental Impact Statement for a detailed discussion of the social and cultural values of the region.<sup>98</sup>

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<sup>98</sup> Robert Simon (October 2, 2002) and the New Mexico Interstate Stream Commission (October 2, 2002) commented that this analysis should consider the social and cultural impacts of the reduction of agriculture on the region. For a thorough discussion of social and cultural values associated with agriculture in the region, please refer to the Designation of Critical Habitat for the Rio Grande Silvery Minnow Final Environmental Impact Statement.

<b>Exhibit 5-6</b>				
<b>REGIONAL ECONOMIC EFFECTS OF REALLOCATING WATER FOR INSTREAM FLOW</b>				
	<b>Value of Forgone Crop Production (2001\$)</b>	<b>Effect on Regional Output (2001\$)<sup>a</sup> (% of baseline)</b>	<b>Effect on Regional Employment (persons) (% of baseline)</b>	<b>Effect on Regional Tax Revenue (2001\$) (% of baseline)</b>
<b>River Segment</b>	<i>Direct Effect</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>
<i>95th Percentile Scenario</i>				
Middle Rio Grande	\$5,979,390	\$8,392,464 (0.026%)	362 (0.081%)	\$1,430,771 (0.10%)
Pecos	\$4,212,436	\$6,243,432 (0.12%)	158 (0.28%)	\$615,779 (0.31%)
<b>Total</b>	<b>\$10,191,826</b>	<b>\$14,635,896 (0.017%)</b>	<b>520 (0.10%)</b>	<b>\$2,046,550 (0.13%)</b>
<i>50th Percentile Scenario</i>				
Middle Rio Grande	\$833,450	\$1,169,801 (0.0036%)	51 (0.011%)	\$199,431 (0.014%)
Pecos	\$2,829,356	\$4,193,509 (0.080%)	106 (0.19%)	\$413,599 (0.21%)
<b>Total</b>	<b>\$3,662,806</b>	<b>\$5,363,310 (0.014%)</b>	<b>157 (0.031%)</b>	<b>\$613,030 (0.038%)</b>
<sup>a</sup> Note that the effects on regional output, employment, and tax revenue include both the direct effect used as an input to the model (see Section 5.2.1) and the modeled indirect or secondary effects on the economy of the study area.				

165. Note that the estimated regional economic effects presented in Exhibit 5-6 are an entirely different measure of impact than the annualized and 20-year estimates included in other parts of the analysis. The regional economic impacts measure distributional impact rather than the efficiency impacts measured in Section 7. As such, they are not comparable to and cannot be summed with the section 7 cost estimates presented in Section 7. That is, these are both important, but distinct measures of impact.

### **Rio Grande Study Area- Sandoval, Bernalillo, Valencia, and Socorro Counties**

166. Effects on total output are heavily concentrated in the hay and pasture industry, with a total effect of \$6.0 million.<sup>99</sup> Real estate has the second greatest impact at \$260,000.<sup>100</sup> Other industries that lose over \$100,000 in total output include owner-occupied dwellings, wholesale trade, doctors and dentists, eating and drinking, and hospitals. The total economic effects equal \$8.4 million, 29 percent of which is in secondary (i.e., indirect and induced) effects. The entire effect translates to approximately 0.026 percent of the total regional output.
167. Effects on employment follow the same pattern. In the Middle Rio Grande, these changes translate to a loss of 328 jobs in the hay and pasture industry, three in eating and drinking, and two in miscellaneous retail. Other industries losing one or more job include real estate, agricultural/forestry/fishery services, wholesale trade, hospitals, doctors and dentists, food stores, and general merchandise stores. These positions account for 95 percent of the jobs lost. Other lost employment is measured in partial jobs, summing to a total of 362 for the region or about 0.08 percent of the total employment.
168. The changes to the water market and resulting reduction in agricultural production also affect the tax income of the region. The inputs described above produce a \$740,000 reduction in Federal taxes collected in the region and a \$690,000 reduction in State and local taxes.<sup>101</sup> Reductions to Federal tax income consist primarily of income and corporate profit taxes while reduced sales tax income is the largest component of the reduction to State and local taxes. These changes sum to a total loss in tax revenue of \$1.4 million or about 0.10 percent of the total regional tax revenue.

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<sup>99</sup> Note that IMPLAN uses industry categories to generalize specific effects and model their effects on other sectors of the economy. Alfalfa farming falls under "Hay and Pasture." The Rio Grande Study Area contains a total of 61,734 irrigated acres. Approximately 15 percent of irrigated acreage occurs in each Bernalillo and Sandoval, while 35 percent occurs in both Socorro and Valencia. New Mexico Agricultural Statistics 2000. Available at: <http://www.nass.usda.gov/>.

<sup>100</sup> The Middle Rio Grande Conservancy District (October 2, 2002) has commented that this analysis should address impacts on property values. The analytical results of IMPLAN capture some of the effects on property values as effects on the real estate market.

<sup>101</sup> Note that the inputs to IMPLAN also result in \$423 of corporate transfers which are captured in the total tax reduction but not in either the Federal or State tax subtotals.

### **Rio Grande Study Area- Socorro County Isolated**

169. This analysis performed a sensitivity analysis of the regional impact model by calculating the impact of reducing the production of alfalfa in only one county in the study area, Socorro.<sup>102</sup> Reducing the production of alfalfa in the Rio Grande study area, isolated in Socorro county, by \$6 million results in a total reduction of \$7.3 million, or about 2.2 percent of the area's economic output. This result is about \$1 million less than if production losses are experienced throughout Sandoval, Bernalillo, Valencia, and Socorro counties. Changes to agricultural production described above result in a total loss of 375 jobs or about 5.6 percent of the total employment in the isolated study area. This result is approximately 13 more lost jobs than if the production losses are experienced throughout the entire study area. Changes in the agricultural output described above would cause a \$1.3 million reduction, which is equal to approximately 12.1 percent of the total tax income of the isolated study area. This result is approximately \$100,000 less total tax income lost than if losses are experienced throughout the entire study area.

### **Pecos Study Area**

170. Reducing the production of alfalfa in the Pecos study area by \$4.2 million results in a total reduction of \$6.2 million, or about 0.1 percent of the area's economic output. This consists primarily of reductions to the hay and pasture industry, followed by those to agricultural/forestry/fishery services and real estate at \$260,000 and \$230,000, respectively. Other industries that lose more than \$100,000 in total output include wholesale trade, petroleum refining, and facility maintenance and repair.
171. Changes to agricultural production described above result in a total loss of 158 jobs or about 0.28 percent of the total employment in the Pecos study area, 121 of which would be in the hay and pasture industry. Agricultural/ forestry/fishery services would lose 15 jobs and wholesale trade would lose two. Facility maintenance and repair, real estate, eating and drinking, and credit agencies would also lose between one and two jobs each. These positions account for 91 percent of the jobs lost. Other lost employment is measured in fractions of positions, the total of which comprises the remaining 9 percent, or 14 positions.

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<sup>102</sup> Michelle Henrie (October 2, 2002) has commented that this analysis should separate impacts into separate counties. In order to address this comment the analysis presents the sensitivity analysis above that models the regional impacts as if they were realized by Socorro County alone.

172. Changes in the agricultural output described above would cause a \$616,000 reduction, which is equal to approximately 0.31 percent of the total tax income of the Pecos study area. This represents \$330,000 of lost Federal taxes and \$290,000 of State and local taxes.<sup>103</sup> As in the case of the Rio Grande study area, income and corporate profit taxes comprise the majority of the lost Federal tax income, while sales tax is the largest component of the lost State and local taxes.

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<sup>103</sup> Note that they also result in \$254 of corporate transfers which are captured in the total tax reduction, but not in either the Federal or State tax subtotals.

**ESTIMATED COSTS OF THE DESIGNATION OF CRITICAL  
HABITAT RELATED TO SECTION 7 CONSULTATIONS**

**SECTION 6**

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173. This section describes the total economic costs likely to result from section 7 consultations if critical habitat is designated in the Middle Rio Grande and in two other areas considered to be essential to the conservation of the silvery minnow over the next 20 years. Consultation activities 20 years in the future are difficult to predict, and the outcomes of such consultations are even more uncertain. Thus, this analysis relies heavily on historical patterns of consultation behavior by Federal, State, and local agencies to predict future consultation types and likely project modifications. Efforts were also made to interview staff at Federal agencies potentially affected by a critical habitat designation in the Middle Rio Grande and in two other areas considered to be essential to the conservation of the silvery minnow. This section defines the types of economic impacts likely to be encountered in areas of critical habitat and estimates the number of technical assistance efforts, consultations, project modifications, and re-initiations that are likely to result from the designation of critical habitat for the silvery minnow as well as the per-unit costs of each of these activities. Based on this analysis, an estimate of section 7 impacts is derived which incorporates both "coextensive" costs (i.e. costs that would likely be incurred even absent critical habitat) as well as costs resulting from designation of critical habitat alone. Costs for individual reaches of the Middle Rio Grande are presented in Appendix D.

**6.1 Categories of Economic Impacts Associated with Critical Habitat**

174. Section 7(a)(2) of the Act requires Federal agencies (Action agencies) to consult with the Service whenever activities that they undertake, authorize, permit, or fund may affect a listed species or designated critical habitat. In these cases, the Service, the Action agency, and the landowner applying for Federal funding or permitting (if applicable) communicate in an effort to minimize potential adverse effects to the species and/or to critical habitat. Communication between these parties may occur via written letters, phone calls, in-person

meetings, or any combination of these. The duration and complexity of these interactions depends on a number of variables, including the type of consultation, the species, the activity of concern, the region where critical habitat has been designated, and the landowner.

175. Section 7 consultations with the Service may be either informal or formal. An *informal consultation*, which consists of informal discussions between the Service, the Action agency, and the applicant concerning an action that may affect a listed species or its designated critical habitat, is designed to identify and resolve potential concerns at an early stage in the planning process. In contrast, a *formal consultation* is required if the Service finds that the proposed action is likely to adversely affect the listed species or designated critical habitat in ways that cannot be resolved through informal consultation. Regardless of the type of proposed project, section 7 consultations can require substantial administrative effort on the part of all participants.

## **6.2 Number of Future Coextensive Consultations Associated with Silvery Minnow Critical Habitat Areas**

176. This section examines historical patterns of Federal agency consultations on the silvery minnow, in order to determine the likelihood that future consultations on the silvery minnow would have occurred even absent critical habitat. Past consultations since 1994 were classified and sorted by date, agency, activity, and type of consultation. Historical consultations on the silvery minnow have only occurred on the Upper/Middle Rio Grande. Thus all consultations considered likely to have occurred absent critical habitat are anticipated to occur in this area. Appendix D presents an analysis of these likely consultations in the Middle Rio Grande unit by individual river reach.
177. Since 1994, the average annual number of Federal actions for the silvery minnow has been 7, including formal, informal, and technical assistance efforts that involved the Service. The majority of these efforts have gone into informal consultations (averaging 4.5 per year).<sup>104</sup> Exhibit 6-1 displays the historic consultation rate for each Action agency as an annual average. Based on that average, the number of future consultations likely to have occurred even absent critical habitat are estimated for the silvery minnow over the next 20 years.

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<sup>104</sup> This analysis classifies all records involving Federal Action agencies as formal or informal consultations, depending on the record. Efforts with no Federal Action agency involvement have been classified as technical assistance efforts. Phone call records of technical assistance efforts were not part of the available consultation record, and thus have not been tallied.



<b>Exhibit 6-1</b>			
<b>ESTIMATED NUMBER OF FUTURE CONSULTATIONS RIO GRANDE SILVERY MINNOW CRITICAL HABITAT AREAS LIKELY TO HAVE OCCURRED REGARDLESS OF CRITICAL HABITAT (20 YEARS)<sup>a</sup></b>			
<b>Federal Agency</b>	<b>Historical Activities Resulting in Consultation<sup>b</sup></b>	<b>Annual Consultation Rate Since 1994 (Formal, Informal)</b>	<b>Total Estimated Number of Coextensive Consultations Over 20 Years<sup>a</sup></b>
U.S. Fish and Wildlife Service (internal)	Emergency rescue/relocation of silvery minnow, reservoir fish stocking, vegetation management.	0.38, 1	Formal: 8 Informal: 20
Bureau of Reclamation	Water operations, including: bioengineering, habitat enhancement, river training, sediment removal, levee maintenance, vegetation removal.	0.75, 1.75	Formal: 15 Informal: 35
Army Corps of Engineers	Authorization and permitting of dredging and filling of wetlands, channelization of streams, flood control actions, bridge construction, sand and gravel operations under Section 404 of the Clean Water Act.	0.5, 0.88	Formal: 10 Informal: 18
Environmental Protection Agency	Permitting of municipal and industrial discharges under the National Pollutant Discharge Elimination System (NPDES).	0.13, 0.63	Formal: 3 Informal: 13
Federal Energy Regulatory Commission	Authorization and licensing for oil and gas pipelines.	None, 0.13	Formal: 0 Informal: 3
U.S. Department of Transportation	Road and bridge construction activities.	None, 0.13	Formal: 0 Informal: 3
Bureau of Indian Affairs	Possible water management changes to benefit the silvery minnow.	None, None	Formal: 0 Informal: 0
Federal Emergency Management Agency	Issuance of flood insurance, disaster relief efforts.	None, None	Formal: 0 Informal: 0
Bureau of Land Management	Land management activities.	None, None	Formal: 0 Informal: 0
Technical Assistance <sup>c</sup>	Various: inquiries from private companies about procedure, notice of well-monitoring by State Engineer's Office, nitrate removal facilities by NM Environmental Department	0.75	T.A.: 15
<b>Total</b>			<b>Formal: 36 Informal: 92 T.A.: 15</b>
<p>Sources: Administrative records provided by the Albuquerque Ecological Field Office, U.S. Fish and Wildlife Service, Albuquerque, NM, 2001. Note that these estimates assume that all past actions on the Rio Grande occur within the designated critical habitat unit. In reality, several may occur outside these boundaries. Thus, these estimates may overstate the number of anticipated actions within critical habitat areas. Any anticipated increases in consultation activity by these agencies are not considered part of the coextensive effects, and will be discussed in Section 6.3 of this report.</p> <p><sup>a</sup> Appendix D presents an analysis of individual reaches in the Middle Rio Grande.</p> <p><sup>b</sup> Historical consultations have only occurred on the Upper/Middle Rio Grande.</p> <p><sup>c</sup> Technical assistance here only include those requiring written correspondence.</p>			

### **6.3 Section 7 Effects Anticipated in Silvery Minnow Critical Habitat Areas due to Critical Habitat Alone**

#### **6.3.1 Middle Rio Grande Unit**

178. At least 13 formal consultations and 36 informal consultations involving the silvery minnow have occurred on the Middle Rio Grande since 1994.<sup>105</sup> Because critical habitat was previously designated for the silvery minnow, most consultations that have occurred since 1999 have included consideration of silvery minnow critical habitat. Nevertheless, these actions will require the reinitiation of consultation after critical habitat is re-designated as the action is still ongoing. In addition, because of the high level of public and agency attention that the silvery minnow has received since designation, many agencies have already engaged in consultation or conferencing on activities that may affect the silvery minnow. Thus, most projected future consultations on the silvery minnow stem from the extensive consultation history on the silvery minnow in the Middle Rio Grande, and are captured as part of the coextensive silvery minnow consultation estimates above in Exhibit 6-1. Appendix D presents an analysis of individual reaches in the Middle Rio Grande unit.
179. To estimate changes in consultation patterns that may occur in the future after critical habitat is designated for the silvery minnow on the Middle Rio Grande, efforts were made to interview staff at Federal agencies with knowledge of upcoming agency activities and the critical habitat consultation process. Service estimates of anticipated technical assistance efforts are used as the basis of projections for these efforts. The results of these interviews, and the resulting consultation projections are summarized in Exhibit 6-2.

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<sup>105</sup> Administrative record for the silvery minnow, 1992-2001. U.S. Fish and Wildlife Service. Albuquerque, NM. 2001.

Exhibit 6-2

**EXPECTED INCREASE IN NUMBER OF SILVERY MINNOW CONSULTATIONS ON THE MIDDLE RIO GRANDE  
DUE TO CRITICAL HABITAT FOR THE SILVERY MINNOW  
(20 YEARS)<sup>a</sup>**

Federal Agency	Activities Potentially Resulting in New Consultations on the Silvery Minnow	Notes	Estimated Increase in the Number of Consultations Over 20 Years <sup>b</sup>
U.S. Fish and Wildlife Service (internal)	Emergency rescue/relocation of silvery minnow, reservoir fish stocking, vegetation management.	As efforts to rehabilitate the silvery minnow continue, rescue/relocation efforts may intensify. Although these consultations are more likely to be related to jeopardy issues than critical habitat, this analysis conservatively assumes that the full administrative costs associated with these consultations will be due to the designation of critical habitat alone. This analysis assumes a 50 percent increase due to critical habitat designation in the number of consultations that would have occurred on the silvery minnow.	Formal: 4 Informal: 10
Bureau of Reclamation	Water operations, including: bioengineering, habitat enhancement, river training, sediment removal, levee maintenance, vegetation removal.	Based on BOR interpretation of the effect of critical habitat on its actions, this analysis expects BOR to formally consult annually in the future on the silvery minnow. This translates into an increase of approximately 25 percent above historic consultation rates. While it is likely that this consultation rate will decline over time, this analysis conservatively assumes a constant consultation rate. <sup>c</sup>	Formal: 5 Informal: 9
Army Corps of Engineers	Authorization and permitting of dredging and filling of wetlands, channelization of streams, flood control actions, bridge construction, sand and gravel operations under Section 404 of the Clean Water Act.	Assumes a 25 percent increase in consultation numbers due to critical habitat designation, as concerns about flood control and erosion increase.	Formal: 3 <sup>106</sup> Informal: 5

<sup>106</sup> Comment was received from ACOE Albuquerque District September 3, 2002 that indicated the ACOE anticipated additional informal and/or formal consultations. In a follow up conversation with ACOE Albuquerque District Regulatory Branch personnel (November 12, 2002) clarified that the total number of consultations are not anticipated to increase but the potential exists for informal consultations to be shifted to formal consultations. Due to the uncertainty of how many informal consultations may be shifted to formal this revised analysis relies on the previous estimate.

Exhibit 6-2

**EXPECTED INCREASE IN NUMBER OF SILVERY MINNOW CONSULTATIONS ON THE MIDDLE RIO GRANDE DUE TO CRITICAL HABITAT FOR THE SILVERY MINNOW (20 YEARS)<sup>a</sup>**

Federal Agency	Activities Potentially Resulting in New Consultations on the Silvery Minnow	Notes	Estimated Increase in the Number of Consultations Over 20 Years <sup>b</sup>
Environmental Protection Agency	Permitting of municipal and industrial discharges under the National Pollutant Discharge Elimination System (NPDES).	EPA staff note that their agency already considers effects on endangered species in the Middle Rio Grande whenever they issue/reissue a NPDES permit. EPA staff state that, typically, the Service finds no effect on the species, and that the consultations remain informal. EPA staff state that this is because current permit toxicity levels appear to be safe for the fathead minnow, the silvery minnow's surrogate species in toxicity tests. Larger, formal consultations tend to be associated with high-profile facilities (e.g. Socorro Municipal Wastewater Treatment Facility). In the Middle Rio Grande, staff expect that the current rate of consultations will be sufficient to predict future consultation rates. <sup>107</sup>	Formal: 0 Informal: 0
Bureau of Indian Affairs	Possible water management changes to benefit the silvery minnow.	Public comments from the Pueblos and staff at the Bureau of Indian Affairs indicate that the primary impact that concerns the Tribal governments with the designation of critical habitat for the silvery minnow is any potential threat to Tribal water rights that may occur. <sup>108</sup> Should Tribal governments consider water trades that would benefit the silvery minnow, it is possible that the BIA would consult on this effort. <sup>109</sup> Because the action would be likely to benefit the silvery minnow, the consultation would likely remain informal. While the BIA has no history of consultation on the silvery minnow, and the Tribes have had limited interaction with the Service on this issue, this analysis conservatively assumes that one informal consultation with each Tribe may occur over the next 20 years on the silvery minnow.	Formal: 0 Informal: 6
Federal Energy Regulatory Commission	Authorization and licensing for oil and gas pipelines.	FERC has consulted once informally with the Service on the silvery minnow for a Rio Grande pipeline crossing project. However, FERC activities are frequently implemented by BLM in this area, and thus are unlikely to result in consultation with the Service. Consultation rates are not expected to increase. <sup>110</sup>	Formal: 0 Informal: 0

<sup>107</sup> Personal communication with Staff, EPA, October 24, 2001.

<sup>108</sup> Personal communication with Staff, BIA, October 23, 2001. Public comments on EIS process from Pueblos of Santa Ana, Cochiti, Isleta, Santo Domingo, and Sandia.

<sup>109</sup> This analysis assumes that water trades that occur in order to provide a target river flows for silvery minnow critical habitat will be voluntary.

<sup>110</sup> Personal communication with Staff, BLM, October 23, 2001. Public comments on EIS process from Pueblos of Santa Ana, Cochiti, Isleta, Santo Domingo, and Sandia.

Exhibit 6-2

**EXPECTED INCREASE IN NUMBER OF SILVERY MINNOW CONSULTATIONS ON THE MIDDLE RIO GRANDE DUE TO CRITICAL HABITAT FOR THE SILVERY MINNOW (20 YEARS)<sup>a</sup>**

Federal Agency	Activities Potentially Resulting in New Consultations on the Silvery Minnow	Notes	Estimated Increase in the Number of Consultations Over 20 Years <sup>b</sup>
Federal Emergency Management Agency	Issuance of flood insurance, disaster relief efforts.	In January 2001, FEMA was sued in New Mexico for violating the Act for issuing insurance that could result in impacts on endangered species without consulting with the Service. As a result of this and other recent lawsuits, FEMA is undertaking a national, programmatic review of their flood insurance actions and the Act. In New Mexico, a programmatic consultation on all endangered riverine species is presently underway. FEMA staff state that, in general, disaster relief efforts are unlikely on New Mexico Rivers. <sup>111</sup> Although FEMA does not appear to have consulted on disaster relief efforts or flood insurance and the silvery minnow in the past, future consultation policies are uncertain. Thus, this analysis conservatively estimates that future consultation rates with FEMA will increase due to critical habitat designation, resulting in one formal and 4 informal consultations with FEMA over the next 20 years.	Formal: 1 Informal: 4
U.S. Department of Transportation (Federal Highways)	Funding of road and bridge construction activities.	DOT consulted informally on the silvery minnow once in the past on a State highway and bridge construction project. The Service concurred that this project would have no effect on the silvery minnow. DOT states that silvery minnow critical habitat designation will cause little potential economic impact on their Federal programs. DOT states that no plans currently exist for projects in the three areas under consideration in this analysis. Consultation rates are not expected to increase. <sup>112</sup>	Formal: 0 Informal: 0
Bureau of Land Management	Land management activities.	Although the administrative record does not show that BLM has engaged in any past informal consultations on the silvery minnow on the Middle Rio Grande, they may choose to consult after critical habitat is designated. Informal consultation rates are expected to increase.	Formal: 0 Informal: 5
Technical Assistance <sup>c</sup>	Various: inquiries from private companies about procedure, notice of well-monitoring by State Engineer's Office, nitrate removal facilities by NM Environmental Department.	Because the silvery minnow critical habitat designation is a high profile one, the Service anticipates that a number of landowners and citizens are likely to contact them after critical habitat is designated. This analysis assumes that most of these contacts will occur within the first five years after designation. As a conservative assumption, this analysis estimates that 100 technical assistance efforts will be required per year for the first 5 years, followed by 25 efforts per year for an additional 15 years.	TA: 875

<sup>111</sup> Personal communication with FEMA, National office in Washington, DC, October 24, 2001.

<sup>112</sup> Personal communication with DOT, Federal Highways, Denver office, October 29, 2001.

Exhibit 6-2

**EXPECTED INCREASE IN NUMBER OF SILVERY MINNOW CONSULTATIONS ON THE MIDDLE RIO GRANDE  
DUE TO CRITICAL HABITAT FOR THE SILVERY MINNOW  
(20 YEARS)<sup>a</sup>**

Federal Agency	Activities Potentially Resulting in New Consultations on the Silvery Minnow	Notes	Estimated Increase in the Number of Consultations Over 20 Years <sup>b</sup>
Total	In total, this analysis estimates that after the designation of critical habitat, a 37 percent increase in formal consultations and a 43 percent increase in informal consultations associated with the silvery minnow may occur in the Middle Rio Grande over 20 years. In addition, 875 TAs are anticipated.		Formal: 13 Informal: 39 TA: 875

<sup>a</sup> Appendix D presents an analysis of individual reaches in the Middle Rio Grande unit.

<sup>b</sup> These consultations represent those likely to occur over and above those likely to occur without critical habitat.

<sup>c</sup> A consultation is currently underway regarding the City of Albuquerque's Drinking Water Project.

<sup>d</sup> Although four Pueblos have been removed from critical habitat destination (Santo Domingo, Santa Ana, Sandia, and Isleta are not included in the final designation), informal consultations may still occur over the next 20 years on the silvery minnow.

<sup>e</sup> Technical assistance here only include those requiring written correspondence.

### 6.3.2 Pecos River Area

180. Historic consultation activity on the Pecos River in areas identified as essential to the conservation of the silvery minnow has primarily involved the Pecos bluntnose shiner (shiner), a species which has been listed as federally threatened since 1987.<sup>113</sup> According to the consultation record, no past consultations on the silvery minnow have occurred on the Pecos River.<sup>114</sup> The shiner and the silvery minnow share similar biological requirements, and shiner critical habitat areas are entirely included within the area considered essential to the conservation of the silvery minnow. In addition, the Service has issued biological opinions for the shiner requesting that a "minimum flow" be maintained for the shiner on the Pecos River. This analysis further assumes that past consultation rates on the bluntnose shiner will continue, unchanged, in the future.
181. In addition to consultations that would have occurred due to the presence of the shiner, other consultation efforts would occur if critical habitat designation for the silvery minnow were designated on the Pecos River. First, because critical habitat designation for the silvery minnow would encompass more river area than the shiner critical habitat, this analysis projects the number of additional consultations that may occur by assuming that the number of historic consultations is proportional to the amount of river area included as critical habitat. Thus, historically, 2.5 actions occurred per year involving the shiner. Because the river area considered essential to the conservation of the silvery minnow is approximately twice the length of shiner critical habitat, this analysis assumes that twice as many consultations would occur annually if critical habitat were designated for the silvery minnow (4.4 per year). However, this estimate is likely to overstate the actual increase in consultation rate because historical consultations already occur frequently on projects located outside of shiner critical habitat, due to the interdependent nature of the river system.<sup>115</sup> Exhibit 6-3 presents the estimated number of new silvery minnow consultations and technical assistance efforts that would occur over and above baseline efforts if this area were designated as critical habitat for the silvery minnow.

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<sup>113</sup> Other threatened and endangered species for which consultations have occurred on the Pecos include: the interior least tern, Pecos gambusia, Northern aplomado falcon, Kenzler's hedgehog cactus, bald eagle, gypsum wild-buckwheat, Lee pincushion cactus, mountain plover, black-footed ferret, Mexican spotted owl, Pecos sunflower, and the Pecos pupfish.

<sup>114</sup> This is not surprising, as this area has been unoccupied since the silvery minnow was listed as endangered in 1994.

<sup>115</sup> Written correspondence with Biologist, U.S. Fish and Wildlife Service, Ecological Field Office, Albuquerque, New Mexico, December 17, 2001.

**Exhibit 6-3**

**PECOS: ESTIMATED NUMBER OF NEW SILVERY MINNOW SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED (20 YEARS)**

<b>Federal Agency</b>	<b>Activities Potentially Resulting in New Consultations on the Silvery Minnow</b>	<b>Historic Annual Consultation Rate on Bluntnose Shiner (formal, informal)</b>	<b>Annual Efforts Anticipated for Silvery Minnow<sup>a</sup> (formal, informal)</b>	<b>Notes</b>	<b>Estimated Number Future Consultations on the Silvery Minnow</b>
U.S. Fish and Wildlife Service (internal)	Fire management plans, emergency rescue/relocation of silvery minnow, reservoir fish stocking, vegetation management.	None, 0.25	0, 0.5	Assumes that consultation rate would double from that historically occurring on the bluntnose shiner.	Formal: 0 Informal: 10
Bureau of Reclamation	Water operations, including: bioengineering, habitat enhancement, river training, sediment removal, levee maintenance, vegetation removal.	0.38, 0.5	0.75, 1	Assumes that consultation rate would double from that historically occurring on the bluntnose shiner.	Formal: 15 Informal: 20
Army Corps of Engineers	Authorization and permitting of dredging and filling of wetlands, channelization of streams, flood control actions, bridge construction, sand and gravel operations under Section 404 of the Clean Water Act.	0.13, 0.5	0.25, 1	Assumes that consultation rate would double from that historically occurring on the bluntnose shiner.	Formal: 5 Informal: 20
Environmental Protection Agency	Permitting of municipal and industrial discharges under the National Pollutant Discharge Elimination System (NPDES).	None, 0.38	0, 0.75	EPA confirmed that an estimate of twice the historic consultation rate on the bluntnose shiner would be a good estimate of likely EPA efforts on the silvery minnow over 20 years. <sup>116</sup>	Formal: 0 Informal: 15
Bureau of Land Management <sup>c</sup>	Land management activities, grazing permitting.	None, 0.38	0.05, 0.75	BLM estimates that one large consultation would be required to amend the area's Resource Management Plan (RMP). One additional initial consultation may be required on current grazing activities.	Formal: 1 Informal: 15

<sup>116</sup> Personal communication with EPA.



Exhibit 6-3

**PECOS: ESTIMATED NUMBER OF NEW SILVERY MINNOW SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED (20 YEARS)**

Federal Agency	Activities Potentially Resulting in New Consultations on the Silvery Minnow	Historic Annual Consultation Rate on Bluntnose Shiner (formal, informal)	Annual Efforts Anticipated for Silvery Minnow <sup>a</sup> (formal, informal)	Notes	Estimated Number Future Consultations on the Silvery Minnow
Federal Emergency Management Agency <sup>c</sup>	Response and recovery actions following natural disasters.	None, 0	0.05, 0.1	See FEMA description in MRG Exhibit above. Although FEMA has not consulted on disaster relief efforts or flood insurance in the past, and future consultation policies are uncertain, this analysis conservatively estimates that the consultation rates with FEMA may increase, resulting in one formal and two informal consultations with FEMA over the next 20 years.	Formal: 1 Informal: 2
Technical Assistance	Request for information by private companies/landowners.	0.25	0.5	Because the silvery minnow critical habitat designation is a high profile one, the Service anticipates that a number of landowners and citizens are likely to contact them after critical habitat is designated. This analysis assumes that most of these contacts would occur within the first five years after designation. As a conservative assumption, this analysis estimates that 25 technical assistance efforts would be required per year for the first five years, followed by five efforts per year for the remaining years. <sup>b</sup>	TA: 200
Total	In total, this analysis estimates that after the designation of critical habitat, a 2,200 percent increase in formal consultations and a 8,200 percent increase in informal consultations associated with the silvery minnow may occur in the Middle Rio Grande over 20 years. In addition, 200 TAs are anticipated.				Formal: 22 Informal: 82 TA: 200

<sup>a</sup> The estimated consultation rate for the silvery minnow is double the rate historically occurring on the bluntnose shiner, except for FEMA consultation estimates.

<sup>b</sup> Estimates are scaled according to the population in this region.

<sup>c</sup> FEMA (formal and informal) and BLM (formal) consultations did not historically occur, so the estimated consultation rate is more than double the historical rate.

Sources: Administrative records provided by the Albuquerque Ecological Field Office, U.S. Fish and Wildlife Service, Albuquerque, NM, 2001. Note that these estimates assume that all past actions on the Rio Grande occur within the designated critical habitat unit. In reality, several may occur outside these boundaries. Thus, these estimates are likely to overestimate anticipated actions within these areas. Any anticipated increases in consultation activity by these agencies are not considered part of the baseline effects, and will be discussed in the non-baseline effects section of this report.

**6.3.3 Lower Rio Grande Area**

182. The Lower Rio Grande river stretch passes along the U.S. International Border with Mexico as it passes Big Bend National Park, and continues south to the southern border of the Wild and Scenic Rivers designation at the Terrell/Val Verde county line. As this area has been unoccupied by the silvery minnow since at least 1994, no consultations have occurred there on the silvery minnow. Exhibit 6-4 presents the number of estimated new consultations and technical assistance efforts that would occur on the Lower Rio Grande Pecos River over the next 20 years if critical habitat were designated in this area.

<b>Exhibit 6-4</b>			
<b>LOWER RIO GRANDE: ESTIMATED NUMBER OF NEW SILVERY MINNOW SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED (20 YEARS)</b>			
<b>Federal Agency</b>	<b>Activities Potentially Resulting in New Consultations on the Silvery Minnow</b>	<b>Historic Annual Consultation Rate (formal, informal)</b>	<b>Estimated Number of Consultations on the Silvery Minnow (20 Years)</b>
National Parks Service	National Park management, including pesticide application and fishing regulations.	None, none	Formal: 1 Informal: 2
U.S. Fish and Wildlife Service (internal)	Fire management plans, emergency rescue/relocation of silvery minnow, reservoir fish stocking, vegetation management.	None, none	Formal: 0 Informal: 4
U.S. International Boundary and Water Commission	Maintenance of Rio Grande as International boundary: channel improvements, flood control activities, flow regulation. This analysis assumes that one consultation may occur every four years with this agency.	None, none	Formal: 4 Informal: 0
U.S. Environmental Protection Agency	NPDES permitting. This analysis assumes that one formal consultation will occur every three years on either the Presidio or Lajitas wastewater treatment facility.	None, none	Formal: 7 Informal: 0
Technical Assistance	Request for information by private companies/landowners.	None	Technical Assistance: 100
Total			Formal: 12 Informal: 6 TA: 100

**6.4 Summary of the Number of Baseline and Additional Section 7 Actions Anticipated for the Silvery Minnow**

183. Exhibit 6-5 summarizes the numbers of consultations likely to occur in association with section 7 efforts and the silvery minnow over the next 20 years.

<b>Exhibit 6-5</b>			
<b>SUMMARY OF ESTIMATED NUMBER OF SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED FOR THE SILVERY MINNOW (20 YEARS)</b>			
<b>River</b>	<b>Number of Coextensive Consultations</b>	<b>Number of Consultations Due to Critical Habitat Alone</b>	<b>Total Actions</b>
Middle Rio Grande	Formal: 36 Informal: 92 TA: 15	Formal: 13 Informal: 39 TA: 875	Formal: 49 Informal: 131 TA: 890
Pecos	Formal: 0 Informal: 0 TA: 0	Formal: 22 Informal: 82 TA: 200	Formal: 22 Informal: 82 TA: 200
Lower Rio Grande	Formal: 0 Informal: 0 TA: 0	Formal: 12 Informal: 6 TA: 100	Formal: 12 Informal: 6 TA: 100

**6.5 Estimated Per-Effort Costs of Consultations and Technical Assistance**

184. Estimates of the cost of an individual consultation were developed from a review and analysis of historical section 7 files from a number of Service field offices around the country. These files addressed consultations conducted for both listings and critical habitat designations. Cost figures were based on an average level of effort for consultations of low, medium, or high complexity, multiplied by the appropriate labor rates for staff from the Service and other Federal agencies. Estimates take into consideration the level of effort of the Service, the Action agency, and the applicant during both formal and informal consultations, as well as the varying complexity of consultations. Informal consultations are assumed to involve a low to medium level of complexity. Formal consultations are assumed to involve a medium to high level of complexity.

185. Section 7 consultation costs include the administrative costs associated with conducting the consultation, such as the cost of time spent in meetings, preparing letters, and in some cases, developing a biological assessment and biological opinion. The costs of reinitiating a consultation are assumed to be similar to conducting the original consultation

because the re-initiation generally involves time spent in meetings and preparing letters. This analysis assumes that the economic impact associated with a non-substantive re-initiation is similar to the cost of an informal consultation and the economic impact associated with a substantive re-initiation is similar to the cost of a formal consultation.

186. Cost estimates for technical assistance are based on an analysis of past technical assistance efforts by the Service in California (Carlsbad Field and Wildlife Office). Technical assistance costs represent the estimated economic costs of informational conversations between landowners or managers and the Service regarding the designation of critical habitat for the silvery minnow. Most likely, such conversations will occur between municipal or private property owners and the Service regarding areas designated as critical habitat or lands adjacent to critical habitat. Costs associated with these phone calls include the opportunity cost of time spent in conversation, as well as staff costs. Based on conversations with staff at the New Mexico Ecological Services Field Office, estimates of technical assistance efforts appear comparable. Thus, this analysis finds that these estimates can be reasonably applied to silvery minnow technical assistance efforts.

187. Estimated administrative costs associated with section 7 consultations, re-initiations, and technical assistance efforts are presented in Exhibit 6-6 (these are per effort estimates).

<b>Exhibit 6-6</b>				
<b>ESTIMATED ADMINISTRATIVE COSTS OF CONSULTATION AND TECHNICAL ASSISTANCE FOR THE SILVERY MINNOW (PER EFFORT)</b>				
<b>Critical Habitat Impact</b>	<b>Scenario</b>	<b>Service</b>	<b>Action Agency</b>	<b>Third Party</b>
Technical Assistance Effort	Low	\$260	n/a	\$600
	High	\$680	n/a	\$1,500
Informal Consultation/ Non-substantive Re-initiation <sup>a</sup>	Low	\$1,000	\$1,300	\$1,200
	High	\$3,100	\$3,900	\$6,900
Formal Consultation/ Substantive Re-initiation <sup>a</sup>	Low	\$3,100	\$3,900	\$6,900
	High	\$6,100	\$6,500	\$9,700

<sup>a</sup> Includes costs associated with the preparation of a biological assessment or other biological project evaluation.  
 Notes: Low and high estimates primarily reflect variations in staff wages and time involvement by staff. Technical assistance calls also have educational benefits to the landowner or manager and to the Service.  
 Sources: IEc analysis based on data from the Federal Government General Schedule Rates, 2002, Office of Personnel Management, 2002, and level of effort information from Biologists in the U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office.

## 6.6 Estimated Per Effort Costs of Project Modifications

188. The section 7 consultation process may involve some modifications to a proposed project. These modifications may be agreed upon by the Action agency and the applicant and included in the project description as avoidance and minimization measures, or they may be required by the Service as terms and conditions to implement the reasonable and prudent measures. In some cases, the Service may determine that the project will jeopardize the species or adversely modify its critical habitat. In these cases the Service and Action agency may require the applicant to comply with reasonable and prudent alternatives to the proposed project, develop their own reasonable and prudent alternatives, or seek an exemption for the project. All of these project modifications represent some type of cost, as estimated below.
189. This analysis provides estimates of the number and cost of several types of project modifications that may occur as a result of critical habitat designation for the silvery minnow. These project modifications are anticipated because they have occurred in past formal consultations that involved the silvery minnow and/or the Pecos bluntnose shiner.<sup>117</sup> Because past consultations have considered habitat conditions, they are likely to be good predictors of the types of consultations that the Service may require as a result of critical habitat designation for the silvery minnow. In fact, due to the unusual history of critical habitat designation for this species, many consultations on the Middle Rio Grande have already taken critical habitat effects into account when the consultation was originally conducted.
190. Because the Service usually consults on the silvery minnow in conjunction with several other species, some project modifications are not entirely attributable to the inclusion of the silvery minnow in a consultation. For example, some past consultations have required that agencies remove exotic vegetation, a measure that would benefit several endangered species, including the silvery minnow. In other cases, project modifications are designed to specifically target the silvery minnow or its habitat. The following list includes project modifications which are partially or wholly attributable to the inclusion of the silvery minnow in a consultation, and may be included as a part of consultations on silvery minnow critical habitat in the future. Cost estimates are summarized below in Exhibit 6-7.

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<sup>117</sup> This is based on analysis of biological opinions prepared by the Service that consider the silvery minnow and the Pecos bluntnose shiner. Records indicate that Service responses to consultations on the bluntnose shiner are not significantly different from those for the silvery minnow. Thus, both sets of data were analyzed in order to assess the types of project modifications that the Service is likely to recommend in silvery minnow critical habitat areas.

<b>Exhibit 6-7</b>			
<b>ESTIMATED ECONOMIC COSTS ASSOCIATED WITH POTENTIAL PROJECT MODIFICATIONS (PER MODIFICATION)</b>			
<b>Project Type</b>	<b>Potential Project Modification</b>	<b>Typical Costs</b>	
		<b>Low</b>	<b>High</b>
Water Operations	Adequate water supply <sup>a</sup>	~	~
	Upstream Passage	\$180,000	\$600,000 <sup>b</sup>
	River flow monitoring	\$9,000	\$30,000
	Habitat/Ecosystem Restoration	\$500,000	\$1,000,000
	Population/Habitat monitoring	\$18,000	\$54,000
	Silvery minnow handling protocol	negligible	negligible
	Other conservation efforts	\$0	\$325,000 <sup>c</sup>
	<b>Total Project Modification Costs</b>	<b>\$707,000</b>	<b>\$2,009,000</b>
Silvery Minnow rescue/relocation	Silvery minnow handling protocol	negligible	negligible
	<b>Total Project Modification Costs</b>	<b>negligible</b>	<b>negligible</b>
Flood protection	Adequate river flow	~	~
	Exotic species removal	\$500	\$300,000
	Population/Habitat monitoring	\$18,000	\$54,000
	<b>Total Project Modification Costs</b>	<b>\$18,500</b>	<b>\$354,000</b>
Channel modification/ construction	Adequate river flow	~	~
	Annual Monitoring Report	negligible	negligible
	Habitat/Ecosystem Restoration	\$500,000	\$1,000,000
	<b>Total Project Modification Costs</b>	<b>\$500,000</b>	<b>\$1,000,000</b>
Bridge construction	Best Management Practices	negligible	negligible
	Contain hazardous substances	negligible	negligible
	Limit construction period	negligible	negligible
	<b>Total Project Modification Costs</b>	<b>negligible</b>	<b>negligible</b>
NPDES permitting	Larval toxicity tests	\$10,000	\$30,000
	<b>Total Project Modification Costs</b>	<b>\$10,000</b>	<b>\$30,000</b>
Resource Management Plans	Various	0	\$500,000
	<b>Total Project Modification Costs</b>	<b>0</b>	<b>\$500,000</b>

<sup>a</sup> Costs to provide adequate water supply are estimated in Sections 3 and 4.  
<sup>b</sup> This is a construction costs estimate, and thus is estimated as a one-time future cost.  
<sup>c</sup> This cost is rare, and is assumed only to occur in one of ten future consultations.  
Source: Based on IEC conversations with Jones & Stokes Associates, Inc., Irvine CA, May 2001 and Dudek and Associates, Encinitas, CA, April 2001 and Letter from Best, Best, & Krieger, May 23, 2001.

### 6.6.1 Water Operations Projects

191. Water operations projects include consultations on water operations for the winter and irrigation seasons. Based on historic consultation records, this analysis assumes that 80 percent of future formal consultations with BOR and 50 percent of consultations with ACOE on the silvery minnow will be associated with water operations projects.<sup>118</sup> In addition to these agencies, the following agencies may also bear some costs for conservation efforts: MRGCD, Carlsbad Irrigation District, New Mexico Fish and Game, New Mexico Office of the State Engineer, the New Mexico Interstate Stream Commission (ISC), and private water holders.

- C **Provide adequate river flow.** In several past formal consultations with BOR and ACOE, the Service has requested that these agencies attempt to provide adequate river flow for the silvery minnow and the bluntnose shiner. The programmatic opinion written by the Service on water operations in the Rio Grande specified that minimum flows be provided for the silvery minnow (May 2001). Similarly, a recent biological opinion on the bluntnose shiner specified that minimum flows be provided for that species. The future costs of this effort are estimated to be substantial, and thus are discussed at length in Sections 4 and 5 of this report.
- C **Provide upstream fish passage.** At least two past formal biological opinions on the silvery minnow have recommended that the agencies provide upstream passage for silvery minnow at San Acacia Dam. An estimate given to the Service of the costs to install a denil fishway<sup>119</sup> at San Acacia Dam was \$600,000, including costs of construction materials, design and construction management, borings, removal of bedrock, etc.<sup>120</sup> Costs to maintain fish passage systems are assumed to be 10 percent of construction costs, or \$60,000 per year (\$180,000 over the term of the consultation).
- C **Monitoring of flows and river conditions throughout summer operations.** In several past consultations, the Service has recommended that site visits be conducted to monitor surface flow conditions. The Service states that such

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<sup>118</sup> See biological opinions for project numbers 01-431, 96-422, and 97-300.

<sup>119</sup> A denil fishway is a series of sloped water channels which allow fish to swim over the dam.

<sup>120</sup> Written communication between the Service and fishway consultant, January 7, 2000.

monitoring efforts may include visiting the river three to four times a day in dry months. Costs of this effort are estimated at \$3,000 to \$10,000 per year, or \$9,000 to \$30,000 over the term of the consultation.

- C **Conduct habitat/ecosystem restoration projects.** In past consultations on the silvery minnow associated with water operations, the Service has requested that one of several habitat restoration projects be undertaken, including restocking fish upstream of presently inhabited areas, installing fish screens, and restoring habitat. The Service estimates that the most costly of these projects could include a gradient restoration or habitat improvement facility, which could involve the manipulation of the river channel shape, and tree or other vegetation removal. The Service has received estimates that these efforts may cost \$500,000 to \$1 million.<sup>121</sup>
- C **Population and habitat monitoring.** Past consultations have recommended that agencies monitor fish populations and salvage eggs. Efforts are assumed to continue monthly year round. Costs are estimated at \$5,700 to \$18,000 per year, or \$17,000 to \$54,000 over the term of the consultation.
- C **Follow established silvery minnow handling protocol.** All formal consultations involving water operations caution that the Service should follow the established protocols that governs the collection, transport, and release of fish. These include specific water temperatures, oxygen levels, fish net types, etc. The Service does not expect that the costs of implementing these guidelines will increase the costs already being undertaken for fish transport and release. Thus, costs of following this protocol are assumed to be negligible.
- C **Other conservation recommendations.** A single past formal consultation on the silvery minnow has resulted in the recommendation that agencies set aside \$325,000 for captive propagation activities and efforts that will establish one or more viable populations of silvery minnow. This recommendation is rarely included in consultations, and thus is assumed to be included in 10 percent of future water operations consultations.

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<sup>121</sup> Personal communication with Biologists, U.S. Fish and Wildlife Service, Albuquerque Ecological Services Field Office, October 19, 2001.



### 6.6.2 Silvery Minnow Rescue/Relocation

192. Silvery minnow rescue and relocation efforts are primarily conducted by the Service in recovery efforts and rescue operations. Based on historical consultation records, this analysis assumes that all internal Service consultations on the silvery minnow will be associated with rescue and relocation of the silvery minnow.<sup>122</sup> In addition to the Service, the New Mexico Department of Fish and Game and BOR may also bear some costs of these conservation efforts.

- C **Follow established silvery minnow handling protocol.** All formal consultations involving water operations caution that the Service should follow the established protocol that govern the collection, transport, and release of fish. These include specific water temperatures, oxygen levels, fish net types, etc. As stated above, the costs of implementing these procedures is expected to be negligible.

### 6.6.3 Flood Protection

193. Flood protection consultations have historically involved the ACOE.<sup>123</sup> Based on historical consultation records, this analysis assumes that 25 percent of future ACOE consultations on the silvery minnow will be associated with flood protection projects. The primary agency likely to bear the costs of these actions is the ACOE, although other stakeholders may include BOR, MRGCD, the New Mexico Office of the State Engineer, the New Mexico Interstate Stream Commission, FEMA, and local or municipal governments.<sup>124</sup>

- C **Provide adequate river flow.** At least one past formal consultation involving flood protection issues and the silvery minnow has encouraged water management that will provide a permanent minimum flow for the silvery minnow throughout its habitat. As stated above, the future costs of these efforts are estimated to be substantial, and thus are discussed at length in Sections 4 and 5 of this report.

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<sup>122</sup> See biological opinion for project numbers 96-305, 00-287, 98-411.

<sup>123</sup> See biological opinion for project numbers 01-431, 96-422, and 97-300.

<sup>124</sup> See biological opinion for project number 95-180.

- C **Exotic species removal.** Past consultations on flood control have recommended the removal of exotic plant species from river bank areas in silvery minnow habitat. The Service estimates that plant removal projects vary from five to 300 acres, and may costs \$100 to \$1,000 per acre. Thus, plant removal projects are estimated to vary in cost from \$500 to \$300,000.
- C **Population and habitat monitoring.** As stated above, consultations have recommended that agencies monitor fish populations and salvage eggs. Efforts are assumed to continue monthly, year round. Costs are estimated at \$5,700 to \$18,000 per year, or \$17,000 to \$54,000 over the term of the consultation.

#### 6.6.4 Channel Modification/Construction

194. Historically, the Service has consulted with BOR and ACOE on projects aiming to build or modify existing channel features. Based on historical consultation records, this analysis assumes that 10 percent of formal BOR consultations and 25 percent of formal ACOE consultations on the silvery minnow will be associated with channel modification or construction projects.<sup>125</sup> Other stakeholders may include the MRGCD, Carlsbad Irrigation District, and the New Mexico Interstate Stream Commission.

- C **Provide adequate river flow.** At least one past formal consultation involving channel modification or construction issues and the silvery minnow has encouraged water management that will provide a permanent minimum flow for the silvery minnow throughout it habitat. As stated above, the future costs of these efforts are estimated to be substantial, and thus are discussed at length in Sections 4 and 5 of this report.
- C **Annual monitoring report.** Channel modification/construction projects have resulted in the preparation of annual monitoring report of all activities associated with the project relative to the silvery minnow for the Service. The Service states that such documents are not generally more than 10 pages long and do not require substantial effort on the part of the Action agency. Thus, this analysis assumes that costs associated with producing an annual status reports are negligible.

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<sup>125</sup> See biological opinion for project number 97-053.

- C **Provide upstream fish passage.** As stated above, an estimate given to the Service of the costs to install a denil fishway at San Acacia Dam was \$600,000, including costs of construction materials, design and construction management, borings, removal of bedrock, etc.<sup>126</sup> Costs to maintain fish passage systems are assumed to be 10 percent of construction costs, or \$60,000 per year (\$180,000 over the term of the consultation).
  
- C **Conduct habitat/ecosystem restoration projects.** As stated above, the Service has requested in the past that one of several habitat restoration projects be undertaken, including restocking fish upstream of presently inhabited areas, installing fish screens, and restoring habitat. The Service estimates that the most costly of these projects could include a gradient restoration or habitat improvement facility, which could involve the manipulation of the river channel shape and tree or other vegetation removal.<sup>127</sup> The Service has received estimates that these efforts may cost as much as \$500,000 to \$1 million.<sup>128</sup>

#### 6.6.5 Bridge Construction

195. Historically, bridge construction activities have primarily involved the BOR and ACOE. Based on historical consultation records, this analysis assumes that 10 percent of formal BOR consultations and 25 percent of formal ACOE consultations on the silvery minnow will be associated with bridge construction activities. Other stakeholders may include DOT (Federal Highways), and local or municipal governments.

- C **Use Best Management Practices for construction activities.** In a past consultation on bridge construction, the Service requested that the Action agency use Best Management Practices associated with construction activities (BMPs). Recommended practices included using silt fences, non-erosive cofferdams, and site drainage systems. In addition, the Service requested that the Agency limit channel disturbance by construction activities by maintaining/replacing instream debris existing prior to construction; limiting stream channel disturbance to cofferdams and work platforms;

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<sup>126</sup> Written communication between the Service and fishway consultant, January 7, 2000.

<sup>127</sup> See biological opinion for project number 01-431.

<sup>128</sup> Personal communication with Biologists, U.S. Fish and Wildlife Service, Albuquerque Ecological Services Field Office, October 19, 2001.

restoring the channel to preconstruction configuration (fill in any deep holes created by platforms); and minimizing silt and erosional materials entering the river. The Service states that such requirements are standard in the Rio Grande, and that such requirements should not place substantial economic burden on the Action agency beyond those already in place for riparian areas. Thus, this analysis assumes that the implementation of BMPs will have a negligible economic impact on the Action agency.

- C **Contain hazardous substances.** Past consultations on the silvery minnow involving bridge construction have requested no refueling of vehicles in the river channel, storage of hazardous substances in bermed and lined locations outside the 100-year floodplain, cleaning vehicles daily of petroleum before entering river, and containing all lubricating slurries to a steel cofferdam. The Service states that such requirements are standard in the Rio Grande, and that these should not place substantial economic burden on the Action agency beyond those already in place for riparian areas. Thus, this analysis assumes that the containment of hazardous substances will have a negligible economic impact on the Action agency.
  
- C **Limit construction period from late July to early March.** Because the recommended construction season is the low-water season, it should also be the best time for construction work. The Service states that a limitation on construction in the high flow period should not cause delays to ongoing projects much beyond those already likely to occur when water levels are high. Thus, this analysis assumes that the low-water construction period limits will have a negligible economic impact on the Action agency.

#### 6.6.6 NPDES Permitting

- 196. Formal consultations associated with NPDES permitting involve EPA, and have historically resulted only on large, high-profile facilities, such as wastewater treatment plants. Past formal consultations on NPDES permits have not resulted in project modifications. However, past informal consultations have requested that the Action agency require the applicant to perform a larval toxicity test for the fathead minnow. Other stakeholders in such consultations are likely to include local or municipal governments.

- C **Larval toxicity testing.** Past informal consultations on the silvery minnow have requested that the Action agency require that the applicant periodically conduct standard larval (i.e. less than 24 hours old) fathead minnow toxicity tests with samples of the treated effluent. The Service estimates the costs of such efforts at \$10,000 to \$30,000.

### 6.6.7 Resource Management Plans

197. Although few consultations on resource management plans have been formal, a past formal consultation on a BLM Resource Management Plan has occurred that included the bluntnose shiner. Costs of project modifications on such plans are difficult to standardize as they are extremely project specific. In the past, project modifications have included:

- C **Protecting the 100-year floodplain.** The historic consultation encouraged the continuation of a policy to have no sales of new oil or gas leases on lands within the 100-year floodplain of the Pecos River, unless BLM could demonstrate the effectiveness of other mandatory protective measures. The Service supported BLM's plan to implement the "no surface occupancy within floodplains" section of management plan, and to establish best management practices for oil and gas drilling operations in the 100-year floodplain. Because these project modifications are likely to vary with each project, this analysis assumes a range of possible impacts of zero to \$500,000.

### 6.7 Costs Summary

198. The total costs of formal, informal, and technical assistance costs are calculated using the projected number of consultations and the per effort costs (see Exhibit 6-6). Project modification costs are calculated using the fraction of formal consultations by each agency that are estimated to be associated with each project type, using the following assumptions:

- C 80 percent of future formal consultations with BOR and 50 percent of consultations with ACOE on the silvery minnow will be associated with water operations projects;
- C All internal Service consultations on the silvery minnow will be associated with rescue and relocation of the silvery minnow;

- C All U.S. International Boundary and Water Commission (USIBWC) consultations on the silvery minnow will be associated with water operations projects;
  - C 25 percent of future ACOE consultations and all future FEMA consultations on the silvery minnow will be associated with flood protection projects;
  - C 10 percent of formal BOR consultations and 25 percent of formal ACOE consultations on the silvery minnow will be associated with channel modification or construction projects;
  - C 10 percent of formal BOR consultations and 25 percent of formal ACOE consultations on the silvery minnow will be associated with bridge construction activities;
  - C All EPA consultations will be associated with NPDES permitting; and
  - C All BLM consultations will be associated with Resource Management Plans.
199. Exhibit 6-8 summarizes the estimated costs that may be associated with baseline formal and informal consultations, technical assistance and project modifications.

<b>Exhibit 6-8</b>								
<b>SUMMARY OF COSTS OF COEXTENSIVE SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED FOR THE SILVERY MINNOW</b>								
<b>Action</b>	<b>Middle Rio Grande</b>		<b>Pecos</b>		<b>Lower Rio Grande</b>		<b>Total Costs</b>	
	<b>Low</b>	<b>High</b>	<b>Low</b>	<b>High</b>	<b>Low</b>	<b>High</b>	<b>Low</b>	<b>High</b>
Formal Consultation	\$500,400	\$802,80000	\$0	\$0	\$0	\$0	\$500,400	\$802,800
Informal Consultation	\$322,000	\$1.3 million	\$0	\$0	\$0	\$0	\$322,000	\$1.3 million
Technical Assistance	\$12,900	\$32,700	\$0	\$0	\$0	\$0	\$12,900	\$32,700
Project Modifications	\$14.0 million	\$23.4 million	\$0	\$0	\$0	\$0	\$14.0 million	\$23.4 million
<b>Total</b>	<b>\$14.9 million</b>	<b>\$25.5 million</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$14.9 million</b>	<b>\$25.5 million</b>
Source: IEC analysis.								

200. Exhibit 6-9 summarizes the estimated costs that may be associated with formal and informal consultations, technical assistance and project modifications that may occur over and above the baseline.

Exhibit 6-9								
SUMMARY OF ESTIMATED COSTS OF NEW SECTION 7 CONSULTATIONS AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED FOR THE SILVERY MINNOW (20 YEARS)								
Action	Middle Rio Grande		Pecos		Lower Rio Grande		Total Costs	
	Low	High	Low	High	Low	High	Low	High
Formal Consultation	\$180,700	\$289,900	\$305,800	\$490,600	\$166,800	\$267,600	<b>\$653,300</b>	<b>\$1.0 million</b>
Informal Consultation	\$119,000	\$472,600	\$287,000	\$1.1 million	\$21,000	\$83,400	<b>\$427,000</b>	<b>\$1.7 million</b>
Technical Assistance	\$752,500	\$1.9 million	\$180,600	\$457,800	\$86,000	\$218,000	<b>\$1.0 million</b>	<b>\$2.6 million</b>
Project Modifications	\$4.5 million	\$8.1 million	\$11.6 million	\$19.4 million	\$3.6 million	\$7.8 million	<b>\$19.8 million</b>	<b>\$35.3 million</b>
<b>Total Costs</b>	<b>\$5.6 million</b>	<b>\$10.8 million</b>	<b>\$12.4 million</b>	<b>\$21.5 million</b>	<b>\$3.9 million</b>	<b>\$8.4 million</b>	<b>\$21.9 million</b>	<b>\$40.7 million</b>

Source: IEc analysis.

## 6.8 Limitations of the Cost Analysis

201. While these cost estimates reflect the best information currently available on the impacts of critical habitat for the silvery minnow, it is important to account for certain limitations and uncertainties associated with the quantitative results. Limitations associated with the estimates of costs of consultations and project modifications are described below.

### 6.8.1 Consultation Cost Estimates

202. It is likely that the estimates of consultation costs presented in this analysis *overestimate* the actual costs associated with section 7 consultations for silvery minnow critical habitat, for the following reasons:

- C **Use of historical data:** This analysis projects that over the next 20 years, the number of section 7 consultations likely to be conducted closely tracks the frequency of historical consultations. However, it is possible that the frequency of consultations will decrease over time because many projects



and activities will be addressed by one or a few section 7 consultations initiated around the time of the project's inception, rather than repeated consultations over a 20-year period.

- C **Double-counting:** Double-counting of consultation costs may arise from two factors: (1) Section 7 consultations often address potential impacts of a given activity or project on multiple listed species and/or critical habitat designations rather than addressing individual species and/or designations in separate consultations. The cost estimates presented in this analysis, however, attribute all of the administrative effort associated with a given project or activity to the presence of the silvery minnow only, and not to other species or designations that overlap with the silvery minnow designation. Therefore, these figures probably overestimate the true costs of consultations associated with the designation for the silvery minnow. (2) In this case, the cost of formally consulting on a project that had been addressed previously during an informal consultation should be significantly less than the cost of a newly initiated formal consultation, as some biological survey costs probably were incurred during the informal consultation. These cost estimates, however, assume that all formal consultations performed due to the silvery minnow designation begin with no prior administrative or biological work, and thereby overestimate actual costs of formal consultations which evolve from informal consultations.

## 6.8.2 Project Modification Costs

203. **Data limitations:** Rather than generating speculative estimates of potential modifications to specific projects on an exhaustive, case-by-case basis, this analysis models modifications to average or "typical" projects likely to affect silvery minnow critical habitat. Actual modification costs will vary significantly according to the specific characteristics of individual projects and consultation outcomes, which are difficult to predict with accuracy.

**SUMMARY OF TOTAL COSTS**

**SECTION 7**

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204. Costs of designating critical habitat for the silvery minnow include (1) the opportunity cost of water needed to supplement instream flow; (2) direct, indirect, and induced economic effects due to the resulting changes in the use of water; and (3) costs of section 7 consultations. Exhibits 7-1 through 7-4 summarize these costs below.

<b>Exhibit 7-1</b>							
<b>ESTIMATED OPPORTUNITY COSTS TO MEET MINIMUM INSTREAM FLOW FOR SILVERY MINNOW CRITICAL AND OTHER ESSENTIAL HABITAT</b>							
<b>River Segment</b>	<b>Unit Price (\$ per acre/foot)</b>	<b>Transaction Costs (\$ per acre/foot)<sup>a</sup></b>	<b>Estimated Annual Water Deficit (acre-feet/year)<sup>b</sup></b>	<b>Estimated Total Opportunity Cost (2001\$)</b>	<b>Estimated Present Value 20 Year Opportunity Cost (3%)</b>	<b>Estimated Present Value 20 Year Opportunity Cost (7%)</b>	<b>Estimated Annual Opportunity Cost<sup>c</sup></b>
<i>95th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	40,427	\$205,490,000	\$91,720,000	\$152,390,000	\$6,160,000 to \$14,380,000
Pecos	\$1,750	\$183	24,463	\$47,290,000	\$21,110,000	\$35,067,000	\$1,420,000 to \$3,310,000
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<i>50th Percentile Scenario</i>							
Middle Rio Grande	\$4,750	\$333	5,635	\$28,640,000	\$12,780,000	\$21,240,000	\$860,000 to \$2,000,000
Pecos	\$1,750	\$183	16,431	\$31,760,000	\$14,180,000	\$23,550,000	\$950,000 to \$2,220,000
Lower Rio Grande	n/a	n/a	0	\$0	\$0	\$0	\$0
<sup>a</sup> Average of transaction cost estimates from Easter et al (1999) and <a href="http://www.waterbank.com/Agreements/Agency%20Agreement.htm">http://www.waterbank.com/Agreements/Agency%20Agreement.htm</a> <sup>b</sup> See Appendices B and C for detailed calculation of these volumes. <sup>c</sup> This estimate uses three and seven percent discount rates to calculate an annualized value.							

Exhibit 7-2				
SUMMARY TABLE OF REGIONAL ECONOMIC EFFECTS OF PROVIDING A TARGET FLOW OF 50 CFS IN SILVERY MINNOW CRITICAL AND OTHER ESSENTIAL HABITAT				
River Segment	Value of Forgone Crop Production (2001\$)	Effect on Regional Output <sup>a</sup> (2001\$)	Effect on Regional Employment (persons)	Effect on Regional Tax Revenue (2001\$)
	<i>Direct Effect</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>
<i>95th Percentile Scenario</i>				
Middle Rio Grande	\$5,979,390	\$8,392,464	362	\$1,430,771
Pecos	\$4,212,436	\$6,243,432	158	\$615,779
<i>50th Percentile Scenario</i>				
Middle Rio Grande	\$833,450	\$1,169,801	51	\$199,431
Pecos	\$2,829,356	\$4,193,509	106	\$413,599

<sup>a</sup> Note that the effects on regional output, employment, and tax revenue include both the direct effect used as an input to the model (see Section 5.2.1) and the modeled indirect or secondary effects on the economy of the study area.

Exhibit 7-3						
SUMMARY OF SECTION 7 COSTS OF CRITICAL AND OTHER ESSENTIAL HABITAT FOR THE SILVERY MINNOW: CONSULTATIONS AND PROJECT MODIFICATIONS						
River Segment	Coextensive Costs (20 years)	Consultations Due to Critical Habitat Alone (20 years)	Total Section 7 Costs (20 years)	Present Value of Total Section 7 Costs 3%	Present Value of Total Section 7 Costs 7%	Total Section 7 Costs (annual) <sup>a</sup>
Middle Rio Grande	\$14.9 to \$25.5 million	\$5.6 to \$10.8 million	\$20.4 to \$36.3 million	\$15.2 to \$27.0 million	\$10.8 to \$19.1 million	\$1.0 to \$1.8 million
Pecos River	\$0	\$12.4 to \$21.5 million	\$12.4 to \$21.5 million	\$9.2 to \$16.0 million	\$6.6 to \$11.4 million	\$620,000 to \$1.1 million
Lower Rio Grande	\$0	\$3.9 to \$8.4 million	\$3.9 to \$8.4 million	\$2.9 to \$6.3 million	\$2.1 to \$4.4 million	\$195,000 to \$420,000

<sup>a</sup> This estimate uses three and seven percent discount rates to calculate an annualized value.

205. Exhibit 7-4 presents the opportunity cost of providing a target flow of 50 cfs (from Exhibit 7-1) as well as the annualized costs associated with section 7 consultations (from Exhibit 7-3). It uses the 95<sup>th</sup> and 50<sup>th</sup> percentile flow values as the basis for high- and low-end cost estimates, in combination with the range of values presented in Exhibit 7-3. Note that the values presented in Exhibit 7-2 represent a one-time change to baseline (e.g., without critical habitat) economic conditions. As such, they are not comparable to and cannot be summed with the impact estimates presented in 7-4. That is, these are both important, but distinct measures of impact.

<b>Exhibit 7-4</b>			
<b>SUMMARY OF ANNUALIZED COSTS ASSOCIATED WITH CRITICAL AND OTHER ESSENTIAL HABITAT: CONSULTATIONS, PROJECT MODIFICATIONS, AND TARGET FLOWS</b>			
<b>River Segment</b>	<b>Consultation and Project Modification Costs (2001\$)</b>	<b>Opportunity Cost to Provide Target Flows (2001\$)</b>	<b>Total Annualized Costs<sup>a</sup> (2001\$)</b>
Middle Rio Grande	\$1.0 to \$1.8 million	\$860,000 to \$14.4 million	\$1.9 to 16.2 million
Pecos	\$620,000 to \$1.1 million	\$950,000 to \$3.3 million	\$1.6 to 4.4 million
Lower Rio Grande	\$195,000 to \$420,000	\$0	\$195,000 to \$420,000

<sup>a</sup> Total annualized costs are calculated by adding the total annual consultation and project modification costs presented in Exhibit ES-1 to the annual opportunity costs presented in Exhibit ES-2. This table does not include regional economic effects.

206. This analysis relies on a number of assumptions. Exhibit 7-5 provides a list of these assumptions and indicates whether each is likely to result in an underestimate or overestimate of costs.

<b>Exhibit 7-5</b>		
<b>CAVEATS TO THE ECONOMIC ANALYSIS</b>		
<b>Analysis</b>	<b>Assumption</b>	<b>Effect on Cost Estimate</b>
Hydrological Analysis	Historic data offer an accurate prediction of future water supplies.	?
	No policy can guarantee flow at all times and so this analysis relies on historical data to estimate the quantity of water needed to achieve an instream flow of 50 cfs in the 95th percentile driest year, rather than an average supplemental value.	+
	The hydrological model accurately predicts water volume needed for silvery minnow.	?
Value of Water/ Market Analysis	The value of water in perpetuity is a reasonable representation of the value of water within the 20-year time horizon of this analysis.	+
	Contingent water markets do not exist.	+
	Inter-state transfers of water are not possible.	+
Regional Economic Analysis	Farmers who trade water rights will retire acreage rather than switch to more efficient technology or less water-intensive crops.	+
	Water removed from irrigation for instream flow will come from alfalfa crops.	+
	The structure of the economy will be static over time.	+
Consultation and Project Modification Costs	Historic patterns of consultations and project modifications are good predictors of future consultation behavior.	?
	Consultation rates will not decrease over time.	+
	The presence of other species (i.e., bluntnose shiner, flycatcher) has no influence on consultation/project modification costs.	+
? : unknown effect - : underestimates costs + : overestimates costs		

## OTHER IMPACTS OF DESIGNATING CRITICAL HABITAT

## SECTION 8

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### 8.1 Potential Impacts on Small Businesses

207. Under the Regulatory Flexibility Act (as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), whenever a Federal agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small government jurisdictions).<sup>129</sup> However, no regulatory flexibility analysis is required if the head of an agency certifies that the rule will not have a significant economic impact on a substantial number of small entities.<sup>130</sup> SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide a statement of the factual basis for certifying that a rule will not have a significant economic impact on a substantial number of small entities. Accordingly, the following represents a screening level analysis of the potential effects of critical habitat designation on small entities to assist the Secretary in making this certification.

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<sup>129</sup> Regulatory Flexibility Act, 5 U.S.C. 601 et. seq.

<sup>130</sup> Thus, for a regulatory flexibility analysis to be required, impacts must exceed a threshold for "significant impact" **and** a threshold for a "substantial number of small entities." See 5 U.S.C. 605 (b).

208. This analysis determines whether this critical habitat designation potentially affects a "substantial number" of small entities in counties supporting critical habitat areas. It also quantifies the probable number of small businesses that will experience a "significant effect." While SBREFA does not explicitly define either "substantial number" or "significant effect," the Small Business Administration (SBA) and other Federal agencies have interpreted these terms to represent an impact on 20 percent or more of the small entities in any industry and an effect equal to three percent or more of a business' annual sales.<sup>131</sup>
209. Note that this analysis is intended to quantify the effects of a rulemaking on small businesses that directly experience an increased regulatory burden. As a result, this analysis does not consider parties, such as individual farmers, who might sell water rights to agencies seeking to increase in instream flow as "affected" small businesses.

#### **8.1.1 Estimated Number of Small Businesses Affected: The "Substantial Number" Test**

210. Based on the past consultation history for the silvery minnow, discharges from municipal wastewater treatment plants and other large manufacturing facilities are the primary activities anticipated to be affected by the designation of critical habitat that could affect small businesses. Historic evidence indicates that NPDES permits have been divided approximately evenly between municipal wastewater treatment facilities and manufacturing facilities. Based on the history, it is not possible to anticipate which specific industries other than wastewater treatment are likely to be affected by critical habitat. As a result, this analysis assumes that the effects of the designation on small businesses will be distributed evenly between wastewater treatment and all sectors of manufacturing. See Exhibit 8-1 below for details.
211. To be conservative, (i.e., more likely to overstate impacts than understate them), this analysis assumes that a unique company will undertake each of the projected consultations in a given year, and so the number of businesses affected is equal to the total annual number of consultations (both formal and informal).<sup>132</sup> This analysis also limits the universe of

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<sup>131</sup> See U.S. Small Business Administration, *The Regulatory Flexibility Act: An Implementation Guide for Federal Agencies*, 1998. Accessed at: [www.sba.gov/advo/laws/rfaguide.pdf](http://www.sba.gov/advo/laws/rfaguide.pdf) on December 3, 2001.

<sup>132</sup> While it is possible that the same business could consult with the Service more than once, it is unlikely to do so during the one-year time frame addressed in this analysis. However, should such multiple consultations occur, they would concentrate effects of the designation on fewer entities. In such a case, the approach outlined here likely would overstate the number of affected



potentially affected entities to include only those within the counties that are either being designated as critical habitat or are considered essential to the conservation of the silvery minnow; this interpretation produces far more conservative results than including all entities nationwide.

212. First, the *number* of small businesses affected is estimated. As shown in Exhibit 8-1, the following calculations yield this estimate.<sup>133</sup>

- Estimate the number of businesses within the study area affected by section 7 implementation annually (assumed to be equal to the number of annual consultations);
- Calculate the *percent* of businesses in the affected industry that are likely to be small;
- Calculate the *number* of affected small businesses in the affected industry;
- Calculate the *percent* of small businesses likely to be affected by critical habitat.

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businesses.

<sup>133</sup> Note that because these values represent the probability that small businesses will be affected during a one-year time period, calculations may result in fractions of businesses. This is an acceptable result, as these values represent the probability that small businesses will be affected.

<b>Exhibit 8-1</b>				
<b>ESTIMATED ANNUAL NUMBER OF SMALL BUSINESSES AFFECTED BY CRITICAL HABITAT DESIGNATION: THE "SUBSTANTIAL" TEST</b>				
<b>Industry Name</b>		<b>Ranching and Farming SIC 0191<sup>134</sup></b>	<b>Wastewater Treatment SIC 4952</b>	<b>Manufacturing SIC 2011-3999</b>
Annual number of affected businesses in industry <sup>135</sup>	By formal consultation	6	0.25	0.25
	By informal consultation	n/a	0.70	0.70
Total number of <i>all</i> businesses in industry within study area		1,855 <sup>136</sup>	5	2,014
Number of <i>small</i> businesses in industry within study area		1,855	4	2,006
Percent of businesses that are small (Number of small businesses)/(Total Number of businesses)		100%	80%	99.6%
Annual number of small businesses affected (Number affected businesses)*(Percent of small businesses)		6	0.8	0.9
<b>Annual percentage of small businesses affected</b> (Number of small businesses affected)/(Total number of small businesses); >20 percent is substantial		<b>0.33%</b>	<b>19%</b>	<b>0.05%</b>

<sup>134</sup> The EPA Region 6 Office (August 30, 2002) has commented this analysis should include agriculture in the small business analysis.

<sup>135</sup> The number of affected businesses in the ranching and farming industry is calculated by the estimated acres removed from alfalfa production (14,732 acres), calculated in Section 5.2, divided by the average farm size (2,390 acres). The number of affected businesses in the waste water treatment and manufacturing industries is calculated based on the total number of future consultations with EPA (10 formal consultations, 28 informal consultations, see Section 6), split evenly between wastewater treatment and general manufacturing. Annual estimates are derived from these 20-year consultation estimates.

<sup>136</sup> New Mexico Agricultural Statistics 2000. Available at: <http://www.nass.usda.gov/nm/nmbulletin/bulletin00.htm>.

213. This calculation reflects conservative assumptions and nonetheless yields an estimate that is still less than the 20 percent threshold that would be considered “substantial” for each industry. As a result, this analysis concludes that a significant economic impact on a substantial number of small entities will not result from the designation of critical habitat for the silvery minnow. Nevertheless, an estimate of the number of small businesses that will experience effects at a significant level is provided below.

### 8.1.2 Estimated Effects on Small Businesses: The “Significant Effect” Test

214. Costs of critical habitat designation to small businesses consist primarily of the cost of participating in section 7 consultations and the cost of project modifications. To calculate the likelihood that a small business will experience a significant effect from critical habitat designation for the silvery minnow, the following calculations were made:

- Calculate the per-business cost. This consists of the unit cost to a third party of participating in a section 7 consultation (formal or informal) and the unit cost of associated project modifications. *To be conservative, this analysis uses the high-end estimate for each cost.*
- Determine the amount of annual sales that a company would need to have for this per-business cost to constitute a “significant effect.” This is calculated by dividing the per-business cost by the three percent “significance” threshold value.
- Estimate the likelihood that small businesses in the study area will have annual sales equal to or less than the threshold amount calculated above. This is estimated using national statistics on the distribution of sales within industries in comparison with the SBA definition for small businesses.<sup>137</sup>

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<sup>137</sup> This probability is calculated based on national industry statistics obtained from the Robert Morris Associated *Annual Statement of Studies: 2001-2002* and from comparison with the SBA definitions of small businesses, available at <http://www.sba.gov/regulations/siccodes/siccodes.html>. Small businesses in the manufacturing industry generally are defined based on the number of employees, rather than on the level of sales. As a result, this analysis conservatively assumes that all small businesses in these industries will experience the effects as significant. See Exhibit 8-2 for details.

- Based on the probability that a single business may experience significant effects, calculate the expected value of the number of businesses likely to experience a significant effect. This is calculated by multiplying the number of small businesses bearing a cost by the probability that they will experience that cost as significant.
- Calculate the percent of businesses in the study area within the affected industry that are likely to be affected significantly. This is done by dividing the number of small businesses experiencing significant effects by the total number of small businesses in the study area.

215. Calculations for costs associated with designating critical habitat for the silvery minnow are provided in Exhibit 8-2 below.

<b>Exhibit 8-2</b>					
<b>ESTIMATED ANNUAL EFFECTS ON SMALL BUSINESSES: THE "SIGNIFICANT EFFECT" TEST</b>					
<b>Industry</b>	<b>Farming and Ranching SIC 0191</b>	<b>Sanitary Services SIC 4952</b>		<b>Manufacturing SIC 2011-3999</b>	
	<i>Forgone Production</i>	<i>Formal Consultations with Project Modifications</i>	<i>Informal Consultations</i>	<i>Formal Consultations with Project Modifications</i>	<i>Informal Consultations</i>
Annual Number of Small Businesses Affected (from Exhibit 8-1)	6	0.20	0.56	0.25	0.70
Per-Business Cost	\$970,000	\$34,100	\$2,900	\$34,100	\$2,900
Level of Annual Sales Below which Effects Would Be Significant (Per-Business Cost / 3%)	\$32,333,333	\$1,136,667	\$96,667	\$1,136,667	\$96,667
Probability that Per-Business Cost is Greater than 3% of Sales for Small Business <sup>a</sup>	100%	46%	3%	100%	100%
Probable Annual Number of Small Businesses Experiencing Significant Effects (Number Small Businesses)* (Probability of Significant Effect)	6	0.09	0.02	0.25	0.70
<b>Total Annual Number of Small Businesses Bearing Significant Costs in Industry</b>	<b>6</b>	<b>0.11</b>		<b>0.95</b>	
<b>Total Annual Percentage of Small Businesses Bearing Significant Costs in Industry</b>	<b>0.33%</b>	<b>2.7%</b>		<b>0.05%</b>	
<p><sup>a</sup> This probability is calculated based on national industry statistics obtained from the <i>Robert Morris Associated Annual Statement of Studies: 2001-2002</i>, which provides data on the distribution of annual sales in an industry within the following ranges: \$0-1 million, \$1-3 million, \$3-5 million, \$5-10, \$10-25 million, and \$25+ million. This analysis uses the ranges that fall within the SBA definition of small businesses (i.e., for industries in which small businesses have sales of less than \$5.0 million, it uses \$0-1 million, \$1-3 million, and \$3-5 million) to estimate a distribution of sales for small businesses. It then calculates the probability that small businesses have sales below the threshold value using the following components: (1) all small businesses (expressed as a percentage of all small businesses) in ranges whose upper limits fall below the threshold value experience the costs as significant; (2) for the range in which the threshold value falls, the percentage of companies in the bin that fall below the threshold value is calculated as <math>[(\text{threshold value} - \text{range minimum}) / (\text{bin maximum} - \text{range minimum})] \times \text{percent of small businesses captured in range}</math>. This percentage is added to the percentage of small businesses captured in each of the lower ranges to reach the total probability that small businesses have sales below the threshold value. Note that in instances in which the threshold value exceeds the definition of small businesses (i.e., the threshold value is \$10 million and the definition of small businesses is sales less than \$5.0 million), all small businesses experience the effects as significant. Because small businesses in the manufacturing industry generally are defined based on the number of employees, rather than on the level of sales, this analysis conservatively assumes that all small businesses in these industries will experience the effects as significant.</p>					

216. Because the costs associated with designating critical habitat for the silvery minnow are likely to be significant for less than one small businesses per year (approximately less than one percent of the small businesses in the farming and ranching industries, two percent in the wastewater treatment industry, and less than one percent in other manufacturing industries) in the affected counties, this analysis concludes that a significant economic impact on a substantial number of small entities will not result from the designation of critical habitat for the silvery minnow. This would be true even if all of the effects of section 7 consultation on these activities were attributed solely to the critical habitat designation.

## 8.2 Potential Benefits of Designated Critical Habitat

217. To estimate the benefits of critical habitat designation for the silvery minnow, this report focuses on the benefits associated with the primary goal of species recovery and, to a lesser extent, the secondary benefits associated with the habitat protection required to achieve this primary goal. Specifically, the Act directs the Service to weigh the benefits *to the species* of designating a unit of critical habitat against the benefits to society of not designating that unit (i.e. the costs, as addressed in preceding sections). Thus, it is appropriate to consider the *marginal* benefits to the silvery minnow of designating an additional unit of critical habitat in terms of increased probability of survival and ultimate recovery. Economic value arises from this change because individuals have demonstrated willingness to pay to preserve threatened or endangered species.
218. Researchers have investigated individuals' willingness to pay to prevent species extinction, preserve habitat for one or more species, or for changes in environmental quality typically associated with habitat designation. However, no published literature has estimated values for the specific *marginal* changes afforded by section 7 protections.<sup>138</sup>
219. While designation of critical habitat will generate secondary benefits in addition to improving the chance of species recovery (e.g., improved water quality and recreational opportunities), these benefits are by definition exogenous to the analysis. As stated, the Service is instructed to consider *benefits to the species*, and *costs to society* when deciding whether to designate habitat. Nonetheless, this report considers existing literature to the extent that it informs the broader decision-making process by providing values associated with the species and habitat in question. The most important implication of this discussion is that the benefits reported in this chapter are not directly comparable to the costs reported

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<sup>138</sup> It is important to recognize the distinction between marginal and total in this context. The relevant benefits are marginal in that they correspond to a specific change in the probability of species recovery. Alternatively, preventing extinction would imply a total value.

in the preceding sections, as implied by one commenter to the Draft Economic Analysis (DEA). An appropriate benefit-cost comparison would entail estimating the benefits, in terms of increased probability of species recovery, of designating an additional unit of critical habitat and comparing those to the costs (i.e. the benefits to society in its highest and best use) of designating that unit.

220. Thus, this section provides largely qualitative information on the benefits of species recovery generally, as well as some discussion of the secondary benefits associated with habitat protection measures for the silvery minnow. Finally, value estimates from two published studies examining individuals' willingness to pay for instream flow protection measures along the Rio Grande are described.

### 8.2.1 Defining Benefits

221. As stated, the appropriate benefits to consider in the context of designation decisions are those associated with changes in the probability of species recovery. Without knowing the exact nature of future consultations and associated project modifications, it is difficult to predict this marginal increase. Nonetheless, implementation of section 7 of the Act is expected to substantially increase the probability of recovery for the silvery minnow. Such implementation includes both the jeopardy provisions afforded by the listing as well as the adverse modification provisions provided by the designation. Specifically, the section 7 consultations that address the silvery minnow will assure that actions taken by Federal agencies do not jeopardize the continued existence of the species or adversely modify its habitat. Note that these measures are separate and distinct from the section 9 "take" provisions of the Act, which also provide protection to this species.

222. Social welfare benefits associated with the marginal change discussed above arise from the value people place on the species existence and protection. Generally, these values may be motivated by use (e.g., viewing opportunities) or non-use considerations. Numerous studies have estimated existence value for various species.<sup>139</sup> However, absent from the literature are studies examining incremental changes in the probability of species recovery. Thus, there is a high degree of uncertainty associated with both the physical change being valued in the current context (i.e., increased probability of silvery minnow recovery attributable to section 7 protections) and the economic value of that change.<sup>140</sup>

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<sup>139</sup> For example see Bishop (1978, 1980), Brookshire and Eubanks (1983), Boyle and Bishop (1986), Hageman (1985), Samples *et al.* (1986), Stoll and Johnson (1984).

<sup>140</sup> It is also important to note that such values are typically elicited using contingent valuation techniques, the validity and reliability of which are a source of controversy among economists and policy-makers. For example, refer to Diamond and Hausman (1994).

223. As discussed, secondary benefits associated with critical habitat are not directly relevant to the Service's specific unit designation decisions. However, this report describes such benefits (largely in a qualitative manner), to the extent that it provides additional information to the broader decision-making process. Including these secondary benefits is consistent with Executive Order 12886, which requires that Federal Agencies consider all relevant costs and benefits before making final policy decisions. In the current case, these additional categories include social welfare benefits associated with maintaining instream flows in the Middle Rio Grande (e.g., ecological improvements, recreational opportunities, and protection afforded to other species, etc). These benefits are described in detail in the next section.
224. In addition, it is possible that critical habitat designation may result in some increase in regional economic activity. Regional economic benefits are expressed in terms of jobs created and regional sector revenues. For example, conservation purchases that occur as part of the section 7 consultation process help to fuel the mitigation banking industry. The Cajon Creek Conservation Bank and Wildlands, Inc., are two examples of mitigation banking organizations that benefit from consultations.<sup>141</sup> Unlike the social welfare benefits described above, which reflect the well-being of *all* citizens under different resource allocations (i.e., species status and extent of habitat), regional economic benefits reflect changes in *local* output, employment and taxes. These types of impacts are generally assumed to be distributive; that is, changes in economic activity in the local economy are offset by changes elsewhere. Social welfare and regional economic benefits are not additive, but represent distinct measures of economic impact.
225. In addition to social welfare and regional economic benefits, critical habitat designation may provide other benefits associated with increased awareness of the extent of silvery minnow habitat. Critical habitat provides a legal definition of silvery minnow habitat that may serve to reduce the amount of uncertainty private parties and Federal agencies face when determining if a section 7 consultation is necessary.
226. Finally, although not a benefit associated with habitat designation for the silvery minnow specifically, it is worth noting that the U.S. Congress recently appropriated \$11.2 million to the Middle Rio Grande Collaborative Program Workshop to enhance habitat, increase populations, and contribute to the recovery of the silvery minnow. These funds may influence economic activity in the region.

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<sup>141</sup> Personal communication with Manager of Reclamation and Special Projects, Vulcan Materials Company, Western Division on May 25, 2001 and Wildlands, Inc. website, accessed at <http://www.wildlandsinc.com/> on May 30, 2001.



### **Secondary Benefits Associated with Habitat Protection**

227. Additional instream flow in the Middle Rio Grande associated with section 7 protections for the silvery minnow will likely generate benefits beyond the primary goal of species recovery. These include, among other things, improved habitat for other threatened or endangered species, improved overall ecosystem health, enhanced recreational benefits, and improved water quality. A number of these benefits are also described in the Bureau of Reclamation's Final Programmatic Environmental Assessment regarding the Bureau's Supplemental Water Program (programmatic opinion).<sup>142</sup> The proposed actions described in the programmatic opinion were designed to supplement water flows in the Rio Grande to benefit the silvery minnow.
228. This section describes these additional categories of benefits. In addition, results from an opinion study conducted in New Mexico are reported that are reflective of the importance the public attaches to conservation of wildlife and aquatic species through scarce water management. Finally, two studies that attempt to quantify the public's willingness to pay to protect instream flow along the Rio Grande are discussed.

### **Benefit to Other Species**

229. Additional instream flow in the Middle Rio Grande will provide benefits to other species, particularly below the San Acacia Diversion Dam. This area includes wetland communities along the river that support a diversity of avian species and other wildlife habitat, as well as a high concentration of sensitive species. Throughout spring and summer, 325 species of birds, 75 species of mammals, 60 species of reptiles and amphibians, and 35 species of fish can be found in this area.<sup>143</sup> Specifically, additional flows may improve habitat for the southwestern willow flycatcher (*Empidonax trailii extimus*), the bald eagle (*Haliaeetus leucocephalus*), the whooping crane (*Grus americana*), and the interior least tern (*Sterna antillarum athalassos*). Enhanced instream flow may also provide for additional off-stream temporary water storage at Federal and State wildlife refuges, which may provide additional benefits to the silvery minnow and other riparian species. It is also possible that additional water releases may provide for increased habitat at downstream reservoirs.<sup>144</sup>

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<sup>142</sup> Bureau of Reclamation. 2002. Final Programmatic Environmental Assessment for the Supplemental Water Program.

<sup>143</sup> Ibid.

<sup>144</sup> Note that additional water releases could potentially impact narrow reaches of the river adjacent to the water releases, but it is expected that, on average, the benefits of additional flow to the species will outweigh these small impacts.

### **Ecosystem Health**

230. Actions to protect the silvery minnow may also directly or indirectly benefit the larger riparian ecosystem. For example, the following may provide additional benefits:
- C Cottonwood and willow recruitment, which has historically been reduced along much of the river resulting from deprivation of flood flows and scouring;
  - C Prevention of fire hazards along riparian areas. Historically, damaging fires have resulted from the piling up of dead wood and other debris in riparian areas.
  - C Re-vegetation of native species (and removal of exotics) will improve the quality of riparian habitat throughout the river. For example project modifications associated with consultations on Army Corps of Engineers projects frequently include habitat/ecosystem restoration and exotic species removal.

### **Water Quality Benefits**

231. If supplemental water is provided for the silvery minnow, water quality may improve as a result of less contaminated agricultural runoff (pesticides, sediment, nutrients, etc) and dilution of existing contaminants. Monetization of this category of benefits would require detailed information that quantifies the reduction in runoff and the impact on water quality. This information is currently not available.

### **Recreational Benefits**

232. The designation of critical habitat for the silvery minnow does not include either Cochiti Reservoir or Elephant Butte Reservoir, where the majority of recreational activity takes place. However, areas of river between these reservoirs provide diverse recreational opportunities. Comments received by MRGCD indicate that the additional flows may be too small to support significant recreational benefits. However, it is likely that given the large number of recreationalists affected (i.e., urban populations in Albuquerque and Santa Fe), participation in activities such as boating, fishing, hunting, hiking, picnicking, horseback riding, birdwatching, and nature study in the area will be enhanced with additional instream flow. This may include the following:

- C Fishermen may benefit from additional flows through improved stocking of catchable size rainbow trout by the New Mexico Department of Game and Fish, particularly in the canals and drains near Albuquerque. These areas support winter fishing activities between November and March. Areas that provide fishing access include Tingley Beach in Albuquerque, and small lakes located on the Isleta and Sandia Pueblos.<sup>145</sup> In addition, increasing flows may improve the fishing experience by allowing anglers and fish to disperse into areas previously dry or inaccessible.
- C Canoers and paddlers may also benefit from an improved recreational experience resulting from increased flows in some areas. For example, increased water may provide additional access to areas that were previously dry and/or isolated and may reduce lengthy portages.
- C Hikers and cyclists on adjacent trails may benefit from reduced drying of the river through enhanced aesthetic quality. Although some pumping and conveyance activities may provide minor visual impacts to recreationalists, the additional water flow is likely to improve the overall experience.
- C Wildlife viewing and possible hunting opportunities may increase to the extent that improved habitat for resident and migratory bird species is maintained or created by supplemental flows.

### **Public Attitudes and Perceptions**

233. Survey research conducted by the University of New Mexico's Institute for Public Policy indicates that State residents value the green landscapes along rivers and riparian areas.<sup>146</sup> Telephone interviews with State residents asked participants, among other things, to rate 13 different public and private water uses (e.g., indoor plumbing use for homes, irrigation for farms, wildlife, etc). Respondents provided a response from zero to 10, where a zero indicates residents do not care whether water is available for that use, and 10 indicates residents want to ensure enough water is available for that use. Survey participants were from both the Middle Rio Grand (MRG) water planning region, which includes Sandoval, Bernalillo, and Valencia Counties (~1150 respondents), and the rest of the state (ROS) (~800 respondents). Exhibit 8-1 provides a summary of New Mexico residents' stated preferences,

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<sup>145</sup> USFWS. 2002. Designation of Critical Habitat for the Silvery Minnow: Draft Environmental Impact Statement.

<sup>146</sup> Brown et al. 2000. Attitudes and Preferences of Residents of the Middle Rio Grande Water Planning Region Regarding Water Issues.

in order from highest to lowest ranking by Middle Rio Grand participants. As shown, both the MRG and ROS participants ranked two environmental uses– (1) preserving the native cottonwood forest and (2) providing food and refuge for fish, birds and other animals –among the top four water uses.<sup>147</sup>

<b>Exhibit 8-1</b>		
<b>RESIDENTS' MEAN VALUE ASSIGNED TO THIRTEEN DIFFERENT PUBLIC AND PRIVATE WATER USES<sup>a</sup></b>		
<i>(Values assigned on scale of 0 to 10, where 0 indicates residents do not care whether water is available for that use, and 10 indicates residents want to be sure that water is available for that use)</i>		
<b>Water Use</b>	<b>Middle Rio Grande</b>	<b>Rest of State</b>
Indoor use in existing homes	8.17	8.32
Preserving the native cottonwood forest and vegetation along river banks known as the bosque, that creates habitat for a variety of different animal species	7.69	7.5
Irrigation for farms	7.59	7.99
Providing food and refuge for fish, birds and other animals	7.54	7.56
Indoor use in new housing developments	6.62	6.94
Cultural and Religious uses in some villages and Pueblos	6.38	6.34
Recreation, such as fishing and rafting	6.14	6.4
Community parks and sports fields	5.66	5.52
New industrial uses, such as manufacturing processes	5.29	5.41
Watering existing yards and landscaping	4.4	4.57
Use for yards and landscaping in new developments	3.82	4.14
Watering golf courses	3.18	2.93
Swimming pools for individual homes	2.68	2.58
<sup>a</sup> Source: Brown et al 2000. Attitudes and Preferences of Residents of the Middle Rio Grande Water Planning Region Regarding Water Issues. Table 3.1.		

234. Not surprisingly, the most “valued” use for water is indoor plumbing. The next highest rating is for conservation purposes, including the preservation of riparian habitats (e.g., cottonwood forests and river vegetation) to benefit a variety of different animal species. Note that participants place very similar ratings on two seemingly contradictory water use categories: irrigation for farms and water for wildlife habitat for fish, birds, and other species. Furthermore, the difference in opinion between those who live immediately

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<sup>147</sup> The margin of sampling error for the MRG sample was roughly +/-3 percent and +/- 4 percent for the rest of the state.

adjacent to the river (MRG participants) and the rest of the state (ROS participants) is remarkably similar. The implication for the case of critical habitat designation for the silvery minnow is that the allocation of water among agricultural and conservation uses appears to receive similar approval by State residents.

### 8.2.2 Quantifying the Benefits of Habitat Protection: The Case of Instream Flow

235. As discussed, the benefits relevant to critical habitat designation decisions are those associated with the resultant increase in probability of species recovery. This section describes results from two contingent valuation studies that estimate the public's willingness to pay to increase instream flow on the Rio Grande (Berrens et al., 1996 and 2000).<sup>148</sup> These surveys were administered to a random, statewide sample of New Mexico residents. The values elicited in these exercises likely encompass both the *total* existence value attributable to the silvery minnow, as well as the secondary benefits associated with habitat protection (described in the previous section).

236. The hypothetical instream flow protection measures described in the two studies are similar to the actual protections afforded the Middle Rio Grande as a result of the designated critical habitat. Examining the information component of the survey provides further insight into the specific nature of the commodity being valued. For example, in questions leading up to the valuation question, survey participants are told:

C *“Instream flows support fish and wildlife, vegetation and habitat, recreation and viewing opportunities. Minimum instream flows can also protect water quality by diluting pollution. Maintaining instream flows may prevent costly federal government actions to protect endangered species and water quality.”* and;

C *“There are currently six fish species listed as endangered in New Mexico, with another five fish species listed as threatened.”* and; the specific valuation question,

C *“Would your household contribute X dollars<sup>149</sup> each year for five years to a special trust fund used to buy or lease water from willing parties to maintain minimum instream flows for the silvery minnow in the Middle Rio Grande?”*

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<sup>148</sup> Note that these studies utilized an identical instrument and survey population in two different time periods: February 1995 and February 1996.

<sup>149</sup> Bid amounts ranged from \$5 to \$200 and were assigned randomly.

237. Expressed in 2001 dollars, the average willingness to pay elicited in the two surveys, conducted in 1995 and 1996, is \$32 and \$29, respectively.<sup>150</sup> Because the surveys are identical and neither value measure is perceived to be superior, they will be treated as a range.
238. Aggregation of this value entails two assumptions: the relevant population and the appropriate time frame. Because the survey was administered to a random, statewide sample, the value is applied to an estimate of the total number of households. According to the 2000 census there were approximately 678,000 households in New Mexico.<sup>151</sup> Regarding the time frame, we conservatively assume that the five-year program being valued by respondents is adequate to support silvery minnow habitat indefinitely.<sup>152</sup> Thus, the total present value of perpetual welfare benefits expected to result from silvery minnow habitat protection are estimated to be approximately \$80 to \$100 million (\$2001). This range reflects the range of welfare values, as well as the present value of the five aggregated payments at both a three and seven percent rate.<sup>153</sup> Alternatively, the present value of these perpetual benefits accrued only over the next 20 years would be \$36 to \$74 million at the same rates.
239. The range of values presented above, based on two different time frame assumptions, represents the benefits associated with maintaining instream flow on the Middle Rio Grande for the primary purpose of silvery minnow protection. However, these benefits necessarily reflect a variety of environmental changes. As described to survey participants, coincident changes in environmental quality include enhanced riparian vegetation, improved recreational and viewing opportunities, improved water quality, and improved habitat for

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<sup>150</sup> Inflated using the GDP implicit price deflator (Bureau of Economic Analysis. 2002. Table 7.1. Quantity and Price Indexes for Gross Domestic Product).

<sup>151</sup> US Census Bureau. 2002. People Quick Facts.

<sup>152</sup> The survey does not explicitly state whether the program would need to be reinstated at the end of five years to continue silvery minnow protection. The description of the trust fund refers to both *purchasing* (implying perpetual) and *leasing* (implying annual) of water rights to protect flows. Consultation with study authors indicates that this was not explicitly defined, nor was it perceived to be a significant issue in pre-test or administration of the survey (Personal communication with Philip Ganderton, November 20, 2002).

<sup>153</sup> As noted by one public commenter, although these are social welfare benefits, the appropriate rate of discount would reflect the opportunity cost of the payments agreed to by the survey respondent. In the absence of such a rate, we report a range consistent with rates used elsewhere in the report.

fish and wildlife— particularly for 10 other threatened and endangered fish species found in the Middle Rio Grande. It is not possible to identify what portion of the public's stated willingness to pay corresponds specifically to the increase in the probability of silvery minnow recovery. Therefore, these total values are not consistent with the *marginal* benefits to the silvery minnow of designating an additional unit of critical habitat. The estimated aggregate values (i.e., \$36 to \$100 million) are not directly comparable to the costs described in preceding sections, but rather reflect the benefits of instream flow and species protection generally.

## **Appendix A to the Economic Analysis**

### **Explanation of critical habitat, previous formal consultations, and target flows in the middle Rio Grande and Pecos River**

Section 7 of the Endangered Species Act of 1973, as amended (Act), directs all Federal agencies to use their existing authorities to conserve threatened and endangered species and, in consultation with the U.S. Fish and Wildlife Service (Service) to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of Federal lands as well as other Federal actions that may affect listed species such as Federal approval of private activities through the issuance of Federal permits, licenses, or other actions. Under the provisions of section 7(a)(2) of the Act, Federal agencies, including the Service, must undergo consultation to ensure that actions they fund, authorize, or carry out do not jeopardize the continued existence of listed species or do not destroy or adversely modify critical habitat to the extent that the action appreciably diminishes the value of the critical habitat for the survival and recovery of the species.

Section 7 can involve informal or formal consultation. Informal consultation occurs when a Federal agency determines that their action is not likely to adversely affect listed species (e.g., the effects are beneficial, insignificant, or discountable) or designated critical habitat and the Service agrees with that determination. Informal consultation concludes when the Service provides concurrence on this determination in writing. Alternatively, if the Federal agency determines that the action is likely to adversely affect listed species or critical habitat, then it must request formal consultation. This request is made in writing to the Service, with a complete initiation package, including a biological assessment. The biological assessment must be prepared if the species or critical habitat may be present in the action and could be impacted by the activity (50 CFR 402.02). Formal consultation concludes with the issuance of a biological opinion. The biological opinion is the document that states the opinion of the Service as to whether the Federal action is likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of critical habitat.

When the Service determines, through the issuance of biological opinion, that an action may jeopardize the continued existence of the species or result in the destruction or adverse modification of critical habitat, the Service, with the assistance of the Federal agency, develops reasonable and prudent alternatives that may be undertaken. Upon the issuance of a biological opinion with reasonable and prudent alternatives, the Federal action agency determines whether and how to proceed with its proposed action. The action agency may: 1) adopt the reasonable and prudent alternatives; 2) not undertake the project (e.g., deny the permit or cancel the project); 3) request an exemption from section 7(a)(2); 4) reinitiate consultation based on modification of the proposed action or the development of reasonable and prudent alternatives not previously considered; or 5) proceed with the action if it believes upon review of the biological opinion, that such action satisfies section 7(a)(2). Regardless of what action the agency chooses, they must notify the Service of their final decision.



If an action is found not to result in jeopardy, but may result in adverse effects to or take of listed species, an incidental take statement is developed in the biological opinion. The incidental take statement allows a species to be taken as a result of implementing an otherwise lawful activity and not be subject to section 9 prohibitions of the Act. The incidental take statement identifies the level of take that is anticipated from the implementation of the project as proposed. This biological opinion also contains reasonable and prudent measures and terms and conditions that are nondiscretionary actions designed to minimize the effects of take and that must be implemented in order for such take to be exempt from section 9.

In a recent programmatic biological opinion issued by the Service 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, the Service concluded that by providing target flows (and other elements contained in the single reasonable and prudent alternative), it may be possible to intensively manage and closely monitor the water in middle Rio Grande without jeopardizing the endangered Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow) and the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) (flycatcher). In fact, this was the case during the 2001 irrigation season on the middle Rio Grande in which the continued existence of the silvery minnow was not jeopardized. The single reasonable and prudent alternative, among other elements of a reasonable and prudent alternative provided for:

“river flow from Cochiti Dam to Elephant Butte Reservoir from October 31 to April 30 of each year, with a target flow of 50 cfs at the San Marcial Floodway gage. Flows will not drop below 40 cfs. From May 1 to June 15 of each year, provide a minimum flow of 50 cfs at the San Marcial Floodway gage. From June 16 to July 1 of each year, ramp down the flow to achieve 50 cfs over San Acacia Diversion Dam” (Service 2001b).

Consequently, the draft economic analysis used the 50 cubic feet per second (cfs) as a metric to estimate the potential economic costs associated with avoiding prolonged periods of low or no flow and providing sufficient flowing water during critical time periods. It is important to note that the consultation on the middle Rio Grande was conducted when no critical habitat was designated for the silvery minnow. The 50 cfs standard was chosen because it was the best estimate of a minimum flow that would not jeopardize the species, and was set forth in the Service's Programmatic Opinion (Service 2001b). A similar biological opinion on the effects on the Pecos bluntnose shiner (*Notropis simus pecosensis*) of actions associated with U.S. Bureau of Reclamation's discretionary actions related to water management on the Pecos River, in New Mexico, provided for target flows of 35 cfs at the Acme Gage (Service 2001a).

Although the Service has not drafted a Biological Opinion for the silvery minnow in the Pecos River or in the lower Rio Grande in the Big Bend river reach, Texas, the economic analysis used a target flow of 50 cfs for each of these areas. The Service recognizes that the 50 cfs standard may be an overestimate for the Pecos River, because of the recent biological opinion on the Pecos River, in New Mexico (Service 2001a). Additionally, on the lower Rio Grande River, Texas, no target flows have been developed through section 7 consultations.

The proposed rule to designate critical habitat for the silvery minnow does not identify quantitative estimates of specific minimum thresholds (e.g., minimum flows or depths), because the Service believes these estimates may vary seasonally, annually, and by proposed critical habitat unit. Thus, the Service believes these thresholds are appropriately enumerated through section 7 consultations (e.g., see Service 2001a, 2001b), which can more easily change if new information reveals effects to critical habitat in a manner or extent not previously considered (see 50 CFR 402.16(b)). The Service acknowledges that if thresholds were established as part of a critical habitat designation, they could be revised if new data became available (50 CFR 424.12(g)); however, the process of new rulemaking can take years (see 50 CFR 424.17), as opposed to months to reinitiate and complete a formal consultation (see 50 CFR 402.14). Formal consultation provides an up-to-date biological status of the species or critical habitat (i.e., environmental baseline) which is used to evaluate a proposed action during formal consultations. Consequently, it is believed that it is more prudent to pursue the establishment of specific thresholds through formal consultation.

The Act provides protection for critical habitat via the adverse modification standard. Thus, the Service evaluates whether a proposed action will adversely modify critical habitat. If this proposal is finalized, Federal agencies with discretion over actions related to water management that affect critical habitat will be required to enter into consultation under section 7 of the Act. These consultations will evaluate whether any Federal discretionary actions destroy or adversely modify critical habitat to the extent that the action appreciably diminishes the value of the critical habitat for the survival and recovery of the species. The adverse modification analysis will likely evaluate whether the adverse effect of prolonged periods of low or no flow is of sufficient magnitude (e.g., length of river) and duration that it would appreciably diminish the value of the critical habitat unit for the survival and recovery of the silvery minnow. For example, the effect of prolonged periods of low or no flow on the habitat quality (e.g., depth of pools, water temperature, pool size, etc.) and the extent of fish mortality is related to the duration of the event (Bestgen and Platania 1991). All of these factors will be analyzed under section 7 of the Act, if they are part of an action proposed by a Federal agency. Additionally, any Federal agency whose actions influence water quantity or quality in a way that may affect proposed critical habitat or the silvery minnow must enter into section 7 consultation with us. Still, these consultations cannot result in biological opinions that require actions that are outside an action agency's legal authority and jurisdiction (50 CFR 402.02).

Previously, target flows may have been formally or informally discussed and ranged from 35 to several hundred cfs, depending on season, river, or other factors. The information the Service considered and used in recent biological opinions on the Rio Grande and Pecos River were bound to use the best scientific and commercial data and are still current recommendations (Service 2001a, 2001b). If critical habitat is designated on the Middle Rio Grande, the Service does not anticipate that it will change the target flow requirement.

For informational purposes, the Service included the single reasonable and prudent alternative from the middle Rio Grande biological opinion. All of the elements of the reasonable and prudent alternative must be implemented to alleviate jeopardy to silvery minnow and the flycatcher. The RPA is as follows:

- A) Provide river flow from Cochiti Dam to Elephant Butte Reservoir from October 31 to April 30 of each year, with a target flow of 50 cfs at the San Marcial Floodway gage. Flows will not drop below 40 cfs. From May 1 to June 15 of each year, provide a minimum flow of 50 cfs at the San Marcial Floodway gage. From June 16 to July 1 of each year, ramp down the flow to achieve 50 cfs over San Acacia Diversion Dam, as described in element D.  
Because of gage error and the fluctuations in river flow, the Service recognizes the difficulties in maintaining a specific minimum flow. Because of these difficulties, the Service understands that flows might drop below the minimum required flows for very short durations. These minor fluctuations may not necessarily trigger the need for reinitiation of consultation. Therefore, Reclamation and the Corps, in coordination with the Service, will develop protocols and procedures for monitoring deviations from the minimum flow requirements for reinitiation purposes. These protocols and procedures shall be developed within 30 days of the date of this biological opinion and shall address the minimum flow requirements in elements A, C, and D.
- B) Between April 15 and June 15 of each year, provide a one-time increase in flows (spawning spike) to cue spawning, if necessary.
- C) Provide year-round river flow from Cochiti Dam to below Isleta Diversion Dam. Flows will not drop below 100 cfs below Isleta Diversion Dam. When reductions in upstream reservoir releases are necessary, ramp down releases to the extent possible.
- D) From July 1 to October 31 of each year, provide a minimum flow of 50 cfs over San Acacia Diversion Dam.
- E) In coordination with the Service, release any supplemental water (from conservation water pool, leases of water from Indian Pueblos and Tribes or other willing parties, etc.) in a manner that will most benefit listed species.
- F) Provide \$150,000 (\$75,000 from Reclamation and \$75,000 from the Corps) to the New Mexico Ecological Services Field Office for captive propagation activities (including egg collection, transportation, relocation, rearing, breeding, etc.) to be used by facilities propagating silvery minnows (Dexter and Mora National Fish Hatcheries and Technology Centers, New Mexico Fishery Resources Office, New Mexico State University, Albuquerque Bio Park, and Rock Lake State Fish Hatchery). These activities will augment captive populations and facilitate repopulating the upper reaches of the river.

- G) Within one year of the date of this opinion, set up an account (\$175,000 total for three years) for the establishment of one or more viable populations of silvery minnows within the historic range of the species, not including off-channel refugial sites. The agencies must make the following contributions to the account: At least \$50,000 by the end of Year 1, \$50,000 by the end of Year 2, and \$75,000 by the end of Year 3. These contributions will be shared equally by the agencies.
- H) Reclamation shall pump water from the Low Flow Conveyance Channel to the river when intermittency is likely. The entire capacity of pumps to be utilized must meet or exceed the total capacity of pumps used in the 2000 irrigation season (100 cfs). Pumping shall be initiated at least 24 hours prior to a recession in flows. Pumping shall continue even if river flow has receded upstream of any particular pump to continue to benefit the flycatcher and its habitats until at least October 1 of each year. Pumps may be placed at Brown Arroyo, Neil Cup, the north and south boundaries of the Bosque del Apache National Wildlife Refuge, and Fort Craig. Dewatered areas upstream, downstream, and between pumps shall be informally surveyed for the presence of breeding flycatchers and pumping implemented, if feasible, where breeding flycatchers are found.
- I) Initiate the procedure to provide for fish passage at the San Acacia Diversion Dam in coordination with the Service and the MRGCD to allow upstream movement of silvery minnows. Reclamation will produce a plan for evaluating a full suite of fish passage alternatives at the San Acacia Diversion Dam within 90 days of the date of this opinion. Reclamation will require time to complete the evaluations. Reclamation will make every reasonable effort to begin the environmental evaluation process within 120 days of the date of this opinion and begin implementation as soon as possible. Reclamation will provide the Service with written reports providing the status of this element on a quarterly basis for the duration of this opinion. Reclamation and the Service will annually review the progress made and adjust the time line if needed. Consultation with the Service for the provision of fish passage will tier to this programmatic biological opinion. In the interim, implement all feasible short-term fish passage/river reconnectivity actions.
- J) In consultation with the Service, conduct habitat/ecosystem restoration projects in the Middle Rio Grande to increase backwaters and oxbows, widen the river channel, and lower river banks to produce shallow water habitats, overbank flooding and regenerating stands of willows and cottonwoods to benefit the silvery minnow and flycatcher and their habitats. Restoration will take place on at least one site per reach on the Rio Grande from the area of Velarde to the headwaters of Elephant Butte Reservoir. The reaches include the following, as described on page 13 of the assessment: Velarde, Española, Cochiti, Middle, Belen, Rio Puerco, Socorro, San Marcial. Based on the size of a successful breeding area used by a group of flycatchers on the Middle Rio Grande, each restoration site will encompass approximately 60 acres (approximately 100 meters wide by 2.5 kilometers long) along the river's edge, incorporating modifications of these dimensions based on site-specificity, as needed. Monitoring for effectiveness of each restoration

project to benefit the silvery minnow and flycatcher will be conducted at each site annually for a period of at least fifteen years post-project completion in order to assess whether native riparian habitats are self-sustaining and successfully regenerating, and whether the habitats are maintaining suitability for recovery of listed species. Monitoring reports will be provided to the Service by January 31 of each year. Adaptive management principles will be used, if necessary, to obtain successful restoration of silvery minnow and flycatcher habitats. The environmental evaluation process for each project should begin when this opinion is issued and construction at the first restoration site should begin no later than six months from the date of this opinion. At least four reaches must be completed by the end of this consultation period. Consultation with the Service on each site will tie to this programmatic biological opinion.

- K) When bioengineering cannot be used in Reclamation river maintenance projects, habitat restoration will be implemented to offset adverse environmental impacts resulting from river alteration. Restoration will occur at a ratio of 5:1 in terms of area of riverine habitat restored to area of habitat adversely impacted, respectively. Habitat restoration will occur within the same or adjoining reach as the river maintenance project, or in tributaries of those reaches, in consultation with the Service.
- L) The Corps will begin the procedures to implement the proposed relocation of the San Marcial Railroad Bridge to increase the channel capacity in the lower reach of the Middle Rio Grande.
- M) Each year that annual snowpack runoff is at or above average on the mainstem Rio Grande, and is legally and physically available, and is in excess of the water needed for the proposed conservation water pool, the Corps will ensure seasonal overbank flooding over baseline levels and increase sites of overbank flooding to create backwater habitats for the silvery minnow. The timing, amount and locations of overbank flooding will be planned each year in conjunction with the Service, and may be conducted in coordination with compact deliveries. Duration and extent of overbank flooding will be monitored annually, and the results will be reported to the Service by October 15 of each year.
- N) Each year that annual snowpack runoff is at or above average on the mainstem Rio Grande, and is legally and physically available, and is in excess of the water needed for the proposed conservation water pool, the Corps will ensure that suitable and potential flycatcher breeding habitats experience natural seasonal overbank flooding and pooling of, or slow velocity, water in backwater habitats throughout the breeding season. The timing, amount and locations of overbank flooding will be planned each year in conjunction with the Service, and may be conducted in coordination with compact deliveries. Duration and extent of overbank flooding will be monitored annually, and the results will be reported to the Service by October 15 of each year.

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 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.

#### Literature Cited

- Bestgen, K. R., and S. P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow *Hybognathus amarus*. *The Southwestern Naturalist* 36:225-232.
- 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* 59:36988-37001.
- U.S. Fish and Wildlife Service. May 21, 2001 (2001a). Biological Opinion on the Effects of Actions Associated on the Pecos Bluntnose Shiner (*Notropis simus pecosensis*) with Reclamation's Discretionary Actions Related to Water Management on the Pecos River, New Mexico. Albuquerque.
- U.S. Fish and Wildlife Service. June 29, 2001 (2001b). 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. Albuquerque

**Appendix B**

**ESTIMATE OF WATER NEEDED TO MEET FLOW REQUIREMENTS  
IN THE MIDDLE RIO GRANDE**

**Michael Jones, Hydrologist**

**ESTIMATE OF WATER NEEDED TO MEET FLOW REQUIREMENTS  
IN THE RIO GRANDE**

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Below is an analysis of the water required to meet minimum flows in the Rio Grande between the San Acacia Diversion Dam and San Marcial Flooding Gage, as specified in a draft biological opinion concerning protection of the Rio Grande Silvery Minnow.<sup>1</sup> Minimum flows are summarized in Table B-1.

<b>Table B-1 Minimum Flow Requirements</b>	
<b>Period</b>	<b>Minimum Allowed Flow</b>
1-Nov to 30-Apr	40 cubic feet per second (cfs) at San Marcial
1-May to 15-Jun	50 cfs at San Marcial
16-Jun to 31-Oct	50 cfs at San Acacia

This analysis assumes that during low flow periods, additional water would be delivered to San Acacia to meet minimum flow requirements. The Rio Grande typically loses about 200 cubic feet per second of flow from San Acacia to San Marcial.<sup>2</sup>

**Hydrologic System**

The hydrologic system in the Rio Grande between San Acacia and San Marcial consists of river, conveyance channel, groundwater reservoir, and riparian vegetation. Water is consumed by evaporation of open water and by transpiration from riparian vegetation. The groundwater table is recharged by the river and discharges to the low-flow conveyance channel, which runs alongside the Rio Grande from San Acacia to the Elephant Butte Reservoir.

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<sup>1</sup> U.S. Fish and Wildlife Service. June 29, 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."

<sup>2</sup> Balleau Groundwater Inc. May 5, 1999. "Hydrologic Effects of Designating Critical Habitat for Rio Grande Silvery Minnow." Consultant report prepared for Middle Rio Grande Conservancy District, p. 9.



The conveyance channel acts as a drain to the river and the riparian system. Water seeps from the river, through the ground, into the conveyance channel. Normally dry at San Acacia, the conveyance channel carries a minimum of 200 cfs at San Marcial.

Water is consumed by evapotranspiration. The area of riparian vegetation and open water between San Acacia and San Marcial is estimated at 20,000 acres, based on an estimate of 23,000 acres between Rio Puerco and Elephant Butte.<sup>3</sup> Assuming an evapotranspiration rate of 46 inches per year,<sup>4</sup> annual average evapotranspiration between San Acacia and Elephant Butte is computed to be about 106 cfs, or 76,500 acre-feet per year (afy).

## Data

Daily flow measurements from the following gauging stations were obtained from the United States Geological Survey internet site and examined:

8355000	RIO GRANDE AT SAN ACACIA N M (pre-conveyance channel)
8358500	RIO GRANDE AT SAN MARCIAL, NM (pre-conveyance channel)
8354900	RIO GRANDE FLOODWAY AT SAN ACACIA, NM (post-conveyance channel)
8358400	RIO GRANDE FLOODWAY AT SAN MARCIAL, NM (post-conveyance channel)
8354800	RIO GRANDE CONVEYANCE CHANNEL AT SAN ACACIA, NM
8358300	RIO GRANDE CONVEYANCE CHANNEL AT SAN MARCIAL, NM

## Correlation of annual flow

The relationship between total annual water delivered to San Acacia and total annual water delivered to San Marcial (which includes flow in river and flow in conveyance channel) is presented in Figure 1. The relationship generally fits a trend line with a slope of 1.07. Thus, on an annual basis, every 1.07 units added to the flow at San Acacia results in 1 unit of additional delivery to San Marcial.

The linear relationship is not valid for extreme low flow years. Under extremely dry conditions, a larger portion of flow is consumed by the riparian system above San Marcial. An equation was developed to fit both the linear and nonlinear portions of the relationship. The equation is:

$$Y = C*(0.1-\ln(u)+u-u^2/4+u^3/18-u^4/96+u^5/600)$$

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<sup>3</sup> Balleau Groundwater Inc. May 5, 1999. "Hydrologic Effects of Designating Critical Habitat for Rio Grande Silvery Minnow." Consultant report prepared for Middle Rio Grande Conservancy District, p. 13.

<sup>4</sup> Balleau Groundwater Inc. May 5, 1999. "Hydrologic Effects of Designating Critical Habitat for Rio Grande Silvery Minnow." Consultant report prepared for Middle Rio Grande Conservancy District, p. 6.

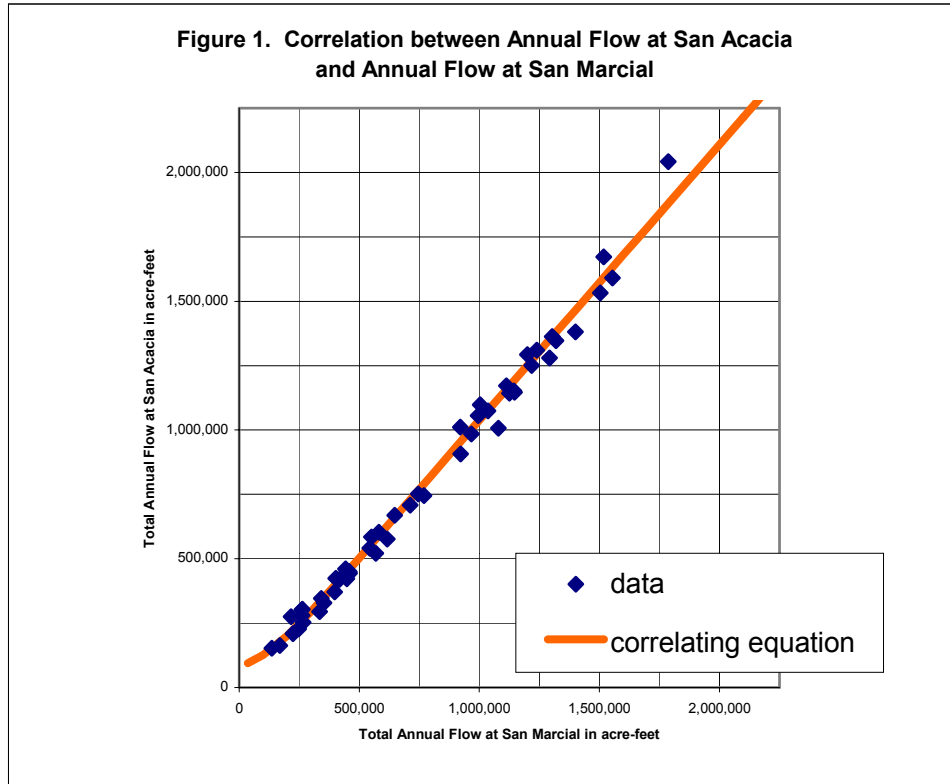
Where

- Y = flow at San Acacia
- X = flow at San Marcial
- $u = ae^{-X/B}$
- a=1.5
- B= 100,000 acre-feet
- C=107,000 acre feet

Note that the choice of equation does not imply any physical correlation. The equation used was chosen simply because it yields the correct shape to properly describe the correlation between annual flow at San Acacia and annual flow at San Marcial.

Using this equation, a flow of 83,400 afy at San Acacia produces zero flow at San Marcial, generally agreeing with the 76,500 afy estimate of evapotranspiration between San Acacia and San Marcial.

The relationship shown on Figure 1 does not apply to daily flows, which are not as well-correlated as annual flows. Daily flows are influenced by tributary inflows, irrigation return flows and groundwater storage.



## Daily water deficit

Historical daily flows at San Acacia were examined to estimate the additional water required to meet minimum flows. Minimum flows at San Acacia were estimated by adding 200 cfs to minimum flows at San Marcial, based on estimated river losses from San Acacia to San Marcial.<sup>5</sup> For each day in which the recorded flow was below the minimum, daily water deficit was computed as the difference between minimum flow and recorded flow. Estimated historical water deficits are summarized in Table B-2.

After 1995, additional water was delivered to San Acacia as follows:<sup>6</sup>

1996 47,547 acre-feet  
 1997 13,736 acre-feet  
 1998 47,333 acre-feet  
 1999 58,000 acre-feet

Data after 1995 were excluded from the analysis due to the supplements listed above.

<b>Year</b>	<b>Deficit</b>	<b>Year</b>	<b>Deficit</b>
1936	1,200	1966	9,857
1937	980	1967	34,637
1938	2,884	1968	6,313
1939	15,249	1969	1,627
1940	10,264	1970	4,984
1941	0	1971	22,573
1942	607	1972	37,528
1943	4,479	1973	0
1944	12	1974	26,506
1945	301	1975	847
1946	36,589	1976	8,076
1947	21,580	1977	41,063
1948	5,901	1978	19,339
1949	972	1979	566
1950	36,159	1980	1,540
1951	70,648	1981	31,663
1952	9,126	1982	591
1953	36,163	1983	384
1954	31,259	1984	1,425
1955	40,427	1985	1,140

<sup>5</sup> The New Mexico Interstate Stream Commission (October 2, 2002) has commented that the analysis fails to consider transportation losses and therefore underestimating the amount of water needed.

<sup>6</sup> Balleau Groundwater Inc. May 5, 1999. "Hydrologic Effects of Designating Critical Habitat for Rio Grande Silvery Minnow." Consultant report prepared for Middle Rio Grande Conservancy District, p. 30.

Year	Deficit	Year	Deficit
1956	49,473	1986	0
1957	10,867	1987	526
1958	3,675	1988	962
1959	32,459	1989	15,159
1960	8,579	1990	9,028
1961	5,635	1991	141
1962	6,111	1992	141
1963	34,863	1993	0
1964	40,264	1994	95
1965	1,191	1995	0
Average = 13,244			
Maximum = 70,648			

Of water used to meet minimum flows, some is consumed by evapotranspiration and the remainder is delivered to the Elephant Butte Reservoir. Delivery to Elephant Butte is defined as flow at San Marcial.

### Losses above San Acacia

Some water diverted toward San Acacia is consumed before arriving. Following current convention,<sup>7</sup> 50 percent of water released from Cochiti Reservoir is assumed to arrive at San Acacia. Loss of water from selected points between Cochiti and San Acacia is interpolated in Table B-3.

Points of diversion to the Rio Grande	Percent of flow reaching San Acacia
Cochiti	50
Bernalillo	57
Albuquerque	64
Isleta	68
Belen	78
Bernardo	89
San Acacia	100

### Losses below San Acacia

Much of the flow lost from the river between San Acacia and San Marcial arrives at San Marcial as flow in the conveyance channel. Accordingly, the change in flow in the river channel does not represent consumptive use. Consumptive use between San Acacia and San Marcial was

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<sup>7</sup> Balleau Groundwater Inc. May 5, 1999. "Hydrologic Effects of Designating Critical Habitat for Rio Grande Silvery Minnow." Consultant report prepared for Middle Rio Grande Conservancy District, p. 9.

estimated instead from the relationship shown on Figure 1, in which seven percent of flow is consumed and 93 percent reaches San Marcial. Statistical distributions of water deficits and consumptive use are presented in Table B-4.

<b>Sample probability</b>	<b>Additional water to be delivered to San Acacia not greater than</b>	<b>Amount consumed between San Acacia and San Marcial (7%)</b>	<b>Amount of water reaching San Marcial</b>
0.02	0	0	0
0.03	0	0	0
0.05	0	0	0
0.07	0	0	0
0.08	0	0	0
0.10	12	1	11
0.12	95	7	89
0.13	141	10	131
0.15	141	10	131
0.17	301	21	280
0.18	384	27	357
0.20	526	37	489
0.22	566	40	527
0.23	591	41	550
0.25	607	42	564
0.27	847	59	787
0.28	962	67	895
0.30	972	68	904
0.32	980	69	911
0.33	1,140	80	1,060
0.35	1,191	83	1,108
0.37	1,200	84	1,116
0.38	1,425	100	1,325
0.40	1,540	108	1,432
0.42	1,627	114	1,513
0.43	2,884	202	2,682
0.45	3,675	257	3,418
0.47	4,479	314	4,165
0.48	4,984	349	4,635
0.50	5,635	394	5,241
0.52	5,901	413	5,488
0.53	6,111	428	5,683
0.55	6,313	442	5,871
0.57	8,076	565	7,510
0.58	8,579	601	7,978
0.60	9,028	632	8,396
0.62	9,126	639	8,487
0.63	9,857	690	9,167
0.65	10,264	719	9,546
0.67	10,867	761	10,107

<b>Sample probability</b>	<b>Additional water to be delivered to San Acacia not greater than</b>	<b>Amount consumed between San Acacia and San Marcial (7%)</b>	<b>Amount of water reaching San Marcial</b>
0.68	15,159	1,061	14,098
0.70	15,249	1,067	14,182
0.72	19,339	1,354	17,985
0.73	21,580	1,511	20,070
0.75	22,573	1,580	20,993
0.77	26,506	1,855	24,650
0.78	31,259	2,188	29,071
0.80	31,663	2,216	29,446
0.82	32,459	2,272	30,187
0.83	34,637	2,425	32,213
0.85	34,863	2,440	32,423
0.87	36,159	2,531	33,628
0.88	36,163	2,531	33,631
0.90	36,589	2,561	34,028
0.92	37,528	2,627	34,901
0.93	40,264	2,818	37,445
0.95	40,427	2,830	37,597
0.97	41,063	2,874	38,188
0.98	49,473	3,463	46,010
1.00	70,648	4,945	65,702
<b>Average</b>	<b>13,244</b>	<b>927</b>	<b>12,317</b>
<b>Maximum</b>	<b>70,648</b>	<b>4,945</b>	<b>65,702</b>

**Appendix C**

**ESTIMATE OF WATER NEEDED TO MEET FLOW REQUIREMENTS  
IN THE PECOS RIVER**

**Michael Jones, Hydrologist**

## ESTIMATE OF WATER NEEDED TO MEET FLOW REQUIREMENTS IN THE PECOS RIVER

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Below is an analysis of the water required to meet minimum flows in the Pecos River between the Sumner Dam and the Brantley Reservoir as specified in a biological opinion concerning protection of endangered species.<sup>1</sup> A minimum flow of 50 cubic feet per second (cfs) at Acme gage was evaluated.

The Acme gage is 171 km downstream of Sumner Dam.<sup>2</sup> In between Sumner Dam and Acme are the Fort Sumner Irrigation District (FSID) diversion dam, 23 km downstream of the Sumner Dam, and the FSID return canal, 24 km downstream of the FSID diversion dam.<sup>3</sup> Travel time for water from the Sumner dam to Acme is 8 to 12 days for low flows.<sup>4</sup> The Brantley Dam is 189 km downstream of Acme.

### Data

Daily flow measurements from the following USGS gaging stations were obtained from the United States Geological Survey internet site and examined:

8384500	PECOS BELOW SUMNER DAM, NM
8385520	PECOS RIVER BELOW FORT SUMNER, NM
8385522	PECOS RIVER BELOW TAIBAN CR NR FT SUMNER, NM
8385620	PECOS RIVER BELOW YESO ARROYO NR. FT. SUMNER, NM
8385630	PECOS RIVER NEAR DUNLAP, NM
8385640	PECOS RIVER AB. HUGGINS CR. NR. ROSWELL, NM

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<sup>1</sup> Note that the Biological Opinion specifies the Acme gage as the point at which the minimum flow requirement must be met (U.S. Fish and Wildlife Service, May 21, 2001).

<sup>2</sup> U.S. Fish and Wildlife Service. May 21, 2001. "Biological Opinion on Reclamation's 2001 Discretionary Action Related to Water Management on the Pecos River, New Mexico." p. 30.

<sup>3</sup> U.S. Fish and Wildlife Service. May 21, 2001. "Biological Opinion on Reclamation's 2001 Discretionary Action Related to Water Management on the Pecos River, New Mexico." p. 15.

<sup>4</sup> U.S. Fish and Wildlife Service. May 21, 2001. "Biological Opinion on Reclamation's 2001 Discretionary Action Related to Water Management on the Pecos River, New Mexico."



## Daily water deficit

Historical daily flows at Acme were examined to estimate the additional water required to meet minimum flows. For each day in which recorded flow was below the minimum, as daily water deficit was computed as the difference between the minimum flow and recorded flow. Estimated historical water deficits are summarized on Table C-1.

<b>Year</b>	<b>Deficit (minimum flow 50 cfs)</b>	<b>Year</b>	<b>Deficit (minimum flow 50 cfs)</b>
1938	20,063	1969	10,838
1939	17,377	1970	14,339
1940	21,156	1971	20,256
1941	6,228	1972	16,171
1942	1,035	1973	12,154
1943	12,321	1974	16,431
1944	15,947	1975	24,463
1945	23,363	1976	19,934
1946	22,635	1977	18,987
1947	27,693	1978	22,272
1948	29,280	1979	18,844
1949	13,682	1980	16,061
1950	11,413	1981	20,860
1951	20,850	1982	18,974
1952	23,502	1983	16,376
1953	27,281	1984	16,655
1954	23,022	1985	15,517
1955	15,215	1986	13,170
1956	22,292	1987	5,528
1957	23,155	1988	12,877
1958	8,922	1989	19,953
1959	12,083	1990	18,312
1960	10,056	1991	11,733
1961	4,925	1992	4,302
1962	16,804	1993	9,108
1963	17,956	1994	11,701
1964	28,294	1995	10,038
1965	24,298	1996	11,010
1966	20,387	1997	8,684
1967	23,128	1998	7,612
1968	21,762		
<b>Average</b>			<b>16,546</b>
<b>Maximum</b>			<b>29,280</b>

## Consumptive use

In Fiscal Year 2000, 15 cfs was added to the river at the FSID return canal, with half arriving at Acme, about 124 km downstream.<sup>5</sup> The observed flow loss of 50 percent between FSID return canal and Acme was extrapolated to estimate losses between selected points, shown in Table C-2.

<b>Point of diversion to the Pecos</b>	<b>Water loss prior to arrival at Acme</b>
Sumner Dam	69%
FSID diversion dam	60%
FSID return	50%
Acme	0%

The estimated 69 percent loss over 171 km from Sumner Dam to Acme was extrapolated to an estimated 70 percent loss over 189 km from Acme to the Brantley Reservoir. Thus it is assumed that 30 percent of flow released at Acme would arrive at the Brantley Reservoir. An estimated consumptive use of 70 percent agrees with the standard irrigation return flow credit.<sup>6</sup>

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<sup>5</sup> U.S. Fish and Wildlife Service, May 15, 2001.

<sup>6</sup> U.S. Fish and Wildlife Service. May 21, 2001. "Biological Opinion on Reclamation's 2001 Discretionary Action Related to Water Management on the Pecos River, New Mexico."

Statistical distributions of Acme water deficit and consumptive use are presented in Table C-3 below.

<b>Table C-3</b>			
<b>Distribution of water deficit at Acme</b>			
<b>(acre-feet per year)</b>			
<b>Sample probability</b>	<b>Deficit (minimum flow 50 cfs) not greater than:</b>	<b>Amount consumed</b>	<b>Amount delivered to Brantley</b>
0.02	1,035	725	311
0.03	4,302	3,011	1,291
0.05	4,925	3,448	1,478
0.07	5,528	3,870	1,658
0.08	6,228	4,360	1,868
0.10	7,612	5,328	2,284
0.12	8,684	6,079	2,605
0.13	8,922	6,245	2,677
0.15	9,108	6,376	2,732
0.17	10,038	7,027	3,011
0.18	10,056	7,039	3,017
0.20	10,838	7,587	3,251
0.22	11,010	7,707	3,303
0.23	11,413	7,989	3,424
0.25	11,701	8,191	3,510
0.27	11,733	8,213	3,520
0.28	12,083	8,458	3,625
0.30	12,154	8,508	3,646
0.32	12,321	8,625	3,696
0.33	12,877	9,014	3,863
0.35	13,170	9,219	3,951
0.37	13,682	9,577	4,105
0.38	14,339	10,037	4,302
0.40	15,215	10,651	4,565
0.42	15,517	10,862	4,655
0.43	15,947	11,163	4,784
0.45	16,061	11,243	4,818
0.47	16,171	11,320	4,851
0.48	16,376	11,463	4,913
0.50	16,431	11,502	4,929
0.52	16,655	11,659	4,997
0.53	16,804	11,763	5,041
0.55	17,377	12,164	5,213
0.57	17,956	12,569	5,387
0.58	18,312	12,818	5,494
0.60	18,844	13,191	5,653
0.62	18,974	13,282	5,692
0.63	18,987	13,291	5,696
0.65	19,934	13,954	5,980
0.67	19,953	13,967	5,986
0.68	20,063	14,044	6,019
0.70	20,256	14,179	6,077

<b>Sample probability</b>	<b>Deficit (minimum flow 50 cfs) not greater than:</b>	<b>Amount consumed</b>	<b>Amount delivered to Brantley</b>
0.72	20,387	14,271	6,116
0.73	20,850	14,595	6,255
0.75	20,860	14,602	6,258
0.77	21,156	14,809	6,347
0.78	21,762	15,233	6,529
0.80	22,272	15,590	6,682
0.82	22,292	15,604	6,688
0.83	22,635	15,845	6,791
0.85	23,022	16,115	6,907
0.87	23,128	16,190	6,938
0.88	23,155	16,209	6,947
0.90	23,363	16,354	7,009
0.92	23,502	16,451	7,051
0.93	24,298	17,009	7,289
0.95	24,463	17,124	7,339
0.97	27,281	19,097	8,184
0.98	27,693	19,385	8,308
1.00	28,294	19,806	8,488
<b>Average</b>	<b>16,337</b>	<b>11,436</b>	<b>4,901</b>

**Appendix D**

**ESTIMATE OF COSTS OF DESIGNATING CRITICAL HABITAT FOR THE SILVERY  
MINNOW IN THE MIDDLE RIO GRANDE, BY REACH**

## **ESTIMATE OF COSTS OF DESIGNATING CRITICAL HABITAT IN THE MIDDLE RIO GRANDE, BY REACH**

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This Appendix presents an analysis of the cost of designating critical habitat for the silvery minnow in each of the five reaches of the Middle Rio Grande unit. This analysis parallels those presented in Sections 4, 5, and 6 of this report in that it examines the quantity and value of water needed to meet target flows, the secondary economic effects of shifting water from agriculture to instream flow, and the cost of anticipated consultations and project modifications.

### **D.1 Water Volume Required to Sustain a Minimum Flow for the Silvery Minnow**

This analysis estimates the quantity of water required to achieve a target flow of 50 cfs in both the 95th and 50th percentile driest year in the Middle Rio Grande unit of the critical habitat. This analysis discusses flows required for each reach. Because any supplemental water is assumed to be released from upstream reaches and flow downstream to subsequent reaches, the estimated volumes are cumulative; thus, a volume of water presented here for one reach is estimated to provide minimum flows for upstream reaches as well. Note that flows in the Jemez Canyon Reach are considered to be isolated because the Jemez is not part of the main stem of the Middle Rio Grande, and thus are not included in the cumulative estimates.

As in the analysis of flows for the entire river units, this analysis calculates the deficit at the gage that serves as the measuring point for each reach. This analysis uses data from a U.S. Geological Survey gage in the lower portion of each reach to estimate the probability of deficits in instream flow.<sup>1</sup> The quantity of supplemental water needed for each reach is provided in Exhibit D-1 below.

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<sup>1</sup> The following USGS gages were used for the Cochiti, Jemez Canyon, Angostura, and Isleta reaches, respectively: San Felipe, Jemez Canyon, Albuquerque, and Bernardo. See <http://water.usgs.gov/realtime.html>.

Exhibit D-1								
ESTIMATED OPPORTUNITY COSTS TO MEET MINIMUM INSTREAM FLOW FOR SILVERY MINNOW CRITICAL HABITAT, BY REACH								
River Segment	Unit Price (\$ per acre/foot)	Transaction Cost (\$ per acre/foot)	Estimated Annual Water Deficit (acre-feet/year)	Estimated Total Opportunity Cost (2001\$)	Estimated Annual Opportunity Cost (3%)	Present Value (3%)	Estimated Annual Opportunity Cost (7%)	Present Value (7%)
<i>95th Percentile Scenario</i>								
Cochiti	\$4,750	\$333	0	\$0	\$0	\$0	\$0	\$0
Jemez Canyon <sup>2</sup>	\$4,750	\$333	24,038	\$114,180,000	\$3,670,000	\$54,530,000	\$8,550,000	\$90,610,000
Angostura	\$4,750	\$333	4,561	\$21,660,000	\$700,000	\$10,350,000	\$1,620,000	\$17,190,000
Isleta	\$4,750	\$333	32,160	\$ 152,760,000	\$ 4,900,000	\$72,960,000	\$11,440,000	\$121,230,000
San Acacia <sup>3</sup>	\$4,750	\$333	40,427	\$192,030,000	\$6,160,000	\$91,720,000	\$14,380,000	\$152,390,000
<i>50th Percentile Scenario</i>								
Cochiti	\$4,750	\$333	0	\$0	\$0	\$0	\$0	\$0
Jemez Canyon	\$4,750	\$333	17,838	\$84,730,000	\$2,720,000	\$40,670,000	\$6,350,000	\$67,240,000
Angostura	\$4,750	\$333	0	\$0	\$0	\$0	\$0	\$0
Isleta	\$4,750	\$333	2,096	\$ 9,960,000	\$ 320,000	\$4,760,000	\$750,000	\$7,900,000
San Acacia	\$4,750	\$333	5,635	\$26,770,250	\$860,000	\$12,780,000	\$2,000,000	\$21,240,000

<sup>2</sup> Note that while deficits for each of the other reaches in this table represent the volume of water needed to achieve 50 cfs of instream flow in that reach *and those above it*, the Jemez Canyon reach is considered in isolation. As a result, the deficits given for Jemez Canyon are for that reach alone. In addition, deficits calculated for downstream reaches do not account for inputs from the Jemez Canyon reach that reflect an augmented flow of 50 cfs.

<sup>3</sup> The values of supplemental flow for the San Acacia reach are based on the calculations described in Appendix B of this analysis. Because the proposed rule for critical habitat specifies flows that vary by season and location only within the San Acacia reach, the methodology used to calculate this deficit differs slightly from that for other reaches.

This analysis captures the cost of holding water rights for the finite time horizon of 20 years. The implied cost of holding these water rights in the Middle Rio Grande for 20 years would range from \$92 million to \$152 million in the 95<sup>th</sup> percentile scenario and \$13 million to \$21 million in the 50<sup>th</sup> percentile scenario. The implied cost of holding these water rights in the Pecos for 20 years would range from \$21 million to \$35 million in the 95<sup>th</sup> percentile scenario and \$14 million to \$24 million in the 50<sup>th</sup> percentile scenario.

## **D.2 Opportunity Cost of Meeting Minimum Water Flow for the Silvery Minnow**

This analysis uses the purchase price of a water right as a proxy for the value of water. According to data collected by the New Mexico Natural Resource Trustee and professional water trade brokers, prices for water rights have risen steadily in recent years. This analysis uses the recent going price of approximately \$4,750 per acre foot in the Middle Rio Grande.<sup>4</sup> This value is used to calculate the total value of the water that would be used to supplement instream flows for the silvery minnow. This cost estimate is not confined to the 20-year time horizon used in the rest of this analysis, but rather represents the value of this water in perpetuity. To determine an annual value, this analysis uses the standard social discount rate of three percent, which is applied frequently in the evaluation of natural resource management decisions and seven percent, which is commonly used by the U.S. Office of Management and Budget as it reflects the social opportunity cost of capital (measured by the before-tax rate of return for private investment).<sup>5</sup> These discount rates are used to calculate the present value of a permanent good. This results in an annual value of \$143 to \$333 per acre foot per year in the Middle Rio Grande.

Multiplication of the unit value by the estimated volume of water needed to meet minimum target flow requirements for the silvery minnow yields a total direct opportunity cost of supplemental water for each reach, as shown in Exhibit D-1 below. Values in the text of this report are for the 95th percentile scenario; those for the 50th percentile are presented in the summary tables. Note that this analysis does not address transaction costs associated with water transfers as it is not advocating an actual purchase program. It also does not include the cost of pumping water

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<sup>4</sup> See William Turner, New Mexico National Resource Trustee. "Value of Water in the Middle Rio Grande and Pecos River Valleys". Memorandum, October 31, 2000.

<sup>5</sup> Discounting is commonly applied in financial analysis because it provides a means for converting future benefits (or costs) into their worth today. The principle behind discounting is the "time value of money" -- i.e., a dollar paid today is worth more than a dollar paid a year into the future because the person holding the dollar can invest it and earn a return.



from the low-flow conveyance channel into the lower part of the Middle Rio Grande, as this cost is not part of the value of the water.<sup>6</sup>

### **D.3 Regional Economic Analysis**

To determine the extent of economic activity affected by the reduction in water used for irrigation, this analysis utilizes regional economic analysis techniques that are described in detail in Section 5 of this report. Exhibit D-2 provides calculations of the forgone crop production in the Middle Rio Grande study area that will occur if the volumes of water listed in Exhibit D-1 are transferred from irrigation to instream flow. These figures constitute the direct effects of the anticipated change in water use.

Exhibit D-3 below summarizes the regional economic effects of the changes in water use described above. The costs listed above would be incurred in a single year, but are not annual values and can not be combined to reach a total cost over the 20-year time period of this report. The reductions in regional output, employment, and tax revenue represent a one-time change to baseline conditions. As such, they are removed from the projected baseline (e.g., "without critical habitat") conditions permanently, thereby affecting each year of the time period. However, they are not re-subtracted from each subsequent year under the "with critical habitat" conditions.

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<sup>6</sup> The Bureau of Reclamation currently pumps water from the low-flow conveyance channel into the main channel of the Middle Rio Grande near San Marcial. The estimated annual cost of this effort is approximately \$1.2 million. Jaci Gould, U.S. Bureau of Reclamation. Memorandum, February 8, 2002.

<b>Exhibit D-2</b>					
<b>ESTIMATED VALUE OF FORGONE PRODUCTION: INPUTS TO THE IMPLAN MODEL BY REACH (<i>Direct Impacts</i>)<sup>a</sup></b>					
<b>Variable</b>	<b>Cochiti Reach</b>	<b>Jemez Canyon Reach</b>	<b>Angostura Reach</b>	<b>Isleta Reach</b>	<b>San Acacia Reach</b>
Water Removed from Market	0 acre-feet/year (0)	24,038 acre-feet/year (17,838)	4,561 acre-feet/year (0)	32,160 acre-feet/year (2,096)	40,427 acre-feet/year (5,635)
Water Consumption <sup>b</sup>	4.45 acre-feet/acre of crop	4.45 acre-feet/acre of crop	4.45 acre-feet/acre of crop	4.45 acre-feet/acre of crop	4.45 acre-feet/acre of crop
Acres Removed from Production	0 acres	5,407 acres	1,026 acres	7,234 acres	9,094 acres
Yield per Acre per Year <sup>b</sup>	5.67 tons/acre	5.67 tons/acre	5.67 tons/acre	5.67 tons/acre	5.67 tons/acre
Tons of Forgone Production	0 tons	30,650 tons	5,816 tons	41,006 tons	51,546 tons
Unit Price <sup>c</sup>	\$116	\$116	\$116	\$116	\$116
<b>Value of Forgone Production</b>	<b>\$0 (\$0)</b>	<b>\$3,555,361 (\$2,638,345)</b>	<b>\$674,599 (\$0)</b>	<b>\$4,756,653 (\$310,011)</b>	<b>\$5,979,390 (\$833,450)</b>

<sup>a</sup> Values in the table are calculated based on the 95th percentile scenario with volumes of water and values of foregone production under the 50th percentile scenario included in parentheses. Note that the values presented in this table have been rounded and so calculations may appear imprecise.

<sup>b</sup> New Mexico Cooperative Extension Service Crop Models. Available at: <http://agecon.mnsu.edu/jlibbin/2001%20projected/hane.edu>

<sup>c</sup> State of New Mexico. New Mexico Agricultural Statistics 1999. New Mexico Agricultural Statistics Service, Department of Agriculture, 1999.

<b>Exhibit D-3</b>				
<b>REGIONAL ECONOMIC EFFECTS OF REALLOCATING WATER FOR INSTREAM FLOW BY REACH</b>				
<b>River Segment</b>	<b>Value of Forgone Crop Production (2001\$)</b>	<b>Effect on Regional Output (2001\$)<sup>a</sup></b>	<b>Effect on Regional Employment (persons)</b>	<b>Effect on Regional Tax Revenue (2001\$)</b>
	<i>Direct Effect</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>	<i>Direct, Indirect, and Induced Effects</i>
<i>95th Percentile Scenario</i>				
Cochiti	\$0	\$0	0	\$0
Jemez Canyon	\$3,555,361	\$4,581,405	216	\$850,740
Angostura	\$674,599	\$869,282	41	\$161,421
Isleta	\$4,756,653	\$6,129,378	288	\$1,138,190
San Acacia	\$5,979,390	\$8,392,464	362	\$1,430,771
<i>50th Percentile Scenario</i>				
Cochiti	\$0	\$0	0	\$0
Jemez Canyon	\$2,638,345	\$3,399,747	160	\$631,313
Angostura	\$0	\$0	0	\$0
Isleta	\$310,011	\$399,477	19	\$74,181
San Acacia	\$833,450	\$1,169,801	51	\$199,431
<sup>a</sup> Note that the effect on Regional Output includes both the direct effect used as an input to the model (see Section 5.2.1) and the modeled indirect or secondary effects on the economy of the study area.				

#### **D.4 Number and Cost of Future Baseline Consultations Associated with Silvery Minnow Critical Habitat**

This section describes the total economic costs likely to result from section 7 consultations associated with the designation of critical habitat for the silvery minnow over the next 20 years in the Middle Rio Grande unit of the proposed critical habitat designation. This section breaks down the costs presented in Section 6 by reach, according to the following steps.

First, this section examines historical patterns of Federal agency consultations on the silvery minnow, in order to determine the number of future consultations likely to occur on the silvery minnow that would have occurred even absent critical habitat. Past consultations since 1994 were classified and sorted by date, agency, activity, and type of consultation. Historical consultations on

the silvery minnow have only occurred on the Upper/Middle Rio Grande. Thus all consultations considered likely to have occurred absent critical habitat are anticipated to occur in this area.

Since 1994, the average annual number of Federal actions for the silvery minnow has been 7, including formal, informal, and technical assistance efforts that involved the Service. The majority of these efforts have gone into informal consultations (averaging 4.5 per year).<sup>7</sup> Exhibit D-4 displays the historic distributions of consultations for each Action agency by river reach. Based on that average, the number of future consultations likely to have occurred even absent critical habitat are estimated for the silvery minnow over the next 20 years by reach. Exhibit D-5 provides the costs for these consultations over a 20 year time period.

Most projected future consultations in the Middle Rio Grande on the minnow stem from the extensive consultation history on the silvery minnow in this area, and are captured as part of the coextensive silvery minnow consultation estimates above. To estimate any changes in consultation patterns that may occur in the future after critical habitat is designated for the silvery minnow on the Middle Rio Grande, efforts were made to interview staff at Federal agencies with knowledge of upcoming agency activities and the critical habitat consultation process. Service estimates of anticipated technical assistance efforts are used as the basis of projections for these efforts. The results of these interviews, and the resulting consultation projections are summarized by Middle Rio Grande reach in Exhibit D-6. Note that all of the limitations described in Section 6.8 of this report apply to this reach-by-reach analysis as well.

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<sup>7</sup> This analysis classifies all records involving Federal Action agencies as formal or informal consultations, depending on the record. Efforts with no Federal Action agency involvement have been classified as technical assistance efforts. Phone call records of technical assistance efforts were not part of the available consultation record, and thus have not been tallied.

<b>Exhibit D-4</b>		
<b>PAST CONSULTATION BEHAVIOR IN PROPOSED CRITICAL HABITAT AREAS FOR THE RIO GRANDE SILVERY MINNOW</b>		
<b>Federal Agency</b>	<b>Historical Activities Resulting in Consultation<sup>a,b</sup></b>	<b>Consultation Pattern Since 1994</b>
U.S. Fish and Wildlife Service (internal)	Emergency rescue/relocation of silvery minnow, reservoir fish stocking, vegetation management.	Cochiti: 12 % Jemez: 2 % Angostura: 12% Isleta: 24 % San Acacia: 51 %
Bureau of Reclamation	Water operations, including: bioengineering, habitat enhancement, river training, sediment removal, levee maintenance, vegetation removal.	Cochiti: 19 % Jemez: 4 % Angostura: 24% Isleta: 9 % San Acacia: 44 %
Army Corps of Engineers	Authorization and permitting of dredging and filling of wetlands, channelization of streams, flood control actions, bridge construction, sand and gravel operations under Section 404 of the Clean Water Act.	Cochiti: 31% Jemez: 4 % Angostura: 31 % Isleta: 4 % San Acacia: 31%
Environmental Protection Agency	Permitting of municipal and industrial discharges under the National Pollutant Discharge Elimination System (NPDES).	Cochiti: Jemez: Angostura: 33% Isleta: 50% San Acacia: 17%
Federal Energy Regulatory Commission	Authorization and licensing for oil and gas pipelines.	Cochiti Jemez Angostura Isleta: 100% San Acacia:
U.S. Department of Transportation	Road and bridge construction activities.	Cochiti: 100% Jemez Angostura Isleta San Acacia:
Sources: Administrative records provided by the Albuquerque Ecological Field Office, U.S. Fish and Wildlife Service, Albuquerque, NM, 2001. Note that these estimates assume that all past actions on the Rio Grande occur within the proposed critical habitat units. In reality, several may occur outside these boundaries. Thus, these estimates may overstate the number of anticipated actions within critical habitat areas. Any anticipated increases in consultation activity by these agencies are not considered part of the baseline effects, and will be discussed in the non-baseline effects section of this report.		
<sup>a</sup> Historical consultations have only occurred on the Upper/Middle Rio Grande.		
<sup>b</sup> Technical assistance here only include those requiring written correspondence.		

**Exhibit D-5**

**SUMMARY OF COSTS OF COEXTENSIVE SECTION 7 CONSULTATIONS  
AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED FOR THE SILVERY MINNOW  
BY REACH  
(20 YEARS)**

Action	<i>Cochiti</i>		<i>Jemez</i>		<i>Angostura</i>		<i>Isleta</i>		<i>San Acacia</i>		Total Costs	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Formal Consultation	\$95,700	\$153,500	\$15,600	\$25,000	\$120,000	\$192,500	\$70,800	\$113,600	\$198,300	\$318,200	<b>\$500,400</b>	<b>\$802,800</b>
Informal Consultation	\$61,500	\$244,200	\$8,600	\$34,000	\$72,300	\$287,000	\$63,000	\$250,300	\$116,600	\$463,200	<b>\$322,000</b>	<b>\$1.3 million</b>
Technical Assistance	\$2,580	\$6,540	\$2,580	\$6,540	\$2,580	\$6,540	\$2,580	\$6,540	\$2,580	\$6,540	<b>\$12,900</b>	<b>\$32,700</b>
Project Modifications	\$3.2 million	\$5.2 million	\$0.5 million	\$0.9 million	\$3.7 million	\$5.9 million	\$1.0 million	\$1.6 million	\$5.5 million	\$9.7 million	<b>\$14.0 million</b>	<b>\$23.4 million</b>
Total	\$3.3 million	\$5.6 million	\$0.5 million	\$1.0 million	\$3.9 million	\$6.4 million	\$1.1 million	\$2.0 million	\$5.8 million	\$10.5 million	<b>\$14.9 million</b>	<b>\$25.5 million</b>

Source: IEC analysis. Note that numbers may not sum due to rounding.

**Exhibit D-6**

**SUMMARY OF ESTIMATED COSTS OF NEW SECTION 7 CONSULTATIONS  
AND TECHNICAL ASSISTANCE EFFORTS LIKELY TO OCCUR IF CRITICAL HABITAT IS DESIGNATED FOR THE SILVERY MINNOW  
(20 YEARS)**

Action	<i>Cochiti</i>		<i>Jemez</i>		<i>Angostura</i>		<i>Isleta</i>		<i>San Acacia</i>		Total Costs	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Formal Consultation	\$32,600	\$52,300	\$5,400	\$8,600	\$36,100	\$58,000	\$34,700	\$55,800	\$71,800	\$115,200	<b>\$180,700</b>	<b>\$290,000</b>
Informal Consultation	\$36,500	\$145,000	\$2,600	\$10,300	\$17,100	\$67,900	\$25,700	\$102,100	\$37,100	\$147,400	<b>\$119,000</b>	<b>\$472,600</b>
Technical Assistance	\$150,500	\$381,500	\$150,500	\$381,500	\$150,500	\$381,500	\$150,500	\$381,500	\$150,500	\$381,500	<b>\$752,500</b>	<b>\$1.9 million</b>
Project Modifications	\$1.0 million	\$1.7 million	\$0.2 million	\$0.3 million	\$1.2 million	\$1.9 million	\$0.3 million	\$0.5 million	\$1.8 million	\$3.8 million	<b>\$4.5 million</b>	<b>\$8.1 million</b>
Total	\$1.2 million	\$2.3 million	\$0.4 million	\$0.7 million	\$1.4 million	\$2.4 million	\$0.5 million	\$1.0 million	\$2.1 million	\$4.4 million	<b>\$5.6 million</b>	<b>\$10.8 million</b>

Source: IEC analysis.