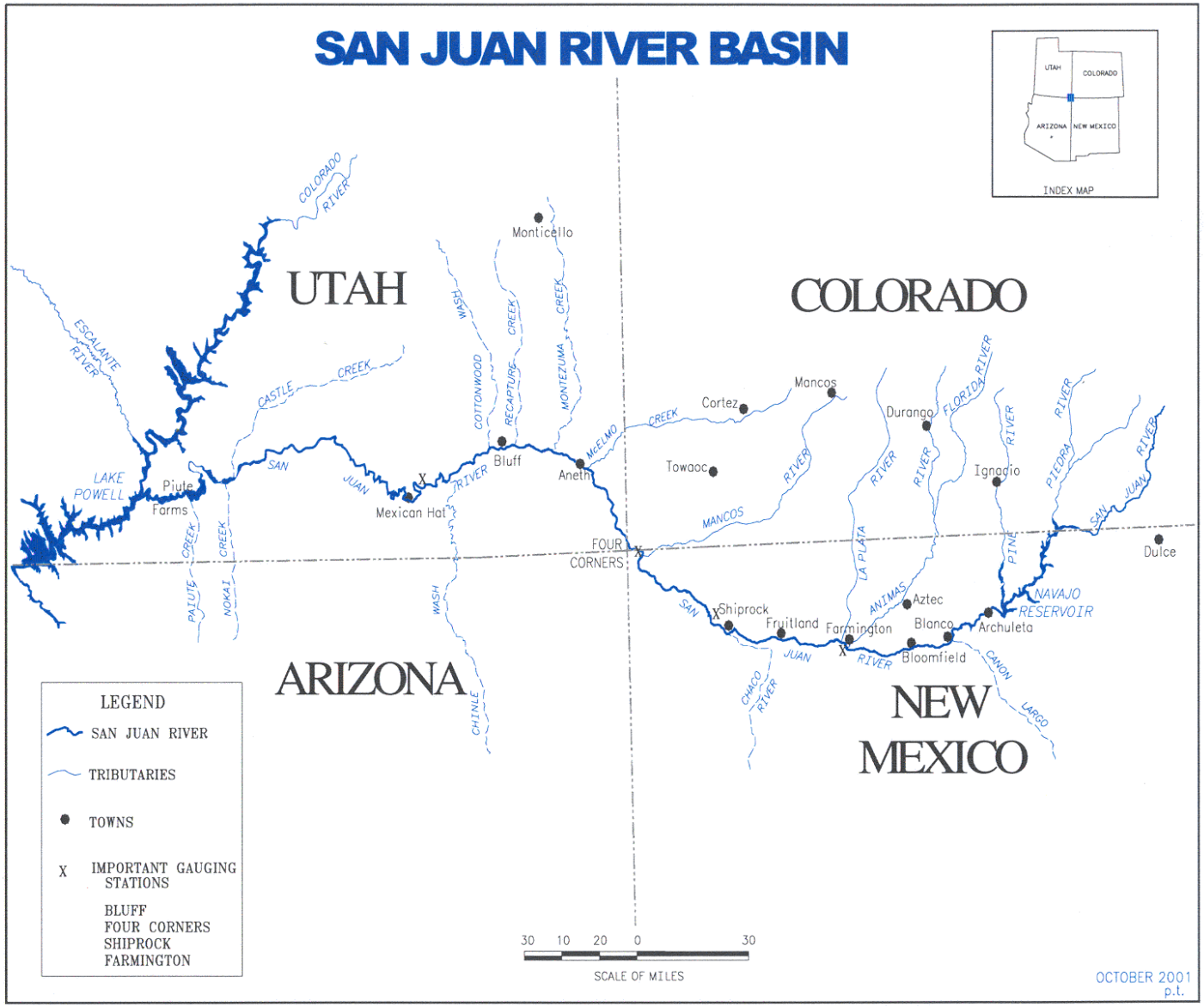
Biological Assessment

Navajo Reservoir Operations, Colorado River Storage Project
Colorado-New Mexico-Utah

Bureau of Reclamation
Upper Colorado Region
Western Colorado Area Office

July 24, 2002
(Revised July 2003)


SAN JUAN RIVER BASIN
INDEX MAP
UTAH
COLORADO
NEW MEXICO
ARIZONA
Monticello
Bluff
Aneth
Cortez
Mancos
Towaoc
Durango
Ignacio
Dulce
Piute Farms
Mexican Hat
FOUR CORNERS
Shiprock
Fruitland
Farmington
Aztec
Blanco
Bloomfield
Archuleta
NAVAJO RESERVOIR
COLORADO RIVER
ESCALANTE RIVER
LAKE POWELL
CASTLE CREEK
SAN JUAN RIVER
COTTONWOOD WASH
RECAPTURE CREEK
MONTEZUMA CREEK
McELMO CREEK
MANCOS RIVER
LA PLATA RIVER
FLORIDA RIVER
PINE RIVER
PIEDRA RIVER
ANIMAS RIVER
CHACO RIVER
CANON LARGO
CHINLE WASH
PAIUTE CREEK
NOKAI CREEK
LEGEND
SAN JUAN RIVER
TRIBUTARIES
TOWNS
IMPORTANT GAUGING STATIONS
BLUFF
FOUR CORNERS
SHIPROCK
FARMINGTON
30 10 20 0 30
SCALE OF MILES
OCTOBER 2001
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Contents

Attachments

Biological Assessment –
Navajo Reservoir Operations

Introduction

This biological assessment is prepared pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, to address impacts of a proposal to operate Navajo Dam and Reservoir on threatened or endangered species, species that are candidates for listing, and other species of concern. Included are the impacts of depletions from evaporation from Navajo Reservoir. A biological assessment was originally prepared in July, 2002; this 2003 version replaces the July version and addresses several questions and concerns brought up by the Fish and Wildlife Service (Service) in a memorandum dated October 30, 2002 (Service, 2002a) and in subsequent meetings.

Navajo Dam was constructed between 1958 and 1963 under the Colorado River Storage Project Act of 1956 (CRSP) to meet multiple water resource purposes. The dam is located on the San Juan River approximately 44 miles upstream from Farmington, New Mexico. The reservoir created holds approximately 1.7 million acre-feet of water and extends into both New Mexico and Colorado. The reservoir has a surface area of 15,610 acres and has
150 miles of shoreline. The normal operating range for the reservoir is between 5,990 feet and 6,085 feet. Navajo Reservoir has a maximum content of 1,701,300 acre-feet. Below
5,985 feet the inactive pool contains 625,675 acre-feet.

CRSP authorized the Navajo Unit to regulate the flow of the San Juan River to make it possible for Upper Basin States to consistently use their Upper Colorado River Basin Compact (Compact) apportionments. The components of the Compact apportionment for New Mexico and Colorado supported by the Navajo Unit include the San Juan-Chama Project, the Navajo Indian Irrigation Project (NIIP), the Jicarilla Apache Nation water right settlement, and the Animas-La Plata Project (ALP Project) as well as numerous smaller water uses, both existing and proposed. The Unit provides the benefits of river

regulation, flood control, recreation, fish and wildlife, and generation of hydroelectric power. Reclamation's proposed reoperation of Navajo Reservoir must be compatible with the authorizing legislation for the Navajo Unit.

In addition to regulating riverflows, the reservoir stores water for the Navajo Indian Irrigation Project (NIIP) and various municipal and industrial uses. At the present time, NIIP diverts an average of approximately 160,000 acre-feet from the reservoir for irrigation south of Farmington. In the future this use is expected to approximately double. Navajo Dam provides flood control and also recreation and fishery benefits.

After completion of the Navajo Unit in 1962, criteria governing releases of water from the dam focused primarily on meeting irrigation needs, providing flood control, maintaining stable river flows, and providing a recreation pool in Navajo Reservoir. Native fish populations and their habitat have been adversely affected or modified by the Navajo Unit.

Some of the other factors affecting native fish in the San Juan are loss of riverine habitat to Lake Powell, introduction of non-native fish, past control of native fish to enhance recreational fisheries, migration barriers, and channel modifications.

Reclamation requested initiation of ESA consultation on the operation of Navajo Dam in a memorandum to the Service dated July 30, 1991. The Service (1991) concurred with a later request from Reclamation that consultation on the operation of Navajo Dam and Reservoir under Section 7 of the ESA be extended while research was conducted on flow needs of endangered fish in the San Juan River. During the research period, which extended from 1991 to 1997, Reclamation provided test flows to mimic a natural hydrograph. Following the research period, a report on Flow Recommendations for endangered fish was prepared (Holden, 1999). Holden (2000) presents an evaluation of the results of the research period.

The Service and Reclamation have consulted formally and informally throughout the 1990s regarding the potential impacts of operation of Navajo Dam on listed species. Previous versions of this biological assessment have previously been provided the Service and Tribal governments.

Reclamation plans to implement the proposed action "to operate Navajo Dam to meet Flow Recommendations for endangered fish" by modifying the operation decision criteria of the dam to provide sufficient releases of water at times, quantities, and durations necessary to protect endangered fish and their designated critical habitat while meeting the authorized purposes of the Navajo Unit and enabling future water development to proceed in compliance with Federal and State laws, interstate compacts, court decrees, and Indian trust responsibilities. Reclamation plans to complete a final environmental impact statement (EIS) and Record of Decision prior to finalizing operation plans and criteria.

The Service's Region 2 (2001a) has provided the following list of endangered, threatened, and species of concern that could

potentially be affected by the EIS's proposed operation changes.

Bald eagle (*Haliaeetus leucocephalus*)	Threatened
Interior least tern (*Sterna antillarum athalassos*)	Endangered
Southwestern willow flycatcher (*Empidonax trailii extimus*)	Endangered
Colorado pikeminnow (*Ptychocheilus lucius*)	Endangered
Razorback sucker (*Xyrauchen texanus*)	Species of concern
American peregrine falcon (*Falco peregrinus anatum*)	Species of concern
Arctic peregrine falcon (*Falco peregrinus tundrius*)	Species of concern
Black tern (*Chlidonias niger*)	Species of concern
White-faced ibis (*Plegadis chihi*)	Species of concern
Yellow-billed cuckoo (*Coccyzus americanus*)	Species of concern
Roundtail chub (*Gila robusta*)	Species of concern
New Mexico silverspot butterfly (*Speyeria nokomis nitocris*)	Species of concern
San Juan checkerspot butterfly (*Euphydryas anicia chuskae*)	Species of concern
San Jaun tiger beetle (*Cicindela lengi jordai*)	

Region 6 of the Service (with responsibilities in the Utah portion of study area) has reviewed the above list and has added the following additional species for consideration (Service, 2001b):

Navajo sedge (*Carex specuicola*)	Threatened
Bonytail (*Gila elegans*)	Endangered
Humpback chub (*Gila cypha*)	Endangered
California condor (*Gymnogyps californianus)*	Endangered
Mexican spotted owl (*Strix occidentalis lucida*)	Threatened
Black-footed ferret (*Mustela nigripes*)	Endangered
Gunnison sage grouse (*Centrocercus minimus*)	Candidate

Indian Tribes and Nations in the area have been requested to provide lists of species of concern to the Tribes. The Navajo Nation (2001) provided a list of species of special concern that could occur within the project impact area. Species included the golden eagle (*Aquila chrysaetos*), bluehead sucker (*Catostomus discobolus*), mottled sculpin (*Cottus bairdi*), southwestern willow flycatcher, peregrine falcon, roundtail chub, bald eagle, Colorado pikeminnow, northern leopard frog (*Rana pipiens*), razorback sucker, yellow-billed cuckoo, bighorn sheep (*Ovis canadensis*), and alcove rock daisy (*Perityle specuicola*).

This assessment concludes that the operational changes in the Proposed Plan may affect, but not likely adversely affect the following listed species: Colorado pikeminnow, razorback sucker, southwestern willow flycatcher, and bald eagle. It is predicted that these species will be benefitted by the new flow regime that improves their habitat conditions. Depletions from the reservoir evaporation and other Unit depletions are considered an adverse effect on listed fish; however, the proposed plan should be beneficial.

Background

On August 6, 1991, the Service issued an updated Recovery Plan for the Colorado pikeminnow that identified the San Juan

River from Farmington, New Mexico to Lake Powell as a recovery area. The Service issued a final biological opinion for the ALP Project[1] in 1991 with a reasonable and prudent alternative that included: seven years of research to determine endangered fish habitat needs in the San Juan; operation of Navajo Dam to provide water for a wide range of flow conditions for the endangered fish; a guarantee that the Navajo Reservoir would be operated to mimic a natural hydrograph and such operation would be based on research; legal protection for the reservoir releases to and through the endangered fish habitat to Lake Powell; and a commitment to develop and implement the San Juan River Basin Recovery Implementation Program (SJRBRIP). As a result of this opinion, the SJRBRIP was formulated (Service, 2000).

[1] The Animas-LaPlata Project would deplete flows from the Animas River, a major tributary of the San Juan River upstream from critical fish habitat. See the FSFEIS (Reclamation, 2000) for further information.

The SJRBRIP[2] was established in 1992 to protect and recover the Colorado pikeminnow and razorback sucker in the San Juan Basin while water development proceeds in compliance with applicable Federal and State laws, including fulfillment of Federal trust responsibilities to several Indian tribes. Research goals of the program were to determine limiting factors to the endangered fish and to determine measures to eliminate or reduce the limiting factors. Holden (2000) summarizes research findings and provides direction for future activities under the SJRBRIP.

The SJRBRIP is intended to provide measures for compliance with the ESA for water development and water management activities in the San Juan River Basin. The program includes elements to protect the genetic integrity of the species, to augment populations through stocking, to protect and restore habitat, to protect water quality, to address non-native fish competition, and to monitor endangered fish population status and trends. Further information can be found at the program's website: <http://southwest.fws.gov/ sjrip/>. Operating Navajo Reservoir to meet Flow Recommendations is an important component of the overall program.

In 1994 critical habitat was designated for the Colorado pikeminnow including the San Juan River from Farmington to Lake Powell and for the razorback sucker, from the Hogback Diversion to Lake Powell.

In 2000, the Service issued a new biological opinion on the ALP Project that included a conservation measure in which ". . .Reclamation is committing to operate Navajo Reservoir to mimic the natural hydrograph of the San Juan River to benefit endangered fishes and their critical habitat. Mimicry of the natural hydrograph will be achieved by following the San Juan Riverflow Recommendations (Holden, 1999) and subject to completion of the Navajo Operations EIS and execution of a Record of Decision" (Service, 2000).

[2] The SJRBRIP is a major cooperative effort among entities interested in the goals of endangered fish recovery, maintenance of existing Navajo Dam and Reservoir authorized purposes, and additional water development in the San Juan River Basin. In addition to Reclamation, participants include the Service, Bureau of Indian Affairs, Bureau of Land Management, Southern Ute Indian Tribe, Ute Mountain Ute Tribe, Navajo Nation, Jicarilla Apache Nation, water development interests, and the States of Colorado and New Mexico.

In addition to the ALP Project, other projects in the San Juan Basin, for example completion of the Navajo Indian Irrigation Project (NIIP), rely on the SJRRIP, including the reoperation of the Navajo Unit according to the Flow Recommendations, to comply with the ESA.

The Coordination Committee of the SJRBRIP has adopted principles for conducting ESA consultations (SJRBRIP, 2001c) on water development and these should be referred to for information on ESA consultation for existing and future water developments. The Service uses these principles to evaluate water project compliance with the ESA. When consultation is initiated, the Service determines if progress toward recovery has been sufficient for the SJRBRIP to serve as a reasonable and prudent alternative or measure. The Service also considers whether the probable success of the SJRBRIP is compromised as a result of new depletions.

San Juan River

The San Juan River Basin encompasses approximately 25,000 square miles and the river extends 350 miles from its headwaters in the San Juan and La Plata Mountains of Colorado to Lake Powell. The river crosses the Southern Ute and the Ute Mountain Ute Reservations and the Navajo Nation. Approximately 225 miles of the San Juan River are between Navajo Dam and Lake Powell; the lower 180 miles downstream from Farmington are designated as critical habitat for the Colorado pikeminnow and the lower 155 miles as critical habitat for the razorback sucker. Mean annual runoff in the river at Farmington just downstream from the confluence with the Animas River is 1.3 million acre-feet; near Bluff, Utah, this increases to about 1.4 million acre-feet.

Below Navajo Reservoir, the San Juan River is joined by its largest tributary, the Animas River, at Farmington before flowing westward to the Navajo Nation boundary west of Waterflow, New Mexico. The river continues west and northwest before entering Colorado near the Four Corners landmark and flowing into Utah and then Lake Powell.

Since the late 1880s over 20 non-native fish have been introduced to the San Juan River drainage; channel catfish and common carp are two of the more common introduced species in the river. In addition to the Colorado pikeminnow and razorback sucker, six other native species occur. The Colorado River cutthroat trout is found in isolated tributaries. The roundtail chub is found in very low numbers in the San Juan and Animas but can be locally common in smaller tributaries. Bluehead and flannelmouth suckers are found in both the Animas and San Juan as is the speckled dace which occurs in upstream areas. Mottled sculpin are found primarily in the Animas River.

The San Juan River supports a high quality trout fishery for 7 miles downstream from Navajo Dam and a good trout fishery for the next 10 miles to the Hammond Diversion. According to a draft report by New Mexico Game and Fish Department (Wethington and Wilkinson, 2003), native fish declined

significantly in the river around the Hammond Diversion, possibly due to increased spring flows. Throughout the 28-mile reach from the Hammond Diversion downstream to Farmington, native fish populations increase as habitat becomes more favorable for those species, although populations may be limited due to reductions in physical habitat related to existing flow depletions. The Hammond Diversion to Farmington reach of river has the highest percentage of native fish; however, non-native fish such as carp and fathead minnows are still common in this reach.

The reach between Farmington and Lake Powell maintains the river's most natural hydrologic conditions, primarily due to the influence of the Animas River which is largely unregulated. This area includes designated critical habitat for the Colorado pikeminnow and razorback sucker and supports other native fish such as the bluehead and flannelmouth suckers. Early fishery studies and anecdotal information indicate that both the pikeminnow and razorback were common to fairly common in the San Juan River in the early years of settlement (Holden, 2000). Non-native fish are now common in this reach, particularly downstream from the Public Service of New Mexico (PNM) diversion dam.

The historic San Juan was similar to other rivers in the upper Colorado River Basin with large flows during spring snowmelt followed by low (base) flows the rest of the year; however, summer and fall spike flows occur due to thunderstorm events to a greater degree than in other rivers. Following Navajo Dam construction, spring peaks were reduced by nearly half and base flows increased (Bliesner and Lamarra, 2000). In general, upper reaches of the river are cobble-dominated and lower reaches are sand-dominated; much of the lower reaches are canyon-bound. Summer water temperatures have been lowered in the upper reach of the river due to cold water releases from Navajo Dam.

Sediment inflow to the river is significant during summer and fall thunderstorms; there is historical evidence that this was much greater around the turn of the century, when there was rapid erosion of the watershed due to overgrazing or other

factors. In the 20th century there was also a large invasion of non-native vegetation into the river's riparian area. Overall, the combination of accelerated erosion in the watershed, invasion of non-native plants, and regulation of flow by Navajo Dam has probably created a quite different river environment than occurred 150 years ago.

The first 7 miles of the river downstream from Navajo Dam supports a significant wetland/ riparian zone; this section of river is upstream from irrigation diversions so wetland vegetation receives water primarily from the river and tributary groundwater. Important wetlands, extending approximately 2 miles downstream from the dam, have developed in areas formerly used for construction borrow along the river. On the 40 mile reach of river between Archuleta and Farmington, riparian areas have been impacted by agriculture, grazing, natural gas development, and commercial developments. Many of the wetlands in this area receive water from irrigation ditch seepage and return flows.

From Farmington to Lake Powell, riparian areas of varying sizes and quality exist and are mainly dependent on riverflows. While spring peaks have been reduced in this reach, flows are more natural in this area, but riparian areas are impacted by livestock grazing and invasion by non-native plants. The San Juan River corridor supports riparian species such as cottonwood, willow, and non-native tamarisk and Russian olive. Non-native species dominate, with native willows and cottonwoods accounting for less than 15 percent of the riparian vegetation (Bliesner and Lamarra, 2000). Sedges, rushes, reed canary grass, cattails, bulrushes, alkali sacaton, and galleta grass are typical herbaceous species (BLM, 2002b).

The upland region north and south of the San Juan River is characterized by desert physiography; broad dry washes carry significant sediment loads during periodic thunder-storm events. The project area is semi-arid to arid; the major part of the basin is less than 6,000 feet in elevation and receives less than 8 inches of precipitation annually. Vegetation ranges from pinon-juniper areas around Navajo Reservoir to

desert shrubs and grasses around the lower San Juan River. The pinon-juniper areas are characterized by pinon pine, Utah juniper, Gambel's oak, mountain mahogany, big sagebrush, and bitterbrush. Scattered ponderosa pine and Douglas fir also occur.

Towns and communities in the study area include Farmington at the confluence with the Animas; and Bloomfield, Blanco, and Archuleta upstream and Fruitland, Shiprock, Bluff, and Mexican Hat downstream from Farmington. Energy development, agriculture, and tourism and recreation are important industries in the area. In particular, agriculture and recreation are closely related to Navajo Reservoir and its operation and to flow patterns in the San Juan River.

The frontispiece map shows the general project area and attachment A provides a demarcation of the river with river mile designations, starting with River Mile 0 above the high water line of Lake Powell and ending at River Mile 225 at Navajo Dam (these River Mile locations will be referred to throughout the text).

Project Description

The Bureau of Reclamation (Reclamation) proposes to operate Navajo Dam and Reservoir to implement Endangered Species Act (ESA)-related Flow Recommendations on the San Juan River. This change in reservoir operation, along with other elements of the Recovery Program, would assist in conserving endangered fish in the San Juan River downstream from Farmington, New Mexico, and in enabling water development to proceed in the San Juan River Basin in compliance with applicable laws, compacts, court decrees, and American Indian trust responsibilities. To accomplish this action, Reclamation would continue to operate Navajo Dam to meet the authorized project purposes while modifying reservoir release patterns to meet Flow Recommendations which are designed to maintain or improve habitat for the razorback sucker and Colorado pikeminnow. Additional information can be found in the environmental impact statement on the project (Reclamation,

2002b).

The twofold purpose of the Proposed Alternative (also referred to as the 250/5000 Alternative or the Preferred Alternative) is to (1) develop operating criteria for Navajo Dam and Reservoir in order to assist in creating and maintaining habitat in the San Juan River to help conserve and recover populations and designated critical habitat of the Colorado pikeminnow and razorback sucker, and (2) maintain the authorized purposes of the Navajo Unit, including enabling future water development.

This Proposed Alternative is designed to mimic a natural hydrograph downstream from the confluence of the Animas River. Navajo Dam would be operated so that releases range from 250 cubic feet per second (cfs) to 5,000 cfs and flexibility would be retained to adjust release rates within this range to respond to new information as it becomes available. The SJRBRIP uses a process that involves annual monitoring and continued research, so the Flow Recommendations may be refined in response to new information. Reclamation expects the Service will periodically review operations to determine if the Flow Recommendations are being met. This will be done by reviewing operations in light of forecasted inflow and by reviewing river gage data.

The spring peak release will be planned to meet the statistical requirements of the spring flow recommendations and will involve 5,000 cfs releases from Navajo Dam. The decision chart on the following page will be used to determine spring releases. The spring peaks would occur in approximately 70 percent of the years. The summer, fall and winter base releases are also intended to meet the flow recommendation targets in the river downstream of Farmington of 500 to 1,000 cfs for habitat protection and water storage.[3]

The proposed operation will help meet or exceed endangered

[3] The SJRBRIP Biology Committee acknowledged that some flexibility exists in interpreting the meeting of the upper limit of 1,000 cfs during the irrigation season. The Biology Committee indicated that during the irrigation season (March through October) "it may not be effective or necessary to lower releases below 500 cfs until water use in the basin increases to the point that the water is needed to meet runoff period recommendations. This flexibility is extended only to the irrigation season as defined...and only until water development reaches the level that additional water is needed for Spring releases" (February 21, 2002, memorandum from Biology Committee to Reclamation).

fish spring peak recom-mendations. The operation criteria are also designed and intended to consistently meet endangered fish minimum base flows downstream from Farmington (500 cfs). Maximum recommended base flows (1,000 cfs) downstream from Farmington will occasionally be exceeded because of high inflows from the Animas River this would occur even with
250 cfs releases from Navajo Dam.

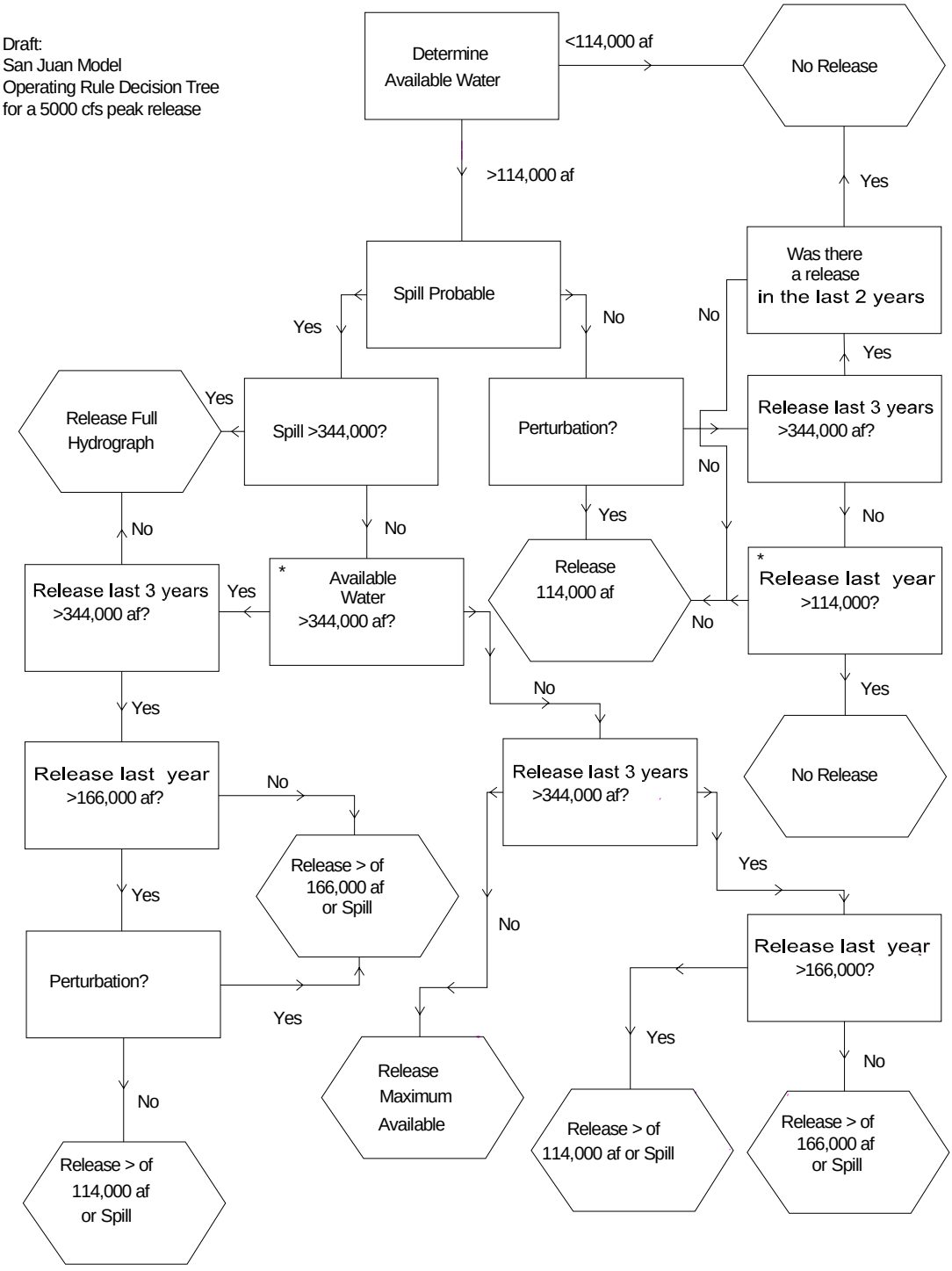
The Flow Recommendations call for using a moving average of 2 of the 4 downstream gages to monitor whether flows are kept between 500 and 1,000 cfs. There can be significant variability in these gage readings and the selective use of any 2 gages could give results above or below the intent of the Flow Recommendations. Because of this, in 2002 the Biology Committee of the SJRBRIP suggested that flows be monitored by following: Use the lesser of the average of Bluff, Four Corners and Shiprock (gages) and the average of Farmington, Shiprock, and Four Corners (gages). . .extreme conditions (low or high flows) identified by. . .Reclamation will be handled on a case-by-case basis with recommendations of the Biology Committee. The Service has provided written support of this approach to monitoring.

Reclamations intent, which will be documented in the FEIS, will be to maintain the recommended base flows in the critical habitat reaches by using the best available gage information. In practice, Reclamation and the Service will discuss flows routinely during the irrigation season and as needed the remainder of the year to determine the operation needed to meet the base flows. Reclamation, in consultation with the Service, will use the lesser of the weekly moving average of the Bluff, Four Corners, and Shiprock gages and the average of the Farmington, Shiprock, and Four Corners gages as the guide in meeting this intent.

In periods of severe drought, Reclamation will work with the Service to arrive at operating criteria to respond to these conditions. For example, in 2002, Reclamation and the Service agreed to reduce target base flows in the critical habitat reaches to 350 cfs due to the extreme drought

conditions. This is an example of how extreme conditions can be handled. If water shortages to Navajo Reservoir water users, including the endangered fish, occur, all users will share the shortage as an equal percentage. For example, a 10 percent shortage would reduce water supply to the fish and to Navajo water users by 10 percent.

Draft:
San Juan Model
Operating Rule Decision Tree
for a 5000 cfs peak release



Taken from: May 1999 SJRIP Biology Committee flow recommendations Report

If reservoir releases need to be increased in the late summer or fall due to heavy monsoonal moisture upstream from the reservoir, the unusually high inflows will be released as a fall spike.

Reclamation will utilize existing Navajo Reservoir Operations Meetings, held three times a year, to discuss the upcoming period's operations. At these meetings, held in January, April, and August of each year, Reclamation will solicit input regarding the many and diverse affected resources on the San Juan River from members of the public, government (local, state, Federal) agencies, tribes, and others to gain the required information needed to set water releases from Navajo Reservoir. For each operation meeting, Reclamation will also utilize existing water inflow forecasts, reservoir level, and historic averages to predict the upcoming water supply available to meet endangered fish Flow Recommendations and authorized purposes. This information along with the decision tree for peak flows will be analyzed and considered by Reclamation to develop an operation plan. The operations will fall within the sideboards analyzed within the Navajo Reservoir Operations EIS, with releases between 250 and 5,000 cfs. Reclamation will be responsible for implementing the operation plan following completion of a Record of Decision under the NEPA process.

Inherent in the operation of Navajo Dam there exist variables that influence dam operations under all conditions and these must be considered when evaluating operations. These influences include changes or errors associated with inflow forecasts, fluctuations in the Animas River, strong precipitation events, the water's travel time down the river after an adjustment at the dam occurs, gage errors and discrepancies, contractual obligations with the city of Farmington (powerplant operations), and unexpected maintenance needs at Navajo Dam. Reclamation will take these variables into account when making operating plans to meet the Flow Recommendations.

Two areas of flexibility exist in the reservoir's operations. First, water committed for future development (e.g., completion of NIIP) but not currently used offers flexibility in

reservoir releases. This may be a significant amount of water in many, but not all, years. The release of this water will be incorporated into operations to augment the 250 cfs minimum release during the irrigation season; the goal will be to maintain irrigation season releases between 350 and 500 cfs, while assuring a spring release as described in the Flow Recommendations will not be affected and assuring recommended minimum flows are met. Water forecasted to be available for this flexibility will be identified and quantified to the extent possible during the Navajo Reservoir Operations Meetings and the scheduling of its release will be discussed. Based on recommendations from resource experts, options will be presented for the use of this water and comments will be solicited from the public. Reclamation will use these comments to make decisions on the release of water.

The second area of flexibility exists as full water development occurs. Minimum releases would be no lower than 250 cfs, but in the long term, flexibility will diminish; in drought years, flexibility may not exist at all. Existing flexibility within the endangered fish Flow Recommendations could occasionally allow minimum summer releases to be above 250 cfs. During the Navajo Reservoir Operations Meetings and in discussions with the Service, an operation plan to meet endangered fish flows, authorized project purposes, and water

development needs will be prepared. Unutilized or unaccounted for water, resulting from the aforementioned variables, would be identified and used to increase irrigation season releases or for other uses.

Part of the SJRBRIP is to implement a process of "adaptive management," whereby the effects of dam operations on endangered fish and their habitat and downstream resources would be monitored and the results of that monitoring would form the basis for possible future tests or modifications of dam operations and/or the Flow Recommendations. Uncertainties are recognized in both the EIS alternatives for Navajo Dam re-operation and in the overall SJRBRIP recovery plan for the endangered fish. For example, hydrology modeling assumed that future precipitation and runoff patterns are reflected in the historic hydrologic record. If this is not correct, Flow Recommendations may be more or less difficult to meet. Responses of the endangered fish to the Flow Recommendations and other recovery elements have been predicted based on scientific studies of the fish and their habitat, but only actual monitoring of the fish and habitat over a period of years will give conclusive evidence of the responses. Also, it is uncertain to what extent non-native fish will benefit from the recommended flows and whether these benefits will offset the positive effects of the modified hydrology on endangered fish.

Scientific monitoring conducted through the SJRBRIP will determine the status and
trends of the endangered fish and their habitats following implementation of the Flow Recommendations and other recovery activities. Criteria established to determine positive population responses and overall species recovery are discussed elsewhere in this biological assessment. The Biology Committee of the SJRBRIP, which includes Federal, State, Tribal and water development interests, would be responsible for conducting monitoring and research, and for communicating results of this work to stakeholders and the public during Navajo Reservoir operation meetings. The Biology Committee can also recommend recovery actions that would address all of the recovery factors related to the endangered fish. These

actions may include experimentation to test new hypotheses, modifications to the Flow Recommendations, or control actions directed against non-native fish, if warranted by monitoring and research results. Any adjustments in, or modifications to, the Flow Recommendations must be approved by the Coordination Committee, which is the governing committee of the SJRBRIP.

Recommendations for dam release modifications can then be considered by Reclamation, the agency ultimately responsible for Unit operations. Recommendations for changes not under Reclamation's authority would be considered by the appropriate agency. Thrice-yearly Navajo Reservoir operation meetings will provide the forum for all interested parties to discuss Navajo Unit operations and recovery program progress and recommendations. The SJRBRIP Biology Committee and other scientists will be invited to each meeting to discuss the effects of dam operations and other resource management actions on the endangered fish. Flexibility in dam releases will also be discussed at these meetings. Future changes in the Flow Recommendations, dam operations, and other management policies could be implemented long-term after compliance with applicable law.

The anticipated long-term species response to the proposed reoperation, in concert with other recovery actions, is attainment of Recovery Goals. These goals (Service, 2002b and 2002c) are summarized later in the species accounts for the pikeminnow and razorback and basically present a method to determine when listed fish species are eligible for removal from threatened or endangered status. Positive population response criteria (Reclamation, 2001) have also been developed for the San Juan River as part of the ALP Project ESA consultation; the purpose of these criteria is to provide measurable criteria to determine
if populations in the San Juan are responding to management actions and showing improvement prior to attainment of the Recovery Goals. The Service (2001e) has concurred with the criteria. The positive population response criteria include criteria not specifically identified in the Recovery Goals for example, the presence of larval or young-of-the-year fishes and range expansion. Criteria are summarized in the table 1. If, based on SJRBRIP monitoring results, flow recommendations and other recovery elements do not result in positive population responses in the time frames outlined in the recovery goals and positive population response criteria, reinitiation of section 7 consultation on San Juan River water projects may be required by the Service.

As indicated previously, in addition to meeting flow recommendations, the Proposed Plan is intended to maintain the authorized purposes of the Navajo Unit. The Unit, along with other major storage units, was authorized by the Colorado River Storage Project (Act of April 11, 1956, ch. 203, 70 Stat. 105). The storage units were authorized to:

- ❑ Regulate the flow of the Colorado River
- ❑ Store water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize the apportionments made to and among them in the Colorado River compacts
- ❑ Provide for irrigation

- ❑ Provide for flood control
- ❑ Provide for the generation of hydroelectric power[4]
- ❑ Provide for recreation and facilities to mitigate or enhance fish and wildlife

Both the Flow Recommendations, described later in this assessment, and the Unit's authorized purposes can be met under the Proposed Plan. The effects of meeting authorized purposes are discussed in more detail at the beginning of the "Species Accounts" section of this biological assessment.

[4] Hydropower was not authorized at Navajo; however, the city of Farmington's power plant was licensed under the Federal Power Act

Table 1.—Summary of criteria that denote a positive population response for endangered fish in the San Juan River[1]

Species	Criteria for an interim positive population response (2002-2006)	Criteria for a positive population response (2007-2011)
Colorado pikeminnow	1A – Collection of 10 or more (≥ to 350 mm) during the annual adult fish community SMP[2] or 1B – A population estimate which is significantly greater than the Ryden (2000) estimate of fish ≥ 350 mm or 1C – A river wide population estimate of age 5+ subadults that exceeds 500 and 2A – Presence of wild larval or YOY in SMP collections in at least 2 of 5 years or 2B – Range expansion above Hogback Diversion	1 – Collection of 10 or more (≥ to 450 mm) in at least 2 of 5 years by the adult fish community SMP and 2A – A positive trend of increasing numbers of adult/subadult fish based on the SMP or 2B – A river wide population estimate of age 7+ adults that exceeds 400 and 3 – Presence of larval or YOY in SMP collections in 3 of 5 years and 4A – Density of 0.67 larval pikeminnow/1,000 cubic meters in SMP drift collections or 4B – A density of 0.5/100 square meters wild YOY pikeminnow in low velocity habitats as detected during the SMP and 5 – Range expansion above Hogback Diversion
Razorback sucker	1A – Collection of 20 or more adult/subadults (≥ to 300 mm) during the annual adult community SMP or 1B – An increase in the catch per unit effort of adult/subadults (≥ to 300 mm) to 0.15 fish/hour during the adult fish community SMP and 2 – Evidence of reproduction (i.e., presence of wild larvae and/or YOY) in at least 2 of 5 years	1A – Collection of 80 or more adults (≥ to 400 mm) during the adult fish community SMP or 1B – An increase in the catch per unit effort of adults (≥ to 400 mm) to 0.6 fish/hour during the adult fish community SMP trip and 2 – A river wide population estimate of adult fish ≥ to 2,900 fish and 3 – Evidence of increased reproduction (i.e., presence of wild larvae and/or YOY) in at least 3 of 5 years

[1] Source: Bureau of Reclamation. 2001. Positive population response criteria for Colorado pikeminnow and razorback sucker in the San Juan River. Memorandum from Area Manager, Grand Junction, Colorado, to Colorado State Supervisor, Fish and Wildlife Service, Denver. July 6, 2001.

[2] Standardized Monitoring Program.

Flow Recommendations.—Mimicry of a natural hydrograph downstream from Farmington is the basis of the flow recommendations for the San Juan River. The recommendations provide flow variability that is at this time considered necessary to create and maintain habitat for the Colorado pikeminnow and razorback sucker. The recommendations integrate hydrology, geomorphology, habitat, and biology to define flow magnitude, duration, and frequency for the spring runoff period and base flows for the non-runoff periods.

In general the flow recommendations provide for a spring peak flow and a base flow at other times of the year. For a complete description of the recommendations, refer to *Flow Recommendations for the San Juan River* prepared by the SJRBRIP (Holden, 1999).

The . . .flow/duration/frequency recommendations will result in a naturally varying hydrograph, providing high-flow and low-flow years. These recommendations also provide for adequate base flow conditions and peak flow conditions of sufficient magnitude, duration, and frequency to provide suitable conditions for the endangered species. They can be achieved by using the operating criteria for Navajo Dam outlined (in the Flow Recommendation Report). . .By recommending operating rules, natural variability in the hydrograph is maintained and decision making for annual releases from Navajo Dam is simplified. (Holden, 1999).

The Proposed Plan follows the recommended operating rules and meets or exceeds flow criteria according to model results. This model uses long-term historic flow data which encompass a great variety of wet and dry conditions; however, there is always a level of uncertainty in future climatic conditions which could have a positive or negative effect on water availability to meet the flow recommendations. For example, the drought of 2002 was worse than any years in the period of record used.

The operating criteria are considered recommendations; any

operating procedure that would allow the flow recommendations to be met would be acceptable. Flow Recommendations are targeted for the 180 miles of the San Juan River between the Animas River confluence and Lake Powell.

A summary of flow recommendation criteria follows:

A. Category: Flows >10,000 cfs during runoff
Duration: A minimum of 5 days between March 1 and July 31
Frequency: 20% of years, with maximum number of years between events 10 yrs.

B. Category: Flow >8,000 cfs during runoff
Duration: A minimum of 10 days between March 1 and July 31
Frequency: 33% of years, with maximum number of years between events 6 yrs.

C. Category: Flows >5,000 cfs during runoff
Duration: A minimum of 21 days between March 1 and July 31
Frequency: 50% of years, with maximum number of years between events 4 yrs.

D. Category: Flows >2,500 cfs during runoff
Duration: A minimum of 10 days between March 1 and July 31
Frequency: 80% of years, with maximum number of years between events 2 yrs.

E. Category: Timing of peak flows
Timing: Within 5 days of historical mean peak date of May 31

F. Category: Target base flows (mean weekly)
Level: 500 cfs target from Farmington to Lake Powell with 250 cfs minimum release from Navajo Dam. Range–500–1,000 cfs.

G. Category: Flood control releases
Control: Handle as a high magnitude, short duration spike and release when flood control rules require, except that the release shall not occur earlier than September 1. If an earlier release is required, extend duration.

Statistics for criteria A–E are measured at the Four Corners gage. Statistics for criteria F will be measured as a weekly moving average of downstream gages as discussed previously. Additional details on the recommendations are included in the Flow Recommendation Report. By applying operating rules based on the Flow Recommendation Report, the Flow Recommendations can be met while the depletions shown in the table entitled "Summary of San Juan River Basin Depletions" in attachment B are occurring. The depletions shown in attachment B are for existing private and public projects that affect San Juan River flows–some of these projects have undergone ESA compliance and others have not.[5]

The table also includes future projects that have been cleared under the ESA and NEPA; these projects include the ALP Project, completion of the NIIP Project, and the Jicarilla Apache Nation water sale to Public Service Company of New Mexico. Depletions due to evaporation of water from Navajo Reservoir are also included in the table. The table represents the baseline used in this analysis for depletions in the basin and is also representative of cumulative impacts on the hydrology of the river.

The majority of the depletions shown in attachment B are independent of the Navajo Unit; however, certain of the depletions occur in relation to meeting the purposes of the Unit and are interrelated with the Unit. These depletions directly related to the Unit are listed below. These depletions, with the exception of the Navajo Reservoir evaporation, have been previously consulted on under the ESA.

[5] Reclamation projects in the depletion table will complete ESA consultation. Projects include the Hammond Project, the Florida Project, the Pine River Project, and the Mancos Project. This biological assessment is not intended to serve as ESA compliance for these projects. Reclamation's priority has been to complete consultation on major projects (such as major CRSP storage units) with the most flexibility to assist in recovery efforts. These future consultations will be scheduled to be completed in the next 5 years. Reclamation has no authority in the private depletions and cannot lead consultation on them.

- Navajo Indian Irrigation Project 280,600 acre-feet
- Navajo Reservoir evaporation 27,428 acre-feet
- San Juan power plant contract 16,200 acre-feet
- Minor depletions (small contracts) <1,000 acre-feet

It is intended for the Proposed Plan to meet the flow recommendations, thereby complying with the ESA for Navajo Reservoir operations and its evaporation depletions. This biological assessment is not intended to provide ESA compliance for any depletions in the table, other than Navajo Reservoir evaporation (average annual depletion of 27,428 acre-feet).

It should be noted that full development of State compact water and Indian trust water is not included in the depletion table. Only existing public and private projects along with future projects with ESA and NEPA compliance are included in the table of depletions.

Significantly more depletions are shown in the table under the Proposed Action than under the No Action Alternative. This is because certain depletions, such as would occur under the completion of NIIP and the ALP Project, depend on reoperation of Navajo Reservoir as part of their separate ESA compliance and are more likely to occur under the proposed action.

The Proposed Plan also does not preclude depletions beyond those shown in the depletion table; however, additional evaluation, NEPA compliance, and ESA consultation would be necessary for any depletions beyond these. The SJRBRIP has developed principles[6] that explain and outline the process under which additional water projects and depletions will be evaluated:

> The SJRBRIP will produce a list of actions defined in a Long Range Plan that can be implemented to assist in

[6] Principles for Conducting ESA Section 7 Consultations on Water Development and Water Management Activities Affecting Endangered Fish Species in the San Juan River Basin.

the recovery of the fish. When ESA consultation is initiated on a new water depletion, the Service will determine if progress toward recovery has been sufficient for the Program to serve as a reasonable and prudent alternative or measure. The Service will also consider whether the probable success of the SJRBRIP is compromised as a result of a specific depletion or the cumulative effects of depletions. The Service will assess the sufficiency of Program actions in proportion to the potential impacts—that is, the smaller the impact of the action, the lower the level of actions by the SJRBRIP or others needed to avoid jeopardy and/or destruction or adverse modification of critical habitat. The Service will determine whether progress by the SJRBRIP is sufficient to provide a reasonable and prudent alterative or measure based on the following factors: (1) Actions that will result in a measurable positive population response, a measurable improvement in habitat for the fishes, legal protection of flows

needed for recovery, or a reduction in the threat of immediate extinction.
(2) Status of fish populations. (3) Adequacy of flows. (4) Magnitude of the impacts
of the activities.

If the Service finds that SJRBRIP and other efforts are sufficient, the biological opinions will identify that these are a reasonable and prudent alternative. If the Service finds that they are not sufficient, the biological opinion will be written to identify actions that must be taken to provide a reasonable and prudent alternative.

Hydrology and Water Quality

Hydrology.—This section of the biological assessment addresses changes to hydrology that would occur with implementation of the Proposed Plan for reservoir operations. In general, the changes will involve a long-term change in operations to provide for a spring peak and maintenance of a base flow. Maintenance of the base flow will generally cause releases to be lower than presently occur, although at certain times during the summer (particularly during dry years), releases will be increased over existing conditions to meet base flow requirements.

Flow recommendations were developed using U.S. Geological Survey (USGS) flow data records from 1929 to 1993. This extensive record includes a variety of wet and dry periods; however, it must be recognized that there is a degree of uncertainty that this record will accurately represent conditions that occur in the future.

Prior to Navajo Dam, approximately 73 percent of the total annual flow occurred during spring runoff (March-July) (Bliesner and Lamarra, 2000) with mean daily peaks at Bluff, UT ranging from 3,810 to 33,800 cfs and averaging 10,500 cfs. The highest peaks have actually occurred during summer and fall thunderstorms and reached an estimated 70,000 cfs at Bluff, UT in September 1927 (USGS data). Prior to Navajo Dam, annual flow was quite variable, ranging from 618,000

acre-feet to over 4,000,000 acre-feet at Bluff; median annual flow was 1,620,000 acre-feet. Summer low flows occasionally reached zero pre-dam and monthly mean flows were as low as 65 cfs. While low summer flows are a natural condition, these very low flows occurred due to a combination of irrigation diversions and dry periods. Following operation of Navajo Dam, spring peaks were substantially decreased (post-dam peaks averaged 54 percent of pre-dam peaks) and flows for the remainder of the year increased (August-February flows averaged 168 percent higher).

Beginning in 1991, test flows to determine effects on endangered fish were provided from Navajo Dam, including spring releases of 5,000 cfs to increase downstream peaks. This test period showed that operation changes could successfully better mimic a natural hydrograph (see attachment C for graph of flows during test period). The test period also showed that the cooling effect of Navajo Dam on water flows extended further downstream with the high releases.

Tables and figures in attachment C compare average reservoir elevations and riverflows between the No Action Alternative and the Proposed Plan. The No Action Alternative represents the baseline for reservoir and river conditions:

- Table C-1 San Juan Riverflows at Archuleta
- Table C-2 San Juan Riverflows at Bluff
- Table C-3 Seasonal Frequency Distribution of Navajo Reservoir Releases
- Table C-4 San Juan River at Bluff-Distribution Frequency of Monthly Flow
- Table C-5 Summary of Streamflows Measured During 2001 Summer Low Flow Test
- Figure C-1 San Juan River near Bluff, Average Daily Flow, Compares pre-Dam, post-Dam, and Natural Flow
- Figure C-2 Average Monthly Navajo Dam Releases
- Figure C-3 Degree to which Flow Recommendations Met under Proposed Plan

Under the Proposed Plan and following full development of NIIP and the ALP Project, average monthly releases of 250 cfs would occur 28 percent of the months in the winter and 29 percent of the months in the March thru November period. Overall monthly releases would be below 500 cfs 98 percent of the time in the winter and 65 percent of the time the remainder of the year.[7]

The Archuleta gage is approximately 6 miles downstream from the dam and approximately 1 mile upstream from the Citizens' Ditch, a major diversion. Thus, flows would be much

[7] As indicated previously, during the interim period prior to additional water development, there is flexibility to keep irrigation season releases above 250 cfs; these percentages do not reflect this flexibility.

lower downstream from the Citizens' Ditch than shown at the Archuleta gage. Even lower flows would occur just downstream from the Hammond Diversion Dam, approximately 20 miles downstream from the dam. During the 2001 Low Flow Test (Dam releases were lowered to around 250 cfs), flows fell to 133 cfs downstream from the Citizens' Ditch and 63 cfs downstream from the Hammond Diversion (Reclamation, 2002a). Under actual low flow releases, flows may be less or greater than these amounts. Table C-5 in attachment C summarizes riverflows measured during the Low Flow Test. These low flows should not occur in early years of operation changes because of the flexibility of using "undeveloped" water to supplement low summer releases as explained previously. In the long term as development occurs, however, these low flows are expected to occur frequently.

The No Action Alternative does not mimic the natural hydrograph and it is assumed that projects that rely on such mimicry for ESA compliance (e.g., ALP Project and completion of NIIP) would require reinitiation of consultation. Under No Action, it is assumed that Navajo Dam would be operated as it was from 1973 to 1991, with a minimum release of 500 cfs. Operational goals would be to store as much water in the reservoir as possible and to maintain uniform flows downstream.

Water Quality.—The San Juan River is characterized by good water quality when flows are released from Navajo Dam, but water quality progressively degrades downstream due to natural and induced bank erosion, diversions, agricultural and municipal return flows, and tributary contributions. The State of New Mexico has listed reaches of the San Juan River where water quality does not fully support intended uses. Turbidity, fecal coliform, and sediments impact the designated uses of the river most often. Several trace elements (selenium, aluminum, arsenic, mercury, copper, and zinc) have occasionally exceeded State standards from Navajo Dam to Farmington, New Mexico (Reclamation, 2000a).

Water quality standards for the San Juan River are based on

water uses. For example, some river segments may be considered of a quality to classify them as cold water fisheries, while others would be classified as suitable for irrigation or other uses. The river segment from Navajo Dam to the Blanco Bridge is classified by the State of New Mexico as a "high quality cold water fishery." From there to the confluence with the Animas River, it is considered a "marginal cold water fishery," with different physical standards than the segment upstream.

San Juan River water quality generally declines to Shiprock, New Mexico, with the stretch of the river between Farmington and Shiprock having the highest number of water quality standard exceedences. At the Four Corners gage/sampling site, water quality improves and the number of exceedences decreases, but water quality declines again from Four Corners to Mexican Hat, Utah (Reclamation, 2000a).

Studies used in analyzing water quality impacts in the Navajo Operations DEIS included extensive water quality studies that have been conducted on the San Juan River and its tributaries within the last 10 years. The USGS has conducted studies under the Department of the Interior's National Irrigation Water Quality Project (Blanchard et al., 1993; Thomas et al., 1998). The SJRBRIP, initiated in October 1991, has been collecting data on water quality on the San Juan River ever since. In addition, water quality data were collected and analyzed as part of the NIIP environmental studies on the San Juan River mainstem as
well as on tributaries, seeps, springs, ponds, and wells on the project lands. The table in attachment E is a summary of historical water quality data collected on the San Juan River at the USGS gaging stations.

The early USGS investigations (Blanchard et al., 1993) were reconnaissance-level studies to identify whether irrigation drainage: (1) has caused or had the potential to cause adverse harmful effects to human health, fish, and wildlife; or (2) may adversely affect the suitability of water for other beneficial uses in the San Juan Basin. It concluded that selenium was the major trace element of concern in all

sampled media (water, bottom sediments, and biota). The USGS performed a detailed study of selenium and selected constituents in water, bottom sediments, soil, and biota associated with irrigation drainage in the San Juan River area (Thomas et al., 1998). Selenium was much less concentrated in water samples than in bottom sediment, soil, or biota samples. Mean selenium concentrations in water samples were greatest from seeps and tributaries draining irrigated lands; less concentrated at irrigation–drainage sites and ponds on irrigated land; and least concentrated at irrigation–supply sites, backwater, and San Juan River sites. Other elevated trace elements in water, bottom sediments, soils, or biota included lead, molybdenum, strontium, zinc, vanadium, barium, cadmium, chromium, iron, mercury, and aluminum.

The NIIP Biological Assessment (Bureau of Indian Affairs, 1999) assessed the impacts from full development of NIIP. The "Water Quality Analysis" section concluded that NIIP will increase arsenic, copper, selenium, and zinc levels in the San Juan River. It was concluded that levels of arsenic and zinc concentrations would be below levels of concern for the two endangered fish species. Conclusions on copper were less certain but levels are not expected to impact the two endangered fish species. Selenium received a low hazard potential, but uncertainty about actual levels in biota downstream from the project and chronic toxicity to razorback sucker leaves the possibility of some impact to the recovery of the species. The Navajo Nation developed water quality regulations in 1999.[8] The predicted arsenic, copper, selenium, and zinc levels in the biological assessment are below the Navajo Nation water quality standards. The predicted dissolved selenium level is 1.9 µg/L, while the standard for total selenium is 2.0 µg/L in the San Juan River. The NIIP Biological Assessment assumed that the minimum release rate from Navajo Reservoir would be 250 cfs in the future.

The SJRBRIP study on environmental contaminants in aquatic plants, invertebrates, and fishes of the San Juan River

[8] The Navajo Nation Water Quality Standards are awaiting Environmental Protection Agency approval.

mainstem was completed in 1999. The trace elements evaluated included aluminum, arsenic, copper, selenium, and zinc. Aluminum appeared to be related to sediment geochemistry, and most life forms associated with sediment had elevated levels. Arsenic levels showed no consistent pattern for any river reach or site. Elevated arsenic levels were found in most plants and some invertebrates and fish. Elevated copper levels were found in the trout from upstream coldwater river reaches. Generally, copper concentrations in plants, invertebrates, and fish increased downstream from the coldwater areas. Selenium concentrations were clearly elevated in all biota above ambient background concentrations. Zinc concentrations in plants, invertebrates, and fish below Farmington to the "Mixer area" (RM 128)[9] were generally higher than the rest of the river, and it appears the source may be the Animas River. The study found no consistent correlation between contaminant concentrations and river discharges.

Studies under the SJRBRIP have identified contaminants of concern to be arsenic, copper, selenium, zinc, and polycyclic aromatic hydrocarbons (PAHs) (Simpson and Lusk, 1999). These studies pointed out potential water quality problems that could affect the endangered fish, and also concluded that concentrations of contaminants in biota inhabiting the mainstem of the San Juan River were not consistently correlated with riverflows. These studies did not include extensive sampling of backwater habitats which are important habitats for the endangered fish. The Service (2000) discusses San Juan River water quality concerns in more detail. Information on PAHs in the river can be found in BLM (2002b).

The ALP Project FSEIS reports: "These historic values could be slightly affected by the operation of Navajo Dam for endangered fish." The increase in spring runoff flows will result in improvement of water quality during the runoff period, but the lower flows during the rest of the year will provide less dilution and may impact the water quality of the

[9] The "Mixer area" is a suspected Colorado pikeminnow spawning site.

San Juan River. Monitoring over the last 7 years of modified flows (reflects 500/5000 Alternative due to releases above 500 cfs) has not detected a measurable change in water quality.

Under the No Action Alternative, no significant changes in Navajo Reservoir water quality are expected. Releases from Navajo Reservoir would be similar to those under historical 1973 – 1991 period operations. Water quality parameters in the reservoir and in the San Juan River downstream to Lake Powell would probably be similar to existing conditions. Under the No Action Alternative, flow releases from Navajo Dam would not fall below 500 cfs under normal operations. Sources of pollutants along the river include municipal, industrial, and irrigation returns, and bank destabilization could occur mostly from Navajo Dam to Shiprock, New Mexico. Water quality in the San Juan River can also change rapidly from thunderstorm runoff in streams and washes entering the river.

Under the Proposed Alternative, the spring releases from Navajo Reservoir would be designed up to 5,000 cfs, but releases the rest of the year could be lowered to 250 cfs. The increased spring releases under the Proposed Plan would lower concentrations of pollutants because of dilution, while the lower releases during other periods would increase concentrations. This would be most apparent in the reach of river upstream from the Animas River confluence. A 250 cfs release from Navajo Reservoir during the irrigation season would result in low flows (in the range of approximately 60–150 cfs) from Citizens Ditch (river mile 217) diversion to Farmington (river mile 181) due to irrigation demands. During the Summer Low Flow Test (Reclamation, 2002a), several water quality parameters (temperature, aluminum, fecal coliform, total organic carbon, and conductivity) exceeded the State standards for this reach. Exceedences of water quality standards would probably increase at these lower flows over the long term.

Water quality parameter exceedences in the San Juan River from Farmington to Lake Powell would probably increase slightly, but significant increases in exceedences would

probably not occur due to maintenance of the 500 cfs minimum flows in the critical habitat sections.

A few exceedences occur under the Proposed Plan at Archuleta, Farmington, Four Corners, and Bluff USGS gages. The increase in exceedences at Shiprock occurs in fecal coliform, temperature, turbidity, and mercury. The exceedences in mercury probably occur because of the habitat standards are lower than the other Navajo Nation water use standards and other regulatory agencies have the San Juan River designated as a warm water fishery.

Species Accounts

The following sections address the effects of the proposed action on threatened and endangered species, candidate species, and other species of special status. Table 2 summarizes the findings of this assessment. Information is provided on species distribution and habitat needs, and impacts of the proposed operation changes are presented. For some species there is an abundance of literature on habitat requirements and other factors; this assessment summarizes appropriate information and the reader should refer to technical reports and papers for detailed information.

Research and monitoring on the endangered fishes continues. Work includes completion
of a population model, water temperature analysis and modeling, characterization of spawning areas, study of hybridization, and monitoring of larval fish, channel morphology, and water quality (UCRRP/SJRRIP, 2002).

The purposes of the Proposed Plan are twofold—meeting the Flow Recommendations and continuing to meet Navajo Unit authorized purposes. Table 3 summarizes information on the effects of the authorized purposes on meeting Flow Recommendations and on endangered species that utilize the river.

Endangered Species.—

*Colorado Pikeminnow.—*The Colorado pikeminnow is endemic to the Colorado River system and occurs in low numbers in the Green River and the Colorado River upstream from Lake Powell and in their major tributaries. The species

does not reproduce in reservoirs and construction of Glen Canyon Dam has generally isolated the San Juan River population from other Upper Colorado River populations since the 1960s.

According to reports reviewed in Holden (1999), there is little information on historical abundance in the San Juan River although anecdotal information and early fishery inventories suggest the pikeminnow was common and extended upstream into what is now Navajo Reservoir and into tributaries such as the Animas River. Based on SJRBRIP surveys, there were likely fewer than 100 adult pikeminnows and maybe fewer than 50 reported in Holden (1999). Wild pikeminnow numbers are probably now lower.

Critical habitat has been designated for the pikeminnow along the lower San Juan River as follows:

> New Mexico, San Juan County, and Utah, San Juan County. The San Juan River and its 100-year flood plain from the State Route 371 bridge in T.29N., R.13W., section 17 (New Mexico Meridian) to Neskahai Canyon in the San Juan arm of Lake Powell in T.41S., R.11E., section 26 (Salt Lake Meridian) up to the full pool elevation.

Ryden (2000) reported on the updated status of the fish in the San Juan. Only 19 wild (not stocked) adult and juvenile pikeminnows were located during SJRBRIP electrofishing surveys between 1991 and 1996—most were found in the relatively short reach of river between the Mancos River confluence and the Cudei Diversion Dam (RM 120-145). In

Table 2.—Effect of Proposed Plan on species

Species and status	Effect
Colorado pikeminnow-endangered	May affect, not likely to adversely affect[1]
Razorback sucker-endangered	May affect, not likely to adversely affect[1]
Southwestern willow flycatcher-endangered	May affect, not likely to adversely affect
Bonytail and humpback chub-endangered	No effect
California condor-endangered	No effect
Black-footed ferret-endangered	No effect
Bald eagle-threatened	May affect, not likely to adversely affect
Navajo sedge-threatened	No effect
Mexican spotted owl-threatened	No effect
Gunnison sage grouse-candidate	No effect
Black tern-special concern	No effect
White-faced ibis-special concern	No effect
Yellow-billed cuckoo-special concern	May affect, not likely to adversely affect
Roundtail chub-special concern	May affect, not likely to adversely affect
New Mexico silverspot and San Juan checkerspot butterflies-special concern	No effect
San Juan tiger beetle-special concern	May affect, not likely to adversely affect
Peregrine falcons–special concern	No effect
Golden eagle-special concern	No effect
Bluehead sucker-special concern	May affect, not likely to adversely affect
Mottled sculpin-special concern	May affect, not likely to adversely affect
Northern leopard frog-special concern	May affect, likely to adversely affect

Bighorn sheep-special concern	No effect
Alcove rock daisy-special concern	No effect

[1] The depletion from Navajo Reservoir evaporation and depletions from authorized purposes are considered an adverse effect on the endangered fish. Overall, however, the reoperation under the Preferred Alternative is not likely to adversely affect these species.

Table 3.—Navajo Unit purposes related to Flow Recommendations and endangered species

Navajo Unit purpose	Effects
Regulate flow of the Colorado River	In general, the unit operates to store water during spring runoff for use by NIIP or downstream releases. This, along with non-related water storage, decreases spring peaks that are important for maintaining endangered fish habitat and terrestrial riparian habitats. The Flow Recommendations, which are designed to help restore habitats, can still be met while this regulation occurs. The regulation also increases base flows which offset non-related depletions in the base flow periods. Hypolimnic releases reduce summer water temperatures and may restrict upstream expansion of native fish.
Storing water for beneficial consumptive use	The unit provides water by contract to several users. A total of 23,020 acre-feet (of depletion) has been contracted. This water is primarily used for municipal or industrial purposes, although 210 acre-feet are for irrigation. More information on these contracts, including the ESA consultation status, is included in attachment D. The consumptive use is included in the baseline for this biological assessment and Flow Recommendations can be met with these uses occurring. It is possible that future contracts may be sought; these would be subject to ESA consultation which would address effects on Flow Recommendations. See irrigation discussion below for further information.
Assisting States in compact water development	By storing water during high flow months and wet years, a more dependable water supply is made available for water users.
Providing for irrigation	Under separate authorization, the Navajo Indian Irrigation Project diverts water directly from Navajo Reservoir. Existing and future depletions reduce water available to maintain habitat in the San Juan River. Both the existing and future (ESA consultation complete) depletions of the irrigation are included in the baseline for this assessment. Flow Recommendations can be met with these depletions occurring.

Flood control	Navajo Reservoir is operated to reduce both spring runoff flooding and flooding from monsoonal moisture that occurs upstream from the reservoir. This has the effect of reducing high spring flows that are important for maintenance of endangered fish habitat and riparian areas. The Flow Recommendations can be met along with flood control under the Proposed Plan.

Table 3.—Navajo Unit purposes related to Flow Recommendations and endangered species (continued)

Hydroelectric power	The city of Farmington operates a hydropower plant at Navajo Dam. It operates as a "run of the river" plant and thus does not affect riverflows or the ability to meet Flow Recommendations. There is a contractual notification process prior to making flow changes and this can affect responding to base flow changes as quickly as would otherwise occur, but Reclamation does not consider this a significant problem in meeting Flow Recommendations.
Recreation	Under the Unit, recreation facilities have been constructed around the reservoir and in the tailwater area. These do not affect flows, reservoir levels, or the ability to meet Flow Recommendations. Standard environmental safeguards are used to minimize pollution potential from marine fuel use.
Fish and wildlife mitigation and enhancement	Fish and wildlife facilities do not affect reservoir releases or reservoir levels nor the ability to meet Flow Recommendations.

addition to actual captures, 12 pikeminnow were observed, mostly between the Four Corners and the Cudei Diversion. The furthest upstream a pikeminnow was observed was near the Hogback Diversion (RM 160). Only one adult wild Colorado pikeminnow has been captured in the last several years in the river (SJRBRIP, 2001b). Fish passages opened in 2003 are expected to increase the upstream range of the fish.

Larval and juvenile pikeminnows have been collected, all downstream from a presumed spawning area near River Mile 129–133 (referred to as the Mixer); however, the number of larval fish has been very low. There is concern that larval fish can be quickly transported downstream and lost to predation in Lake Powell.

Beginning in1996, Colorado pikeminnow were stocked near Shiprock and Mexican Hat (River Miles 148 and 53) and at least some of these are surviving in the river (Ryden, 2000). In 2001, 148 adult Colorado pikeminnow were stocked in the San Juan River and approxi–mately 250,000 fingerlings were stocked in the fall of 2002 above the Hogback Diversion. The

Service (Ryden, 2003a) has published an augmentation plan for the San Juan River which contains more details on stocking plans and their role in recovery efforts.

Habitat of the fish in the San Juan River includes a complex mix of low-velocity habitats such as eddies, pools, and backwaters adjacent to swifter run and riffle habitats. A natural hydrograph (high spring flows, lower base flows) is important in maintaining the habitat and one of the main effects of Navajo Reservoir under historic operations has been to reduce high spring flows while increasing base flows. Miller and Ptacek (2000) and Holden (1999 and 2000) discuss habitat types seasonally used by the pikeminnow and should be referred to for specific information.

Habitat types used varies seasonally. During the pre-spawn period, pikeminnow use mainly slower velocity habitats, including mouths of tributaries such as the Mancos River. During spawning, higher velocity and often complex habitat areas are used. Riffles, runs, and chutes with adjacent low-velocity habitats seem preferred for spawning. Following spawning the fish move into simpler habitat complexes such as runs and pools; and runs and low-velocity areas provide fall and winter habitat.

After eggs hatch, larval fish drift downstream into low-velocity habitats such as backwaters. Juvenile fish prefer shallow, low velocity habitats including backwaters, shoals, eddies, and pools. These low velocity habitats comprise less than 15 percent of the river's habitats (Bliesner and Lamarra, 1996).

Tributaries have been shown to be important to pikeminnow in the Green River and may have been historically important in the San Juan; however, migration barriers and extensive dewatering on San Juan tributaries have greatly reduced their use.

Loss of habitat, competition from non-native fish, possible water quality problems, and migration barriers are all thought to be factors in the fishes' decline. Reductions of water temperatures due to the operation of Navajo Reservoir may also be a factor in reducing the range of the species, and habitat in the lower river was lost when Lake Powell was filled. Larval fish that drift into Lake Powell may all be lost due to predation.

Non-native fish are common throughout the critical habitat reach and include channel catfish, carp, fathead minnows, and other species. During monitoring trips on the river in 2000, striped bass were also common (SJRBRIP, 2001b). Striped bass represent a predatory threat to native fish. There is an active program to remove nonnative fish from the river, concentrating on channel catfish and common carp (UCRRP/SJRRIP, 2002).

There were five major diversion structures between RM 142

and RM 178, which impede
fish movement to varying degrees (Masslich and Holden, 1996); and these may strongly influence the range of the pikeminnow which is a migratory species. A fish passage has been completed at the Hogback Diversion; passages are scheduled for the Public Service Company of New Mexico (PNM) Diversion and the Arizona Public Service weir; and the Cudei Diversion was removed (UCRRP/SJRRIP, 2002).

Recovery Goals for the pikeminnow were approved by the Service in 2002 (Service, 2002b) and are summarized below.

The Colorado pikeminnow will be eligible for removal from the list of threatened and endangered species when:

- A self-sustaining population exceeding 2,500 adults is maintained over a 7-year period beyond downlisting in the Green River

- A self-sustaining population exceeding 1,000 adults is maintained over a 7-year period beyond downlisting in the Upper Colorado River

- A self-sustaining population exceeding 700 adults is maintained and a self-sustaining population exceeding 800 adults is maintained over a 7-year period beyond downlisting in the San Juan River

- All management actions identified in the Recovery Goals are implemented and achieved, including necessary flow regimes provided; passage of fish assured in the Green, Upper Colorado, Gunnison and San Juan rivers; entrainment of subadults minimized; adequate protection from overutilization; adequate protection from effects of diseases and parasites; nonnative fish stocking procedures implemented; mechanisms determined for legal protection of habitat; conservation plans identified for long-term protection; hazardous materials emergency response plans revised to ensure protection; shut-off valves installed in petroleum-product pipelines within the 100-year floodplain; and effects of selenium identified and mediated

The Flow Recommendations are specifically designed to create and protect habitats used by the fish (Holden, 1999). Higher spring flows (>10,000 cfs) generate new cobble sources, channel diversity, and provide nutrient loading. Lower peaks provide and maintain spawning habitat. The proposed operation should meet or exceed recommendations for spring flows. Table 4 indicates how the frequency of spring flows is met under the proposed action and No Action Alternatives. This material is also presented in graph form in attachment C. Overall, the No Action Alternative fails to meet the desired frequency and duration of the three categories of spring flows (>10,000 cfs, >8,000 cfs, >5,000 cfs). Under the Proposed Plan, the desired frequency and duration of the categories are fully met or exceeded. Because of this, the spring flows under the proposed action should meet many of the purposes of the flow recommendations, including generation of new cobble sources,

creation of channel diversity, provision of nutrient loading, maintenance of spawning areas, and creation and maintenance of backwaters and other low-velocity habitats.

Maintaining low, stable base flows enhances nursery habitat conditions and flows between 500 and 1,000 cfs optimize backwater conditions selecting flows at the low end of the range increases the availability of water for development and spring releases. Bliesner and Lamarra (2000) reported that backwater habitats, which are extremely important for the endangered fish, demonstrated a high degree of variability at low flows; but low flows clearly maximized this habitat. Juvenile low velocity habitat is likely maximized between 800 and 1,000 cfs (Service, 2001d).

Bliesner and Lamarra (2000) report on studies that relate flow levels to habitat creation and maintenance and should be referred to for further information.

The Proposed Plan includes operations to attempt to maintain the base flows in the 500 to 1,000 cfs range in areas of critical habitat; however, this cannot always be accomplished. Inflows from tributaries, combined with even minimum releases from Navajo Dam, will cause the 1,000 cfs to be exceeded at times. This is particularly true during spring runoff when downstream tributaries are high and during the frequent summer thunderstorms that

Table 4.—Summary statistics of meeting Flow Recommendations criteria for alternatives retained for further analysis

	No Action Alternative				**250/5000 Alternative**				**500/5000 Alternative**			
	>10,000	>8,000	>5,000	>2,500	>10,000	>8,000	>5,000	>2,500	>10,000	>8,000	>5,000	>2,500
Duration	*Average frequency (percent)*				*Average frequency (percent)*				*Average frequency (percent)*			
1 day	26.2	**36.9**	**53.8**	100.0	33.8	56.9	73.8	95.4	**27.7**	43.1	**55.4**	96.9
5 days	18.5	**33.8**	**43.1**	90.8	27.7	47.7	69.2	86.2	21.5	35.4	**47.7**	86.2
10 days	7.7	**30.8**	**38.5**	81.5	15.4	38.5	66.2	81.5	13.8	**29.2**	**44.6**	80.0
15 days	4.6	**23.1**	**36.9**	72.3	7.7	30.8	56.9	75.4	6.2	**27.7**	**41.5**	72.3
20 days		13.8		69.2		24.6		72.3		21.5		66.2
21 days			**36.9**				53.8				**40.0**	
30 days		**7.7**	**35.4**	61.5		13.8	44.6	64.6		13.8	**33.8**	60.0
40 days			30.8	50.8			32.3	55.4			**27.7**	**49.2**
50 days			26.2	46.2			26.2	49.2			23.1	**40.0**
60 days			16.9	40.0			18.5	41.5			15.4	**33.8**
80 days			7.7	30.8			9.2	30.8			6.2	26.2

Maximum duration between events

Flow criteria - Max duration	Allowed	Modeled	Allowed	Modeled	Allowed	Modeled
9,700 cfs for 5 days - 10 years	10	**14**	10	10	10	**14**
7,760 cfs for 10 days - 6 years	6	**7**	6	6	6	**14**
4,850 cfs for 21 days - 4 years	4	**7**	4	4	4	**7**
2,450 cfs for 10 days - 2 years	2	2	2	2	2	2

Note: Shaded cells containing bolded numbers indicate failure to meet Flow Recommendations.

Flow recommendations flow/duration statistics				
	Discharge			
	>10,000	>8,000	>5,000	>2,500
Duration	*Average frequency (percent)*			
1 day	30.0	40.0	65.0	90.0
5 days	20.0	35.0	60.0	82.0
10 days	10.0	33.0	58.0	80.0
15 days	5.0	30.0	55.0	70.0
20 days		20.0		65.0
21 days			50.0	
30 days		10.0	40.0	60.0
40 days			30.0	50.0
50 days			20.0	45.0
60 days			15.0	40.0
80 days			5.0	25.0

can add sudden spike flows to the river. In addition, there are difficulties with travel time for changed releases to reach critical habitat and discrepancies with gage readings in the critical habitat area.

Holden (2000) discussed the effect of flow recommendations on both the pikeminnow and razorback sucker:

> If Navajo Dam is operated as prescribed in the flow recommendations, key habitats for the endangered fish species will be maximized in both quantity and quality, and they will be provided at the proper time of the year for use by the fish, based on information gathered during the 7-year research period. New information may improve the flow recommendations through adaptive management. However, larval habitat availability, a major potential habitat limitation for both endangered fish species, was not explored. In addition, YOY (young of year) razorback sucker habitat availability was not researched. These potential habitat limitations will be studied when the adult populations of both species increase sufficiently to produce millions of larvae.

There is potential that water contaminants may also affect the fish; these include selenium and PAHs. Further studies are needed to determine if water quality in the main river and in tributary inflow areas are affecting the species. The proposed action will affect water quality in the San Juan River. Releases from Navajo Reservoir of high quality water generally dilute pollutants downstream. This dilution effect will be increased during certain periods under the Proposed Plan but will be decreased in the winter months and periodically at other times of the year as releases are reduced. Contaminants of concern include PAHs and trace elements such as selenium, arsenic, copper, and zinc. Simpson (1999) concluded . . .that the concentrations of contaminants in biota inhabiting the mainstem of the San Juan River were not consistently correlated with instream flow discharges.

Holden (2000) summarized contaminant studies on the San

Juan:

> In summary, investigations by the SJRIP showed that some contaminant issues occurred in the San Juan River Basin, but they tended to be limited to irrigation drainage areas. It is also possible that contaminants were more prevalent during low-flow periods. It is doubtful that any of the populations of native fishes studied during the 7-year research period were limited by contaminants. However, this does not mean that contaminants were not a major limiting factor at some time in the past, when safeguards were not as prevalent as they are today.

There is some belief that a more natural hydrograph may result in some natural control of non-native fish that compete with the endangered fish. This hypothesis was studied and initial conclusions are that a negative response of non-natives in the San Juan River to the more natural hydrograph during the test flow period did not occur (Brooks et al., 2000).

It is possible that in the future, the Colorado pikeminnow will expand its range upstream into the reach of river between Farmington and the Hammond Diversion as populations increase and migration barriers are reduced. This area is expected to have periods of lower base flows than now occur because of reduced releases from Navajo Reservoir to meet flow recommendations and because of future diversions to NIIP and other water users. The Recovery Program includes a program whereby the effects of dam operations and other Recovery Program actions would be monitored and the results of that monitoring would form the basis for possible future tests or modifications of dam operations and/or flow recommendations. Reclamation believes it is the Recovery Program's responsibility to monitor this reach of river and modify flow recommendations if warranted. If this reach of river becomes important habitat to the pikeminnow, it would represent a change of conditions that could trigger reconsultation on projects such as NIIP or Navajo Reservoir reoperation that affect this reach.

Overall, the proposed action should beneficially affect the Colorado pikeminnow and its designated critical habitat; however, water quality changes associated with low flows may have adverse impacts under certain conditions when dilution flows are reduced, and depletions from reservoir evaporation adversely affect this species. Depletions reduce the water supply available to maintain various habitat types; however, the proposed flow regime is designed to offset these losses. The proposed action also provides for adjustments that can be made to reflect new research and findings. Combined with other elements of the SJRBRIP, the proposed action should provide the best opportunity for recovery of the species.

Razorback Sucker.—The razorback is endemic to the Colorado River Basin with a wide historical distribution. Historically the razorback occurred in the San Juan and Animas Rivers but little is known about population abundance (Holden, 1999). Through-out its range the species is now very rare with low to nonexistent recruitment. Small concentrations of razorback suckers have been reported in the

inflow area in the San Juan arm of Lake Powell. Ryden (2000) reports that no wild razorback suckers had been collected in the San Juan River since 1988, when one individual was collected near Bluff (Holden, 1999). Overall this species is extremely rare in the San Juan River.

The lower San Juan River is designated as critical habitat for the razorback as follows:

> New Mexico, San Juan County, and Utah, San Juan County. The San Juan River and its 100-year flood plain from the Hogback Diversion in T.29N.,R.16W., section 9 (New Mexico Meridian) to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in T.41S., R.11E., section 26 (Salt Lake Meridian).

Experimental stocking began in 1994 and these stocked fish have been observed in spawning condition. Since 1994, approximately 6,835 adult and subadult razorback suckers have been stocked in the San Juan River; approximately 2,000 adult fish will be stocked in 2002 (UCRRP/SJRRIP, 2002). Ponds have been developed to raise fish for stocking in the river; in 2001, 16.5 surface acres of new growout ponds for the razorbacks were build on the Navajo Indian Irrigation Project lands. Spawning activity of stocked fish has been recorded at a specific area near RM 100 (SJRBRIP, 2001b). Larval fish were collected between Bluff and Montezuma Creek in 1997 (Service, 2000a) and larval fish have been collected every year since with a positive trend in abundance. This indicates that stocked fish are successfully reproducing. The razorback's current distribution in the San Juan, counting introduced fish, is from Lake Powell to near the Hogback Diversion (RM 158). Twenty-one of the stocked razorbacks were recaptured during a May 2001 monitoring trip (SJRBRIP, 2001b). An augmentation plan for the San Juan River has been published (Ryden, 2003b) and should be referred to for more details.

Razorbacks spawn on the ascending limb of the hydrograph; thus, they spawn earlier than the pikeminnow. Razorbacks use backwaters or flooded bottomlands prior to spawning; they

generally spawn in runs over gravel or cobble. Backwaters and flooded bottomlands are important to complete the life cycle of the species; drifting larva enter backwaters where food sources can be abundant.

The razorback decline has probably occurred for similar reasons as the pikeminnow's decline. Loss of backwaters and predation by non-natives in remaining backwaters is a major problem as are migration barriers. In addition, larval fish may be lost due to predation in Lake Powell.

Recovery Goals for the razorback were approved by the Service in 2002 (Service, 2002c) and are summarized below.

The razorback will be eligible for removal from the list of threatened and endangered species when:

- A self-sustaining population exceeding 5,800 adults is maintained over a 5-year period in the Green River
- A self-sustaining population exceeding 5,800 adults is maintained over a 5-year period in either the Upper Colorado River or the San Juan River
- Genetic refugia are maintained in Lake Mohave over a 5-year period
- Two self-sustaining populations each exceeding 5,800 adults are maintained over a 5-year period in the Lower Colorado River Basin
- All management actions identified in the Recovery Goals are implemented and achieved, including: necessary flow regimes identified and implemented; passage of fish established in the Green, Upper Colorado, Gunnison, and San Juan rivers; entrainment of subadults identified and actions taken to minimize; appropriate bottomland sites identified and acquisition

assessed; protection from over-utilization implemented; protection from effects of diseases and parasites implemented; nonnative fish stocking procedures implemented; control of nonnative fish implemented; mechanisms determined for legal protection of habitat; conservation plans identified for long-term protection; levels of hybridization with white sucker assessed; hazardous materials emergency response plans revised to ensure protection; shut-off valves installed in petroleum-product pipelines within the 100-year floodplain; and effects of selenium identified and mediated

Overall, the proposed action should benefit this species and its critical habitat by improving riverine and backwater habitat conditions; and, in combination with other SJRBRIP recovery elements should assist in species recovery. As with the pikeminnow, periodic lower flows may adversely affect water quality in the razorback's habitat and depletions from reservoir evaporation and water uses reduce water available to maintain habitat. In the future, it is possible that the razorback's present range may expand upstream toward the Hammond Diversion. Effects of new flow regimes in this reach would be similar to those discussed for the Colorado pikeminnow previously.

Bonytail and Humpback Chub.—These endangered fish do not occur in the
San Juan River and would not be affected by the operation changes of the Proposed Plan. Historical presence or absence is unclear; however, there is some evidence that the bonytail occurred in the river prior to the 20th Century (Service, 2001d). If introductions are made in the future to the San Juan River, new operations under the proposed action may benefit these species.

Interior Least Tern.—The interior least tern is a small, migratory, piscivorus tern associated with shallow waters of

lakes and rivers. These birds are primarily found in the Mississippi Basin, although a breeding population occurs at Bitter Lake National Wildlife Refuge in Chaves County New Mexico. Nesting occurs in late May. The New Mexico Department of Game and Fish (NMDGF) reports infrequent sitings in San Juan County in the project area. The BLM (2002b) reports that it may be an occasional visitor to rivers in the area.

The interior least tern is not known to depend on the habitats along the San Juan River and Navajo Reservoir potentially affected by the Proposed Plan and thus should not be affected.

Southwestern Willow Flycatcher.—The southwestern willow flycatcher is a small, migratory passerine bird that has lost habitat due to water diversion and floodplain channelization, introduction of non-native vegetation, livestock grazing, and brown-headed cowbird nest parasitism. The birds nest in dense riparian vegetation with a nesting period from May through July. Willow flycatchers typically nest in native vegetation; they also use areas dominated by tamarisk or Russian olive. Surface water or saturated soils are often present in nesting areas and may be correlated with food supplies. Only 986 nesting territories have been identified in the United States, with four of these in the San Juan Basin (Sogge et al., 2002). A recovery plan was approved for this species in 2002 (Service, 2002d) and can be referred to for information on habitat, distribution, and other information. Habitat loss, habitat fragmentation, and brood parasitism are significant problems for the survival of this species.

Potential habitat in the project impact area occurs along the arms of Navajo Reservoir and downstream along the San Juan River. Data suggest that the better willow flycatcher habitat exists downstream from the Animas River confluence (CUP, 2001), although some areas immediately downstream from Navajo Dam provide excellent potential habitat.

Willow flycatchers were observed along the Piedra Arm of

Navajo Reservoir in 1999 but were not confirmed to be nesting (Reclamation, 1999). Additional surveys are being conducted in 2003 and results will be distributed when available. Low-gradient inflow areas to the reservoir have developed willow/cottonwood habitat areas that are supported by both reservoir water levels and tributary inflow in conjunction with sediment deposition from the tributaries. These areas have developed under fluctuating reservoir conditions (drawdowns of over 35 feet have occurred in 5 of the last 16 years). In 2002 the drawdown exceeded 75 feet.

CUP (2001) provides detail on habitat conditions and willow flycatcher distribution along the river downstream from Navajo Dam. The public lands immediately downstream from the dam were rated as marginal to excellent potential habitat. Along the San Juan, particularly in downstream areas, habitat is now dominated by tamarisk and Russian olive, although native willow stands occur.

Studies reported by Johnson and O'Brien (1998) indicate that the lower river in Utah is primarily used by migrating birds and, as such, serves as an important stopover to replenish strength for the continued migration to breeding grounds. Migrating willow flycatchers have also been observed along the river in New Mexico. BLM surveys between 1993 and 2002 of their lands along the San Juan River have not detected nesting birds but have recorded migrants.

The river area also provides suitable nesting habitat that may be used in the future (CUP, 2001). In 1997, one nesting pair was documented along the San Juan River in New Mexico downstream from Shiprock. Nesting was confirmed in this area again in 1998 but not in 1999 (BIA, 1999 and CUP, 2001).

The proposed action could affect willow flycatchers by either affecting habitat or changing the level of human disturbance.

Under the proposed action, Navajo Reservoir elevations would change in response to meeting Flow Recommendations. Beginning in mid- to late May, reservoir levels would, on average, be 5 to 10 feet lower than under the No Action

Alternative because of the release of water for spring peaks in most years under the Flow Recommendations. (It should be noted that this has been occurring in recent years as spring peak releases have been made for research purposes). It is difficult to predict if this new operation, in the long term, will affect the willow/cottonwood habitat. Vegetation in the spring of 2003 does not appear to be stressed despite very large, drought-related drawdowns, and spring releases have been ongoing in recent years. Accordingly, although there is an indication that potential habitat will not be affected by the proposed action, the actual vegetation response may not be apparent for many years; thus, the new operations may affect the quality or extent of potential habitat along the reservoir.

In potential habitat areas in the first few miles downstream from Navajo Dam, high spring releases should benefit habitat and reduce human disturbance during the high flow period. On the other hand, releases of 250 cfs outside of the spring peak could increase disturbance to potential habitat by anglers who can more easily wade the river and travel up and down the river bank. Low flows could also stress vegetation, although river elevations and associated groundwater changes are only about 4.5 inches when flows drop from 500 to 250 cfs. Between Archuleta and Farmington, irrigated fields border the river and
ground water from irrigation helps maintain riparian vegetation and should moderate
low-flow effects. In this area, and especially downstream from Farmington, the high spring releases (and reduced low-flow periods downstream from Farmington) would favor more natural river characteristics that should benefit riparian vegetation and potential willow flycatcher habitat.

Overall, the more natural flow regime under the Proposed Plan may benefit this species.

California Condor.—Relocation efforts involving this large raptor have resulted in the introduction of this species to northern Arizona. Previously the species occurred in recent years only in California, where it was extremely rare.

Individuals from the northern Arizona population have traveled into Utah and Colorado, and certainly could occur on an irregular basis in the project area. The bird is a carrion feeder and generally nests in cliff areas. Existing or potential habitat for the species would not be affected by the Proposed Plan and there would be no effect on the species.

Black-Footed Ferret.—There are no recent reports of this species, which is closely associated with prairie dog towns, in the project area. The species has not been observed in the wild in New Mexico since 1934 (BLM, 2002b). Potential habitat of the species would not be affected by the proposed action.

Threatened Species.—

Bald Eagle.—Bald eagles occur around Navajo Reservoir and along the San Juan River, primarily during the winter. Peak use at the reservoir occurs in December through February. Average numbers of birds observed on the New Mexico portion of the reservoir was 35 in February surveys between 1993 and 2001 (BLM, 2002b). No bald eagle nesting is known to occur in the New Mexico portion of the project area (Reclamation, 1999), but
an active nest occurs in Colorado on private lands north of Navajo Reservoir. Winter concentration areas occur around Navajo Reservoir and some of its tributaries. Winter concentration areas have been designated along the Piedra, San Juan, and Lost Pinos rivers and reservoir arms in Colorado and in several areas around the reservoir in New Mexico. BLM has identified 32 Areas of Critical Environmental Concern for wintering eagles on the New Mexico portion of the reservoir. Food sources include fish, waterfowl, and carrion. Night roost sites, consisting of undisturbed cottonwood groves or ponderosa pine groves from which eagles disperse daily for feeding, are important factors in maintaining wintering populations.

The bald eagle is not expected to be adversely affected by the proposed action. A more natural hydrograph along the San Juan River should maintain and possibly enhance regeneration

of cottonwood trees along the San Juan River which are important winter habitat. In addition the periodic high spring flows may discourage human encroachment into floodplain areas thus indirectly benefitting the eagle's habitat. Increased riverflows will cause more loss of mature trees to bank erosion, possibly offsetting this benefit. Although some changes in fish populations are anticipated, food supplies in the waterways affected should not be significantly affected. Reduced reservoir levels may stress cottonwood trees developing around Navajo Reservoir, thus reducing roosting areas. Overall there should be no adverse effect on this species.

Navajo Sedge.—This member of the sedge family occurs only in a few localities in Arizona (Apache, Coconino, and Navajo Counties) and Utah (San Juan County), although surveys are incomplete. Its specialized habitat consists of seep–springs on vertical cliffs of Navajo sandstone or other eolian sandstone formations. One population is reported 1.5 miles south of the San Juan River (Utah Division of Wildlife Resources, 1998). Threats may include grazing, trampling, and disturbance to ground water supplies. The proposed action would not affect the types of habitat used by this species.

Mexican Spotted Owl.—The Mexican spotted owl inhabits canyon and montane forest habitats in a range that includes southern Utah and Colorado, New Mexico, and Arizona. Critical habitat has been designated on 4.6 million acres in the 4 states. Critical habitat does not include the project area but does include portions of the San Juan arm of Lake Powell (Service, 2001c).

Mixed conifer forests are commonly used; and in the northern part of its range (which would be the project area), the owls primarily occur in rocky canyons. Prey species are thought to primarily be small, nocturnal mammals. Habitat types used or potentially used by this species would not be affected

by the proposed action.

Species of Concern.—

American and Arctic Peregrine Falcons.—These two species occur in Colorado and New Mexico, with nesting of the American peregrine falcon occurring in both states. There are no known nests around Navajo Reservoir (Reclamation, 1999). Potential nesting habitat occurs on cliffs along the San Juan River. Riparian areas in the project region provide migration and foraging habitat. These habitats should not be significantly affected by the proposed action.

Black Tern.—The black terns would most likely be encountered in the project area during spring migration. Habitat includes lakes and reservoirs and other open fresh water; nesting occurs in large marshes adjacent to open water. Nesting populations occur in northern Utah around waterways and in wetland areas in eastern Colorado and Colorado's San Luis Valley. Populations have been declining due to losses of habitat and possibly pesticides. Suitable habitat should not be affected by the Proposed Plan.

White-Faced Ibis.—The white-faced ibis typically nests in colonies in dense marsh habitats and feeds in shallow water and flood-irrigated fields. Nesting does not occur in the project area and the species is considered a casual migrant (BIA, 1999; BLM, 2002a; and Reclamation, 1999). However nesting has been confirmed in Montezuma County, Colorado just north of the project area, indicating that nesting in the project area
is possible. Suitable habitat should not be affected by the Proposed Plan.

Yellow-Billed Cuckoo.—The yellow-billed cuckoo would be considered a rare summer resident in the project area. Populations have declined significantly throughout the species range; a major factor has probably been the loss of mature

riparian forests. Loss of prey insects to pesticides is also believed to be a factor. Protection of riparian areas is critical to this species. Surveys of portions of the San Juan River in 1997 and 1998 indicated that the birds are present in small numbers during migration and there is some evidence of breeding (Johnson and O□Brien, 1998). BLM (2002a) report that they are very rare in the San Juan River valley. Sites where birds have been observed generally consist of dense Russian olive, tamarisk, and willow with and associated stand or an overstory of cottonwoods. No birds were observed in sites with little vegetative understory. Factors that adversely affect populations along the river may include grazing, oil/gas exploration, and agricultural practices (Johnson and O□Brien, 1998).

The Proposed Plan is not anticipated to significantly affect this species. While a more natural hydrograph seen under the proposed action may scour some of the riverbank riparian areas, they also may be more conducive to maintenance and establishment of important cottonwood groves along the river.

Roundtail Chub.—While this species is relatively common in parts of the Upper Colorado River Basin, it is uncommon in the project area. The roundtail chub sustains a small population in the San Juan River downstream from Navajo Dam and also occurs in tributaries such as the LaPlata and Mancos Rivers (BIA, 1999 and Propst, 1999). The species also occurs in the San Juan above the reservoir (Reclamation, 1999). Ryden (2000) collected this species between River Miles 78 and 177, but the species was uncommon.

The roundtail was one of the most common fishes collected from Navajo Reservoir within the first few years after the dam was closed in the mid-1960s. It is now rarely collected, indicating that much of its reproductive habitat was lost to the reservoir.

Habitat used most commonly are pools with some type of cover, and spawning occurs in pool-riffles or in riffles upstream from pools (Propst, 1999). Loss of habitat through flow depletion or channel modification, and competition from non-native fish are probably factors in their low populations in the San Juan. Olson (1962) attributed low numbers to changes in water temperatures below Navajo Dam and due to early efforts to remove nongame fish from the river.

The more natural hydrograph downstream from Farmington may benefit these species by reducing non-native fish that compete and by providing more natural habitat conditions.

Upstream from Farmington, adverse effects are possible because of reduced habitat associated with lower summer flows and possibly by water quality declines; however, the fish is very uncommon in this area.

New Mexico Silverspot and San Juan Checkerspot Butterflies.—These insect species are native species with limited distribution. Populations are affected by habitat losses and in some cases collection. Habitat includes moist habitats around marshes and along streams. The proposed action should not affect these species, although it would provide a more natural river and floodplain condition which may benefit them.

San Juan Tiger Beetle.—Tiger beetles are common but some species have limited distribution. Habitat includes sandy areas and sandy washes, including riparian areas. As a native species, the San Juan tiger beetle would be expected to benefit from a more natural riparian area; the Proposed Plan should have either a neutral or beneficial effect.

Gunnison Sage Grouse.—The Gunnison sage grouse currently occurs in eight isolated populations in western Colorado and southeastern Utah. The species has been in decline, presumably due to habitat loss and fragmentation. Habitat includes large expanses of sagebrush with a diversity of grasses and forbs and healthy riparian areas. Existing or potential habitat of this species would not be affected by the proposed reoperation of Navajo Reservoir.

Other Species of Concern.—The Navajo Nation provided a list of species of special concern that included several of the species discussed above, but contained the following additional species:

Golden Eagle.—The golden eagle uses a variety of habitats in the San Juan basin including the San Juan River corridor. Nesting occurs on cliffs or large trees. Primary foods include small mammals and carrion although birds and fish can be included. Habitat used by these birds should not be adversely affected by the Proposed Plan.

Bluehead Sucker.—Bluehead suckers tend to occur more frequently in the upper reaches of the San Juan River and occur both upstream and downstream of Farmington, including tributaries that feed Navajo Reservoir. Propst (1999) reported them as common in the San Juan River system. Ryden (2000) indicated that during the period of testing recommended flows, there was an overall improvement for this species in the San Juan. This may be related to maintenance of cobble areas which provide feeding habitat. Based on results of the test flows, it is anticipated that this species will benefit from the proposed action. The exception to this may be in areas between Farmington and Navajo Dam that will have significant flow reductions in summer and fall months, reducing water quality and perhaps reducing the quality of cobble feeding areas.

Mottled Sculpin.—Ryden (2000) reported collections of mottled sculpin between River Miles 155 and 178 in the San Juan River. Miller and Rees (2000) reports the species as common to abundant in the Animas River and tributaries upstream from Navajo Reservoir. They were also common in the upper LaPlata River. The species is less common in New Mexico and Propst (1999) reported the species may warrant state protection. More natural flows and maintenance of channel conditions may benefit this species under the proposed alternative.

Northern Leopard Frog.—This frog is associated with wetlands and waterways along the San Juan River. Reduced summer flows between Navajo Dam and Farmington under the

Proposed Plan may adversely affect its habitat, particularly in the extensive wetlands just downstream from Navajo Dam. Water supply to these wetlands will be reduced when summer releases from Navajo Dam are reduced from 500 to 250 cfs.

Bighorn Sheep.—Desert bighorn sheep are often associated with river canyons, including the lower reaches of the San Juan River. The sheep can utilize rivers for drinking water and some use of riparian areas can occur. There is no indication that this species would be affected by riverflow changes under the Proposed Plan.

Alcove Rock Daisy.—This species occurs in southeastern Utah and is reported from the canyons of the Colorado River from its confluence with the Dolores River on the north to San Juan County on the south. The species grows in alcove sites in sandstone cliffs that receive little direct sunlight and in sites with drier conditions (Utah Division of Wildlife Resources, 1998). Habitat of this species would not be affected by project alternatives.

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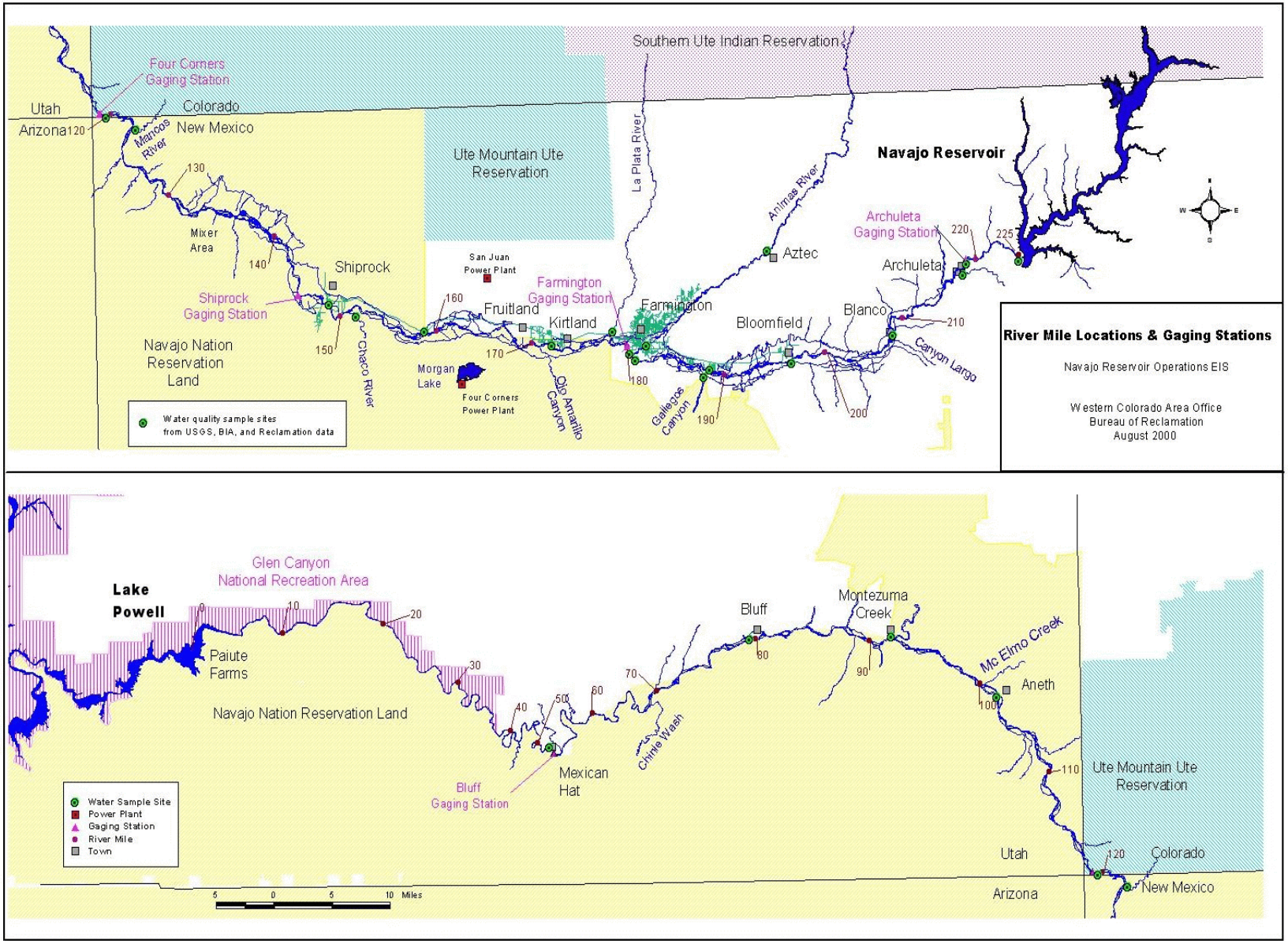
Attachment A

River Mile Demarcations
San Juan River

River mile	Location
0	Paiute Farms (Lake Powell)
53	Mexican Hat
68	Chinle Creek
80	Bluff UT
100	McElmo Creek confluence
105	Aneth UT
120	Four Corners
128	The Mixer
148	Shiprock
158	Hogback Diversion
180	Animas River confluence
208	Hammond Diversion
217	Hammond Diversion
220	Archuleta Gage
225	Navajo Dam


Southern Ute Indian Reservation
Four Corners Gaging Station
Utah
Arizona
Colorado
New Mexico
Mancos River
Ute Mountain Ute Reservation
La Plata River
Navajo Reservoir
Animas River
Archuleta Gaging Station
Aztec
Archuleta
Mixer Area
Shiprock
San Juan Power Plant
Farmington Gaging Station
Shiprock Gaging Station
Fruitland
Kirtland
Farmington
Bloomfield
Blanco
Navajo Nation Reservation Land
Chaco River
Morgan Lake
Four Corners Power Plant
Qio Amarillo Canyon
Gallegos Canyon
Canyon Largo
Water quality sample sites from USGS, BIA, and Reclamation data
River Mile Locations & Gaging Stations
Navajo Reservoir Operations EIS
Western Colorado Area Office
Bureau of Reclamation
August 2000
Glen Canyon National Recreation Area
Lake Powell
Paiute Farms
Navajo Nation Reservation Land
Bluff
Montezuma Creek
Mc Elmo Creek
Aneth
Chinle Wash
Mexican Hat
Bluff Gaging Station
Ute Mountain Ute Reservation
Utah
Colorado
Arizona
New Mexico
Water Sample Site
Power Plant
Gaging Station
River Mile
Town
Miles

Attachment B

Depletion Table Utilized in Hydrology Analysis

Table B-1.—Summary of San Juan River Basin depletions for each alternative[1, 2, 3]

Depletion category	No Action Alternative (acre-feet/year)	250/5000 Alternative (acre-feet/year)	500/5000 Alternative (acre-feet/year)
New Mexico depletions			
Navajo lands irrigation depletions			
Navajo Indian Irrigation Project	[4]143,600	[4]280,600	[4]280,235
Hogback	26,163	[5]12,100	[5]12,065
Fruitland	10,233	[5]7,898	[5]7,898
Cudei	900	900	900
Chaco River offstream depletion	[6]2,832	[6]2,832	[6]2,832
Whiskey Creek offstream depletion	[6]523	[6]523	[6]523
Subtotal	184,252	304,853	304,454
Non-Navajo lands irrigation depletions			
Above Navajo Dam – private	738	738	738
Above Navajo Dam – Jicarilla	2,190	2,190	2,190
Animas River	36,711	36,711	36,711
La Plata River	9,739	9,739	9,739
Upper San Juan	9,137	9,137	9,045
Hammond Area	10,268	10,268	10,164
Farmers Mutual Ditch	9,532	9,532	9,532
Jewett Valley	3,088	3,088	3,088
Westwater	110	110	110
Subtotal	81,513	81,513	81,318
Total New Mexico irrigation depletions	265,765	386,366	385773
Non-irrigation depletions			
Navajo Reservoir evaporation	29,209	27,428	26,274
BHP Navajo Coal Company	39,000	39,000	38,981
San Juan power plant	[7]16,200	[7]16,200	[7]16,200
Industrial diversions near Bloomfield	2,500	2,500	2,500
Municipal and industrial uses	8,454	8,454	8,432
Scattered rural domestic uses	[6]1,400	[6]1,400	[6]1,400
Scattered stock ponds and livestock uses	[6]2,200	[6]2,200	[6]2,200
Fish and wildlife	[6]1,400	[6]1,400	[6]1,400
Total New Mexico non-irrigation depletions	100,363	98,582	97,387
San Juan-Chama Project exportation	107,514	107,514	107,514
Unspecified minor depletions	[8]1,500	[9]4,500	[9]4,486
Animas-La Plata Project	0	13,600	13,600
Total New Mexico depletions	475,142	610,562	608,760

Table B-1.—Summary of San Juan River Basin depletions for each alternative[1, 2, 3] (continued)

Depletion category	No Action Alternative (acre-feet/year)	250/5000 Alternative (acre-feet/year)	500/5000 Alternative (acre-feet/year)
Colorado depletions			
Upstream of Navajo Reservoir			
Upper San Juan	10,858	10,858	10,858
Navajo-Blanco	7,865	7,865	7,865
Piedra	8,098	8,098	8,098
Pine River	71,671	71,671	71,671
Subtotal	98,492	98,492	98,492
Downstream of Navajo Reservoir			
Florida	28,607	28,607	28,607
Animas	25,113	25,113	25,113
La Plata	13,049	13,049	13,049
Mancos	19,530	19,532	19,532
McElmo Basin imports	(11,769)	(11,769)	(11,769)
Subtotal	74,530	74,532	74,532
Animas-La Plata Project	0	43,533	43523
Total Colorado depletions	173,021	216,557	216,546
Colorado and New Mexico combined depletions	648,163	827,119	825,306
Utah depletion	[6, 10]9,140	[6, 10]9,140	[6, 10]9,140
Arizona depletion	[6]10,010	[6]10,010	[6]10,010
Grand total	667,313	846,269	844,456

[1] The State of New Mexico does not necessarily agree with the depletions shown in terms of constituting evidence of actual water use, water rights, or water availability under the Compact. The SJRBRIP Hydrology Committee uses a hydrology model disclaimer that reads in part, "The model data methodologies and assumptions do not under any circumstances constitute evidence of actual water use, water rights, or water availability under Compact apportionments and should not be construed as binding on any party."

[2] The New Mexico Interstate Stream Commission (NMISC) and the San Juan Water Commission (SJWC) believe there are inconsistencies in depletion calculations (communications from NMISC and SJWC dated April 3 and March 21, 2002, respectively).

[3] It should be noted that full development of State compact water and Indian trust water is not included in this table. Only existing projects and projects with Endangered Species Act and NEPA compliance are included in the depletion table.

[4] Includes 10,600 acre-feet per year of annual groundwater storage. At equilibrium, the No Action Alternative drops to 133,000 acre-feet per year and the action alternatives drop to 270,000 acre-feet per year.

[5] Accounts for 16,420 acre-feet per year transferred from Hogback, including the Hogback Extension, and Fruitland Projects to NIIP.

[6] Indicates offstream depletion accounted for in calculated natural gains.

[7] Water contract with the Jicarilla Apache Nation (Public Service of New Mexico).

[8] 1,500 acre-feet per year of depletion from minor depletions approved by SJRBRIP in 1992.

[9] 3,000 acre-feet per year of depletion from 1999 Inter-Service consultation, a portion of which may be in Colorado.

[10] 1,705 acre-feet per year San Juan River depletion, 7,435 acre-feet per year offstream depletion.

Attachment C

Hydrology Analysis Tables and Figures

Table C-1.—San Juan River flows at Archuleta monthly summary statistics for the No Action, 250/5000, and 500/5000 Alternatives (1929 – 93 data)

	San Juan at Archuleta								
	No Action			**250/5000**			**500/5000**		
	Average monthly flows (cfs)			Average monthly flows (cfs)			Average monthly flows (cfs)		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
October	984	3,791	500	388	1,010	250	501	957	0
November	1,015	3,126	500	321	1,554	250	507	1,189	0
December	978	1,782	500	360	1,617	250	544	1,780	0
January	887	1,290	500	296	433	250	486	500	0
February	500	500	500	287	444	250	488	500	0
March	606	4,929	500	672	5,000	250	715	4,250	500
April	1,144	5,000	500	1,260	5,000	250	1,063	4,750	500
May	1,323	5,000	500	2,195	5,000	250	1,795	5,000	500
June	1,798	5,000	500	2,215	3,937	250	1,660	3,749	500
July	1,022	4,590	500	386	1,476	250	538	1,454	227
August	898	3,465	500	471	1,104	250	531	1,081	0
September	1,004	4,339	500	459	1,027	250	517	1,004	0
Average	1,013	3,568	500	776	2,300	250	779	2,184	186
Maximum	1,798	5,000	500	2,215	5,000	250	1,795	5,000	500
Minimum	500	500	500	287	433	250	486	500	0

Note: Minimum flows of zero are shown under the 500/5000 Alternative because the reservoir is occasionally drawn down below the NIIP inlet works. In actuality, the reservoir inflows would be bypassed to meet downstream water rights.

Table C-2.—San Juan River flows at Bluff, Utah, monthly summary statistics for the No Action, 250/5000, and 500/5000 Alternatives (1929 – 93 data)

	San Juan at Bluff								
	No Action			**250/5000**			**500/5000**		
	Average monthly flows (cfs)			Average monthly flows (cfs)			Average monthly flows (cfs)		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
October	1,668	10,189	455	1,012	7,338	525	1,127	7,285	36
November	1,548	4,982	644	824	3,261	525	1,010	2,895	249
December	1,415	2,806	742	777	2,645	525	964	2,808	261
January	1,309	2,717	734	716	1,743	525	907	1,993	367
February	1,154	3,036	729	940	2,792	547	1,141	3,014	503
March	1,303	6,332	451	1,329	6,285	525	1,372	5,535	525
April	2,130	8,079	220	2,151	7,704	525	1,956	7,454	525
May	3,232	12,934	380	4,017	12,863	525	3,621	12,872	525
June	4,317	10,314	509	4,680	9,081	609	4,113	8,944	609
July	2,102	7,836	258	1,465	4,715	525	1,618	4,692	525
August	1,522	8,223	67	1,110	5,175	525	1,171	5,183	435
September	1,538	8,218	182	990	4,288	525	1,050	4,296	42
Average	1,936	7,139	448	1,668	5,657	534	1,671	5,581	384
Maximum	4,317	12,934	742	4,680	12,863	609	4,113	12,872	609
Minimum	1,154	2,717	67	716	1,743	525	907	1,993	36

Table C-3.—Seasonal frequency distribution of monthly Navajo Reservoir releases
for the three alternatives (based on 1929 – 93 hydrology)

Release range (cfs)		Number of occurrences			Occurrences as percent[1]		
		All months					
		No Action	250/5000	500/5000	No Action	250/5000	500/5000
0	249	0	0	15	0	0	2
249	251	0	222	0	0	28	0
251	350	0	191	0	0	24	0
350	499	0	144	0	0	18	0
499	501	345	3	593	44	0	76
501	1,000	185	103	93	24	13	12
1,000	2,500	196	38	24	25	5	3
2,500	5,000	54	79	55	7	10	7
Total number of months		780	780	780	100	98	100
		December through February					
		No Action	250/5000	500/5000	No Action	250/5000	500/5000
0	249	0	0	6	0	0	3
249	251	0	54	0	0	28	0
251	350	0	121	0	0	62	0
350	499	0	16	0	0	8	0
499	501	109	0	185	56	0	95
501	1,000	16	0	0	8	0	0
1,000	2,500	70	4	4	36	2	2
2,500	5,000	0	0	0	0	0	0
Total number of months		195	195	195	100	100	100
		March through November[2]					
		No Action	250/5000	500/5000	No Action	250/5000	500/5000
0	249	0	0	9	0	0	2
249	251	0	168	0	0	29	0
251	350	0	70	0	0	12	0
350	499	0	128	0	0	22	0
499	501	236	3	408	40	1	70
501	1,000	169	103	93	29	18	16
1,000	2,500	126	34	20	22	6	3
2,500	5,000	54	79	55	9	14	9
Total number of months		585	585	585	100	102	100

[1] Total percentages differ slightly from 100 percent due to using rounded monthly percentages.

[2] As planned, minimum releases would be released during the irrigation season until additional water development occurs. This increase is not reflected in the table.

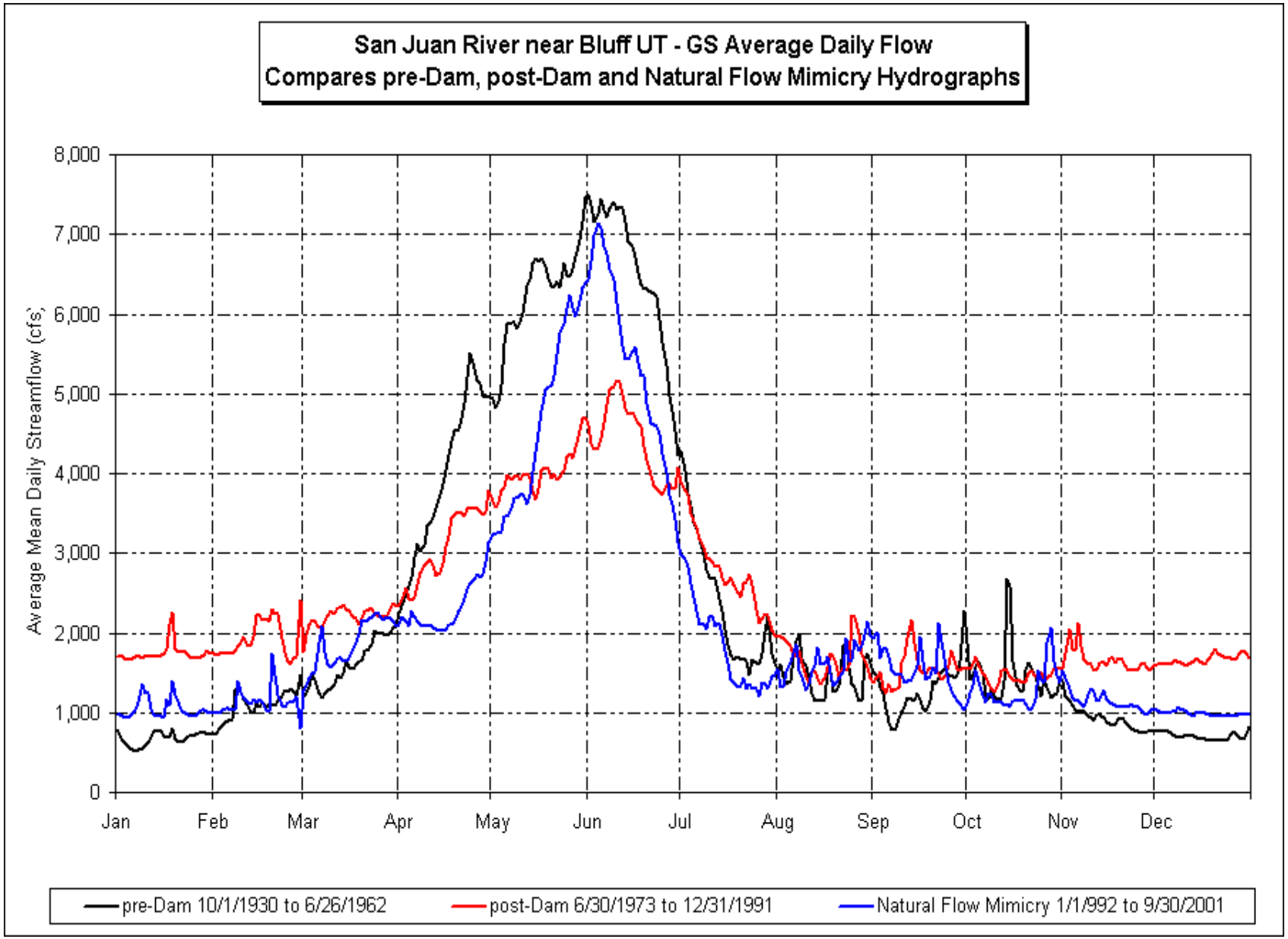
Table C-4.—San Juan River at Bluff – distribution frequency of monthly flow 1929 – 93

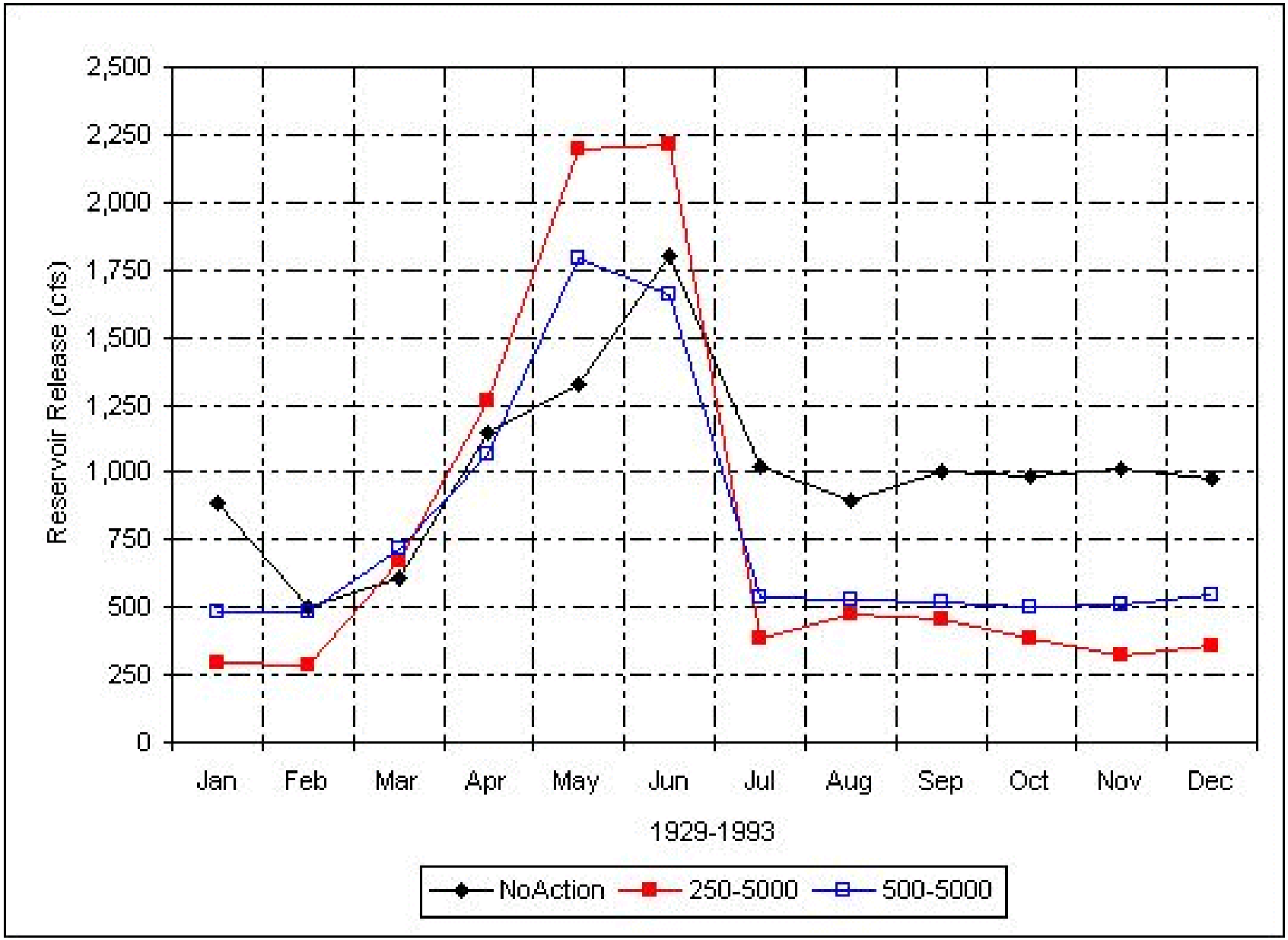
Month	Percent of time mean monthly streamflow is less than 500 cfs[1]			Percent of time mean monthly streamflow is between 500 and 800 cfs			Percent of time mean monthly streamflow is greater than 800 cfs		
	No Action	250/ 5000	500/ 5000	No Action	250/ 5000	500/ 5000	No Action	250/ 5000	500/ 5000
January	0.0	0.0	3.1	6.2	78.5	26.2	93.8	21.5	70.8
February	0.0	0.0	0.0	12.3	49.2	12.3	87.7	50.8	87.7
March	3.1	0.0	0.0	23.1	55.4	29.2	73.8	44.6	70.8
April	12.3	0.0	0.0	21.5	44.6	40.0	66.2	55.4	60.0
May	1.5	0.0	0.0	6.2	9.2	9.2	92.3	90.8	90.8
June	0.0	0.0	0.0	1.5	3.1	1.5	98.5	96.9	98.5
July	4.6	0.0	0.0	10.8	18.5	13.8	84.6	81.5	86.2
August	6.2	0.0	1.5	15.4	40.0	36.9	78.5	60.0	61.5
September	12.3	0.0	3.1	10.8	53.8	41.5	76.9	46.2	55.4
October	3.1	0.0	3.1	15.4	66.2	43.1	81.5	33.8	53.8
November	0.0	0.0	3.1	9.2	67.7	18.5	90.8	32.3	78.5
December	0.0	0.0	3.1	7.7	76.9	26.2	92.3	23.1	70.8

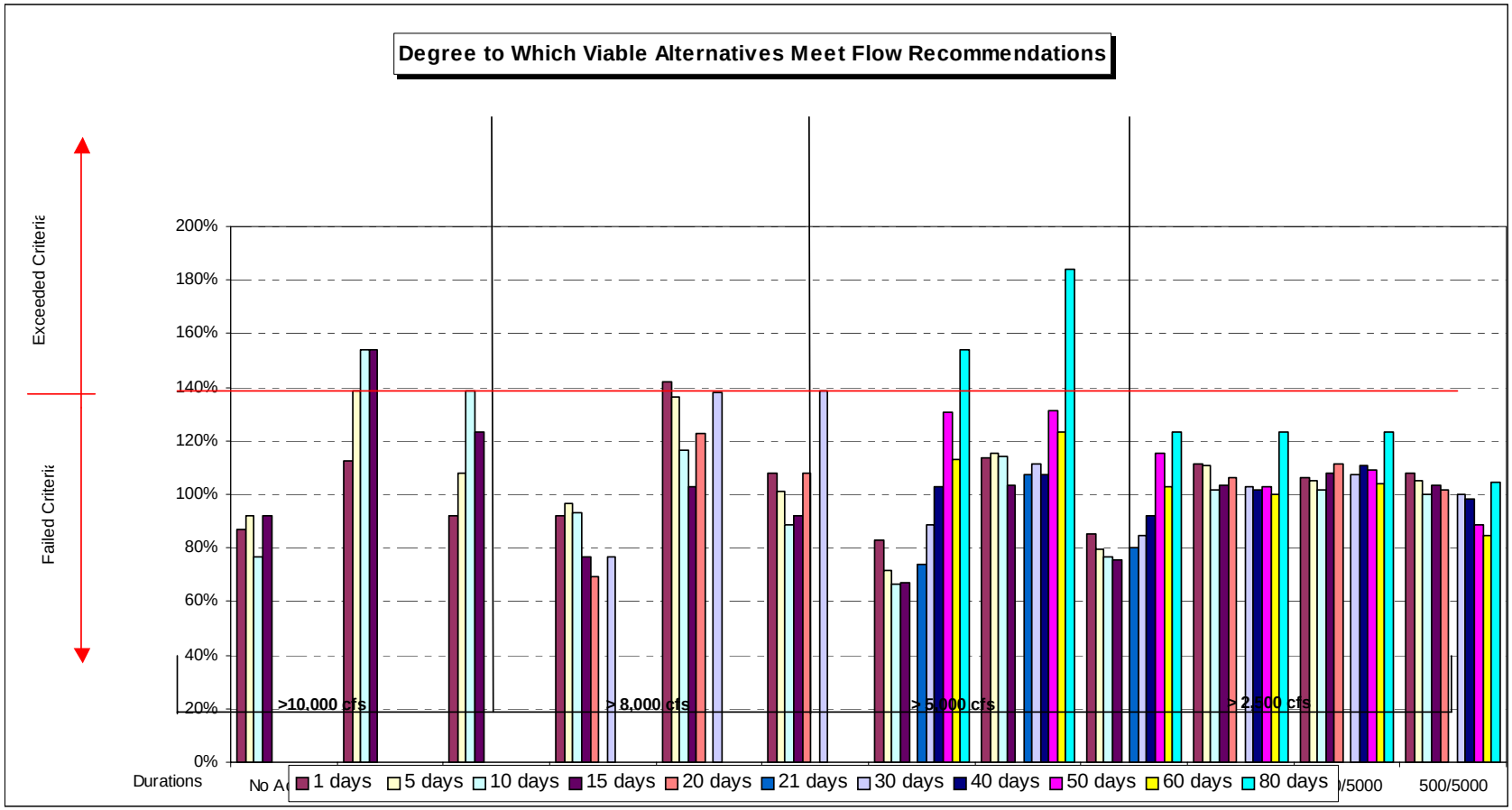
[1] While the goal is to remain above 500 cfs, it is anticipated that flows will occasionally fall below 500 cfs.

Table C-5.—Summary of streamflows measured during the 2001 Summer Low Flow Test

Location	River Mile	Average Flow (cfs)
San Juan River at Soaring Eagle Lodge (below Citizens Ditch)	216.4	132.7
San Juan River above Turley Inlet Channel	214.4	131.4
San Juan River below Hammond Diversion	209.1	63.0
San Juan River below Blanco Bridge	207.0	87.7
San Juan River above Bloomfield Bridge	195.8	130.0
San Juan River below Bloomfield Sewer discharge	194.8	131.1
San Juan River below Lees Acre Bridge	188.5	185.7
San Juan River 1/4 mile above Animas River confluence	181.4	218.7


San Juan River near Bluff UT - GS Average Daily Flow
Compares pre-Dam, post-Dam and Natural Flow Mimicry Hydrographs
Average Mean Daily Streamflow (cfs)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
pre-Dam 10/1/1930 to 6/26/1962
post-Dam 6/30/1973 to 12/31/1991
Natural Flow Mimicry 1/1/992 to 9/30/2001


2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
Reservoir Release (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1929-1993
NoAction
250-5000
500-5000


Degree to Which Viable Alternatives Meet Flow Recommendations
Exceeded Criteria
Failed Criteria
200%
180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
>10,000 cfs
> 8,000 cfs
> 5,000 cfs
> 2,500 cfs
Durations
1 days
5 days
10 days
15 days
20 days
21 days
30 days
40 days
50 days
60 days
80 days
500/5000

Attachment D

Existing Water Contracts from Navajo Reservoir

Colorado River Storage Project
Navajo Unit Water Service Contract[1]

Contractor	Effective date	Type of water use	Acre-feet deplation	ESA consultation status
Public Service Company of New Mexico	1977	Industrial	16,200	Included in baseline; consulted on as a Jicarilla Nation subcontract
Williams Gas Processing	1988	Industrial	50	Included in baseline[2]
San Juan Refining Company	2001	Industrial	340	Included in baseline; subcontract with Jicarilla[3]
San Juan Water Haulers Assoc.	2001	Industrial	200	Included in baseline; subcontract with Jicarilla[2]
Jesus Villalobos	2001	Irrigation	150	Included in baseline; subcontract with Jicarilla[2]
Douglas Lee	2001	Irrigation	60	Included in baseline; subcontract with Jicarilla[2]
Elks Lodge No. 1747	2001	Municipal	20	Included in baseline; subcontract with Jicarilla[2]

[1] Diversions to NIIP are not considered a contract. These diversions are projected to deplete the river by 280,600 acre-feet. Consultation has been completed on this water use.
[2] ESA consultation status not determined.
[3] ESA consultation completed under minor contracts.

Attachment E

Water Quality Data

Table E-1.—Historical (1950-1998) water quality measurements on the San Juan River

	Farmington		Shiprock		Four Corners		Bluff	
Parameter	n	Mean	n	Mean	n	Mean	n	Mean
Alkalinity total (mg/L as $CaCO_3$)	607	114	646	119	59	121	2,333	147
Aluminum dissolved (µg/L as Al)	34	34.4	138	58.5	40	63.9	174	64.1
Aluminum total (µg/l as Al)	30	5,283	83	15,636	30	11,373	134	20,500
Arsenic dissolved (µg/L as As)	76	1.9	267	2.3	78	1.8	345	1.9
Arsenic total (µg/L as As)	78	2.8	224	4.4	72	3.8	309	4.3
Boron dissolved (µg/L as B)	315	49.5	678	103.9	45	126.0	1,720	68.7
Cadmium dissolved (µg/L as Cd)	11	0.8	71	0.9	15	1.2	56	1.0
Cadmium total (µg/L as Cd)	12	5.7	29	3.6	7	3.7	15	3.7
Calcium dissolved (mg/L as Ca)	859	61.6	1,178	72.4	135	65.6	2,627	93.8
Calcium total (mg/L as Ca)	5	71.5	12	70.8	6	78.8	23	88.8
Chloride total in water (mg/L)	830	9.8	1,084	16.9	104	13.5	2,568	20.6
Chromium dissolved (µg/L as Cr)	4	11.3	53	3.2	4	2.9	48	2.5
Chromium total (µg/L as Cr)	9	51.8	25	22.5	5	17.0	17	52.1
Cobalt dissolved (µg/L as Co)	9	1.5	67	1.4	10	1.6	53	1.5
Cobalt total (µg/L as Co)	13	44.4	29	22.9	7	10.6	21	41.7
Copper dissolved (µg/L as Cu)	45	3.8	165	4.2	48	5.0	203	4.9
Copper total (µg/L as Cu)	45	29.5	121	35.5	42	20.8	163	35.8
Fecal coliform (counts/100 mL)	93	10,588	162	1,040	23	256	72	185
Hardness calc. (mg/L as $CaCO_3$)	859	189	1,154	237	123	222	2589	326
Hardness total (mg/L as $CaCO_3$)	824	189	969	245	45	224	2423	336
Iron dissolved (µg/L as Fe)	164	47.2	251	31.2	42	22.0	69	30.5
Iron total (µg/L as Fe)	15	25,691	39	30,449	13	13,405	201	4,809
Lead dissolved (µg/L as Pb)	67	0.7	256	1.5	70	0.8	343	1.0
Lead total (µg/L as Pb)	79	30.3	222	27.6	71	23.6	305	26.1
Magnesium dissolved (mg/L as Mg)	859	8.4	1,176	13.4	135	14.4	2,628	25.0
Magnesium total (mg/L as Mg)	5	11.9	12	14.0	6	17.4	23	27.1
Manganese dissolved (µg/L as Mn)	26	22.3	110	45.0	30	6.3	86	6.1
Manganese total (µg/L as Mn)	20	852	56	978	27	449	39	1,109
Mercury dissolved (µg/L as Hg)	70	0.12	254	0.13	75	0.10	338	0.11
Mercury total (µg/L as Hg)	78	0.14	225	0.15	71	0.13	309	0.14

Table E-1.—Historical (1950-1998) water quality measurements on the San Juan River (continued)

Parameter	Farmington		Shiprock		Four Corners		Bluff	
	n	Mean	n	Mean	n	Mean	n	Mean
Nickel dissolved (µg/L as Ni)	28	6.1	146	4.6	36	5.2	184	4.6
Nickel total (µg/L as Ni)	28	6.8	105	12.1	39	9.7	144	15.5
Nitrite + nitrate total (mg/L as N)	47	0.27	98	0.39	27	0.74	55	0.78
Oxygen dissolved (mg/L)	251	9.5	455	9.8	159	9.5	478	9.2
pH lab (standard units)	879	7.81	1,097	7.89	107	8.25	1,357	7.78
pH field (standard units)	60	8.13	190	8.26	60	8.25	285	8.20
Phosphorus total (mg/L as P)	59	0.27	164	0.32	31	0.37	95	0.58
Residue total filtrable (dried at 180° C) (mg/L)	374	382	667	498	102	422	1,313	656
Selenium dissolved (µg/L as Se)	81	0.6	277	1.0	78	1.3	349	1.1
Selenium total (µg/L as Se)	76	0.7	227	0.9	71	1.6	309	1.4
Selenium total recoverable (µg/L as Se)	10	0.5	29	1.0	10	0.9	47	0.8
Silver dissolved (µg/L as Ag)	2	0.75	51	0.56	n/a	n/a	45	0.56
Silver total (µg/L as Ag)	2	0.75	10	1.10	n/a	n/a	9	2.06
Sodium dissolved (mg/L as Na)	836	44.7	951	64.6	112	49.3	2,047	79.2
Sodium total (mg/L as Na)	5	37.7	12	38.5	6	43.8	23	58.2
Solids susp.-residue on evap. at 180 °C (mg/L)	59	242	191	956	60	663	283	934
Specific conductance (µmhos/cm @ 25 ° C)	905	550	1136	716	112	644	2,020	931
Sulfate total (mg/L as SO_4)	827	154	1,083	225	104	193	2,568	329
Turbidity (NTU, FTU, JTU)	117	158	142	527	104	406	92	503
Water temperature (°C)	60	10.6	227	12.2	79	12.4	343	12.6
Zinc dissolved (µg/L as Zn)	80	9.2	268	9.2	77	7.8	346	15.7
Zinc total (µg/L as Zn)	75	92.9	224	114.1	71	204.0	306	109.6

Source: Final Supplemental Environmental Impact Statement, Animas-La Plata Project, Technical Appendices, Water Quality Analysis (Reclamation, 2000a).