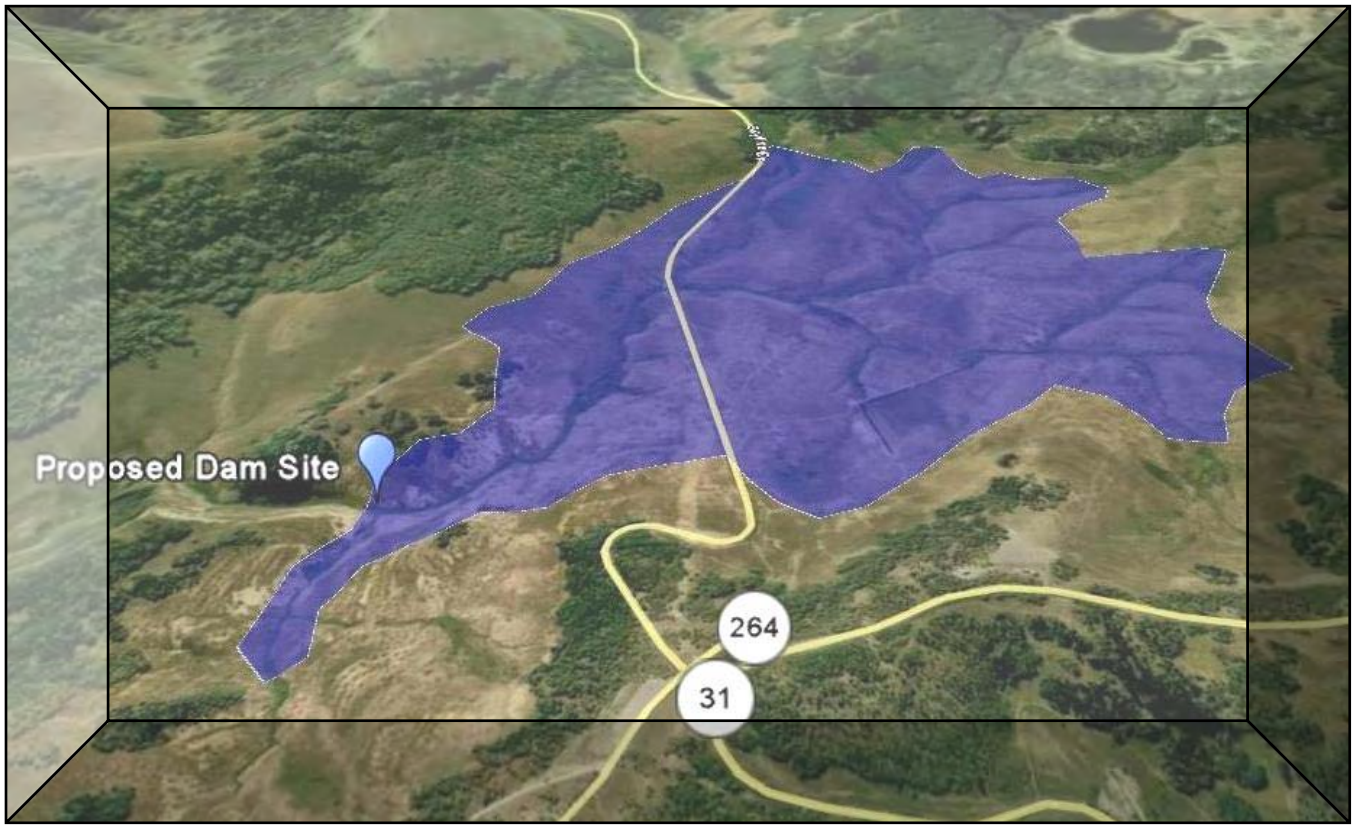
RECLAMATION

*Managing Water in the West*

# Narrows Project Final Environmental Impact Statement

## Narrows Project, Sanpete County, Utah





**U.S. Department of the Interior**
**Bureau of Reclamation**
**Upper Colorado Region**
**Provo Area Office**
**Provo, Utah**



**November 2012**

# Mission Statements

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

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

**Narrows Project**
**Final Environmental Impact Statement**

*Lead Agency:* United States Department of the Interior, Bureau of Reclamation

*Cooperating Agencies:* United States Department of Agriculture, Forest Service
United States Department of the Army, U.S. Army Corps of Engineers

*Abstract:*

The Bureau of Reclamation (Reclamation), the Federal agency with administrative authority under the Small Reclamation Projects Act (SRPA), in cooperation with the U.S. Department of Agriculture Forest Service and U.S. Army Corps of Engineers, has prepared this final environmental impact statement (FEIS) pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and the Council on Environmental Quality (CEQ) and U.S. Department of the Interior (Interior) regulations implementing NEPA. This FEIS updates a previously released draft environmental impact statement (EIS) and describes the effects of granting a SRPA loan and authorizing use of withdrawn lands to the Sanpete Water Conservancy District (SWCD) to construct the non-Federal Narrows Dam and Reservoir and to rehabilitate the existing Narrows Tunnel. The purpose of SWCD's proposal is to develop an existing non-Federal Narrows Project water right of 5,400 acre-feet of water.

If the SRPA loan is approved and funds are obtained, through construction of the Narrows Dam and Reservoir, SWCD would implement its plan to develop a supplemental water supply for agriculture and municipal and industrial water use in northern Sanpete County, Utah. This FEIS updates data and analyses from the 1998 draft EIS, for the Proposed Action Alternative, action alternatives, and the No Action Alternative and outlines mitigation measures that would be implemented as part of the Proposed Action.

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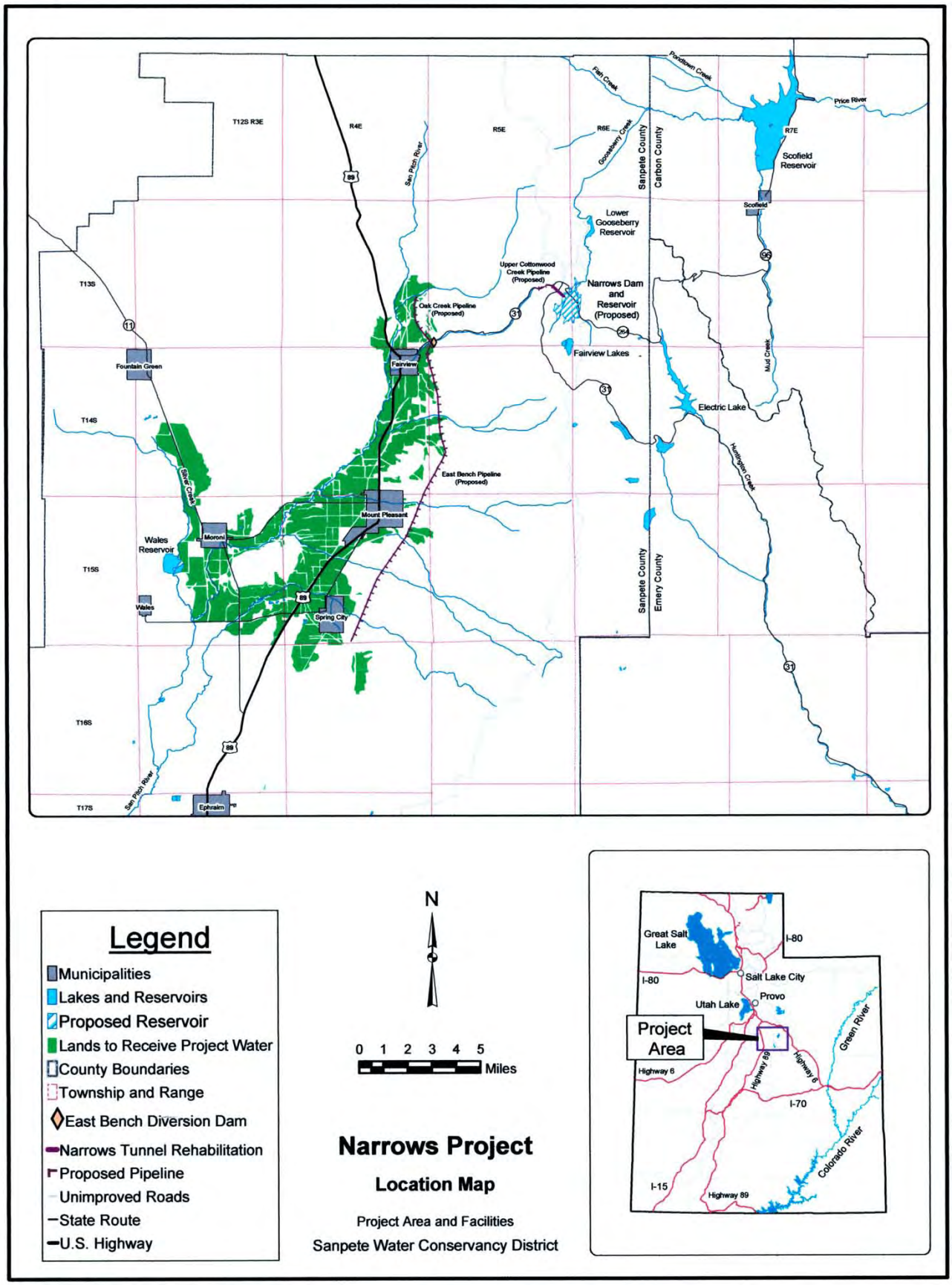
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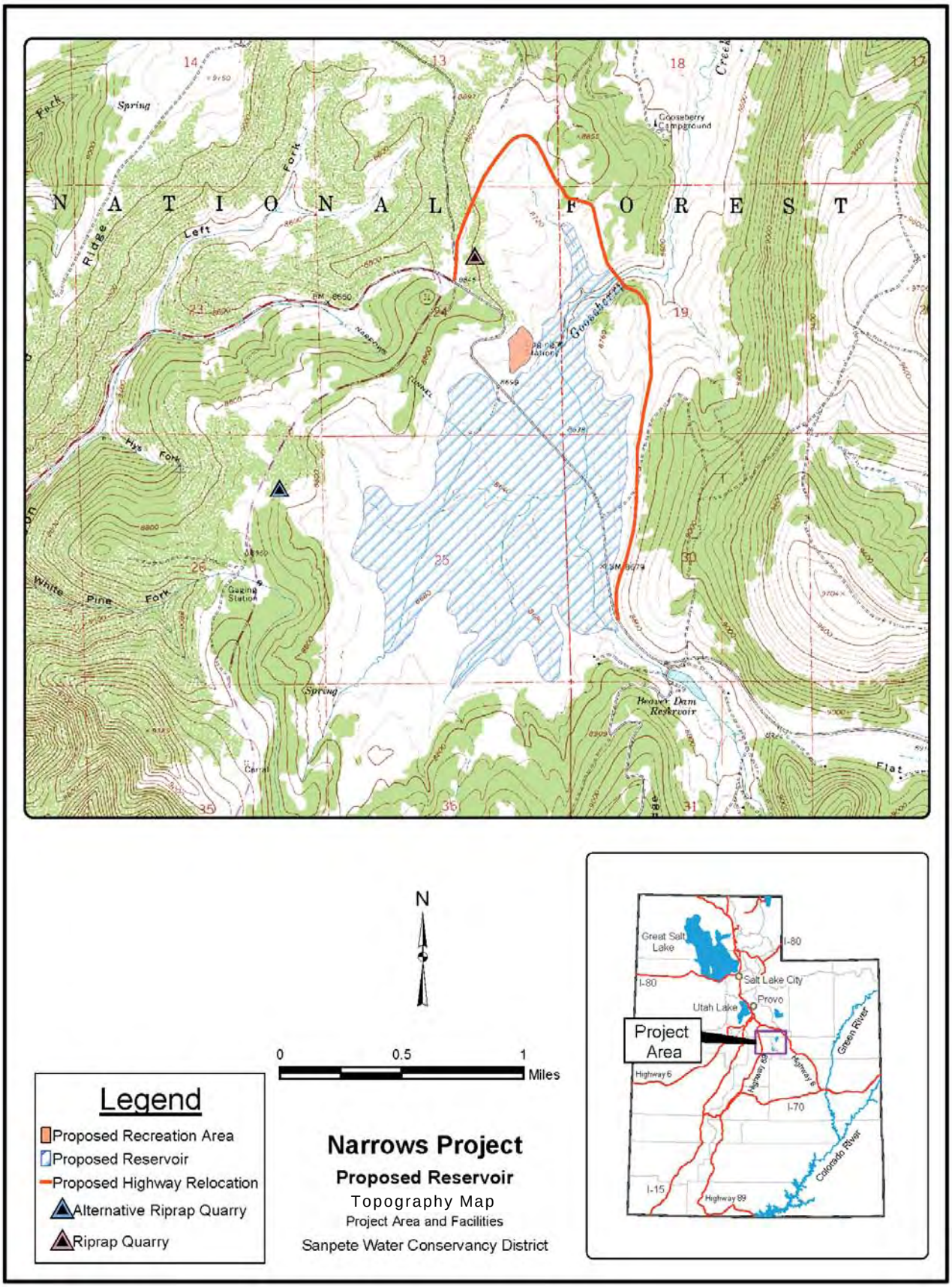



**Narrows Project**

**Proposed Reservoir**

Topography Map

Project Area and Facilities

Sanpete Water Conservancy District

EXECUTIVE SUMMARY

# Narrows Project
# Final Environmental Impact Statement

## S1.0 INTRODUCTION

The Narrows Project, Utah, (Narrows Project) final environmental impact statement (FEIS) updates information and analyses contained in the *Supplemental Draft Environmental Impact Statement, Narrows Project* (DES-09-55) published in March 2010 (SDEIS) and the *Draft Environmental Impact Statement, Narrows Project* (DES-98-10) published in March 1998 (1998 DEIS). The FEIS discloses the direct, indirect, and cumulative effects of the non-Federal Narrows Project as proposed by Sanpete Water Conservancy District (SWCD). This is an executive summary of the FEIS.

## S1.1 THE PROPOSED ACTION ALTERNATIVE

The SWCD has applied to the Bureau of Reclamation (Reclamation) for a Small Reclamation Projects Act (SRPA) loan to help finance construction of a private reservoir and related facilities. SWCD also has requested authorization to use federally administered withdrawn lands as the site for dam construction. Most of the reservoir basin would be located on adjacent, privately owned land. The proposed Federal action is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow the SWCD to use 304.5 acres of Reclamation withdrawn land. If SWCD obtains its requisite financing, either through the SRPA loan or from other private funding source(s), and if Reclamation approves the land use a supplemental water supply would be developed for presently irrigated lands and municipal and industrial (M&I) water users in northern Sanpete County. To develop this supplemental water supply a dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel and a proposed pipeline to Cottonwood Creek; the existing tunnel would be rehabilitated. Pipelines would be constructed to deliver the water to existing water distribution systems. Recreation facilities would be developed, and a minimum pool for fish habitat would be provided. The resulting water storage and delivery system would be a non-Federal project owned and operated by SWCD.

Mitigation measures would be implemented to offset adverse impacts. Water conservation measures would be implemented independent of the Proposed Action. To be eligible to receive water from the Narrows Project, water users would be required to use, or agree to implement, conservation measures.

## S1.2 LEAD AND COOPERATING AGENCIES

Reclamation is the lead agency in preparing the FEIS. The two cooperating agencies are the U.S. Department of Agriculture Forest Service (USDA Forest Service) and the U.S. Army Corps of Engineers (USACE).

## S1.3 Decisions To Be Made Based on this Analysis

Based on the analysis documented in the FEIS, the responsible official for Reclamation will make the following decisions:

- Should Reclamation approve SWCD's application for a SRPA loan to construct the Narrows Project?[1]
- Should Reclamation approve SWCD's use of Reclamation withdrawn lands for the Narrows Project, in accordance with Reclamation law?
- Under what terms and conditions (of a local supplemental agreement between Reclamation and the USDA Forest Service) should the agencies administer resources within the total areas of project influence?

In addition, the cooperating agencies may use the FEIS to aid them in making the following decisions:

- Should the USDA Forest Service:
    1. Amend the 1986 Forest Land and Resource Management Plan for the Manti-La Sal National Forest (Forest Plan) to reflect Narrows Project land use changes
    2. Authorize mitigation measures on USDA Forest Service administered lands outside the Reclamation withdrawn lands
    3. Issue necessary easements to the Utah Department of Transportation (UDOT) for relocating State Route (SR) 264
    4. Accept responsibility for management of the recreation facilities
    5. Sign various agreements, such as memoranda of understanding (MOU), easements, and rights-of-way (ROW)
    6. Amend grazing permits and allotment management plans
- Should the USACE approve SWCD's application for a Clean Water Act Section 404 permit authorizing the placement of discharged dredge or fill material into waters of the United States for constructing the Narrows Dam and other features of the Narrows Project
    1. Identify the Least Environmentally Damaging Practicable Alternative (LEDPA) based on reservoir size

## S1.4 Purpose and Need

Because Reclamation administers the Federal Reclamation laws, including the Small Reclamation Projects Act of 1956 and the Reclamation Project Act of 1939, particularly Section 10, Reclamation's purpose and need is considering approval of SWCD's SRPA loan application to build the Narrows Project and SWCD's request for authorization to use withdrawn lands to construct and operate the proposed dam and reservoir. This SRPA loan application is appended to the FEIS (appendix J).

By way of background, SWCD's purpose for the Narrows Project is to enable development of an irrigation and M&I water supply source for users in north Sanpete County, Utah. Its

[1] There are six indicators that will be used to determine the overall loan risk and category assignments. These indicators are described in the economic section of this FEIS.

need is to reduce the average annual shortages to irrigators in Sanpete County as nearly as possible to 5 percent (%), which is considered full irrigation supply.

Specifically, the following are SWCD's water-related needs addressed by the proposed project:

- Demand for municipal water for present and future use exceeds the currently available supply. The proposed Narrows Project would develop, through exchange, an additional supply of municipal water to offset current shortages and accommodate anticipated population growth in Sanpete County.
- The current water supply for agricultural irrigation does not provide adequate supply and storage at the needed times—typically in July, August, and September of each year. The proposed Narrows Project would provide late season irrigation water to offset some of the current shortages.

In addition to its primary purpose of supplying water to Sanpete County, SWCD believes the project would have the additional benefit of providing reservoir-based recreation and fishery opportunities in Sanpete County.

It is important to note that Reclamation's purpose and need for action is limited to responding to the loan application and the request to use Federal land for the Narrows Project (see figure 1-1).

Due to USACE's need to determine the LEDPA, three reservoir sizes were analyzed.

## S1.5 Relationship to Other Projects

This section describes other Federal actions that are considered for past, present and cumulative impact analyses in chapter 3. Construction and operation of the proposed project would reflect consideration of, and cooperation with, the following existing projects described in the FEIS:

- Central Utah Project
- Scofield Project
- Fairview Lakes, Gunnison Reservoir, Wales Reservoir
- Price-San Rafael Rivers Unit, Colorado River Salinity Control Program
- Upper Colorado River Endangered Fish Recovery Program
- Forest Plan

## S1.6 Environmental Issues Associated with the Proposed Action Alternative

The issues identified through the initial scoping effort are listed below. The issues are phrased as questions. Chapter 2 of the FEIS contains a comparison summary of the alternatives and their responses to the issues.[2] Chapter 3 presents the existing environment and the environmental consequences as they relate to the resource issues.

**Issue No. 1** – How would threatened and endangered species be affected by the Narrows Project?

**Issue No. 2** – How would the Narrows Project affect wildlife resources?

**Issue No. 3** – What effects would there be on water resources from the Narrows Project?

[2] References to chapters, tables, and figures within the Executive Summary are to the respective chapter, table, or figure within the main portion of the FEIS.

**Issue No. 4** – How would the Narrows Project affect the fishery resource?

**Issue No. 5** – How would water quality be affected by the Narrows Project?

**Issue No. 6** – What would the effect be on wetland resources from the Narrows Project?

**Issue No. 7** – What would the effect be on aquatic and riparian resources from the Narrows Project?

**Issue No. 8** – How would the Narrows Project affect the recreation and visual resources within the project area?

**Issue No. 9** – What effect would there be on cultural resources from the Narrows Project?

**Issue No. 10** – What social and economic effects would be expected from the Narrows Project?

**Issue No. 11** – What effect would there be on existing land uses, rights-of-way, and potential mineral leasing?

**Issue No. 12** – What effects on public safety would there be from the Narrows Project?

**Issue No. 13** – What would be the effects upon air quality associated with constructing the Narrows Project?

**Issue No. 14** – Would the slopes of Fairview Canyon be affected by construction and operation of the Narrows Project? What effects will there be on channel stability from the Narrows Project?

**Issue No. 15** – What would the geologic hazards and earthquake hazards be from the Narrows Project?

**Issue No. 16** – What would the effect be upon the soils of the area from the Narrows Project?

**Issue No. 17** – What would the effect be upon levels of trace elements in the ground water supply from constructing the Narrows Project?

**Issue No. 18** – What would the impact of the Narrows Project be on Indian trust assets (ITAs)?

**Issue No. 19** – What would the impact of the Narrows Project be on environmental justice?

**Issue No. 20** – What climate change and greenhouse gas emission issues might affect, or be affected by, the Proposed Action?

## S1.7 PERMITS, AUTHORIZATIONS, AND AGREEMENTS

Implementation of the Proposed Action could require a number of authorizations or permits from State and Federal agencies. These are summarized below.[3]

- Reclamation approval of the SRPA loan and congressional approval of the necessary funds to construct the Narrows Project.
- Reclamation authorization for SWCD use of withdrawn lands to construct and operate Narrows Dam and Reservoir.
- Utah Division of Water Quality authorization needed for a Storm Water Discharge Permit (Section 402 of the Clean Water Act, as amended).
- A USACE permit in compliance with Section 404 of the Clean Water Act, as amended, or Utah Department of Natural Resources authorization for a State

[3] Before beginning activities under the Proposed Action, SWCD would consult with both USACE and the Utah Department of Natural Resources to determine which permits would be necessary.

Stream Alteration Permit (Section 404 of the Clean Water Act, as amended).

- Utah Division of Water Quality authorization for a Utah Pollution Discharge Elimination Permit (Section 402 of the Clean Water Act, as amended).
- Reclamation consultation with the State Historic Preservation Office (SHPO).
- Utah Division of Water Quality authorization needed for 401 Certification following a Level II Antidegradation Review.
- Utah Division of Water Quality authorized needed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.
- Utah Division of Water Quality authorization needed for Utah Pollutant Discharge Elimination System General Permit for Construction Dewatering if dewatering is required.

# S2.0 THE ALTERNATIVES CONSIDERED INCLUDING THE PROPOSED ACTION ALTERNATIVE

As the lead Federal agency for the FEIS, Reclamation's action under review is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow SWCD to use 304.5 acres of Reclamation withdrawn land. The USACE and USDA Forest Service also must make decisions based on the FEIS. To fully explore the effects of the proposed action and possible alternate courses of action, the SWCD, working with Reclamation and the other cooperating agencies, developed an array of alternatives to answer the issues raised in chapter 1.

## S2.1 DESCRIPTION OF ALTERNATIVES

### S2.1.1 No Action Alternative

The No Action Alternative represents the conditions of the affected area if Reclamation does not approve the SRPA loan and use of withdrawn lands by SWCD for the non-Federal Narrows Project (figure 2-1). It establishes the baseline for evaluating the environmental impacts of providing a supplemental water supply to north Sanpete County. It also establishes anticipated conditions in the affected two-county areas without further development and assumes that irrigation operations would continue according to historic use.

Under this alternative, the Narrows Dam and Reservoir would not be constructed. Without the dam construction, there would be no need to relocate SR-264; and there would be no recreational facilities constructed at the reservoir site. The East Bench, Oak Creek, and Upper Cottonwood Creek Pipelines would not be built. The demand on municipal water supplies in Fairview, Mount Pleasant, Spring City, and Moroni would continue to increase as supplies for outdoor municipal uses run short and as the population increased. Most likely, there would be a conversion of agricultural water to municipal use as the demand for municipal water increased with a growing population.

Water conservation measures would continue to be implemented. These conservation measures would reduce average shortages on irrigated farmland to about 29.5% or about 15,250 acre-feet per year. Implementing new conservation measures most likely would reduce irrigation return flows now supplying wetlands, aquatic habitat, and downstream users by an estimated 3,500 acre-feet per year.

There would be no wetlands, wildlife, or fisheries mitigation measures implemented under the No Action Alternative because there would be no impact to existing wetlands and wildlife habitat. Streamflows in Gooseberry and Fish Creeks would remain unaltered from their present state. Under this Plan, no flat water fishery would be developed in the proposed reservoir basin.

### S2.1.2 Proposed Action Alternative

If SWCD obtains its requisite financing, either through the SRPA loan or from other private funding source(s), and if Reclamation approves the land use, a supplemental water supply may be developed for presently irrigated lands and M&I water users in north Sanpete County under the Proposed Action. This additional water supply would satisfy the 1984 Compromise Agreement.

The Proposed Action would provide funding for and authorize the use of Federal lands by SWCD to build a private dam and reservoir to provide north Sanpete County an average annual supply of 4,281 acre-feet of supplemental irrigation water for 15,420 acres of presently irrigated farmland and 855 acre-feet of water for municipal use. The project facilities would include construction of the 17,000-acre-foot Narrows Dam and Reservoir on Gooseberry Creek, pipelines to deliver the water to existing water distribution systems, rehabilitation of the existing 3,100-foot Narrows Tunnel to control releases, and relocation of 2.9 miles of SR 264. The dam would be 120 feet high with a crest length of 550 feet and crest width of 30 feet.

SWCD's non-Federal Narrows Project would include a transmountain diversion of water from the Gooseberry Creek drainage of the Price-Green-Colorado River Basins to the San Pitch-Sevier River of the Great Basin. Geographically, the project facilities are located in close proximity to the drainage divide between the Price River system and the San Pitch River system. The general location is shown on the location map at the front of this document.

The Price River flows southeast to the Green River, a tributary of the Colorado River. The San Pitch River flows southwest to the Sevier River, which is completely consumed in the Bonneville Basin, a part of the arid Great Basin. The county line dividing Sanpete County and Carbon County is located more than 6 miles downstream from and about 3 miles east of the proposed Narrows damsite on Gooseberry Creek.

The proposed damsite, the transmountain Narrows Tunnel, and the project water distribution facilities are all located in Sanpete County. The source of the project water supply generally arises in Sanpete County and naturally flows into Carbon County and the Price River system, unless the flows are captured and diverted transmountain to Sanpete County. The service area of the Narrows Project would be situated in the San Pitch River drainage.

A dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel to Cottonwood Creek. Pipelines would be constructed to deliver the water to existing water distribution systems located near Fairview, Utah. Recreation facilities would be developed at the reservoir, and a 2,500-acre-foot minimum pool for fish habitat would be maintained.

Mitigation measures would be implemented to offset adverse impacts to wetlands, terrestrial wildlife, and stream fisheries. In addition to mitigation measures to offset project impacts, other measures would be included to enhance or improve fish and wildlife habitat. Additional water conservation measures would be required

independent of the Proposed Action. However, according to SWCD, only those water users who have implemented or would agree to implement water conservation measures would be eligible to receive project water. These practices would include improved water conveyances such as lined canals, pipelines, or improved irrigation practices such as sprinklers or gated pipe.

### S2.1.3 Mid-Sized Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 12,450 acre-feet. Of that amount, 9,950 acre-feet would be active capacity, and 2,500 acre-feet would be inactive storage. The 110-foot-high dam, with a crest length of 475 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-3). Other features of the project would be the same as those for the Proposed Action and would include the construction of pipelines, rehabilitation of the existing Narrows Tunnel to control releases, relocation of SR-264 and would provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are described below.

### S2.1.4 Small Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 7,900 acre-feet. Of that amount, 5,400 acre-feet would be active capacity, and 2,500 acre-feet would be inactive storage. The 100-foot-high dam, with a crest length of 425 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-3). Other features of the project would be the same as those for the Proposed Action and would include the construction of pipelines, rehabilitation of the existing Narrows Tunnel to control releases, and the relocation of SR-264 and would provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are discussed below.

## S2.2 ALTERNATIVES CONSIDERED AND ELIMINATED FROM THE STUDY

Several alternatives considered were determined to be unviable. In general, alternatives considered and eliminated from further study did not meet Reclamation's criteria for providing a SRPA loan or licensing the use of Federal Land. It is important to note that, in addition to not meeting Reclamations purpose and need, these alternatives do not meet SWCD's water development objectives. Those alternatives are listed below and described in detail in the FEIS.

- Direct Diversion Without Reservoir Alternative
- Direct Diversion with Reservoir in Sanpete Valley Alternative
- Conservation Without Development of Other Water Supplies Alternative
- Mammoth Damsite Alternative
- Valley Damsite Alternative
- Skyline Mine Alternative
- Year-round Release with Ground Water Exchange and Pumping Alternative
- New Ground Water Development Alternative

- New Surface Water Development in Sanpete County Alternative
- Central Utah Project Water Alternative
- Conservation Through Retirement of Irrigation Lands Alternative
- Purchase of Sanpete County's Water Rights by Carbon County Water Interests Alternative
- Carbon County Proposed Recharge Alternative

## S2.3 COMPARISON OF ALTERNATIVES

Table 2-8 compares the closely examined alternatives against the issues associated with the Proposed Action that are outlined in chapter 1. The scientific and analytical basis for these comparisons can be found in chapter 3.

## S2.4 PREFERRED ALTERNATIVE

Based on the comparison of alternatives provided in the FEIS, Reclamation has selected the Proposed Action Alternative (the large reservoir) as the preferred alternative.

## S3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This section summarizes chapter 3, which discusses the affected environment and environmental consequences that would result from the construction, operation, and maintenance of the project features associated with the Proposed Action and alternatives of the Narrows Project should Reclamation approve the loan application and the use of the Federal land. The affected environment discussions describe existing conditions for resources within the project area. The impact analyses focus on potential direct, indirect, and cumulative impacts on these resources. Potentially significant impacts, together with criteria developed at the beginning of this study for assessing the significance of potential impacts, are identified. Resource specialists reviewed all data and results of the March 1998 DEIS analysis and updated information based on available data and the substantive public comments received, where appropriate, in the FEIS. Mitigation measures that would reduce or avoid certain adverse impacts or would compensate for some unavoidable adverse impacts also are identified.

## S3.1 WATER RESOURCES

### S3.1.1 Affected Environment

Water resources affected by the Proposed Action include Gooseberry Creek and its three unnamed tributaries located high in the Price River drainage. Gooseberry Creek, a tributary of Fish Creek, flows directly into Scofield Reservoir (see figure 1.1). Scofield Reservoir is included in the affected environment, as is the segment of the Price River immediately below the reservoir down to the first diversion at the town of Heiner, some 25 miles below the dam. Cottonwood Creek, located in the San Pitch River Basin, is located on the opposite side of the divide from Gooseberry Creek. The water from the Narrows Tunnel is diverted into Cottonwood Creek. Cottonwood Creek and the San Pitch River are located in the Sevier River subbasin of the Great Basin.

Typical of Wasatch Mountain streams, flows in these creeks are greatest in the spring, when snowmelt runoff is peaking. Peak flows during May and June are estimated to range from 15 to over 100 cubic feet per

second (cfs) in Upper Gooseberry Creek near the proposed damsite. The flow declines considerably in late summer and reaches a minimum in late fall or winter. Late-season flows are estimated to be 1.5–5 cfs in Upper Gooseberry Creek.

The average annual natural runoff volume of Upper Gooseberry Creek, near the proposed damsite, is 9,032 acre-feet. Of this amount, an average of 1,815 acre-feet presently is stored in Fairview Lakes and diverted transmountain to Cottonwood Creek through the Narrows Tunnel. The remaining water continues down Gooseberry Creek to Fish Creek. An average of 35,800 acre-feet per year enters Scofield Reservoir from Fish Creek. The total annual inflow to Scofield Reservoir from all tributaries averages 57,500 acre-feet. The average total contents of Scofield Reservoir are about 42,360 acre-feet. Averages are based on the 1960–2002 hydrologic period of record.

The Price River below Scofield Reservoir, referred to as lower Fish Creek, has a wide range of flows that vary according to downstream water demands and hydrologic conditions. Releases consist of direct flow right bypasses and Scofield Reservoir storage deliveries for Scofield Project users. Spills occur when the reservoir is full and water flows over the spillway or when releases are made in excess of downstream demands. These total releases and spills have averaged 51,815 acre-feet for 1960–2002 but historically have varied from 13,762–154,475 acre-feet. Low flow conditions generally occur from November–March. There are no minimum flow requirements in the Price River, and it is not unusual for the flow below the dam to be completely shut off during winter months. Peak flows below the dam occur in wet years when the reservoir spills. While normal dam releases in June are about 150 cfs, the total releases with these spills have ranged up to more than 1,100 cfs. Because spills are in excess of downstream consumptive use requirements, they usually increase river flows throughout the lower Price River to the confluence with the Green River. From 1960–2002, the reservoir filled and spilled 17 times.

About 25 miles downstream from Scofield Reservoir near the small community of Heiner, the average annual flow of the Price River is about 74,800 acre-feet based on 1960–2002 data. Within 5 miles of Heiner, numerous diversions from the river occur. The largest diversion is the head of the Carbon and Price Wellington Canals, located about 1.5 miles south of Spring Glen. Except during high water conditions when the flow of the river exceeds the capacity of the canals, the river is essentially dry below this diversion. In addition to irrigation water, winter flows also are diverted for stock watering.

Irrigation return flows in this area discharge back to the river, and the flow of the river increases after passing through the Price-Wellington area. Near its confluence with the Green River, measured at the Price River at Woodside, the average annual flow of the river is 94,929 acre-feet, based on 1960–92 records. The stream gauging station on the Price River at Woodside was discontinued in September 1992 and renewed in July 2000.

Operation of the Narrows Project would affect streamflows in Gooseberry Creek, Lower Fish Creek, Scofield Reservoir, Price River to Heiner, Cottonwood Creek, and about 3 miles of the San Pitch River. Table 3-1 provides a comparison of average monthly streamflows under the four project alternatives evaluated. Monthly streamflow data were used to develop this table because reliable daily streamflow data were not available.

Impacts to Lower Gooseberry Creek and Fish Creek would occur primarily during the spring snowmelt period as water is stored in Narrows Reservoir for release later in the summer. Impacts to Lower Gooseberry Reservoir would consist of reduced inflow. However, the effect would be negligible because the reservoir is not operated as a storage reservoir. As a result, the outflow would be reduced in the same proportion as the inflow would be reduced. Impacts to Scofield Reservoir would be in the form of reduced inflows, resulting in a lowering of the average reservoir storage. Impacts to regulated releases from Scofield Reservoir for Scofield Project use would occur only during multiple successive drought years, such as occurred in the early 1960s, early 1990s, and the early 2000s. Impacts to the Price, Green, and Colorado Rivers would result primarily in reduced spills from Scofield Reservoir.

The impacts of the Narrows Project on water resources are most pronounced near the reservoir. About 1 mile of Upper Gooseberry Creek and 4.3 miles of small streams in the proposed reservoir basin would be inundated by the reservoir. In addition, annual flows in the middle 3 miles of Gooseberry Creek between Narrows Reservoir and inflow into Lower Gooseberry Reservoir would be reduced by about 74%. Under the Proposed Action, a 1.0-cfs minimum flow would be made from Narrows Reservoir to Gooseberry Creek to provide a 1.5-cfs minimum flow at the USDA Forest Service campground ⅛ mile downstream from the proposed damsite. If the 1.5-cfs flow at the campground is not met, up to an additional 0.25 cfs would be released from the reservoir to meet the required flow. Minimum streamflow releases from Narrows Reservoir would eliminate periodic dry stream channels in the Middle Gooseberry Creek segment. An average of 300 acre-feet per year also would be released for channel maintenance or other instream flow purposes.

Flows in Cottonwood Creek would increase during the irrigation season, with the import of project water through the Narrows Tunnel. However, during the irrigation season, these flows would be less than peak flows that occur naturally during the spring snowmelt period. The Upper Cottonwood Creek Pipeline would convey these increased flows outside the stream channel between the tunnel outlet and the confluence with Left Hand Fork. About 300 feet below the Left Hand Fork confluence, the project flows would be discharged to the stream. At this point, the increase in average July and August flows from current conditions would be about 200%.

Depletions to the Price River drainage would average 5,597 acre-feet per year. This amount would consist of 5,227 acre-feet of transbasin diversions and 370 acre-feet of increased evaporation in the Price River Basin. When measured in Gooseberry Creek below Narrows Reservoir, the reduction in annual streamflow varies between 1,760 and 10,200 acre-feet, depending on the storage level of Narrows Reservoir and the magnitude of the streamflow into the reservoir. As shown in table 3-1, the greatest impact would occur during the spring snowmelt runoff period. Releases from Narrows Reservoir to Gooseberry Creek would remain at a minimum of 1.0 cfs; and when the reservoir is spilling or when flushing releases are made, the flow would be greater.

As a result of constructing Narrows Reservoir, the operation of Scofield Reservoir would be altered within the normal historic range. Scofield Reservoir would operate at a lower level with implementing the Proposed Action, as shown in figure 3-1. Under project conditions, the average total contents of Scofield Reservoir would be reduced from about 42,400 acre-feet to about 31,900 acre-feet. Average reduction in storage releases to irrigators in the Price area

would be about 753 acre-feet per year. Total depletions to the Price River drainage would average 5,597 acre-feet per year. Both the volume and frequency of spills from the reservoir would be reduced. With the no action alternative, the average reservoir surface area would be reduced from 2,370 acres to about 2,125 acres. This is about a 10% reduction or about 245 acres of the surface area of the No Action Alternative.

Since Scofield Reservoir would operate at a lower level, there is an increased potential for the reservoir to be drained to the bottom of its active storage. The frequency of this occurrence increases from 3 times in 43 years for the No Action Alternative to 12 times in 43 years with the Proposed Action.

During most years, controlled releases from Scofield Reservoir to meet Scofield Project demands would remain unaltered.

In summary, the residual impacts (after mitigation) of the Proposed Action include the inundation of 1.0 mile of Gooseberry Creek and 4.3 miles of unnamed tributaries. Flows in Gooseberry Creek below Narrows Reservoir, Fish Creek, and the Price River would be reduced as shown in table 3-1. The flow in Cottonwood Creek below the confluence with Left Hand Fork would be increased during the nonrunoff portions of the irrigation season. Scofield Reservoir would operate at a lower level in most years; and reductions in storage releases to irrigators in the Price area would occur only after several successive years of drought and would average about 753 acre-feet per year. However, on the average, these reductions would be about 1,500 acre-feet less than the reductions that would have occurred if Scofield Reservoir had not been enlarged to accommodate the Gooseberry Project (Narrows Project).

## S3.2 WATER RIGHTS

### S3.2.1 Affected Environment

Utah water use is governed by the prior appropriation doctrine. Under this doctrine Utah's water resources are owned by the State for the welfare of the public and individuals, corporations, and public entities can acquire conditional rights to beneficial use this resource. Water rights are established either through historic water use prior to the enactment of State water laws or through an application to appropriate water. All water rights are assigned a priority date based upon when the water right was first established, either by use or by application. In times of water shortages water is allocated to water rights based on their priority dates with senior rights being able to divert ahead of junior water rights—hence, the maxim "first in time, first in right." In river systems, a water right can typically only divert water when all downstream senior water rights have all the water they currently need or are entitled to.

SWCD holds Water Right Numbers (Nos.) 91-130(A14025), 91-131(A14026), and 91-132 (A14477) for the Narrows Project. These water rights were established by Applications to Appropriate Nos. A14025, A14026, and A14477 filed by Reclamation in January and September of 1941. Reclamation later transferred these applications, still unapproved, to SWCD in July 1975 for use in the Narrow project. These applications have been involved in several agreements, the most significant of which is the 1984 Compromise Agreement that was mediated by the Utah State Engineer. The conditions of the 1984 Compromise Agreement, which were incorporated into the January 7, 1985, approval of these applications to appropriate, subordinated certain Price River Water Users Association's water rights to the Narrows Project, limited the annual transbasin

diversion and storage allowed by the Narrows Project, and specified how stored water from Scofield reservoir would be used to satisfy the downstream water rights that are senior to the Narrows Project.

## S3.2.2 Environmental Consequences

### S3.2.2.1 No Action Alternative

The North Sanpete water users would continue to hold valid water rights in Gooseberry Creek and would be entitled to develop these rights under Utah water law. If the Narrows Project water rights were amended to allow their development without Federal approval, they could be developed outside the scope of the FEIS. Whether or not the Narrows Project is constructed, the distribution of water between the Carbon and Sanpete water users will be based on the priority dates of the individual water rights (except as stipulated in the 1984 Compromise Agreement) that each water user holds.

### S3.2.2.2 Proposed Action Alternative

Sanpete County's water rights would be allowed to divert water in accordance to their respective priority dates and according to the terms of the 1984 Compromise Agreement. Sanpete County is allowed to develop their approved water rights even if doing so impairs previously developed junior water rights.

Although the development of the Narrow's Project could impair junior Carbon County water rights holders, it is anticipated that this impairment would be minimal. First, the 5,400-acre-foot annual depletion of the Narrows water rights represents only about 6.6% of the average annual yield of the Price River above the city of Price. Secondly, the Proposed Action should have no or minimal effect because of how Scofield Reservoir is operated (i.e., it is shut off completely for flood control when the White River is running high and then opened as needed to meet the downstream agricultural demands). Scofield Reservoir was enlarged in 1946 by 35,000 acre feet of additional storage, in part at Federal expense, to offset or provide a buffer to the potential effects of the proposed development of Gooseberry Creek to benefit Sanpete Valley. The two facilities were originally conceived as components of a single project. The Scofield Reservoir enlargement was intended as compensatory storage for the anticipated effects of the transbasin diversion to the Sanpete Valley. Therefore, because of this additional storage in Scofield Reservoir, there should be limited adverse impacts to the direct flow water right holders in the Price River system.

### S3.2.2.3 Mid-Sized Reservoir Alternative

This alternative is nearly identical to the Proposed Action, except Narrows Reservoir is limited to 10,000 acre-feet. The effects to other water right holders are nearly identical to the Proposed Action except that the potential impairment to Carbon County water users would be slightly less than that of the full size reservoir.

### S3.2.2.4 Small Reservoir Alternative

This alternative is nearly identical to the Proposed Action except Narrows Reservoir is limited to 5,400 acre-feet. The effects to other water right holders are also nearly identical to the Proposed Action except that the potential impairment to Carbon County water users would be slightly less than that of the Mid-Sized Reservoir.

## S3.3 WATER QUALITY

### S3.3.1 Upper Gooseberry Creek

On the basis of data collected from Upper Gooseberry Creek and Cottonwood Creek, where much of the flow is from Gooseberry Creek through the Narrows Tunnel, the water is considered very good quality. As shown in table 3-2, the dominant chemical constituents are calcium and bicarbonate, with other common ions being minor in concentration. Total dissolved solids (TDS) are low, ranging from 184–258 milligrams per liter (mg/L) in Gooseberry Creek and 160–316 mg/L in Cottonwood Creek. Trace elements are very low in concentration, with most below detection limits.

Although most of the phosphate levels in these samples were considerably less than 0.05 mg/L, previous studies conducted by the Utah Division of Wildlife Resources (UDWR) indicate that the 0.05-mg/L guideline for streams is often exceeded in Cottonwood Creek. Existing soil and rock erosion may be the major sources of phosphates exceeding this pollution indicator, with livestock grazing, recreation, and wildlife also contributing. At levels of 0.05 mg/L or greater, the Utah Department of Environmental Quality (UDEQ) indicates that investigations should be conducted to develop more information concerning phosphate sources.

### S3.3.2 Lower Gooseberry Reservoir

The Utah Division of Water Quality completed a limnological assessment of Lower Gooseberry Reservoir that indicates it is a fairly stable mesotrophic (moderate levels of organic and mineral nutrients) system with good water quality (UDEQ, Division of Water Quality, 2008). The only parameters to exceed State water quality standards for defined beneficial uses are phosphorus, pH, and dissolved oxygen (DO). The average concentration of total phosphorus in the water column has not exceeded the recommended pollution indicator for phosphorus of 0.025 mg/L; but occasionally, higher values are reported at various depths in the water column. Occasionally, DO levels and pH values have violated State standards near the bottom of the reservoir, mainly during winter ice coverage. The extensive macrophyte coverage of the bottom of the reservoir is the primary factor in the reservoir responsible for this phenomenon. The reservoir is shallow, with a mean depth of 3.7 feet; has good light penetration throughout the water column; and does not stratify. The UDWR has expressed concern about nutrient loading of Lower Gooseberry Reservoir and its effect upon DO levels in the reservoir. The oxygen depletion of the reservoir during the winter is believed to result from low winter inflows combined with decomposition of organic material resulting from the extensive macrophyte growth during the summer, as mentioned above.

### S3.3.3 Scofield Reservoir

Recent water quality assessment indicates that Scofield Reservoir is mesotrophic in its present state. Data collected in 1990 and 1991 depicted the reservoir as hypereutrophic, while data in 1992, after treatment and eradication of trash fish, indicated a moderately eutrophic system.

Data collected between 1992–2007 indicate an overall mesotrophic system (UDEQ, Division of Water Quality, 2010). Eutrophication is a term applied to the organic degradation of a body of water and is associated with elevated levels of carbon, nitrogen, phosphorus, and other inorganic nutrients. The degree of eutrophication generally is exhibited by the growth and

appearance of large colonies of algae in highly eutrophic waters, coupled with a green cast or color to the water. This generally occurs during the warm summer months.

Trophic State Index (TSI) is a general measure of the level of eutrophication in a reservoir. The Carlson TSI is determined using measures of secchi depth, chlorophyll, and phosphorus (Carlson, 1977). TSI values greater than 50 are indicative of a eutrophic system, and TSI values between 40–50 are indicative of a mesotrophic system. The average TSI value for Scofield Reservoir of 53.3 (for 1979–80) was reported by UDEQ in a report entitled *Scofield Reservoir Restoration Through Phosphorus Control*. For 1981–2007, the average TSI value was computed to be 47.1 (see figure 3-4).

Scofield Reservoir typically does not stratify during the summer and only weakly when it does stratify. Stratification in Scofield is largely influenced by its shallow depth (mean depth of 26 feet) and reservoir operations, which withdraw water from near the bottom of the reservoir. For these reasons, Scofield Reservoir is often mixed from top to bottom. During periods of weak stratification, oxygen levels near the bottom of the reservoir become depleted. Low dissolved oxygen increases phosphorus leaching from the bottom sediments (Judd, 1992).

The water quality of Scofield Reservoir is considered fair. Average constituent levels of the reservoir and its tributaries are listed in table 3-3. The average detention time is about 1.4 years. The maximum depth is 66 feet, and the mean depth is 26 feet. The shallow areas with water less than about 15 feet deep normally are covered with extensive macrophyte growth, although these are normally submergent. This adds to the oxygen deficit problem during parts of the year.

The principal pollutants are nutrients, sediments, and trace elements associated with erosion and mining and nonpoint sources such as construction of roads and mine portals, domestic waste disposal, animal grazing, and natural deposits of rock containing phosphates (table 3-3).

Several independent water quality studies of Scofield Reservoir (listed in the "Bibliography") show that phosphorus is the limiting nutrient. This means that all available phosphorus is used up in producing algae or other cell bodies, while there remains a surplus of carbon, nitrogen, and other nutrients. Thus, without the input of additional phosphorus into the system, no additional algal cells can form. About 53% of the phosphorus loading to Scofield Reservoir enters from Fish Creek, according to a 1983 Utah Department of Health study. Indications are that the source of most of the phosphorus consists of naturally occurring, phosphorus-laden soils in the upper watershed.

Fishkills in Scofield Reservoir have been reported during 14 of the 46 years from 1960–2005. These fishkills are minor and generally occur in late summer. They are an indicator of water quality problems with low DO levels being the most probable cause of the fish dying.

In 1984, UDEQ received a Clean Lakes Phase II grant pursuant to the Clean Water Act, Section 314, to rehabilitate Scofield Reservoir through a program to reduce total phosphorus loading to the reservoir. UDEQ had concluded that:

> "the most pragmatic and effective means to control the further eutrophication of Scofield Reservoir, or possibly to effect a moderate reversal of the eutrophication process, appears to be a reduction of the phosphorus load to the lake."

The restoration project consisted of installing stream revetments and checkdams, revegetating denuded streambanks, replacing water diversion systems for irrigation, providing a fish cleaning station, and developing a public awareness and education program to alert people of the pollution problem and solicit their support in reducing phosphorus loads to the reservoir. Streambank rehabilitation activities occurred on segments of Mud Creek and Fish Creek. The overall streambank work was designed to reduce stream sediments and erosion through streambank stabilization and revegetation of denuded soils in highly eroded areas.

A postproject monitoring program indicated that the project was initially effective. Streambank stabilization and revegetation occurred in the project area. Visual observations indicated that sediments were being removed from the streams. Although there is insufficient empirical data to conclusively support the effects of the implementation effort, the data indicated a decline in total phosphorus concentrations. However, many aspects of the project were voluntary on the part of the landowners. Since project completion, many of the project measures have not been maintained. In particular, one aspect included fencing Mud Creek to prevent cattle from entering the stream, damaging the streambanks, and defecating in the stream. This was initially effective, but the landowners currently keep the gates open, thus allowing cattle access to the stream.

Total organic carbon (TOC) data collected by the Utah Division of Water Quality from 1979–1991 indicated higher concentrations were present in the reservoir during 1980–1981 and 1984–1985 when the reservoir was near capacity. Data collected during 1989–1991 when the reservoir's capacity was much less have lower TOC concentrations. Similar patterns for TOC data are observed for data collected from the Price River above Willow Creek (STORET ID 7932810).

Utah Division of Water Quality officials believe that the presence of "rough fish," such as carp and suckers, also contribute to the water quality problems in Scofield Reservoir. These fish feed on the reservoir bottom and stir up sediments. This agitation could increase the internal phosphorus loading of the reservoir. In critical water quality years, removal of these fish species might improve the water quality of the reservoir. For example, 1992 was a critical year for Scofield Reservoir operation. Reservoir levels were extremely low, and fishkills were anticipated. However, a fish eradication program was conducted the previous year that killed the undesirable fish. No fishkills were observed in 1992, even though water levels were critically low.

During the 1992 drought year, residents of Price asked the State of Utah to investigate an apparent increase in gastrointestinal disease. Residents believed the increase in disease was caused by either residual bacterial coliforms in the treated water or the superchlorination that was necessary to render the water safe. The State thoroughly reviewed all the required monitoring (chlorine residual and coliform counts) by the water treatment entities. There were no documented problems with the treated water, nor was the water superchlorinated, because it was not needed. Likewise, neither the State nor local Health Departments documented any increased gastrointestinal illnesses during that time period.

In 2000, the Utah Department of Water Quality submitted, and the U.S. Environmental Protection Agency (EPA) approved, a phosphorus total maximum daily load (TMDL) for Scofield Reservoir (UDEQ, Division of Water Quality, 2000). The TMDL identifies total phosphorus and DO as pollutants of concern that have attributed to

the impairment Scofield Reservoir's Class 3A beneficial use for cold water species of game fish. The TMDL focuses on total phosphorus as the pollutant of concern because low DO is linked to high phosphorus levels. The loading assessment quantified the current total phosphorus load to the reservoir at 6,723 kilograms per year (kg/yr). The TMDL identified three endpoints to improve reservoir water quality:

1. Shift in phytoplankton dominance from blue-green algae
2. DO level of no less than 4.0 mg/L in 50% of water column
3. TSI values between 40 and 50

These endpoints are to be met by reducing the total phosphorus load to the reservoir by 1,881 kg/yr.

### S3.3.4 Price River

Water in the Price River suffers major water quality deterioration as the stream crosses the irrigated sectors of the river basin. The deterioration results from both geologic and human factors. From about November–April, little water is released from Scofield Reservoir, and the upper portion of the basin contributes little water to the river. During this period, irrigation return flow is not significantly diluted by better quality water. Although major releases are made from Scofield Reservoir from May–October, a large part of the flow is diverted during this period into major irrigation canals in the upstream part of the basin. Significant amounts of poor quality irrigation return flow enter the river downstream from points where most of the flow is diverted from the river.

Accordingly, during most of the year, the flow in Price River in the central basin is composed of relatively small amounts of good quality water from the upper basin and variable amounts of irrigation return flow and natural flow from tributaries that drain the marine shales. This increases the TDS level from about 300 mg/L to about 2,000 mg/L as measured above and below the areas of principal use. Although some deterioration in the chemical quality of the Price River probably would occur in the absence of stream regulation and irrigated agriculture in the central basin, deterioration is intensified with the presence of both.

From its confluence with the Green River upstream to its confluence with Soldier Creek, the Price River is listed as impaired for TDS. A TMDL has been completed and approved for these segments (UDEQ, Division of Water Quality, 2004). The TMDL established target daily TDS concentrations of 1,200 mg/L for all flow regimes.

### S3.3.5 Colorado River Salinity

At its headwaters in the mountains of north-central Colorado, the Colorado River has a salinity concentration of 50 mg/L. As a tributary to the Colorado River, the Price River contributes to the salinity load of the river system. The concentration progressively increases downstream as a result of water diversions and salt contributions from a variety of sources. Near Yuma, Arizona, the Imperial Dam, built in the 1930s, diverts Colorado River water into three different canals and holds the river water until it can be directed into a desilting plant. Annual salinity concentrations at Imperial Dam are expected to decrease from the 2007 measured average level of 702 mg/L, assuming continuing successful implementation of the salinity control program (Colorado River Basin Salinity Control Forum, 2008). Congress established the Colorado River Water Quality Improvement Program, which includes

numerous salinity control projects to mitigate the salinity impacts of water development as the Upper Basin States develop their existing Compact apportionments and water supplies.

### S3.3.6 Cottonwood Creek and San Pitch River

As indicated above, Cottonwood Creek has good water quality and generally meets all of its present beneficial use classifications. The San Pitch River is also generally good quality water above Fairview. However, the San Pitch River degrades downstream since most of the water is diverted; and near Moroni, the river is composed mostly of return flows from irrigation and municipal waste water. However, the TDS levels are generally below 500 mg/L in this reach, and the water is very suitable for irrigation. Most of the water is diverted from the stream about 2.5 miles west of Mt. Pleasant. Table 3-4 summarizes the water quality in this reach of the San Pitch River. Levels of trace elements (metals) in both streams are normally below detection levels.

Table 3-5 summarizes the water quality in the lower section of the San Pitch River and in Sixmile Creek near the mouth. Water in Sixmile Creek is very good quality with TDS levels averaging about 350 mg/L. Waters in the lower San Pitch River consist of mostly return flows and are further degraded below the proposed project area. The average TDS in the San Pitch River above Gunnison Reservoir is about 1,050 mg/L and 1,635 mg/L below Gunnison Reservoir, respectively. The recommended TDS criterion for irrigation water is 1,200 mg/L. The San Pitch River from its confluence with the Sevier River upstream to the U132 crossing was listed as impaired for TDS. A TMDL has been completed and approved for these segments (UDEQ, Division of Water Quality, 2003). The TMDL determined that cause of impairment was natural sources and that current TDS criteria could not be obtained. The TMDL further recommended site-specific criteria and that the impaired status be removed. Levels of trace elements (metals) in both streams are normally below detection levels.

### S3.3.7 Environmental Consequences

Under the Proposed Action, there could be some water quality impacts during construction; however, measures would be implemented to minimize those impacts. The contractor would be required to comply with applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution. The contractor's construction activities would be performed by methods that would prevent solid matter, contaminants, debris, and other objectionable pollutants and wastes from entering or accidentally spilling into streams, lakes, and underground water sources. Sanitary wastes would be disposed of by approved methods.

The construction contract would require the contractor to develop and implement a Water Quality Management Plan (Erosion Control Plan) and a Storm Water Pollution Prevention Plan. The contractor also would be required to implement the best management practices specified in the *Nonpoint Source Water Pollution Control Plan for Hydrologic Modifications in Utah*, which is an addendum to the *Utah Nonpoint Source Management Plan*. Specifically, applicable sections, such as Hydromod Planning Process, Measures to Control Construction Activities, and Impoundments, would be followed and implemented. Implementation of these measures would be expected to limit construction-related impacts on water quality to temporary sediment and turbidity impacts. Under a worst case scenario, if sediment

control facilities temporarily failed and any stream sections were significantly impaired, remediation/restoration work would be implemented to the satisfaction of the appropriate government agencies.

Any construction work occurring in streams or associated wetlands would be conducted in compliance with USACE's 404 Permit and/or the Utah State Engineer's stream alteration permit, which would include the State 401 certification process.

#### S3.3.7.1 Lower Gooseberry Reservoir

The average annual inflow (based on 1978–2005 data) to Lower Gooseberry Reservoir would be reduced by 40%. The average annual phosphorus load levels below the proposed Narrows Reservoir would be reduced by about 113 kg/yr, resulting from phosphorus export and uptake in the Narrows Reservoir. This would result in a 45% reduction in the average nutrient load in the total inflowing water. The average in-lake phosphorus concentration would be reduced from 0.0131 to 0.0119 mg/L, and the probability of eutrophication would be reduced from 24.3 to 19.7%. Because the DO levels are greatest near the stream inlet, a decrease in inflow is expected to decrease the overall DO level of the reservoir in winter during iced-over conditions, thus increasing the potential for fish kills, unless mitigation is implemented. Mitigation for this would include minimum streamflow releases as discussed in section 3.10, "Fisheries."

#### S3.3.7.2 Scofield Reservoir

As a result of the Proposed Action, the inflow to Scofield Reservoir would be reduced by an annual average of 5,726 acre-feet (about 9.2%). This means that Scofield Reservoir generally would operate at a lower elevation and smaller surface area. Shallower conditions in Scofield Reservoir would decrease periods of weak stratification, and reservoir turnover would occur earlier in the fall. Water temperatures at the surface of the reservoir, which is a function of solar input and wind mixing, would not be expected to change. Water temperature throughout the water column would increase slightly as the volume of water in the hypolimnion, or bottom temperature zone in the water column, would be reduced. Oxygen depletion at depth in the reservoir would occur less frequently due to shallower depths and increased mixing. Shallower conditions may lead to reduced water clarity as a result of wind-induced mixing.

The results of the eutrophication study (Franson-Noble Engineering) (appendix F) with the Narrows Dam and Reservoir show that, under the Proposed Action, there would be a reduction of average annual phosphorus mass loading into Scofield Reservoir (105 kg/yr) and an increase by 10.8% in phosphorus in-lake concentration from 0.0279 to 0.0309 mg/L. The reduction in phosphorus loading results from basin export and uptake in Narrows and Lower Gooseberry Reservoirs. The increase in phosphorus in-lake concentrations results from decreased dilution caused by water depletion from the Proposed Action. Figure 3-5 shows a comparison of the future without project and project phosphorus level in Scofield Reservoir based on external loading.

Increased phosphorus concentrations would be expected to lead to increased algal blooms, particularly blue-green algae, and increased eutrophication. The overall probability of eutrophication for the period studied shows an increase from 68.3 to 73.5% (about a 5.2% increase). The probability of eutrophication was increased every year except 1984.

Increased algal blooms also may lead to increased organic matter in the reservoir and in releases. Significant increases in organic matter would impact drinking water treatment processes.

The increase of in-lake phosphorus concentration and increased probability of eutrophication indicates that the overall water quality in Scofield Reservoir would be degraded by the Proposed Action without mitigation. Mitigation measures to offset these potential impacts are described in section 3.3.3.2.6.

#### S3.3.7.3 Proposed Narrows Reservoir

The overall water quality in the proposed Narrows Reservoir is projected to be good. The probability of eutrophication would be about 12% (compared to 73.5% for Scofield Reservoir and 19.7% for Lower Gooseberry Reservoir). The proposed Narrows Reservoir is not expected to strongly stratify due to its shape, water budget, and location. The active pool (the storage above the inactive pool) would only be 45 feet deep, with an average drawdown of 9 feet during the recreation season and 12 feet annually. The proposed plan is to have three outlets spaced 20 feet apart, at elevations 8,640; 8,660; and 8,680 feet, respectively. The normal water surface elevation is 8,690 feet. If a mild thermocline develops, it normally would start at about 16–20 feet and, over the summer season, migrate down to a depth of 32–45 feet, depending upon the release pattern, level of water withdrawn, and type of year. Once the reservoir was constructed, filled, and operated for several years, an operating plan would be developed jointly with the State and Federal agencies to enhance habitat for fish and wildlife downstream. As a result of the small releases and stream channel conditions downstream, the water would reach ambient conditions within the first ¼ to 2 miles downstream, relative to temperature and dissolved oxygen, even if conditions were less than optimal in waters released. Releases from the Narrows Reservoir would be expected to meet or exceed water quality standards of the State of Utah as found in Utah Administrative Code R317-2 for downstream designated beneficial uses.

Water quality at the proposed Narrows Reservoir would be protected by establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.

#### S3.3.7.4 Price and Colorado Rivers

The Narrows Project would have virtually no effect on the lower Price River water quality during the November–April high TDS period because the effects of depletions caused by the proposed Narrows Project would consist primarily of reduced spills from Scofield Reservoir during the snowmelt runoff period.

Reduced spills from Scofield Reservoir would slightly increase exceedances of the TMDL established for TDS on the lower Price River (UDEQ, Division of Water Quality, 2004).

Implementing the Proposed Action would have a slight detrimental impact on Colorado River salinity. While operation of the proposed Narrows Dam and Reservoir would remove about 1,520 tons of salt per year from the Colorado River system, depletions from the project would increase salinity concentrations. The project would cause a depletion of about 5,597 acre-feet of water, which would result in an increase in salinity concentration by about 0.54 mg/L at Imperial Dam.

#### S3.3.7.5 Cottonwood Creek and San Pitch River

The overall water quality of Upper Gooseberry Creek is better than that of Cottonwood Creek (see table 3-2), so the additional water imported to Cottonwood Creek would improve its quality slightly. The exception may include temporary periods of slightly higher turbidity from the increased summer flows. Flows in Cottonwood Creek (below Left Hand Fork) would increase in July and August due to the increased irrigation releases, but these flows would be significantly less than peak flows that naturally occur during the spring snowmelt period. As discussed in Section 3.5, "Slope and Channel Stability," the Narrows Tunnel operating gate would be automated to regulate releases through the tunnel so that, even during thunderstorms, the channel forming discharge would not increase above historical conditions. Consequently, even though the Proposed Action would increase the summer base flow, it would have no effect on Cottonwood Creek channel stability because the increase would be well below the 50-year channel forming discharge.

Except during spring runoff and winter conditions, flows in the San Pitch River below the project area consist mostly of return flows from irrigation and municipal waste water. The project would increase the volume of return flows from both of these sources; however, since no new lands receive project water, the quality of return flows would be similar to existing flows or possibly would be of slightly better quality because lands would receive a more complete water supply. Consequently, the concentration of dissolved salts should be more diluted in the increased volume of return flows. The potential decrease in irrigation return flows, resulting from increasing agricultural efficiencies, would be offset by the increase of return flow from the additional project irrigation water. Even if the overall volume of return flow were reduced significantly due to increased efficiencies, the quality of the return flows probably would not change significantly, nor would the existing quality of the San Pitch River change significantly since it mostly is composed already of return flows.

As shown in table 3-5, the salinity of lower San Pitch River is about 1,150–1,635 mg/L TDS compared to about 350 mg/L in Sixmile Creek. If the Manti Meadows Alternative wetland mitigation area is selected, and if water is delivered from Sixmile Creek and replaced with project return flows delivered to Gunnison Reservoir in exchange, there could be some impact to affected irrigated lands.

Diversions to the wetland area would have to be timed to not significantly affect the exchanged irrigation water supply, or replacement waters would need to be blended with higher quality Sixmile water to avoid impact to crops using the water. Under worst case conditions, an agreement with the Manti Irrigation Company might be needed, and minimal compensation might be required.

## S3.4 AIR QUALITY RESOURCES

Utah air quality is monitored by UDEQ, Division of Air Quality, but there are no existing monitoring sites near the proposed Narrows Project located in Sanpete County. The closest monitoring station is located in Utah County, which has poor air quality in terms of carbon monoxide, nitrogen dioxide, and particulate matter (www.epa.gov/air/data).

Under the 1970 Clean Air Act, EPA established National Ambient Air Quality Standards (NAAQS) for particulate matter and five other criteria

pollutants considered harmful to public health and the environment. The NAAQS specify maximum concentrations below which the air quality is considered acceptable, meaning an area below these thresholds are "in attainment" for EPA standards.

Sanpete County is generally in attainment for all but particulate matter. The standards for particulate matter, expressed as micrograms per cubic meter ($\mu g/m^3$), are as follows: 150 $\mu g/m^3$ (24-hour), 50 $\mu g/m^3$ (annual arithmetic average). The impact indicator for this issue is the number of days the project would exceed NAAQS for particulate matter ($PM_{10}$ levels).[4]

Typical $PM_{10}$ emissions associated with construction activities described in the Proposed Action were estimated, using emission factors from the EPA's *Compilation of Air Pollutant Emission Factors* (EPA, 1985). Approximately 232 pounds per day (lb/day) of construction dust $PM_{10}$ emissions would be produced from activities described in the Proposed Action.

Most of these emissions would be from vehicle and equipment travel over unpaved roads or direct disturbance of the soil by excavating, grading, and compacting. Application of standard dust suppression techniques (for example, soil stabilization or watering of stockpiled materials) would reduce daily $PM_{10}$ emissions from 232 lb/day to less than the national standard of 150 lb/day. Short-term increases of particulate matter would occur during construction of the Proposed Action. Fugitive dust emissions and emissions from internal combustion engines would be generated by excavation and earth-moving vehicle traffic on unpaved surfaces. The contractor would be required to meet all applicable regulations concerning exhaust and dust control.

Following construction, long-term impacts on air quality would include some increased vehicle emissions and campfires due to additional recreational facilities that would result from the project. This, along with the increased use associated with project operation and maintenance (O&M), would contribute to some increased level of air pollutants. This impact would not be expected to exceed NAAQS in the Narrows Project area.

Wherever and whenever necessary, the contractor would be required to comply with all Federal regulations and take proper and efficient measures to reduce dust and exhaust pollution that might originate from construction to prevent it from becoming a nuisance to people or causing damage to crops, cultivated fields, or dwellings. The contractor would be required to control particle pollution resulting from the manufacture of concrete aggregate or excessive exhaust pollution resulting from improperly tuned engines or improperly equipped vehicles and equipment.

## S3.5 SLOPE AND CHANNEL STABILITY

Fairview Canyon, which contains Cottonwood Creek, is a steep, narrow canyon located east of Fairview, Utah. Highway SR-31 is located in the canyon. The canyon is approximately 7 miles long. The stream elevation at the mouth of the canyon is about 6,300 feet and about 8,800 feet near the summit. Typical slopes of the canyon wall are 2:1 to 2.5:1 (ratio of horizontal to vertical distance). Numerous landslides are located throughout the canyon on both sides. In several places, continual

[4] $PM_{10}$ is particulate matter of 10 microns in diameter or smaller

road maintenance is required to repair damage caused by landslides.

A total of 104 landslides were identified from aerial photographs and during a 1991 field review along the slopes of a 6-mile reach of Cottonwood Creek. The review team was comprised of individuals from various government agencies and private consulting firms. The review was to determine the impact of projected flow increases from Narrows Tunnel on adjacent slopes of Cottonwood Creek. The state of activity of the slides was noted with 85 slides classified as “active” and 19 classified as “dormant.” The certainty of landslide identification included 89 slides as “definite,” 13 as “probable,” and 2 as “questionable.” The distances of the landslides from the tunnel portal ranged from 0.3 mile to 6.1 miles. Dominant types of slope movement of the 104 landslides are shown in table 3-7.

Based on observations during the review, it was determined that landslide activity is not related to stream channel stability or the flow in Cottonwood Creek but is caused by saturation from water sources on the hillsides.

Under the Proposed Action, increased flows in Cottonwood Creek will occur due to releases from Narrows Reservoir through the Narrows Tunnel and Upper Cottonwood Creek Pipeline. These increased flows will occur below Left Hand Fork where the Upper Cottonwood Creek Pipeline will discharge into the creek. Figure 3-7 is a hydrograph based on daily flow data that compares present, or No Action Alternative, flows in Cottonwood Creek with flows that will occur under the Proposed Action. The figure is based on 1968 data, which is an average year. As shown in the figure, the peak discharge of about 112 cfs occurs during the snowmelt runoff period. Presently, summer base flows are about 18 cfs. Under the Proposed Action, the summer base flows would increase to about 50 cfs. The maximum flow possible through the tunnel was increased in 2011 by 45 cfs, from a capacity of 15 cfs to a capacity of 60 cfs.

The 50-year rainfall peaks expected in the canyon range from 330 cfs below Left Fork to 570 cfs near the mouth of the canyon. The possible maximum increase in tunnel flows is less than 15% of the rainfall peaks. The snowmelt peak is not a consideration because the tunnel will not operate during the snowmelt runoff. Based on the physical characteristics of Cottonwood Creek and the impacts of the proposed project on the flow characteristics, the project is unlikely to have a significant impact on the stability of the creek. To ensure that the tunnel releases will not cause an impact, the measures described below will be implemented.

As described in chapter 2, remote control of the Narrows Tunnel operating gate would be provided to automatically regulate the releases through the tunnel. These controls would be coupled to an automated stream gauging station on Cottonwood Creek near the mouth of the canyon. The streamflow in Cottonwood Creek would be constantly monitored by these controls. As the streamflow increases during high runoff events such as thunderstorms, the tunnel operation would be discontinued when the flow exceeds 100 cfs. The project releases would not resume until after the flows drop below 100 cfs. Under this operating regime, the project flows through the tunnel would not increase streamflows above what is considered safe for channel stability. Increased flows under project conditions would be well below the 50-year channel-forming discharge.

Erosion along the banks of Cottonwood Creek would be carefully monitored, especially during the first year of operation, to verify that the project has no effect on Cottonwood Creek channel stability. Appropriate action would be taken if

additional erosion above background levels is observed during project operation. Remedial actions could include placing additional armoring materials in the channel or along the bank or revising project operation to avoid more widespread stability problems.

## S3.6 GEOLOGIC RESOURCES

The reservoir basin lies within a high elevation, shallow valley in the Wasatch Plateau subprovince of the Colorado Plateau. This subprovince represents the transition between the Colorado Plateau to the east and the Basin and Range Province to the west. Several ridges isolate the valley basin, which lies about 8,680 feet above sea level.

The proposed Narrows Dam and Reservoir area is underlain by the Cretaceous age North Horn Formation. This formation consists primarily of interbedded sandy, clayey siltstone, silty claystone, silty sandstone, and limestone with occasional thin seams of coal. Bedrock crops out on the steeper slopes of the left abutment and in the drainage located immediately upstream of the left abutment. There is less exposure of bedrock on the right abutment. Unconsolidated sediments overlying bedrock consist primarily of a mixture of residual soil (weathered rock) and colluvium that generally consists of silty sand with some fine to coarse gravel. A geologic study performed by SWCD indicates that there is low potential for reservoir-induced landslide activity in the reservoir basin.

The North Horn Formation is overlain by the Flagstaff Limestone Formation that consists primarily of microcrystalline limestone with thinly bedded shale and silty claystone. Abundant fossils are common within the limestone, and the boundary between the formations is transitional. The Flagstaff Limestone Formation generally is present in the higher elevations and beyond the actual limits of the proposed dam and reservoir. The Flagstaff Limestone Formation is present at the downstream portal area of the existing Narrows Tunnel.

Bedrock generally is covered by a mantle of residual soils and/or colluvium. These unconsolidated sediments are about 5–10 feet thick with some areas in excess of 27 feet. The unconsolidated sediments are composed of a mixture of clay, silt, and sand with minor amounts of organic deposits. Within the active stream channel of Gooseberry Creek and its tributaries, there are limited deposits of recent alluvial sand and gravel.

The structure of the Wasatch Plateau is dominated by a series of north-trending faults across the broad, west-dipping monocline of the plateau. The Sevier fault zone lies closest to the damsite at a distance of about 20 miles. The local structure is dominated by north-trending faulting around the site area. The dam and reservoir sites are located entirely on a down-dropped block between two fault traces, which is known as the Gooseberry Graben. Variation in orientation of beds indicates that the dam area is located on a westward-plunging synclinal fold with the axis running about 1,000 feet south of the proposed dam axis.

Three faults have been mapped in the vicinity of the Narrows Project. These faults, shown in figure 3-8, are all north-trending normal faults; and the West Gooseberry Fault, the Fairview Lakes Fault, and the East Gooseberry Fault are from west to east.

Observed earthquakes in the region of the Narrows damsite date back to 1853, giving a historical database of about 158 years. A network of seismograph stations throughout the region currently provides the accurate location of any seismic event. Geologic evaluation of the Wasatch Plateau area indicates that existing faults are not active. Maximum seismic events for the area are, therefore, projected to be controlled by

random background earthquakes—that is, events not attributable to specific faults or geologic structures.

The largest earthquake recorded in the Wasatch Plateau Province is a magnitude 4.9 event. The maximum random earthquake event postulated for the Wasatch Plateau is a 5.5 event, occurring beneath the site at a depth of 3 miles. Such an event would produce a maximum acceleration of approximately 0.35 g (acceleration of gravity). Seismic activity related to mining activities would not be expected to produce events that exceed magnitude 4.5 and, therefore, would not produce the maximum earthquake. Earthquake epicenters are shown on figure 3-9.

From a geoseismic standpoint, the recommended Narrows damsite is suitable for construction. No significant geologic hazards were found in the embankment or reservoir area, and no seismic activity would be expected to occur from or be induced by this reservoir. Faults that occur in the site vicinity are believed to be inactive. However, design of project facilities would be based on a "maximum credible earthquake" (MCE). Preliminary studies indicate that the appropriate MCE would be of magnitude 5.5. Further review of the appropriate MCE would be performed prior to final design of the dam.

Additional geologic field evaluation and assessment of the dam and reservoir site would be completed that addresses the proximal active faults associated with the site, and further characterizes the earth materials underlying the dam site, reservoir, and reservoir rim to evaluate their engineering properties to ensure adequate design of features associated with the dam and reservoir. Designs would incorporate maximum accelerations associated with natural and or manmade seismic events that are determined or probable that could potentially occur in the area. Mitigation for other potential geologic hazards also would be integrated into design.

During construction, detailed observations of the subsurface conditions would be monitored by qualified personnel.

There would be no residual geology or seismicity impacts under the Proposed Action. There would be no geology or seismicity mitigation measures under the Proposed Action.

## S3.7 PALEONTOLOGICAL RESOURCES

Paleontological resources are defined as any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth. Section 6302 of the Paleontological Resources Preservation Act (PRPA) of 2009 (Sections 6301–6312 of the Omnibus Land Management Act of 2009 [Public Law 111-11 123 Stat. 991-1456]) requires the Secretary of the Interior to manage and protect paleontological resources on Federal land using scientific principles and expertise.

Reclamation will be responsible for ensuring the completion of paleontological resource compliance, as stated in the environmental commitments (see appendix G), as a means to fulfill the requirements of the PRPA. The commitment requires a paleontological literature search through the Utah Geological Survey (UGS). This process involves a search of the statewide paleontological resource locality database as well as an examination of geologic maps of the area of potential effects (APE) and its immediate vicinity. Through the literature search process, the UGS will determine the potential for discovering paleontological resources as a result of the Proposed Action. Based on the

determined potential, the UGS will either make a determination of no effect or require that a paleontological survey be conducted.

Environmental consequences to paleontological resources as a result of the Proposed Action will be determined following the paleontological literature search and survey of the APE and its immediate vicinity.

## S3.8 SOIL RESOURCES

Soils in the project service area and along the Oak Creek and East Bench Pipelines alignments have developed under semiarid conditions. They are highly calcareous, are high in inherent plant nutrients, have weak to moderate developed soil profiles, and have a wide range of soil textures. They are derived principally from both old and recent alluvial materials eroded from geologic materials of the Wasatch Plateau. The lands are found on benches and terraces formed by the coalesced alluvial fans of the streams tributary to the San Pitch River. A broad area of valley fill material of deeper soils is found west of Mount Pleasant and in small cove areas at the base of the large alluvial fans. Valley fill also is found in the flat valley or river bottom areas west and southwest of Moroni.

Soils within the vicinity of the proposed Narrows Reservoir are formed mostly in colluvial, alluvial, and residuum materials weathered from sedimentary rocks, limestone, sandstone, and shale. Soils on the high ridges along the west side of the area are formed in materials derived primarily from limestone, while soils in the central and eastern sections of the project area are formed in materials dominated by sandstone, (silty) shale, and some limestone.

Soils are dark colored, rich in bases, freely drained, and cold. Mean annual soil temperature is less than 47 degrees Fahrenheit (°F), and the mean summer soil temperature is less than 59 °F. Average annual precipitation ranges from 20–25 inches, and the growing season is approximately 90–100 days. All but two of the soil series described are in the Cryoboroll Great Group, Boroll Suborder, and Mollisol Order of soil classification. The two exceptions, Fairview and Gooseberry series, are classified as being in the Cryaquoll Great Group, Aquoll Suborder, and Mollisol Order.

The erosion hazard for the soils within the vicinity of the proposed reservoir ranges from severe to low with over 80% of the area being classified as having a moderate or low erosion potential. Precipitation runoff rates range from rapid to slow, with most of the area having a moderate to slow runoff rate. Average sediment yields in the vicinity of the proposed reservoir are estimated to be 73 tons per square mile per year. With a drainage area of about 5.5 square miles, there is an estimated sediment load of 400 tons per year at the proposed damsite. This drainage area excludes the area that drains into Fairview Lakes.

Under the Proposed Action, about 604 acres of land would be inundated by Narrows Reservoir. An additional 32.4 acres would be disturbed by construction of the SR-264 relocation and the recreation area. Development of a rockfill material source area outside of the reservoir basin would disturb another 2.0 acres. Earthfill material source areas would be developed within the reservoir basin, and contractor staging areas and tunnel spoil areas also would be located below the low water level of the reservoir basin.

The alignment of the proposed highway relocation crosses relatively gentle terrain, and cut and fill slopes would be minimal. All cut and fill slopes would be revegetated to minimize erosion. Roadways in the recreation area would be paved to minimize

dust and soil erosion. Following construction, the rockfill material source area would be recontoured, topsoil would be replaced, and the area would be revegetated. Virtually all runoff from disturbed areas would flow into Narrows Reservoir that would act as a trap for all upstream sediment. The current sediment load in Gooseberry Creek downstream from the proposed Narrows Reservoir would be reduced by about 400 tons per year with construction of the Proposed Action. This sediment would accumulate in the reservoir.

The Upper Cottonwood Creek Pipeline would be constructed in a previously disturbed area along the shoulder of SR-31. Construction of the Oak Creek and East Bench Pipelines would disturb about 30 acres. As part of the construction process, the ground would be recontoured and revegetated with native plants to minimize erosion and to restore the natural appearance.

Mitigation for disturbances to soils under the Proposed Action would be accomplished by revegetating all cut and fill slopes to minimize erosion. Roadways in the recreation area would be paved to minimize dust and soil erosion. Following construction, the rockfill material source area would be recontoured, topsoil would be replaced, and the area would be revegetated.

Residual impacts to soils under the Proposed Action would include inundating 604 acres by Narrows Reservoir and the 32.4 acres that would be covered by relocating SR-264.

## S3.9 TRACE ELEMENTS

A trace element survey was conducted in accordance with current Reclamation practices to identify where concentrations of potentially toxic elements, such as selenium, arsenic, and mercury, likely would be to occur in irrigation return flows under project conditions. Accumulations of these substances can be harmful to humans and wildlife. A total of 11 soil samples, collected in 1990, were analyzed by the U.S. Geological Survey. The results are shown in table 3-8 for arsenic, mercury, and selenium from three representative sites in the project area.

Study results indicate that all three elements analyzed are present in low to moderate concentrations; therefore, further testing for these elements was not considered necessary.

Data also was gathered from the National Geochemical Database that contained extensive information on soils in the vicinity of the survey area. Most of the data was from the National Uranium Resource Evaluation Surveys conducted from 1976–80. The primary objective of these surveys was to prospect for uranium; however, many other trace elements also were analyzed in the survey. From this, 59 soil sampling sites were located in the vicinity of the survey area. Almost all sites were in Quaternary alluvium.

The data indicate that most trace elements are present in concentrations within the common range for western soils. Cobalt was the only element consistently present in concentrations outside the common range; however, the levels observed were trace amounts. Cobalt in nature at levels observed in the National Uranium Resources Evaluation Survey for the area is considered a nutrient and nonhazardous. Limited water analysis data indicate cobalt was not detected in the San Pitch River.

Table 3-9 summarizes the number of soil samples with noteworthy concentrations of trace elements. Although these elements were found at elevated concentrations at scattered sites, it appears that none of the elements are present in concentrations of concern in the existing project return flows.

The data indicate that trace elements are present in low concentrations in ground water in or near the proposed Narrows Project. A review of the STORET data for the San Pitch River indicated low concentrations of the same trace elements present in the surface water in the Narrows Unit.

The data presented in table 3-11, from the EPA STORET database, indicate that water quality of the San Pitch River in the project area is generally acceptable. The San Pitch River shows some improvement in water quality through the project area, possibly due to high quality inflows from the Manti-La Sal drainage.

Lands in the project area have been irrigated for more than 50 years, and the results of the data gathered showed no significant quantities of trace or toxic elements in the ground water and in the San Pitch River; therefore, no increase of potentially toxic trace elements is anticipated under project conditions. There would be no residual impacts associated with potentially toxic trace elements under the Proposed Action.

## S3.10 FISHERIES

Most of the Narrows Project alternatives have the potential to affect aquatic resources in Gooseberry Creek, Fish Creek, three unnamed headwater tributaries to Gooseberry Creek, Cottonwood Creek, Lower Gooseberry Reservoir, Fairview Lakes, and Scofield Reservoir (see the location map). Cottonwood Creek is in the San Pitch River Basin, whereas all of the others are in the Price River drainage. Cottonwood Creek flows into the San Pitch River downstream from Fairview, Utah; but the San Pitch River, within the project area, does not support a sport fishery because of low summer flows.

Flows in Gooseberry Creek, its unnamed tributaries, and Cottonwood Creek presently are affected by the operation of Fairview Lakes, which store water during spring runoff. Water from the lakes is delivered during the irrigation season via one of the unnamed tributary streams and a canal to the Narrows Tunnel that discharges into Cottonwood Creek. The released water then is diverted for irrigation in Sanpete County.

Lower Gooseberry Creek and Fish Creek downstream from the confluence with Gooseberry Creek also are affected by the operation and limited regulation offered by Fairview Lakes. If the project is approved, an operating agreement would have to be negotiated between SWCD and Cottonwood-Gooseberry Irrigation Company to regulate seasonal releases from Fairview Lakes in connection with downstream discharges from the Narrows Reservoir.

Cutthroat trout (*Oncorhynchus clarkii*) exist within the streams potentially affected by the proposed project. Identification of these populations to the subspecies level is problematic. It is clear that various non-native subspecies of cutthroat trout as well as rainbow trout (*Oncorhynchus mykiss*), which interbreed with cutthroat trout, have been transplanted and stocked in these drainages in the past. Also, fish eradication activities have been carried out in the past. No genetic analysis has been attempted to determine the level of hybridization found in the current fish assemblages. Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*are) are endemic to Gooseberry Creek. Bonneville cutthroat trout (*Oncorhynchus clarki utah*) are endemic to Cottonwood Creek.

Cutthroat trout within the Gooseberry Drainage are predominantly Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*). The Bear Lake strain of Bonneville cutthroat trout (*Oncorhynchus clarki utah*) also have been transplanted into Scofield Reservoir. These fish spawn in Fish Creek and Gooseberry Creek and likely have

hybridized with other subspecies present. Both Yellowstone and Bear Lake cutthroat trout are not native to these drainages.

Upper Cottonwood Creek does not support a self-sustaining trout population. Lower Cottonwood Creek may contain endemic Bonneville cutthroat trout; however, genetic analysis to determine the degree of hybridization within this population has not been done.

The existing Lower Gooseberry Reservoir acts as a fish barrier that helps to limit the occurrence of transbasin cross breeding between the populations.

Diseases may be spread between the basins within the project area. Currently, these drainages are not known to be infected with whirling disease.

The transbasin diversion has been functioning for decades, and any diseases or fish species present could have crossed the divide between the drainages in either direction numerous times in the past. The proposed project likely would not increase the occurrence of these events and may act as a barrier to these events.

Aquatic resources vary considerably between the different reservoirs and stream segments that could be affected by the Narrows Project. Fish habitat study reaches are shown in figure 3-10.

Under the Proposed Action, the State Engineer stipulates that a minimum of 1.0 cfs is to be released downstream from the proposed Narrows Dam; and, if the flow is not 1.5 cfs at the Gooseberry campground, ⅛ mile downstream from the proposed damsite, SWCD is required to release 1.25 cfs from the dam. It also is stipulated that the dam be constructed by SWCD with a multiple-level outlet to regulate water temperature for the trout located downstream from the dam.

The proposed project would cause flow reductions in Gooseberry and Fish Creeks as shown in table 3-1. Flows in Middle Gooseberry Creek immediately downstream from the proposed dam would be expected to be reduced on average by 74%, whereas flows downstream from Lower Gooseberry Reservoir would be expected to be reduced by 43%. In Fish Creek, flows would be expected to be reduced approximately 15%.

The 5,400-acre-feet diversion of project water into Cottonwood Creek would cause about a 200% increase in the base summer flow in Upper Cottonwood Creek (table 3-1). As shown, the base summer flows in Lower Cottonwood Creek would be increased by about 160%. However, the increased flows would occur only during the July–October period and not during the peak runoff or the low flow months (November–April). Additionally, these base summer flows would be less than the peak flows that currently shape the stream channel. Therefore, the stream channel itself would remain stable.

Providing a 2.0-cfs winter release through the Narrows Tunnel is expected to greatly increase the weighted usable area for all fish species in Cottonwood Creek. This increased flow particularly would benefit the upper reaches of the creek and would be expected to facilitate the overwintering of fish.

The length of time required initially to fill Narrows Reservoir would, of course, depend on hydrologic conditions in the basin. During wet years, the reservoir could fill during a single spring runoff. For more normal conditions, if no diversions were made to Cottonwood Creek until the reservoir filled, it likely would fill in 2 years—almost certainly within 3 years. Under dry conditions, if diversions to Cottonwood Creek did occur during the filling period, it could take 5–15 years to fill Narrows Reservoir. Due to these hydrologic

uncertainties, there is no firm filling schedule for the reservoir.

At maximum storage, the proposed Narrows Reservoir would inundate about 1 mile of Upper Gooseberry Creek and approximately 4.3 miles of the three headwater tributaries with permanent flows that join to form Gooseberry Creek.

Based on the stream habitat that would be inundated by the proposed reservoir, it is expected that 1.3 and 2.1 acres of stream-based aquatic habitat would be lost in Gooseberry Creek and the tributaries, respectively. Using the standing crop estimates, approximately 230 pounds of stream-based cutthroat trout would be lost, of which 22% would occur in Gooseberry Creek and 78% would occur in the tributary streams, although the trout biomass likely would be converted into a flat-water equivalent.

The UDWR does not recognize the creation of a reservoir fishery as adequate compensation for the loss of stream aquatic resources. Creating an additional reservoir fishery would compensate for adverse effects that may occur on Lower Gooseberry Reservoir and Scofield Reservoir. This would represent a cumulative beneficial project impact to reservoir fishery.

In summary, the Proposed Action would result in loss of cutthroat trout stream habitat attributable to reservoir inundation and flow alteration. The project also would result in more reservoir habitat for cutthroat trout. The reservoir cutthroat trout habitat that would be created by the project would compensate for any adverse impacts that may occur on Gooseberry or Scofield Reservoirs. Therefore, mitigation for reservoir habitat has not been proposed.

A total of 11 fishery improvement and mitigation measures have been proposed by SWCD to compensate for the adverse aquatic impacts that have been identified with the proposed project. To the extent possible, an attempt was made to mitigate "in place" and "in kind." These measures have been developed in coordination with various Federal and State agencies and were described in detail in chapter 2, section 2.2.2.2.1. Table 3-20 is a summary of the aquatic impacts and proposed improvement and mitigation commitments for the Proposed Action.

The intent of the aquatic mitigation measures is to provide full mitigation for all adverse impacts resulting in no residual cumulative or overall impacts.

## S3.11 WILDLIFE

The study, *Vegetation and Wildlife Impacts from the Narrows Project*, states that wildlife species found in the general project area are common in the Great Basin Desert valleys and Rocky Mountain Range. There are about 364 species of terrestrial vertebrates that may inhabit the project area. Approximately 88 bird species and 33 mammal species use the habitats that would be disturbed by the proposed project (Mt. Nebo Scientific, 1992).

Table 3-23 summarizes the impacts to wildlife habitat that would result from construction of the Proposed Action. In an assumed worst-case situation where the most habitat would be lost at one time, it would take the reservoir 2 years to fill to capacity. The *1994 Fish and Wildlife Coordination Act Report* evaluates the impacts of the proposed Narrows Project on fish and wildlife resources and recommends appropriate mitigation (see appendix D).

A wildlife mitigation program has been designed to provide at least full mitigation for each impacted species. Because the wetland and upland wildlife mitigation measures are

intended to provide full mitigation for project impacts, there would be no residual impacts.

## S3.12 THREATENED AND ENDANGERED SPECIES

No plant species currently receiving protection under the Endangered Species Act are known to exist in the project area/action area.

A biological assessment of potential effects on endangered, threatened, and candidate wildlife and fish species was conducted in October 1991 and was amended three times, in July 1994, March 1997, and February 1999 for the Narrows Project in compliance with Section 7(c) of the Endangered Species Act of 1973 (appendix C). Federally listed or otherwise protected species addressed in the assessment included: bald eagle (*Haliaeetus luecocephalus*); greater sage-grouse (*Centrocercus urophasianus*), Colorado pikeminnow, (*Ptychocheilus lucius*); bonytail (*Gila elegans*); humpback chub (*Gila cypha*); and razorback sucker (*Xyrauchen texanus*).

The U.S. Fish and Wildlife Service (Service) issued a final biological opinion on August 24, 2000, (appendix C) finding that the proposed project would have no effect upon the bald eagle, which was subsequently delisted in 2007. The Service believes that the southwestern willow flycatcher (SWWF) found at the Fish Creek site is not the endangered subspecies; therefore, no discussion was offered specifically in reference to the SWWF. The Service concluded, however, that the project and associated depletion of water from the Colorado River system is likely to jeopardize the continued existence of four endangered Colorado River fishes and to destroy or adversely modify designated critical habitat in the Green and Colorado Rivers from the confluence of the Price and Green Rivers downstream to Lake Powell. The Recovery Implementation Program for the Upper Colorado River Basin Endangered Fish Species serves as the reasonable and prudent alternative to avoid the likelihood of jeopardizing the continued existence of these listed species or the destruction of adverse modification of their habitat. Measures are implemented to offset project impacts (i.e., payment of a one-time financial contribution by SWCD).

## S3.13 VEGETATIVE RESOURCES

Major plant communities occurring in the project area have been mapped (see figure 3-11) and include vasey sagebrush, silver sagebrush, and wetlands. Wetlands are discussed separately below.

There are also areas within the basin that have been disturbed previously by diverting water to Cottonwood Canyon through the existing Narrows Tunnel. In addition, there are those disturbed areas associated with SR-264 that cross the north end of the basin.

The areas that are disturbed during project construction have a high probability of being infested by noxious weed species. People using the area may spread the weeds by carrying the seeds on their person or on their vehicles. Seeds will get into the water and be spread downstream in both Gooseberry Creek and Cottonwood Creek. Control of noxious weeds as part of the Narrows Project would be the responsibility of SWCD.

Areas along the foothills of the west side of the Wasatch Plateau would be dissected with the diversion pipelines. Plant communities such as big sagebrush, (*Artemisia tridentata var. tridentata*), gamble oak (*Quercus gambelii*), grasslands, and mountain brush communities along with their associated wildlife species would be disturbed by the conveyance pipelines. These disturbances,

however, would be only temporary because the pipelines would be buried. Revegetation that reflects the existing plant community would be accomplished with a mixture of grasses, forbs, and shrubs. A total of 30 acres along a 17-mile-long alignment would be disturbed by the pipeline construction.

The reservoir basin was identified to receive the most significant impact by the proposed project. For this reason, the reservoir basin was studied in greater detail than the other areas associated with the project. The affected wetlands in this area occur in a dendritic pattern in the riparian zones along small drainages. As shown in table 3-26, plant communities that would be highly impacted by reservoir inundation include vasey sagebrush, silver sagebrush, and wetlands. All vegetation in the 604 acres listed in the table would be inundated by the reservoir.

## S3.14 WETLAND RESOURCES

The wetland community lies near the bottom of the basin and comprises 17% of the basin. The wetlands affected by the project are not unique to the area, consisting of wetland plant communities common to high elevation mountain areas. Cattle and sheep were introduced into the area in the 1800s and, subsequently, overgrazed the vegetation to the extent that rangeland restoration was necessary. In 1908, the USDA Forest Service established a controlled grazing plan for rangelands on the Manti-La Sal National Forest. Cattle and sheep grazing are still allowed in this area under USDA Forest Service control.

Within the proposed reservoir basin, water collects and forms meadows, wetlands, and, ultimately, small creeks that converge to Gooseberry Creek. Wetland communities are composed of wet meadows, riparian sedge, and willow thickets. The wet meadows are formed in topographic depressions located adjacent to some of the streamside vegetation and on higher ridges where seeps occur. They consist of plant species such as rushes (*Juncus* spp.), sedges (*Carex* spp.), and various hydric grasses, including tufted hairgrass (*Deschampsia caespitosa*). Similar in species and composition are the riparian sedge communities, which occur in a dendritic pattern along small drainages. They also consist of various rushes, sedges, and grass species, which form narrow bands (usually 3–6 feet wide) of streamside vegetation common to the area. Less common in the reservoir basin are willow thickets, occurring primarily in the upper reaches of the proposed inundation level, usually along stream channels in the basin and along Gooseberry Creek and in Cottonwood Creek. Willow species include Drummond's willow (*Salix drummondiana*), Booth willow (S. *boothii)*, and Wolf willow (*S. wolfii*).

The proposed Narrows Reservoir would inundate 89 acres of wetlands.

Hydrologic and hydraulic studies were conducted to determine the potential impacts to the riparian and wetlands vegetation of Gooseberry Creek resulting from decreased flows. Flow measurements conducted by the Utah Division of Water Rights indicate that the stream is a "gaining stream." This means that the stream flow increases as it moves downstream because the stream is being fed by the adjacent ground water aquifer. Because the stream is serving as a drain for the ground water system, an increase or decrease in stream water level would result in a corresponding increase or decrease in the elevation of the ground water table adjacent to the stream.

Water surface profile studies were conducted to determine the depth of flow in Gooseberry Creek between the Narrows damsite and Lower Gooseberry Reservoir. The studies indicated that, with the reduced flows

proposed by the Proposed Action and with the existing stream cross section, the depth of flow would decrease by 6–11 inches under worst case conditions. However, the project plan includes proposed modifications to this portion of the Gooseberry Creek channel. These modifications include narrowing the channel to maintain the depth of flow. In designing the stream channel modifications, the intent would be to create a stream channel that is more naturally suited to the new flow regime and that will have the same depth of flow as under baseline conditions. Therefore, the depth of ground water adjacent to the stream would not decrease, nor would there be any adverse effects on riparian and wetland vegetation adjacent to the stream. If anything, it is entirely possible that the wetland communities would be enlarged as a result of the project impacts; the current outer bounds of those communities likely would be unchanged as a result of the shallow ground water flowing toward the stream, but the wetlands likely would be increased precisely to the degree that the stream channel itself (or at least, the open water surface of the stream) narrows.

The process of narrowing the stream, as described in the FEIS, is planned so that the configuration of the narrowed streambanks would conform to that of the original streambank with respect to slope, materials, material size, and frequency as well as the water depth. The only change would be in the width of the channel and available open water surface. The result is that the same opportunity for overbank flows and wetted perimeter would exist as in the natural configuration. The gaining nature of the stream in this reach means that ground water is flowing toward and into the stream channel and that the stream does not provide the primary supply for the riparian community. The "wetted perimeter," therefore, should continue to be supplied from this source; and the stream will continue to gain as it flows. Bank saturation will not be affected here, as it would on many streams, because the direction of the ground water flows into the stream rather than away from it. While overbank flows may be reduced in frequency, such flows, for this same reason, also are not critical to the bank saturation that supports the riparian community.

About 160 square feet (0.004 acre) of wetlands adjacent to Cottonwood Creek would be impacted by constructing the discharge structure at the end of the Upper Cottonwood Creek Pipeline. The other proposed pipelines would not affect wetlands.

Wetland mitigation measures are included in the project alternatives to compensate for impacts to wetlands. The wetland mitigation measures would provide similar wildlife habitat values for those potentially lost due to the proposed inundation of the reservoir should the project be built.

## S3.15 Recreation and Visual Resources

### S3.15.1 Recreation Resources

According to the Utah Division of Parks and Recreation's *2009 State Comprehensive Recreation Plan*, the most popular outdoor individual recreational activity in Utah is walking for pleasure or exercise, followed by picnicking. The third most popular activity in most districts was swimming, though camping was the third in the six-county and southeastern planning districts. As with other major reservoirs along the Wasatch Front, Lower Gooseberry Reservoir, Beaver Dam Reservoir, and Fairview Lakes are heavily fished and overcrowded. Boating also ranks as a popular outdoor recreation activity in Utah.

High priority needs for new facilities are mostly new parks, new facilities at existing

parks, new ballfields, new motorized trails, and facilities.

Beaver Dam is a heavily used day-use area for anglers near the proposed project, and there are several developed USDA Forest Service campground facilities in close proximity to the project area. The Lower Gooseberry Reservoir (16 units), Gooseberry (10 units), Flat Canyon (13 units), and Lake Campground (51 units) are all fee areas, with a 92-day season of use from June 15–September 15. Water, sanitation facilities, tables, and fire grills are provided. Also in the area is Boulger Reservoir, a nondeveloped, dispersed camping area equipped with vault toilet facilities. These campgrounds (with the exception of Boulger) are typically full on weekends and one-third full on weekdays throughout their season of use.

The proposed reservoir area is known as a very popular location for snowmobile enthusiasts. The USDA Forest Service and UDOT maintain unloading, parking, and sanitation facilities along SR-31, immediately west of the proposed reservoir area, from which snowmobiles embark for travel along groomed trails following Skyline Drive and SR-31, as well as in the proposed reservoir area itself.

Whitewater boating is limited mostly to a relatively short season when flows are peaking, coinciding with the high flows from the White River, when the gates at Scofield Reservoir are closed. In wet years, spills from Scofield may contribute to the peak. When Scofield releases again are started up to supply irrigation demands downstream, the level of boating falls off significantly. The segment of the river between Scofield Reservoir and the picnic area above Price Canyon Dam (approximately 15 river miles) contains Class I–III rapids. The segment of the river between the picnic area above Price Canyon to Castle Gate (approximately 8.5 river miles) contains Class III–V rapids. This segment of the river is more challenging and requires skill and careful maneuvering to avoid the hazards of the narrow canyon. The segment of the river between Woodside to the confluence with Green River receives the greatest use due to the flow regime and the wilderness setting of the river segment. This segment of the river also contains Class III–V rapids.

Under the Proposed Action Alternative, recreation facilities, including a 24-unit campground, boat ramp, boat ramp parking area for 26 vehicles with trailers, 14 picnic sites, and a corresponding number of restroom facilities, would be provided at the proposed Narrows Reservoir. The recreation facilities would draw heavy use from not only Sanpete, Carbon, and Emery Counties but also from the Provo/Orem and metropolitan Salt Lake City areas. The proposed Narrows Project would help meet the demand for additional boating facilities in the area. In addition, it is expected that the reservoir would develop into an excellent flat-water fishery. A conservation pool would be provided to ensure successful overwintering of fish.

The proposed Narrows Reservoir would increase the State and regional inventory for fishing, boating, and water play. At the top of the active capacity water level for the Proposed Action, the proposed project's facilities are expected to attract a total of 46,930.8 additional recreation days per year of total developed recreation use. These use rates are based on use rates of Scofield, Huntington North, Millsite, Piute, and Otter Creek Reservoirs. Construction of the proposed Narrows Project and its associated recreation facilities would cause the loss of 237 acres of "Roaded Natural" dispersed recreation on Reclamation withdrawn lands and 466 acres on private lands. It is estimated that these 703 acres would provide

approximately 910 visitor days at 1980 levels of use and would provide about 2,670 visitor days of use in 2030. This reduction in dispersed use would be offset by the new facilities that would act as an attraction to local communities and individuals from the Wasatch Front who already contribute above 60% of the use on the Manti-La Sal National Forest. It is anticipated that the 46,930.8 recreation days of newly developed recreation use would be paralleled by an equal amount of dispersed recreation in the reservoir vicinity within the first 5 years of operation. This growth in recreation use would be a direct effect of the project and would require more intensive management in the area surrounding it (approximately, the area 8–10 miles in each direction).

At times when this newly developed recreation site and others in the area are at capacity (most of the summer season and particularly holiday weekends), users would move into nearby nondeveloped or dispersed areas. Some reservoir users actually would prefer dispersed sites regardless of developed site availability, and others would use dispersed sites to avoid associated fees.

The amount of dispersed use within 8–10 miles of the proposed reservoir is already at a level considered to be crowded during holidays and big game hunting seasons. The additional attraction of the new flat-water fishery in this area is expected to increase dispersed use to a point that the USDA Forest Service would need to place restrictions on areas available for this type of use. Such restrictions may include special measures for sensitive areas such as wetlands. In addition to increased resource protection and rehabilitation costs, conflicts among such activities as ice fishing and snowmobile use, hiking, and all terrain vehicle (ATV) users could be expected.

Along with increased, dispersed use in the area, nearby developed recreation facilities would be impacted. Gooseberry Campground and the Lower Gooseberry Reservoir units are immediately adjacent to the proposed reservoir, as is the Scenic Byway and snowmobile parking area. Skyline Drive, Flat Canyon Campground, and the limited facilities at Beaver Dam and Boulger Reservoirs are also within reasonably close proximity.

Implementing the Proposed Action would cause Scofield Reservoir to operate at a slightly lower level, thus reducing the surface area. Based on current recreation use at varying water levels, it is anticipated that there would be no impact to the recreation visits annually. Reclamation data is referenced in table 3-27. Based on use rates obtained in 2005 and 2007 creel surveys by UDWR, there would be a loss of 3,239 angler days of fisherman use. The aquatic mitigation measures of restoring year-round flows in two small tributaries to Gooseberry Creek and maintaining Fairview Lakes at a higher elevation during the prime summer recreational season also would provide angler benefits to the area.

Under the Proposed Action, more frequent fishkills and accelerated eutrophication also could degrade the park. However, water quality mitigation has been provided. Whereas the total inventory of water-based recreation may be increased, some of it would be offset by a downgraded State park at Scofield. The higher elevation of the proposed Narrows Reservoir would have a shorter season of use at an elevation of more than 8,600 feet than would the Scofield Reservoir at about 7,600 feet. Greater snow cover would probably occur at elevation 8,600 feet, causing less access because of deep snow and later snowmelt.

Depending on the type of hydrologic year, water levels in Narrows Reservoir would fluctuate between 25–75% of the full pool area during the recreation period—25% on

average and up to 75% in an extended drought cycle. Recreation action may be affected, particularly for those using the boat dock at maximum drawdown.

### S3.15.2 Visual Resources

The project features would be located within the Manti-La Sal National Forest on the Wasatch Plateau. The dam and diversion works would be located in the Gooseberry Valley, a tributary to the Price River, at about 9,000 feet elevation.

The characteristic landscape is consistent with typical high elevation mountain areas. The topography on top of this plateau is rolling and contains shallow basins covered with sage/grass communities bordered by spruce/fir, interspersed with aspen.

The Narrows damsite is within 2 miles of the intersection of two State highways, SR-31 and SR-264. Both highways have been designated as National and State Scenic Byways. SR-31 connects Fairview in the Sanpete Valley with Huntington in Emery County. SR-264 connects Scofield with SR-31 at Skyline Drive. These are major commuter routes for miners from the Sanpete Valley working in the coal mines on the east side of the Wasatch Plateau. In addition to commuting and recreation traffic, SR-31 serves as a route for hauling livestock from the Sanpete Valley to summer ranges.

It should be emphasized that scenery is an important natural resource and recreational element in this part of the forest. It is primarily through the visual sense that most visitors perceive the forest and its interrelated components. There is additional visual sensitivity here due to the adjacent Scenic Byway, which serves as a forest gateway/viewing corridor for many recreationists.

Under the Proposed Action, temporary and permanent landscape disturbances would be apparent from the placement of project features such as the re-routing of SR-264 and construction of the Narrows Dam structure. These more permanent features would be acceptable in this area of partial retention, especially in the long term. The dam would be within the setting of other dams in the area, and the rerouted portion of the Scenic Byway would serve as a viewing corridor and not a dominant element. Maintaining views within the parameters of partial retention would be contingent upon successful restoration/revegetation of the old highway alignment and any scarred areas associated with the dam. Care would need to be taken in developing any associated recreation facilities to ensure their design is subordinate to the surrounding landscape.

The Narrows Reservoir would be the most noticeable feature. The reservoir would have a surface area of 604 acres when full. However, during the recreation season, the surface area would average 454 acres. A body of water is generally considered to be aesthetically pleasing. However, as the reservoir is drawn down, exposed mud flats around the more shallow parts of the reservoir may be visually detractive but should remain naturally appearing as they follow the natural line of the reservoir's shore. Although viewed from the Scenic Byway and the reservoir itself, these mud flats primarily would be located on private lands that have no Visual Quality Objective designation. However, it is anticipated that these areas would become more naturally appearing over time; and the additional variety provided by the new water body would well offset any negative effect. In the short term, it is anticipated that the visual impact of exposed mud flat or shoreline would be negligible due to steeper topography and the duration and angle of view.

The aquatic mitigation measures of restoring year-round flows in two small tributaries to Gooseberry Creek and maintaining Fairview Lakes at a higher elevation during the prime summer recreational season also would provide aesthetic benefits to the area.

During project construction, increased human activity, heavy machinery, and surface excavation would temporarily detract from the scenery. Such detractions would be visible in localized areas where construction would occur. Minor disruption of traffic on SR-264 would be expected since the existing road would not be inundated until dam construction was completed and the relocated road is serviceable. Temporary disruption on SR-31 is expected.

## S3.16 CULTURAL RESOURCES

Cultural resources are defined as places, natural features, structures, buildings, landscapes, districts, and objects that are significant in history, architecture, archeology, engineering, community, or culture. Cultural resources are protected by a number of statutes, regulations, and policies that must be taken into consideration during the NEPA process. Of particular importance is section 106 of the National Historic Preservation Act (NHPA), which mandates that Federal agencies take into account the potential effects of a proposed Federal undertaking (the Proposed Action Alternative) on historic properties and afford the Advisory Council on Historic Preservation the opportunity to comment. In compliance with the NHPA, historic properties are defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the *National Register of Historic Places*.

The affected environment for cultural resources corresponds to the APE as defined in the regulations implementing Section 106 of the NHPA (36 Code of Federal Regulations [CFR] Part 800).

> "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." [36 CFR 800.16(d)]

The APE for the Proposed Action includes the areas impacted by construction activities associated with the construction of the dam and the land areas eventually inundated by the reservoir pool area. Also included would be any disturbed areas associated with the construction of a proposed pipeline to Cottonwood Creek as well as additional pipelines to deliver water to existing water distribution systems. Finally, impacts from the proposed rehabilitation of an existing tunnel to Cottonwood Creek, the development of recreation facilities, staging areas, access roads, borrow areas, and any other ancillary facilities linked to the Proposed Action would be included in the APE.

Under the Proposed Action Alternative, should the project be built, then the responsible Federal agency would have to work with the SWCD and other consulting parties to comply with the procedures outlined at 36 CFR 800. The regulatory requirements would be as follows:

- Determine whether the project constitutes a Federal undertaking.
- Identify the State Historic Preservation Officer and other consulting parties, including Indian tribes.
- Define the APE.
- Identify any historic properties within the APE.
- Apply the criteria of adverse effect to any historic properties.

- Assusming adverse effects, resolve adverse effects to historic properties as a result of the Federal undertaking per 36 CFR 800.6.

Based on the three sites (1,514 acres) inventoried, there is a low density of sites in the APE, and historic properties eligible to the *National Register of Historic Places* are expected to be few in number. Furthermore, consultation with Indian tribes that might attach religious or cultural significance to these sites or that might have sacred sites (as defined in Executive Order 13007) in this area indicates that such sites are not present.

Reclamation and the other consulting parties could either enter into a programmatic agreement to stipulate how these or alternative procedures would be carried out for the undertaking, or the parties could elect to follow the regulatory process at 36 CFR 800 and enter into a memorandum of agreement to resolve effects.

## S3.17 Economic and Social Resources

Sanpete and Carbon Counties are considered the affected environment for this analysis.

In 2009,[5] population in Carbon County was 19,989 and Sanpete County was 25,946 (i.e., the total county region contained 45,935 persons.) From 1990–2009, Carbon County has the smallest population change, (-0.8%), while Sanpete had an increase of 58.9%. Ethnically, both counties are unusual by United States standards with 91.1% of Carbon County identifying themselves as white and 92.4% of Sanpete County; the median family income in Carbon County was $40,900 in the year 2000, while Sanpete was $37,796.[6] In 2000, Carbon County has 13.4% of its population below the poverty threshold, while Sanpete has a larger share of individuals living below the poverty threshold at 15.9%. In 2000, the United States percentage was 12.4.

For both counties combined, 49.6% of the land is owned by the Federal Government. This high percentage of Federal land is important to socioeconomic analysis because these lands play a role in local employment by providing for commodity extraction, as well as opportunities for travel and tourism. In 2009, mining accounted for 13.8% of the jobs in Carbon County and 0.2% in Sanpete County; agriculture accounted for 2.3% of the jobs in Carbon County and 9.1% in Sanpete. The travel and tourism industry accounted for 13.4% of the jobs in Carbon County and 11.4% in Sanpete. In 1998, travel and tourism accounted for 15.99% of the total employment, and in 2009, 12.63%.

From 1970–2009, farm employment in both counties shrank from 1,641 to 1,332 jobs, an 18.8% decrease.[7] During this same period, nonfarm employment grew by 144.7%. By farms, we include all forms of agricultural production, including livestock operations. In 2007, Carbon County had 294 farms with 215,557 acres devoted to agriculture; while Sanpete had 879 farms with 311,551 acres in agriculture. Some 22.8% of the land area in Carbon County was used for farms and 30.7% in Carbon County.[8] Table 3-31 shows that both counties have the greatest amount of land devoted to raising beef cattle.

[5] U.S. Department of Commerce, 2011. Bureau of Economic Analysis, Regional Economic Information System.

[6] U.S. Department of Commerce, 2011. Census Bureau, American Community Survey Office.

[7] U.S. Department of Commerce, 2011. Bureau of Economic Analysis, Regional Economic Information System, Tables CA25 and CA25N.

[8] U.S. Department of Agriculture, 2009, National Agricultural Statistics Service, Census of Agriculture, table 8.

Under existing conditions in Sanpete County, two crops of alfalfa are harvested each year; and in some years (less than 25% of the time) when weather conditions are favorable, a small third crop is harvested. One crop of meadow hay normally is harvested, and the aftermath is used as late summer and fall pasture. Small grains are used as rotation crops for hay and pasture. Small grains also sometimes are used as a "nurse" or companion crop for alfalfa. The most common small grain crop is barley. Corn silage, which makes up less than 1% of the irrigated area, is raised primarily by dairymen and livestock feeding operations. Present and projected project crop distribution and yields in Sanpete County are summarized in table 3-32.

## S3.17.1 Methodology

There are two main methods of analysis for the economics of the Narrows Project. The first method is the modeling of regional economic effects; the second is the application of six indicators by Reclamation's loan engineer who will make the decision to approve or deny the loan application from SWCD.

### S3.17.1.1 IMPLAN Modeling

The modeling package used in this study to assess the regional economic effects of construction of each alternative is IMpact Analysis for PLANning (IMPLAN). IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in an economic region.

IMPLAN data files are compiled for the study area from a variety of sources, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau. This analysis used 2004 IMPLAN data for Utah's Sanpete County, where most of the construction activity would occur for the regional impact analysis.

The expenditures associated with construction were placed into categories that represent different sectors of production in the economy. The expenditures that are made inside the study region were considered in the regional impact analysis. Expenditures made outside the study area were considered "leakages" and would have no impact on the local economy. Some construction items (specialized equipment and skilled labor) more likely are to be purchased outside the region and brought to the construction site because of their high cost and lack of availability in the region.

Because of the scale of the construction project, it was assumed that local suppliers and contractors would be able to supply only a portion of the necessary construction, equipment, supplies, and expertise. The regional impact analysis assumed that approximately 50% of the labor wages would be spent locally, and approximately 45% of the construction equipment and supplies would be purchased locally.

This analysis also assumed that the majority of the construction expenditures will be funded from sources outside the study area. Money from outside the region that is spent on goods and services within the region would contribute to regional economic impacts, while money that originates from within the study region is much less likely to generate regional economic impacts. Spending from sources within the region represents a redistribution of income and output, resulting in a negligible increase in economic activity.

For the purpose of this study, the construction costs allocated to labor and construction materials spent in the region were used to measure the overall regional impacts. These overall impacts would be spread over the

construction period and would vary year by year proportionate to actual expenditures.

#### S3.17.1.2 Indicators for the Loan Application

Reclamation has not had an active small loan program since the 1990s. However, as mentioned previously, the Narrows Project was "grandfathered in" with the understanding that the factors that would be used to analyze the loan are those in effect in 1991. At that time, the Credit Reform Act of 1990 had been passed by Congress; this, coupled with the Office of Management and Budget's Circular A-11, modified how loans were to be made under the SRPA. In accordance with the Credit Reform Act and OMB requirements, Reclamation was directed to compute loan risks tied to computing loan subsidy and to adjust cash inflows from scheduled principal and interest payments for estimating defaults or deferrals. The six indicators that were established in 1991 to determine the overall loan risk and category assignment were:

- Debt/revenue ratio
- Debt/repayment ratio
- Interest/debt ratio
- Expenditures/cash and securities
- Quality of investments
- Bond rating (Moody's)

For the Narrows Project (and other SRPA loan applications), the results of these six financial indicators will be compared against national averages (standards) to determine the loan's overall classification assignment. In gleaning out this financing and accounting information, the SWCD's audit reports and balance sheets may need to be supplemented and revised to fully evaluate and measure the indicators. The audit report formation and content now required in all loan application reports generally will not cover the entities' bonding status or authority, and this additional information will need to be provided. It is believed that at least four of the six proposed indicators would need to be presented and weighted in determining an overall risk profile and assignment for each loan.

Under the Proposed Action, the number of jobs created in Sanpete and Carbon Counties during construction of the Narrows Project would not be significant based on a regional impact analysis conducted for this study's action alternatives. At the regional level, the project would cause positive economic output to the study area. Potentially, the most significant short-term impact would occur from construction activities.

It was estimated that the regional impacts on employment, regional output, and income would be less than 1% of the study area's base employment, output, and income (see table 3-33).

The regional impacts from the construction costs for all the alternatives would be similar in that the impacts would be less than 1% of the regional employment, output, and income

These regional construction impacts would be lost after construction was completed. A small amount of regional impacts related to O&M activities would be expected but would not significantly impact the overall regional economy in the study area. The additional water amount provided by each of the alternatives would support the existing community lifestyles and social structure in the study area.

## S3.18 LAND RESOURCES

The proposed non-Federal Narrows Project is located within the exterior boundaries of the Manti-La Sal National Forest. The proposed

Federal action is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow the SWCD to use 304.5 acres of Reclamation withdrawn land. SWCD has acquired 366 acres of private lands for project uses from owners by perpetual easement or in fee. SWCD would need to purchase 1,340 additional acres of private and State School Trust lands for project needs (table 2-4). It is important to note that there may be no SRPA loan, but construction may proceed on Reclamation land with other sources of funding.

While there are some private in-holdings, the majority of the lands located within the Manti-La Sal National Forest boundary is federally owned and is administered by the USDA Forest Service pursuant to specific authorities granted by Congress to the Secretary of Agriculture and pursuant to the public land laws.

Lands within forest reserves may, however, be withdrawn and used for irrigation works constructed under authority of Section 3 of the Reclamation Act of 1902 (32 Statute 388). Therefore, by Secretarial Order dated April 1, 1941, Reclamation withdrew certain forest lands from public entry under the first form of withdrawal (as provided in Section 3 of the 1902 Act). These lands were withdrawn for the Federal Gooseberry Project, which, as originally planned, was never constructed. However, a portion of the original project was constructed as the Scofield Project. The Narrows Project is presently proposed as a private project by SWCD. Their proposal is to use 304.5 acres of the 6,728 acres of the lands originally withdrawn by Reclamation for the Gooseberry Project.

The 1941 Reclamation withdrawal of lands within the Manti-La Sal National Forest created the potential for two Federal agencies—Reclamation and the USDA Forest Service—to have overlapping jurisdiction on the same lands. However, the authority of the Secretary of the Interior under the 1902 Act to withdraw and administer lands for Reclamation purposes is limited to the specific water projects provided for in that Act—that is, Reclamation projects.

At present, both Reclamation and the USDA Forest Service have administrative authority over the withdrawn lands—but each for activities related only to its own mission. Thus, Reclamation has jurisdiction over the withdrawn lands for uses associated with water resources, while the USDA Forest Service has jurisdiction over the withdrawn lands for uses related to their mission. If the non-Federal Narrows Project were constructed, the Reclamation withdrawal would be revoked for all but the 304.5 acres that would be licensed to SWCD under the authority of Section 10 of the 1939 Act for the proposed non-Federal Narrows water project.

Land ownership and use characteristics of Sanpete and Carbon Counties are summarized in tables 3-34 and 3-35, respectively. An inventory of prime and unique farmland (Public Law 95-87) did not reveal any prime or unique farmland in the project area, but as described under the Economic and Social Resources section, in 2007, Carbon County had 215,557 acres devoted to agriculture, while Sanpete had 311,551 acres

Lands approximately 3 miles east of the project area are under a Federal coal lease and currently are being mined. Additional mineable coal reserves are believed to exist beneath lands east of the East Gooseberry Fault approximately 1 mile east of the project area. A nearby landowner with both land and mineral rights to the east of the proposed reservoir, between the proposed dam and the currently operating Skyline mine, expressed to Reclamation in April 2009 his intent to mine his coal, but exact plans and timing are unknown at this time. Lands immediately adjacent to the project area (within the

Gooseberry Graben) are not believed to have mineable coal reserves due to an offset of several hundred feet within the Gooseberry Graben area.

Agricultural land use within the project area is based on the livestock economy of the area—principally, cattle and sheep operations and a number of Grade A dairies. Other land uses include the turkey industry, large garden spots, potatoes, raspberries, and conifer or deciduous trees.

The majority of the land area that would be inundated by the reservoir is privately owned; the dam, however, would be on Federal land. Some of the private land near the proposed dam and reservoir within the national forest boundary has been subdivided for summer homes and recreation development. Such development must comply with the zoning and building codes of the Sanpete County Commission and the sanitation requirements of the Utah Department of Environmental Quality. The area adjacent to the proposed Narrows Reservoir is county-owned and is zoned as Forest Watershed 1–10 (one dwelling per 10 acres). The primary areas now under development include the area approximately 2 miles east of Lower Gooseberry Reservoir and the area on the north side of privately owned Fairview Lakes.

The Fairview Lakes development contains approximately 150–200 memberships in the privately owned Fairview Lakes Association. The memberships include the right to use a specific lot in the area north and east of Fairview Lakes and south of the project area to park a trailer or construct a cabin. This area has been rezoned, and the one dwelling per 10 acres development ratio does not apply to this area. As a result, it has been developed with lots every 1+ acre each. About 50 cabins have been constructed within the past 5 years. The cabins are used during the winter as well as the summer, since the general area is a popular cross-country skiing and snowmobiling area. Many of the other lots have one to three trailers parked on them for the summer season (June–September). The private landowners allow their members to use some of the area southwest of Fairview Lakes for recreation use.

Portions of three grazing allotments occur within the project area. They include Swen's Canyon allotment, the Gooseberry-Cottonwood allotment, and the Beaver Dams-Boulger allotment.

Additional allotments that may be impacted by the mitigation measures include the Fairview, Cabin Hollow, and Pondtown allotments.

Swen's Canyon allotment is located in two watershed drainages. That portion, which is located in the same drainage as the proposed Narrows Dam and Reservoir, consists of 583 acres, of which all is suitable for grazing land in fair range condition. Grazing capacity of that portion is about 115 animal unit months (AUMs).

The Beaver Dams-Boulger allotment is a combination of two allotments. Grazing use includes 1,200 head of sheep with a season of July 6–October 5. It is grazed with a rest rotation grazing system where part of the allotment is rested each year.

The Cottonwood-Gooseberry allotment is grazed by 900 head of sheep with a season of July 6–September 30 using a rest rotation grazing system. Suitable grazing land was determined during a range analysis conducted during 1976.

A summary of information concerning the three grazing allotments and four grazing permits is presented in table 3-36. Range conditions and grazing are discussed in the vegetation section of chapter 3.

### S3.18.1 Environmental Consequences

If an action alternative were selected and a non-Federal Narrows Project were constructed (see action alternatives below), the Reclamation withdrawal would be revoked for all but the 304.5 acres, which would be licensed to SWCD under the authority of Section 10 of the 1939 Act for the proposed non-Federal water project. Direct effects of this license on withdrawn lands within the area of the dam and reservoir are described in chapter 3 of the FEIS. Reclamation may license the 304.5 acres to SWCD regardless of SWCD's source of financing for the non-Federal water project. Consequently, these effects remain the same whether the construction of the dam is financed under a SRPA loan or some other mix of public and private financing.

Under the Proposed Action, major changes in land use in the area surrounding the dam and reservoir are not anticipated. Construction of summer homes outside of platted subdivisions might be accelerated but would be limited by zoning restrictions of one dwelling per 10 acres. Development of the Fairview Lakes complex would continue as previously planned although build-out may occur earlier. Narrows Reservoir, SR-264 and forest development roads relocation, the recreation area, and the conservation easements adjacent to the reservoir would reduce the available grazing area by 856 acres. This area is about 10% of the suitable grazing acreage in the area. The Proposed Action may result in the direct loss of 114 AUM grazing use (856 project acres per 1.5 acres per sheep month = 571 sheep months per 5 sheep months per AUM = 114 AUM); however, indirect loss of grazing (estimated to be about 1,014 acres) may occur on adjacent areas around the reservoir, between the highway and the reservoir, and around camping and residence areas. The total grazing impact is estimated to be 249 AUM (1,870 acres per 1.5 acres per sheep month = 1,247 sheep months per 5 sheep per AUM = 249 AUM). This impact of grazing includes both private and Federal lands. Restrictions on the number of sheep and cattle allowed and/or realignment of grazing allotments may be required due to implementing the Proposed Action.

As the recreation use increased and summer home development proceeded, there could be additional areas in the upper Gooseberry drainage that would not be available for livestock grazing due to anticipated or existing livestock-people conflicts. For every 7 to 10 acres of additional land that cannot be grazed due to conflicts with traffic and/or people, there may be a loss of 1 AUM (5 sheep months) grazing use. Grazing permits and allotment boundaries may need to be adjusted. Land use in the *Manti-La Sal National Forest Land and Resource Management Plan* would change to reflect project implementation.

No reduction of acres of mineable coal reserves is anticipated under the Proposed Action

## S3.19 PUBLIC HEALTH AND SAFETY

Two public health and safety issues were raised related to development of the Narrows Project. The first issue deals with increases in recreational traffic, while the second is the public's concern with drinking water quality from Scofield Reservoir. The latter issue is covered in detail in the Water Quality section, but a summary of effects by alternatives is included here.

As to the traffic issue, the area adjacent to the proposed Narrows Reservoir is served by two State highways, SR-31 and SR-264. These two-lane roads are narrow and winding. Both

highways are maintained for year-round use by the Utah Department of Transportation. Average daily traffic (ADT) numbers for these roads are listed in table 3-37.

ADT values shown in the table are based on UDOT traffic counts taken in 2000.

As shown in table 3-37, ADT on SR-31 would increase by 252 or 16% under the Proposed Action. ADT on SR-264 would increase by 31%. However, even with these increases, both roads still would be well within their design capacity. To increase safety, additional turning lanes with adequate sight distance would be provided at recreation area entrances and exits.

With respect to public health and drinking water quality, as mentioned under Water Quality, in 1992 and subsequently, the State of Utah investigated alleged correlations between drought, gastrointestinal illnesses, and chlorination at the city of Price water treatment plant. No correlations were found. Therefore, due to the lack of correlation, the reduction in water availability in Scofield Reservoir should not lead to any public health effects in Price or homes served by the local water treatment plant. Public health should be unaffected by the proposal.

## S3.20 Indian Trust Assets

The United States has a trust responsibility to protect and maintain rights reserved by, or granted to, American Indian tribes or individuals by various treaties, statutes, and Executive orders. These rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires that agencies, such as Reclamation, take actions reasonably necessary to protect these trust assets.

Reclamation policy is to reasonably protect ITAs from adverse impacts of its programs and activities. ITAs are property interests held in trust by the United States for the benefit of Indian tribes or individuals.

No Indian trust assets have been identified in or near the affected area; therefore, implementation of the Proposed Action would have no foreseeable negative impacts on ITAs.

## S3.21 Environmental Justice

On February 11, 1994, the President issued Executive Order 12898 on Environmental Justice in Minority Populations and Low Income Populations. As a result of that Executive order, each Federal agency is required to analyze the environmental effects, including human health, economic, and social effects, of Federal actions, including effects on minority communities and low-income communities.

In the project area, there are no minority or low-income populations; and, therefore, there are no environmental justice effects.

## S3.22 Related Laws, Rules, Regulations, and Executive Orders

The Council of Environmental Quality (CEQ) regulations (40 CFR 1500.2 and 1502.25) encourage related environmental laws, rules, regulations, and Executive orders to be integrated concurrently to the fullest extent possible in an environmental impact statement (EIS).

The following environmental laws, rules, regulations, and Executive orders have been considered during the preparation of the FEIS. It has been determined that the Narrows Project would have no adverse effect upon them.

- Executive Order 11988 (Flood Plain Management).
- Wild and Scenic Rivers Act, Public Law 90-542. In 2007, the USDA Forest Service and Bureau of Land Management evaluated thousands of river miles for potential inclusion in the National Wild and Scenic Rivers System. In determining suitability, a key question was, does the river segment have Outstanding Remarkable Values. The USDA Forest Service conducted an environmental impact statement to evaluate the suitability of 86 eligible river segments (840 miles) including 21 miles of Fish Creek and Gooseberry Creek. The Record of Decision, signed November 2008, determined that Fish Creek and Gooseberry Creek were not suitable to be designated by Congress as components of the National Wild and Scenic Rivers System. All the nonsuitable river segments are no longer afforded agency interim protection under the Wild and Scenic Rivers Act and continue to be managed under the direction of the respective agencies.

## S3.23 CUMULATIVE IMPACTS

### S3.23.1 Cumulative Resource Issues

Cumulative impacts are the effects on the environment that result from the impact of implementing the Proposed Action in combination with other actions. The CEQ regulations for implementing NEPA define cumulative impacts as: "…the impact on the environment, which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1500-1508)

### S3.23.2 Cumulative Impact Area and Reasonably Foreseeable Actions

After a careful review of the resources or components of the environment analyzed in chapter 3 of the FEIS, Sanpete and Carbon Counties are considered the affected environment for this cumulative impact analysis. The cumulative impacts area is Sanpete and Carbon Counties or within the watershed potentially affected by the Narrows Project.

Following U.S. Department of the Interior regulations at 43 CFR 46.30, reasonably foreseeable future actions include all Federal and non-Federal activities not yet undertaken, but sufficiently likely to occur, within the cumulative impact area. These activities include activities for which there are existing decisions, funding, or proposals identified by bureaus or local governments. Plans and environmental decisions of the Bureau of Land Management's (BLM's) Richfield Field Office, the Price Field Office, and the Manti-LaSal National Forest were reviewed to identify any existing decisions, funded projects, or proposals that should be analyzed for their cumulative impacts. For the BLM, all documents posted to their online environmental notification bulletin board were checked to see if actions approved in findings of no significant impact or records of decision would add cumulative impacts to the resources in chapter 3. No decisions were found that would affect any of the resources affected by the Narrows Project.

For the USDA Forest Service, the Manti-LaSal Forest Plan and related social and economic assessment were the main

reasonably foreseeable actions that are considered here. The Narrows Project was planned in conformance with the Forest Plan. Multiple environmental assessments of the USDA Forest Service were checked, but no specific action was identified that meets the definition of a reasonably foreseeable future action for the Narrows Project.

Nor were reasonably foreseeable actions identified by Sanpete or Carbon Counties. Thus, there are no single or specific actions to be analyzed for cumulative effects. Instead, the direct and indirect impacts of the Narrows Project that might contribute to a cumulative impact on identified resources in chapter 3 are summarized below. The action alternatives are grouped for this analysis.

Resource issues have been affected by past Reclamation developments and would be affected by the proposed project; thus, they have the potential to contribute to cumulative (additive) impacts within Sanpete and Carbon Counties. These issues involve stream depletions that can impact fisheries, endangered native fishes, and change salt loading within the Colorado River. These issues are treated below under the headings of water resources, use, and quality; water rights; paleontological resources; fisheries; wildlife; threatened and endangered species; wetlands; recreation and visual; and cultural resources.

#### S3.23.2.1 Water Resources

As described in chapter 3, a long-term diversion of water by the Narrows Project to the Cottonwood Creek and San Pitch River watersheds would permanently reduce flows downstream from the project. The lowered reservoir storage would increase the potential of reaching dead storage in Scofield Reservoir by 20%. Decreased reservoir storage in Scofield Reservoir also would result in reduced spills from the reservoir, which would, in turn, impact the Price, Green, and, ultimately, the Colorado Rivers.

Approximately 5 miles of small streams or creeks, including 1 mile of Upper Gooseberry Creek, would be inundated by Narrows Reservoir. Middle Gooseberry Creek, between the proposed Narrows Reservoir and Lower Gooseberry Reservoir, would see a 74% reduction in annual flows; but the minimum flow requirements from the Narrows Project would eliminate historic periods of dry stream channels. Mitigation measures could include 300 acre-feet of water to be managed for water quality and aquatic biological resources.

Another water resources effect would be that a transbasin diversion through the Narrows Tunnel to Cottonwood Creek would result in lower peak flows during the spring runoff period, offset by higher flows during the irrigation season.

#### S3.23.2.2 Water Quality

Carbon County has identified water quality in the Price River and watershed as a major concern, largely because the county's ground water is unusable due to high salinity. The county has formed a Carbon Water Committee that has and will continue to investigate uses to which the Price River are applied. County planning will continue to attempt to provide a land use and water quality scheme that is viable and in conformance with USDA Forest Service and BLM plans.

If one of the action alternatives is selected, timing of flows, temperature, turbidity, and ecological composition of the rivers and streams would be affected; and water quality downstream from the project would be more sensitive to future activities that degrade or improve water quality. These include phosphorus load increases and reduction

efforts in the Scofield Reservoir drainage and salinity control efforts in the Price River watershed.

Proposed mitigation measures to reduce phosphorus loading in Scofield Reservoir as part of the Narrows Project may impact the ability to meet the target phosphorus load reduction through stream restoration identified in the Scofield Reservoir TMDL. Mitigation measures implemented as part of the Narrows Project may be the most cost effective, most easily implemented, and maintained. This may result in less effective load reduction measures available for implementation as part of the Scofield Reservoir TMDL. A great deal of uncertainty exists surrounding this potential impact though, as specific mitigation measures through stream restoration have not been identified for either the Scofield Reservoir TMDL or the Narrows Project. It is possible that measures are available to satisfy the reduction target of both efforts or that the mitigation from both efforts will not overlap. SWCD is required to mitigate impacts to water quality in Scofield Reservoir and to ensure that it does not deteriorate due to the Narrows Project. Mitigation measures are designed to maintain Scofield Reservoir at its existing condition.

Under a water quality protection program, water quality at the proposed Narrows Reservoir would be protected by meeting State and Federal requirements and establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.

#### S3.23.2.3 Water Rights

If the Narrows Project is built, Water Right Nos. 91-130, 91-131, and 91-132 would be developed and would increase the water depletions in the Gooseberry Creek basin up to 5,400 acre-feet per year. The Narrows water right represents about 6.6% of the average annual yield of the Price River above the city of Price. Although these are valid water rights, their development would incrementally decrease the water available in the Gooseberry, Price, Green, and Colorado River systems. The 1948 Colorado River Compact gives Utah 23% of the Colorado River (and all tributaries) water allocated to the Upper Basin States, which is estimated at approximately 1.3 million acre-feet (maf) of depletion annually. Utah is currently depleting 1.0 maf per year of Colorado River water, and this project would bring Utah closer to using its entire allocation. Once Utah reaches full allocation, there would be a greater likelihood that some water rights would need to be curtailed to ensure that Utah does not exceed its allotment.

#### S3.23.2.4 Paleontological Resources

Under the No Action Alternative, the existing conditions in the APE would remain intact, and paleontological resources likely would not be impacted. No past, present, or reasonably foreseeable actions are expected to result in cumulative effects to fossil resources. Thus, there would be no cumulative effects to paleontological resources from the No Action Alternative.

Under the action alternatives, should paleontological resources located directly within or adjacent to the Narrows Reservoir pool area be present, the lowered reservoir pool could result in damage to or theft of fossil resources due to increased public visitation. This increased visitation, in the form of recreation and residential development, for example, has the potential to cause cumulative impacts to paleontological resources. Therefore, cumulative effects to cultural resources are likely under the action alternatives.

#### S3.23.2.5 Fisheries

Past and future water diversions and depletions have affected and will continue to affect the sport fishery and native species. The analysis in chapter 3 shows that the Narrows Project will have minor impacts on flows below Scofield Reservoir. Mitigation measures are designed to help reduce impacts.

#### S3.23.2.6 Wildlife

If one of the action alternatives is selected, and the reservoir is built, then there will be a future loss of vegetation and wildlife habitat; and the quality of the habitat could be degraded from development around the reservoir. This could increase forage competition among grazing animals. Habitats may be unavailable to wildlife because of human disturbance factors (e.g., traffic or noise during sensitive time periods such as winter, birthing, nesting, and early rearing of young). Impacts on wildlife could result if increased development and surface disturbance altered existing migration corridors where access to important habitat areas would be greatly reduced. Mitigative efforts have reduced these effects or they have improved habitat conditions for these species in various areas.

The additive effects of the Proposed Action, in conjunction with the past action have resulted in irreversible and irretrievable impacts to wildlife. Mitigation measures have been designed to mitigate these impacts to the extent possible.

Conservation species, such as the Columbia spotted frog, roundtail chub, bluehead sucker, flannelmouth sucker, as well as other sensitive species identified in the FEIS, have experienced cumulative effects from loss of habitat from development and construction projects over the years. These species rely on natural water systems for their habitat. The proposed project identifies reasonable actions to reduce or eliminate impacts to these species.

#### S3.23.2.7 Threatened, Endangered, Conservation, and Other Special Species

Under past and ongoing actions, the Colorado pikeminnow, bonytail, razorback sucker, and humpback chub are endangered, in the Colorado River Basin including the Green, Yampa, Gunnison, and San Juan, Rivers. These species evolved in the Colorado River and its larger tributaries under conditions of warm water, large seasonal flow fluctuations, heavy sediment loads, extreme turbulence, and a wide range of dissolved solids concentrations. These conditions have been altered by human activities, and all four species have experienced population declines. The Upper Colorado River Endangered Fish Recovery Program was established as the major offset for the impacts of historic and future water development projects in the basin.

To minimize the possible adverse effects of the Narrows Project on the Colorado pikeminnow, bonytail, humpback chub, and razorback sucker, SWCD would participate in the Recovery Program as described in the FEIS, which includes a one-time depletion fee payment.

#### S3.23.2.8 Wetlands and Riparian

The proposed Narrows Reservoir would permanently inundate approximately 89 acres of wetlands. Proposed modifications to portions of the Gooseberry Creek include narrowing the channel to maintain the depth of flow. Flows in the middle portion of Gooseberry Creek between the proposed dam and Lower Gooseberry Reservoir would decrease the average current flow by about 73.1%. The reduced magnitude and duration

of flood flows would have the potential to impact the riparian area along Gooseberry and Fish Creeks. The riparian vegetation communities of sedges, rushes, and hydric grasses found as bands and small pockets along the banks of the stream may be reduced in quantity and quality by the proposed action. Willow thickets along Gooseberry and Fish Creeks could be reduced in quantity and quality. This reduction of the quantity and quality of riparian and wetland systems is likely to continue. Implementation of recommended flows by the Utah Division of Wildlife Resources and the gaining stream status of Gooseberry Creek could result in positive changes for riparian and wetland vegetation.

#### S3.23.2.9 Recreation and Visual

##### *S3.23.2.9.1 Recreation*

As discussed in chapter 3, travel and tourism employment has decreased from 1998 to 2009 in Sanpete and Carbon Counties by 5.8%. Over the same time period, nontravel and tourism employment has grown from 8,299 to 10,298 jobs, a 24.1% increase. This trend is likely to continue into the future, although there could be some increase in visitor use due to the Narrows Project.

ATVs are popular within the project area for agricultural and recreational use. The Arisen Trail System, a joint effort of Federal, State, and local agencies and communities, is an extensive trail system south of the project area that links Federal- and State-managed public lands with communities. There are areas of intensive ATV use throughout the project area, particularly around some of the communities, where soils, vegetation, and scenic values are being affected. Should the project be implemented, dispersed recreational activity would not change. There would be some changes in recreational use; however, these are disclosed in section 3.15.

## S3.24 OTHER NEPA CONSIDERATIONS

### S3.24.1 Irreversible and Irretrievable Commitments of Resources

Renewable and nonrenewable resources would be irreversibly or irretrievably committed by construction and operation of the Narrows Project. Although it would be theoretically possible to reverse commitments of some of these resources, the Council on Environmental Quality has stated that ". . . construction and facility uses are basically irreversible since a large commitment of resources makes removal or nonuse thereafter unlikely." This section briefly describes these commitments for all alternatives, with the exception of the No Action Alternative. Under that plan, there would be no commitment of resources other than moneys already spent.

#### S3.24.1.1 Water Resources

The Narrows Project would commit up to 5,400 acre-feet of water from Upper Gooseberry Creek and its tributaries, which are located in the Price River drainage, to project purposes. Initially, about 4,900 acre-feet would be used for irrigation, and 500 acre-feet would be designated for municipal use in the northern Sanpete County area. As the need arises, the balance between M&I and irrigation water will change. As the demand for M&I use increases, M&I use will increase, and irrigation use will decrease. The conversion of water from irrigation to M&I use will occur in stages.

Under present Utah water law and the 1984 Compromise Agreement, commitments of water resources essentially would remain permanent, provided that they are beneficially used. Although the area's water resources

would not be irretrievably or irreversibly committed, use of the project water would be long term in nature.

#### S3.24.1.2 Fish, Wildlife, and Grazing Habitat

The inundation by the reservoir of about 1 mile of UDWR Class 3B-Unique stream fishery in Upper Gooseberry Creek and 4.3 miles of cutthroat trout spawning and rearing habitat in the Gooseberry Creek tributaries would be essentially irreversible.

The commitment of land in the reservoir pool for water storage and around the reservoir to recreation uses would be essentially irreversible, since to do otherwise could jeopardize the water quality of the reservoir as well as the proposed wildlife mitigation plan. Streamflow patterns resulting from project operation would be subject to change should water needs in service areas change, but current trends indicate that the proposed operational criteria would be long term and would constitute a basically irreversible commitment. The loss of grazing AUMs also would be considered an irreversible commitment of resources.

#### S3.24.1.3 Land

Narrows Reservoir and other project features (damsite, recreation facilities, and road relocations) would permanently alter use on about 786 acres of the 1,931 acres needed for the project. The land currently functions primarily as recreation, rangeland, and wildlife habitat. The remaining 1,145 acres for the project will, over time, be restored to original functions as rangeland and wildlife habitat. Geologic studies of the reservoir and damsite have not identified any critical mineral resources within the reservoir basin or damsite.

#### S3.24.1.4 Construction Materials

About 375,000 cubic yards of permeable and impermeable earth material, gravel, cobble, and riprap would be irretrievably committed to use in the dam embankments and associated features. Much smaller amounts of concrete aggregate would be used in the dam and project features. Imported cement and manufactured materials would be irretrievably committed to the project features. Fuels, explosives, and electrical power would be consumed during project construction.

#### S3.24.1.5 Aesthetics

Narrows Project would irreversibly alter the scenery of the feature sites by the building of structures, excavation of landscape, and inundation of the reservoir. The construction scars would be revegetated where practical; but the visual impact, which would be unattractive to some people, would be permanent.

### S3.24.2 Short-Term Uses and Long-Term Productivity

The CEQ regulations for implementing NEPA at 40 CFR 1502.16 require analysis of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity.

### S3.24.3 Action Alternatives

Short-term losses from the action alternatives, as described in sections 3.23 and 3.24.1, would include construction impacts such as increased noise, traffic delays, or detours. Air quality would be worse during construction. These temporary environmental impacts would be balanced through mitigation and avoidance as much as is reasonably possible.

Short-term benefits would include increased jobs from construction and revenue generated during construction.

Long-term losses from the action alternatives would include the permanent loss of approximately 1,145 acres of rangeland and wildlife habitat, displacement of wildlife and fish, loss of grazing habitat, reduction of water flows below the dam, visual impacts, possible loss of paleontological resources, and recreational impacts such as access inconveniences.

Long-term benefits would include that the reservoir would make it possible to store water from spring runoff for use during the drier summer months. This would allow local farmers the opportunity to have a longer, more productive growing season. The reservoir also would provide a habitat for sport fish and provide water for the nearby wildlife. Below the dam, a minimum flows requirement would provide year-round flows in Gooseberry Creek and Cottonwood Creek. These stream segments historically have been dewatered at times of the year. Although primarily intended as a measure to facilitate winter survival of fish, this requirement also would have some beneficial effects on the riparian and wetland areas adjacent to the creeks. Providing flows in summer months also would stimulate the growth of riparian and wetland vegetation.

### S3.24.4 No Action Alternative

This alternative would offer none of the benefits or have any of the losses listed above. It would not meet SWCD's proposal or need for additional water for irrigated agriculture.

## S4.0 CONSULTATION AND COORDINATION

This section details the consultation and coordination between Reclamation and other State, Federal, and local agencies; Native American tribes; and the public in preparation of the FEIS, the SDEIS, and the DEIS published in 1998, which the FEIS updates and supplements. Throughout the EIS process dating back to 1990, input has been actively solicited from a broad range of public constituencies as part of the ongoing public involvement process. Comments and involvement in the planning for and preparing of the Narrows Project generally were sought through two broad efforts: communication and consultation with a variety of Federal, State, and local agencies; Native American tribes; and interest groups and the formal FEIS scoping process and comment process, both of which invited input from the general public.

## S4.1 SUMMARY OF INTER-AGENCY COORDINATION 1996–2003

In 1996, Reclamation invited a number of State and Federal agencies to become cooperating agencies in preparation of the DEIS. The two agencies that agreed to become cooperating agencies for the EIS process, including the FEIS, are the USDA Forest Service and U.S. Army Corps of Engineers. In addition to these two agencies, the following agencies had representation on the interdisciplinary team led by Reclamation that prepared the DEIS published in 1998:

- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- Utah Division of Wildlife Resources

- Utah Division of Water Quality
- U.S. Department of the Interior, Office of the Solicitor
- Sanpete Water Conservancy District

Reclamation hosted periodic cooperating agency meetings and interdisciplinary team meetings throughout preparation of the 1998 DEIS and the SDEIS to ensure that all of the agencies were informed of, and involved in, the issues and analyses related to the FEIS.

## S4.2 PUBLIC INVOLVEMENT AND SCOPING

The scoping process for the SDEIS was conducted by Reclamation beginning in November 2003 to provide the general public, organizations, State and local governments, and affected Federal agencies an opportunity to identify issues and concerns they believe should be studied early in preparing the SDEIS. "Scoping" is the public involvement process required by the Council on Environmental Quality regulations to help Federal agencies determine issues and alternatives analyzed in the EIS. Results of the scoping meetings and comments received during the scoping process were used to establish the scope of the SDEIS and focus the environmental analysis on the important issues and concerns.

The original scoping process for the Narrows Project began with scoping meetings held at Fairview and Price, Utah, on October 3 and 4, 1990, respectively. Notice of the scoping meetings was given through a *Federal Register* Notice dated September 7, 1990, and through a news release dated September 24, 1990. In addition, 32 letters were sent to State and Federal agencies and environmental groups giving notice of the meetings. Three newspapers—the Salt Lake Tribune, the Mt. Pleasant Pyramid, and the Sun Advocate—published articles regarding the project and the upcoming scoping meetings. Concerned citizens were encouraged to attend the scoping meetings or express their concerns in writing.

After the 1995 Record of Decision was rescinded, a new DEIS was prepared, beginning in 1996, and was published in 1998. Comments were received on that DEIS (and public hearings were held to receive comments); those comments were analyzed and responded to, and the 1998 DEIS was revised based on input from those comments. Since a decision was made in 2003 to prepare this SDEIS in lieu of publishing a FEIS based on the 1998 DEIS, it should be noted that the SDEIS does capture revisions made earlier based on public comments and input.

After the decision was made to prepare the SDEIS, public meetings to inform the public and to share information were held in Price and Manti, Utah, in September 2003. On November 25, 2003, a *Federal Register* Notice was published to serve as an official notice that Reclamation intended to prepare a supplemental draft environmental impact statement for the Narrows Project. Public hearings were held again in Price and Manti, Utah, in April 2010 during a 63-day comment period ending June 2010. Reclamation received 693 comment documents, and formal responses to substantive comments were published in appendix H of the FEIS. Comments received in response to the *Federal Register* Notice also were taken into consideration, along with all prior public comments in preparing the FEIS.

Section 1.3 provides further information on the scoping process for the FEIS.

## S4.3 DOCUMENT AVAILABILITY

Those who were on the mailing list for the 1998 DEIS, or who asked to be

added to the mailing list in response to the SDEIS in 2010, were provided notification of document availability along with other environmental groups; Federal, State, and local government agencies; and other interested parties. Over 400 notifications of the FEIS have been mailed to interested agencies, organizations, and individuals. The FEIS is available online at www.usbr.gov/uc/envdocs/index.html.

CHAPTER 1

# Purpose of and Need for the Project

## 1.0 INTRODUCTION

This Narrows Project, Utah, final environmental impact statement (FEIS) updates information and analyses contained in the *Supplemental Draft Environmental Impact Statement, Narrows Project* (DES-09-55) published in March 2010 (SDEIS) and the *Draft Environmental Impact Statement, Narrows Project* (DES-98-10) published in March 1998 (1998 DEIS). This FEIS discloses the direct, indirect, and cumulative effects of the non-Federal Narrows Project as proposed by Sanpete Water Conservancy District (SWCD).

## 1.1 THE PROPOSED ACTION ALTERNATIVE

The SWCD has applied to the Bureau of Reclamation (Reclamation) for a Small Reclamation Projects Act (SRPA) loan to help finance construction of a private reservoir and related facilities. SWCD also has requested authorization to use federally administered withdrawn lands as the site for dam construction. Most of the reservoir basin would be located on adjacent, privately owned land. The proposed Federal action is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow the SWCD to use 304.5 acres of Reclamation withdrawn land. If SWCD obtains its requisite financing, either through the SRPA loan or from other private funding source(s), and if Reclamation approves the land use, a supplemental water supply may be developed for presently irrigated lands and municipal and industrial (M&I) water users in north Sanpete County. To develop this supplemental water supply, a dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel and a proposed pipeline to Cottonwood Creek; the existing tunnel would be rehabilitated. Pipelines would be constructed to deliver the water to existing water distribution systems. Recreation facilities would be developed, and a minimum pool for fish habitat would be provided. The resulting water storage and delivery system would be a non-Federal project owned and operated by SWCD.

Mitigation measures would be implemented to offset adverse impacts. Water conservation measures would be implemented independent of the Proposed Action. To be eligible to receive water from the Narrows Project, water users would be required to use, or agree to implement, conservation measures.

## 1.2 LEAD AND COOPERATING AGENCIES

Reclamation is the lead agency in preparing this FEIS. The two cooperating agencies are the U.S. Department of Agriculture Forest Service (USDA Forest Service) and the U.S. Army Corps of Engineers (USACE).

## 1.3 DECISIONS TO BE MADE BASED ON THIS ANALYSIS

Based on the analysis documented in this FEIS, the responsible official for Reclamation will make the following decisions:

- Should Reclamation approve SWCD's application for a SRPA loan to construct the Narrows Project?[1]
- Should Reclamation approve SWCD's use of Reclamation withdrawn lands for the Narrows Project, in accordance with Reclamation law?
- Under what terms and conditions (of a local supplemental agreement between Reclamation and the USDA Forest Service) should the agencies administer resources within the total areas of project influence?

In addition, the cooperating agencies may use this FEIS to aid them in making the following decisions:

- Should the USDA Forest Service:
  1. Amend the 1986 Forest Land and Resource Management Plan for the Manti-La Sal National Forest (Forest Plan) to reflect Narrows Project land use changes?
  2. Authorize mitigation measures on USDA Forest Service administered lands outside the Reclamation withdrawn lands?
  3. Issue necessary easements to the Utah Department of Transportation (UDOT) for relocating State Route (SR) 264?
  4. Accept responsibility for management of the recreation facilities?
  5. Sign various agreements, such as memoranda of understanding (MOU), easements, and rights-of-way (ROW)?
  6. Amend grazing permits and allotment management plans?
- Should the USACE approve SWCD's application for a Clean Water Act Section 404 permit authorizing the placement of discharged dredge or fill material into waters of the United States for constructing the Narrows Dam and other features of the Narrows Project?
  1. Identify the Least Environmentally Damaging Practicable Alternative (LEDPA) based on reservoir size.

## 1.4 History and Background of the Narrows Project

The history of the Narrows Project, as defined in this document, began in the early 1900s with early efforts to appropriate Gooseberry Creek water and transport it to use in north Sanpete County. In 1924, predecessors to SWCD filed an application with the Utah State Engineer to appropriate 15,000 acre-feet of Gooseberry Creek water and deliver it via a transmountain tunnel to Sanpete County.

In the 1930s, Reclamation, the Utah Water Storage Commission, and local Sanpete County interests undertook cooperative studies to formulate a water development plan and enhance water supplies in Sanpete County. The first published cooperative study, undertaken by Reclamation and released in May 1933, outlined what would

[1] There are six indicators that will be used to determine the overall loan risk and category assignments. These indicators are described in the economic section of this FEIS.

become known as the Gooseberry Project Plan. This report defined the Gooseberry Project as:

- Construction of a reservoir on Gooseberry Creek with an active capacity of 15,000 acre-feet and an annual yield of 9,400 acre-feet.
- Construction of a transmountain tunnel.
- Construction of feeder canals to deliver waters from other streams to the dam for transmountain diversion.

In September 1940, Reclamation released another cooperative study that revised the original plan and included expanding Scofield Reservoir as a principal feature of the Gooseberry Project. On November 2, 1940, the Utah Water Storage Commission recommended construction of the Gooseberry Project, defined as:

- Construction of a dam on Gooseberry Creek providing an annual average yield of 10,800 acre-feet to Sanpete County.
- Construction of a transmountain tunnel to deliver the water.
- Construction of feeder canals.
- Enlargement of Scofield Reservoir to provide exchange water for the unrestricted diversion of Gooseberry Creek water to Sanpete County.

Although the Federal Gooseberry Project, as described in the Gooseberry Project Plan, was not authorized by Congress, on March 6, 1941, the lands necessary to complete the Gooseberry Project were withdrawn from public entry under a first form Reclamation withdrawal, 32 Statutes-at-Large (Stat.) 388; 43 United States Code (U.S.C.) Section (§) 372, et seq.

On January 2, 1942, Reclamation released a draft report outlining the Gooseberry Project Plan, including constructing an additional 43,000 acre-feet of storage capacity in Scofield Reservoir to support the unrestricted transmountain diversion of Gooseberry Creek water to Sanpete County.

In 1943, the United States decided that the Scofield Dam and Reservoir portion of the Gooseberry Project Plan should be completed first because of the hazardous conditions the existing structure posed to the war effort and the health, welfare, and safety of Carbon County residents. As described in further detail below, reconstruction of Scofield Dam began the same year and was completed in 1946.

On October 11, 1943, and February 28, 1944, the United States entered into reconstruction and repayment contracts on Scofield Dam and Reservoir with local sponsors. The October 11, 1943, contract has subsequently become known as the "Tripartite Agreement." Among the conditions identified for reconstructing and enlarging Scofield Dam and Reservoir, the agreement:

- Described the United States' intent to construct and operate the remaining Gooseberry Project works.
- Stipulated that the Gooseberry Project has the right to divert and store all flows of Gooseberry Creek at or above the confluence with Cabin Hollow.
- Stipulated that Carbon County's storage rights in Scofield Reservoir are subordinate to those of the Gooseberry Project.

On April 11, 1956, Congress enacted the Colorado River Storage Project (CRSP) Act. Planning was authorized for the Gooseberry Project at 43 U.S.C. § 620a.

In September 1961, the Soil Conservation Service of the U.S. Department of Agriculture proposed the North Sanpete Watershed Work Plan to complete the 1942 Gooseberry Project Plan.

In 1962, the USDA Forest Service issued a Special Use Permit to the Gooseberry Project Plan sponsors to construct, operate, and maintain a tunnel and appurtenances for transmountain diversion of water from the proposed Narrows Reservoir in Gooseberry Creek to Cottonwood Creek for irrigation purposes.

In the 1970s, SWCD proposed constructing the Narrows portion of the Gooseberry Project Plan as a non-Federal project. On July 22, 1975, with the Federal Gooseberry Project not built, Reclamation assigned the Narrows' portion of the Gooseberry Project water right to SWCD to complete the Narrows portion of Gooseberry Project Plan as a non-Federal project.

On March 13, 1981, SWCD filed a notice of intent (NOI) to apply for a SRPA loan to help finance the non-Federal Narrows Project. The project would include:

- The Narrows Reservoir with a capacity of 17,000 acre-feet (10,000 acre-feet active storage and 7,000 acre-feet for fish and recreation).
- Two hydropower plants to provide power for project purposes.
- Improved flows in the San Pitch River by improving select facilities to allow more reliable exchanges without interfering with existing water rights.
- An additional 10 to 12 exchange wells in the San Pitch River Basin to provide exchange water to municipalities.
- Rehabilitation of the existing Gooseberry (Narrows) Tunnel.

On June 28, 1984, Reclamation approved the 1984 Compromise Agreement by and among the SWCD, the Price River Water Users' Association, and the Carbon Water Conservancy District (CWCD) (appendix A). According to the agreement's terms, among other things, SWCD:

- Relinquished and withdrew certain water rights.
- Agreed to a much lower transmountain diversion figure than previously contemplated (reduced to 5,400 acre-feet per year).
- Restricted sources of the water supply by excluding certain stream sources of water from the project plan.
- Limited the active and inactive storage capacity of the reservoir.
- Agreed to locate the dam and reservoir site further up the drainage of the Narrows Project site, thereby relinquishing the historic Mammoth Dam site.

On November 1, 1984, SWCD filed an amended NOI to apply for a SRPA loan. The project had been reformulated in response to the 1984 Compromise Agreement. Specifically, SWCD proposed to:

- Construct the Narrows Reservoir to a capacity of 14,500 acre-feet of active storage and 2,500 acre-feet of dead storage for fish and recreation purposes.
- Construct four hydropower plants to provide power for project purposes.
- Improve flows of the San Pitch River by improving select facilities that would

allow more reliable exchanges without interference with existing water rights.

- Drill 5 to 10 exchange wells in the San Pitch River Basin to provide exchange water to municipalities and irrigation companies.
- Rehabilitate the existing Gooseberry Tunnel.
- Enlarge the existing Gunnison Reservoir by at least 5,400 acre-feet.

On January 7, 1985, the Utah State Engineer approved both the non-Federal Narrows Project water rights and Scofield portion of the Federal Gooseberry Project Plan water rights. With respect to the Narrows Project water rights, among other things, the approval:

- Set the approximate physical location of the Narrows damsite and its active storage capacity (14,500 acre-feet).
- Reduced the amount of an annual transmountain diversion to 5,400 acre-feet.
- Set the instream flow requirements.
- Restricted the sources of water supply that could be used for the Narrows Project purposes.

With respect to the Scofield Project water rights, the approval provided the legal authority to use 43,000 acre-feet of additional storage water in Scofield Reservoir. Both approvals were expressly made subject to the terms of the 1984 Compromise Agreement.

The effect of this decision was to give SWCD the right to divert the first 5,400 acre-feet of water occurring in Gooseberry Creek at the Narrows damsite. The decision also established a Scofield Project water right for the additional 43,000 acre-feet of storage capacity in the enlarged Scofield Reservoir. Of the 43,000 acre-feet, 8,000 acre-feet is for fish propagation. The remaining 35,000 acre-feet of capacity is for Scofield Project purposes (i.e., project water for use in Carbon County), subject only to an obligation to satisfy early water rights that otherwise would be impaired by the diversion and storage of the Narrows Project. Because Scofield Project water rights are junior to Narrows Project water rights, delays in beginning the construction of the Narrows Project temporarily increased the yield of Scofield Project water rights for storage in Scofield Reservoir. At this time, the proposed hydropower plants, exchange wells, and expansion of Gunnison Reservoir were dropped as part of the Gooseberry Project Plan because of the technical and financial infeasibility of these components.

On March 7, 1985, the USDA Forest Service notified the Utah State Engineer of its claim to Federal reserved water rights in the Gooseberry Creek drainage. On July 13, 1989, the United States and SWCD agreed to a water use plan to allow continued development of the Gooseberry Project Plan because of potential conflict between water use under the Federal reserved water rights and the Gooseberry Project water rights. This agreement stipulated that all Federal reserved water rights, which fall within the Gooseberry Creek drainage, shall be subordinate to the Gooseberry Project water rights.

On July 20, 1990, SWCD filed a second amended NOI to apply for a SRPA loan. The project had been further reformulated to conform to the agreements and stipulations contained in the 1984 Compromise Agreement and the State Engineer's Memorandum Decision. SWCD proposed to:

- Construct the 17,000-acre-foot Narrows Reservoir with an active capacity of

14,500 acre-feet supporting an annual transmountain diversion of 5,400 acre-feet.

- Rehabilitate the existing 3,100-foot-long Narrows Tunnel to control releases from Narrows Reservoir.
- Relocate about 2.9 miles of State highway around the Narrows Reservoir.

On May 19, 1992, the draft SRPA Loan Application Report and Environmental Report were submitted to Reclamation for review and comment.

On September 20, 1993, Reclamation released a draft environmental impact statement (DEIS) for public review and comment. Approximately 60 comment documents were received from various Federal, State, and local agencies as well as members of the public. These comments and accompanying responses were included in the January 1995 FEIS.

On December 23, 1994, SWCD submitted the final Loan Application Report for processing. On January 23, 1995, Reclamation filed the 1995 FEIS with the United States Environmental Protection Agency (EPA).

On May 8, 1995, Reclamation's Upper Colorado Regional Director signed a Record of Decision (ROD). The ROD's recommendation was to proceed with the recommended plan identified in the 1995 FEIS.

On July 28, 1995, a Complaint was filed in the United States Federal District Court, District of Utah, by the Carbon Water Committee, Utah Rivers Conservation Council, Utah Wilderness Association, and three individuals (collectively Plaintiffs) against the U.S. Department of the Interior (Interior), Bureau of Reclamation alleging that Reclamation failed to comply with the National Environmental Protection Act (NEPA) in preparing the 1995 FEIS.

In response, Reclamation hired the Environmental Chemical Corporation (ECC), an environmental consultant, to conduct an independent review of the 1995 FEIS. ECC concluded that "the Narrows Project FEIS was complete and technically complied with NEPA, fulfilling most requirements of the Council on Environmental Quality (CEQ), Reclamation, and Department of the Interior guidelines."

In September 1995, a Civil Complaint was filed in the Sixth Judicial District Court of Sanpete County, State of Utah by SWCD (Plaintiff) against Carbon Water Conservancy District and PacifiCorp, also known as Utah Power and Light (Defendants). The Plaintiffs alleged a breach of contract by the Defendants by willfully interfering and hindering the Plaintiff's attempts to develop its Gooseberry Creek water rights and construct the Narrows Project. In June 1999, the court dismissed the suit, and SWCD appealed to the Tenth Circuit Court of Appeals of the United States. The court of appeals upheld the original district court ruling.

On September 11, 1995, Reclamation published a *Federal Register* Notice for rescission of the ROD on the 1995 FEIS for the Narrows Project, due to certain procedural errors in the FEIS process.

On February 8, 1996, Reclamation published a *Federal Register* NOI to prepare a new DEIS, wherein it announced that a new 1996 DEIS and subsequent FEIS would supersede the 1995 FEIS. Reclamation said it would use the 1995 FEIS, along with other materials submitted by SWCD, as the basis for preparing the new 1996 DEIS.

Reclamation's new 1996 DEIS was published in March 1998. Comments were received by mail and at public hearings in Price and Mount Pleasant, Utah, on April 22 and 23, 1998, respectively.

The present document is a new FEIS developed through Reclamation's own analysis of the environmental impacts of the Proposed Action. A NOI to prepare the SDEIS was published in the *Federal Register* on November 25, 2003. Based on scoping results, discussions with interested parties and cooperating agencies, existing laws and regulations, and comments on the 1998 DEIS, Reclamation updated or added the hydrology, water quality, population and demographics, water usage, recreation, discussion regarding Skyline Mine water development, fisheries, project cost estimates, wetlands delineations, Wild and Scenic Rivers, and Endangered Species Act (ESA) compliance in this FEIS. Resources, issues, and concerns identified during the process of completing this FEIS were fully considered, and changes were made to this document as appropriate. Formal responses to comments received on the SDEIS are published in appendix H of this FEIS.

## 1.5 PURPOSE AND NEED

Because Reclamation administers the Federal Reclamation laws, including the Small Reclamation Projects Act of 1956 and the Reclamation Project Act of 1939, particularly Section 10, Reclamation's purpose and need is considering approval of SWCD's SRPA loan application to build the Narrows Project and SWCD's request for authorization to use withdrawn lands to construct and operate the proposed dam and reservoir. This SRPA loan application is appended to this FEIS (appendix J).

By way of background, SWCD's purpose for the Narrows Project is to enable development of an irrigation and M&I water supply source for users in north Sanpete County, Utah. Its need is to reduce the average annual shortages to irrigators in Sanpete County as nearly as possible to 5 percent (%), which is considered full irrigation supply.

Specifically, the following are SWCD's water-related needs addressed by the proposed project:

- Demand for municipal water for present and future use exceeds the currently available supply. The proposed Narrows Project would develop, through exchange, an additional supply of municipal water to offset current shortages and accommodate anticipated population growth in Sanpete County.
- The current water supply for agricultural irrigation does not provide adequate supply and storage at the needed times—typically in July, August, and September of each year. The proposed Narrows Project would provide late season irrigation water to offset some of the current shortages.

In addition to its primary purpose of supplying water to Sanpete County, SWCD believes the project would have the additional benefit of providing reservoir-based recreation and fishery opportunities in Sanpete County.

It is important to note that Reclamation's purpose and need for action is limited to responding to the loan application and the request to use Federal land for the Narrows Project (see figure 1-1).

Due to USACE's need to determine the LEDPA, three reservoir sizes were analyzed.

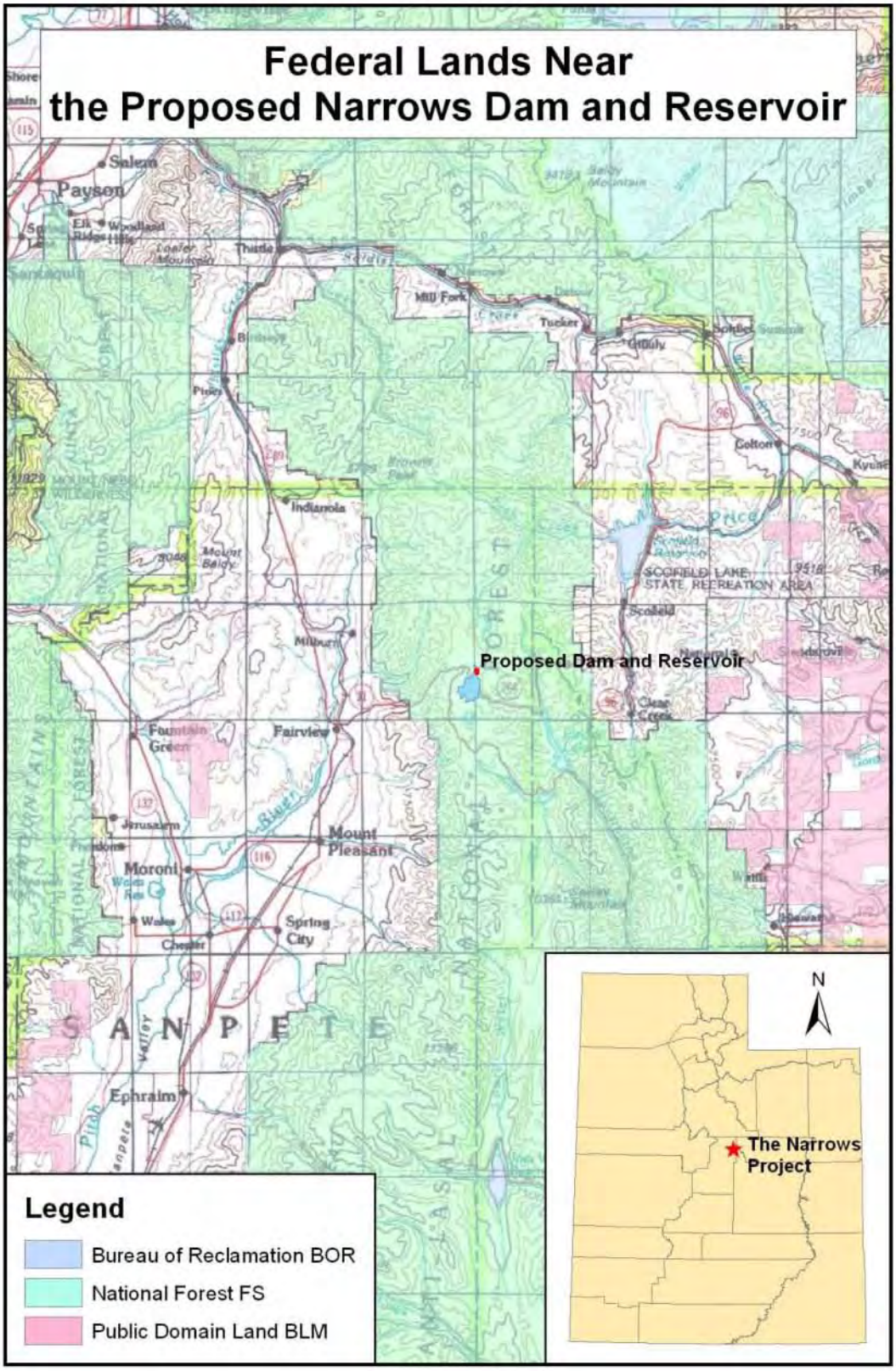



**Figure 1-1.—Federal Lands near the Proposed Narrows Dam and Reservoir.**

### 1.5.1 Municipal and Industrial

Under the current Utah State Water Plan that is intended to guide and direct Utah's water related planning into the next century (Utah Division of Water Resources, 2001). Water needs for M&I uses are projected.

Table 1-1 contains the per capita use rates of public community and secondary water systems from the Utah State Water Plan. Comparison of potable and nonpotable water use contained in table 1-1 shows that considerable water saving could be achieved through implementing conservation measures.

**Table 1-1. Public Community System and Secondary System Water Use (gallons per capita per day)**

| Water Use | West Colorado River | Sevier River | Total/ Average |
|---|---|---|---|
| Potable Uses: | | | |
| Residential | 186 | 171 | 178.5 |
| Commercial | 25 | 30 | 27.5 |
| Institutional | 29 | 44 | 36.5 |
| Industrial | 9 | 22 | 15.5 |
| Total Potable | 249 | 267 | 258 |
| Nonpotable Uses: | | | |
| Residential | 91 | 87 | 89 |
| Commercial | 0 | 0 | 0 |
| Institutional | 26 | 21 | 23.5 |
| Industrial | 0 | 0 | 0 |
| Total Nonpotable | 117 | 108 | 112.5 |
| Total Use by Category: | | | |
| Residential | 277 | 258 | 267.5 |
| Commercial | 25 | 30 | 27.5 |
| Institutional | 55 | 65 | 60 |
| Industrial | 9 | 22 | 15.5 |

Source: Department of Natural Resources, Division of Water Resources, 2001, table 8.

Table 1-2 shows projections of water use by major river basins included in the study area for the years 2020 and 2050 based upon present use rates and future population.

**Table 1-2. Present and Projected Total M&I Water Use by Basin (acre-feet per year)**

| Basin | Present | 2020 | 2050 |
|---|---|---|---|
| West Colorado River | 51,000 | 55,000 | 62,000 |
| Sevier River | 48,000 | 55,000 | 64,000 |
| Total | 99,000 | 110,000 | 126,000 |
| Average | 49,500 | 55,000 | 63,000 |

Source: Department of Natural Resources, Division of Water Resources, 2001, table 7.

### 1.5.2 Agricultural Water Supply

The existing water supply for agricultural irrigation does not provide an adequate supply at the times when it is needed. An additional and dependable irrigation water supply is needed to stabilize and improve the agricultural component of the Sanpete County economy. Successful crop production in north Sanpete County depends on irrigation because the average rainfall during the growing season is approximately 4 inches. The present irrigation water supply consists primarily of runoff from the previous winter snowpack.

The amount of annual runoff varies widely because of natural precipitation patterns during the winter. The greatest volume of runoff occurs in the early part of the growing season. Although irrigation water users have made numerous improvements to their existing water distribution systems in the past (such as canal lining, piped distribution systems, and conversion to sprinkler irrigation), water shortages still occur.

There are 15,420 acres of lands eligible to receive project water. The eligible lands are

classified as Class I, II, or III lands according to Reclamation's land classification system. The remaining lands are considered Class VI (ineligible) lands because of poor soil, inadequate drainage, or topographic characteristics.

In determining water requirements, the project lands were divided into three groups representing similar water supplies and irrigation practices. These groups are described below.

Group 1 lands include the areas serviced by the Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, and Oak Creek Irrigation Companies. Of the 9,777 acres of presently irrigated lands, 5,705 acres are eligible to receive project water. Water is delivered to Group 1 lands through pipeline systems. These lands currently are irrigated by sprinkler systems.

Group 2 lands include the areas served by the Horseshoe, Cedar Creek, and Twin Creek Irrigation Companies. Group 2 contains 6,407 acres of farmland, of which 4,644 acres are eligible to receive project water. Water is delivered to these lands through open canals and ditches. At present, these lands mostly are flood irrigated.

Group 3 lands use the San Pitch River as their principal water supply and are served by numerous irrigation companies. There are 6,996 acres of irrigated land in this group, of which 5,071 acres are eligible for project water. Group 3 lands receive water through open canals and ditches. These lands currently are irrigated with a combination of flood and sprinkler methods. Principal crops grown in the project area include pasture, alfalfa, grass hay, and small grains. The consumptive use requirements are based on the Utah State University Agriculture Experiment Station *Research Report No. 145*.

Consumptive use estimates were computed for the principal crops found in each of the groups. The estimates are based on the crop distribution of each group. Average monthly estimates were computed for April–October, as appropriate for each crop. These estimates represent net irrigation requirements since *Research Report 145* deducts effective precipitation from total consumptive use. Curve No. 1 (crop consumptive use), shown in figure 1-2, presents the monthly net irrigation requirements for the 15,420 acres of project-eligible lands. The average net irrigation requirement is approximately 30,400 acre-feet per year.

The net irrigation requirement is the amount of water that must be artificially applied by irrigation and must be present in the root zone and available for evapotranspiration by the plants for normal plant growth and development. It is not the amount that must be diverted into the irrigation system. Because of inevitable inefficiencies of the delivery, distribution, and application systems, a larger quantity of water must be diverted into the irrigation system to meet actual crop needs. Some of the factors contributing to these inefficiencies include seepage and evaporation from the carriage system, evaporation of applied water, deep percolation of excess applied water, and runoff of excess water. The lack of uniformity in applying irrigation water is the major cause of deep percolation and runoff. Traditionally, flood irrigation is the least uniform, and microirrigation systems are the most uniform. The application systems with the highest uniformity generally also have the highest capital and operating costs. Based on the delivery system conditions and application methods in use, the diversion requirement was computed to be an average

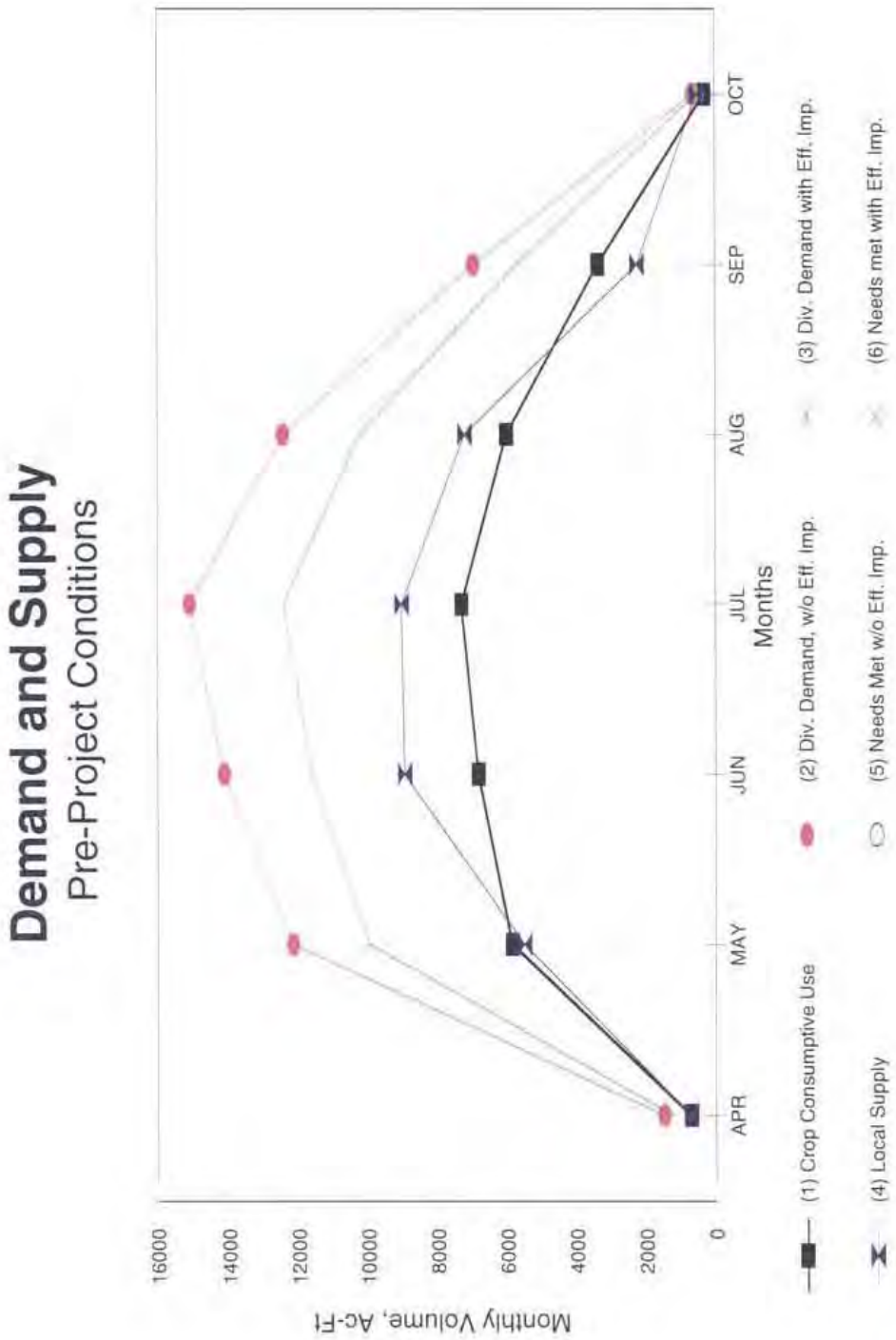



**Figure 1-2.—Narrows Project Demand and Supply, Preproject Conditions.**

of about 62,900 acre-feet per year for the project-eligible lands. This demand is shown as Curve No. 2 (diversion demand without efficiency improvements) in figure 1-2.

Data gathering efforts, conducted during the planning stages of the project, identified private parties and canal companies that were planning to install, or were currently installing, a variety of efficiency improvements (efficiency improvement, conservation measures). These improvements consist mainly of pipe delivery and sprinkler irrigation systems. More precise application methods, such as drip irrigation and microspray systems, are not cost effective. These efficiency improvements are expected to be in place by the time project water would become available. Thus, all calculations of project diversion demands made and discussed herein are based on the increased efficiencies produced by these improvements.

Curve No. 3 (diversion demand with efficiency improvements) in figure 1-2 shows the reduced diversion requirement (or demand) of 51,700 acre-feet per year on the average. The efficiency improvements would result in an 11,200-acre-foot reduction in the diversion demand. It should be emphasized that the reduced diversion requirement is the effect efficiency improvements would have, not a development of a new water supply. The same irrigated lands require less in physical diversion to receive full irrigation. The efficiency improvements also will mean that a larger percentage of diverted water would become available for plant evapotranspiration.

Local water supplies in the project area consist of a small amount of effective precipitation during the growing season, a small amount of storage, and direct runoff from the snowpack. Curve No. 4 (local supply) in figure 1-2 shows the 34,200 acre-feet (spread over the irrigation season) diverted annually to meet the crop water needs. Curve No. 4 is based on long-term historical diversions. It does not include effective precipitation, which is already accounted for in the net irrigation requirement shown in Curve No. 1. As can be seen from figure 1-2, the local supply is considerably less than the reduced diversion demand (Curve No. 3). This shortage is approximately 17,500 acre-feet on an average annual basis (total volume difference between Curve Nos. 3 and 4).

*Research Report 145* indicates that about 3.5 inches of effective precipitation occur during the nongrowing season. Some portion of this effective precipitation would accumulate in the root zone and be available to augment the local supply during the first few weeks of the growing season. There could be as much as 4,500 acre-feet of moisture stored in the soil profile at the beginning of the growing season.

The exact amount of soil moisture has not been determined. In reality, the shortage, therefore, most likely would range between 13,000 and 17,500 acre-feet per year. Assuming that one-half of this precipitation still would be in the root zone at the beginning of the growing season, the average shortage would be about 15,250 acre-feet per year. This represents a 29.5% shortage relative to the diversion demand.

Depending on the efficiency scenario being examined (with or without efficiency improvements), Curve Nos. 5 (needs met without efficiency improvements) and 6 (needs met with efficiency improvements) show that significant soil moisture deficits would occur throughout much of the growing season. With the expected moisture available in the root zone at the beginning of the growing season, the early-season deficits

probably would not be as severe, as shown by the graphs. However, serious soil moisture deficits occur throughout much of the latter part of the growing season. This would result in prolonged or frequent water stress for the crops involved. Consequences of this water stress include reduced crop yield, reduced quality, and poor plant vigor. For example, there should be three good cuttings of alfalfa under adequate water supply conditions. Currently, the first cutting is good, the second is mediocre, and the third generally never occurs. Further, evidence of reduced crop vigor was noted during a Reclamation field tour of the project service area. A large number of fields were noted to have unusually high infestations of weeds. Typically, lower water-use weeds quickly infest a field when the crop is seriously water stressed. This problem is exacerbated in north Sanpete County because the short water supply prevents normal crop rotations that help control weeds and maintain field productivity (because rotation crops have higher water requirements).

As previously noted, only a portion of the water diverted for irrigation would be available for crop use. The remaining portion would be lost through evaporation, seepage losses, deep percolation, and runoff. Except for the amount lost through evaporation, these losses either become part of the water supply for the shallow water table or become return flows to the natural surface streams. These losses support wetlands and aquatic habitat and become part of the water supply for downstream users. Total losses from local supplies would amount to an estimated 17,600 acre-feet per year before efficiency improvements were implemented. The losses would be expected to be reduced to about 14,100 acre-feet per year with implementing efficiency improvements. Thus, efficiency improvements would result in a combined loss reduction of about 3,500 acre-feet per year.

### 1.5.3 Recreation Opportunities

In addition to the primary purpose of supplying water to Sanpete County, a secondary purpose is maintaining or increasing recreational opportunities in Sanpete County. The demand for outdoor recreation is increasing throughout Utah.

The 2009 Utah State Comprehensive Recreation Plan (SCORP) has outdoor camping listed among the highest recreation-based uses in Sanpete County.

The 1986 Forest Plan states that:

> ". . .the demand for developed recreation sites is expected to triple over the next 50 years. At this rate, demand on the Manti-La Sal National Forest is expected to exceed supply at some sites starting in the year 1990."

The Forest Plan also states that:

> "Some lands, especially those next to reservoirs on the Forest, possess a high recreational value."

Developed camping sites around the Narrows Reservoir would help to meet this public purpose.

## 1.6 Relationship to Other Projects

This section describes other Federal actions that are considered for past, present and cumulative impact analyses in chapter 3. Construction and operation of the proposed project would reflect consideration of, and cooperation with, the following existing projects.

### 1.6.1 Central Utah Project

As part of the master water development plan for Sanpete County, the Narrows Project is intended to provide a supplemental water supply for the northern part of the county. Central Utah Project (CUP) water, delivered by the Sevier River, originally was planned to provide a supplemental supply for the southern portion of the county. However, the Central Utah Project Completion Act (CUPCA), which authorized completion of the remaining features of the CUP, restricted CUP development to the Wasatch Front area of central Utah if construction of facilities did not begin within 5 years of the enactment of the legislation. Sevier and Millard Counties withdrew from the Central Utah Project, and plans to deliver CUP water to the Sevier River Basin have been dropped. The 5-year authorization window has since expired; therefore, delivery of CUP water to the Sevier River Basin and, consequently, to Sanpete County will not occur.

To compensate for the CUP water supply loss, Section 206 of the CUPCA was designed to provide some funding for supplemental projects in Sanpete County. Section 206 is intended for counties within the Central Utah Water Conservancy District (CUWCD) that were originally planned to receive CUP water but will not (as explained above). These counties are eligible to receive a rebate of the taxes paid to the CUWCD. This rebate may be used for local water projects such as potable water distribution and treatment, wastewater collection and treatment, and agricultural water management. Participating counties will receive a rebate from the CUWCD of ad valorem tax contributions paid, with interest, but less any benefits or administrative expenses. Under Section 206, this rebate represents a 35% local cost share; and a Federal grant from Interior constitutes the remaining 65% of the project cost.

Through 1996, Sanpete County had paid nearly $2.4 million in ad valorem taxes to the CUWCD, which established the maximum amount of the rebate under CUPCA Section 206. Based on a 65% match, the corresponding amount of matching Federal grant money is approximately $4.4 million. These two sums provide a total Section 206 amount of $6.8 million that could be used to fund water development/conservation projects in Sanpete County.

To use these funds more effectively, in June 2000, SWCD completed the Sanpete County Water Resources Master Plan (Master Plan) for managing, developing, and conserving the limited water resources of the county. The plan was intended to evaluate and prioritize several water management and/or conservation projects that potentially would be funded by SWCD for implementation. The Master Plan clearly places the Narrows Project as its primary objective in obtaining supplemental water to meet shortages in north Sanpete County. However, other water development/conservation projects would be needed to further alleviate shortages that occur throughout Sanpete County. Since 1996, Sanpete County has approved approximately $4.8 million in projects to further develop/conserve its water resources using CUPCA Section 206 funds.

### 1.6.2 Scofield Project

The Scofield Project, authorized on June 24, 1943, arose out of the remnants of various private dams that either failed or never lived up to expectations. The new Scofield Dam and Reservoir replaced the rapidly deteriorating, old Scofield Dam, built by the Price River Water Conservation District. The Scofield Project eventually irrigated area

lands that originally were to be served by Mammoth Dam and later by the defunct Gooseberry Project. Mammoth Dam failed in 1917, before its completion. While the Scofield Project evolved out of the Gooseberry Project, the need to protect vital rail lines from flood damage during World War II was a key to the Scofield Dam construction. Although World War II prompted suspension of construction on most Reclamation projects, the fear that the existing Scofield Dam might fail and cause millions of dollars of damage and disrupt transportation influenced the Federal Government to proceed with the Scofield Project.

The Scofield Project included 30,000 acre-feet of replacement storage capacity (replacing the then existing 30,000-acre-foot structure), 8,000 acre-feet of inactive or dead pool storage (conservation pool), and 35,000 acre-feet of exchange capacity to support the transmountain diversion of Gooseberry Creek water at or near the Narrows damsite. The near doubling in size of Scofield Reservoir was originally accomplished (1943–1946) because of hazardous conditions with the existing structure, the threat it posed to the war effort, and the reservoir's role in accomplishing a portion of the Gooseberry Project Plan, which included an early version of the Narrows Project.

### 1.6.3 Fairview Lakes, Gunnison Reservoir, Wales Reservoir

Through a proposed operating agreement associated with the Narrows Project, releases would be made from the privately owned Fairview Lakes to re-establish minimum instream flows in two small tributaries to Gooseberry Creek above the Narrows Reservoir site (see location map). Wales Reservoir is a small, privately owned reservoir that stores winter runoff from the Upper San Pitch River drainage. Gunnison Reservoir is a storage facility, located southwest of Manti, that stores water from the San Pitch River drainage (Wales Reservoir is located about 19 miles upstream of Gunnison Reservoir on Silver Creek, which is a tributary of the San Pitch River).

### 1.6.4 Price-San Rafael Rivers Unit, Colorado River Salinity Control Program

The principal objective of the Colorado River Basin Salinity Control Program is to meet the water quality standards for salinity adopted by the Basin States while the Upper Basin States continue to develop their water. The Price-San Rafael Rivers Unit of the Colorado River Water Quality Improvement Program under the Colorado River Salinity Control Act would reduce salt contribution to the Colorado River by about 161,000 tons annually through a system of on-farm and off-farm irrigation improvements. The Narrows Project would divert water from the Price-San Rafael River Basins to develop a supplemental irrigation water supply of 5,400 acre-feet per year for municipal use and for approximately 15,420 acres of presently irrigated land in north Sanpete County, Utah. The transbasin diversion of 5,400 acre-feet under the Narrows Project would not affect salt load reduction accomplishments or opportunities of the Price-San Rafael Rivers Unit.

### 1.6.5 Upper Colorado River Endangered Fish Recovery Program

A coalition of agencies and organizations came together in 1988 to recover endangered Colorado River Basin fish and provide for future water development for agricultural, hydroelectric, and municipal uses.

Called the Recovery Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River (Recovery Program), this effort involves Federal, State, and private organizations and agencies in Colorado, Utah, and Wyoming. The Recovery Program complies with all applicable laws, including the Federal Endangered Species Act, State water laws, river laws, and interstate water compacts.

Recovery strategies include conducting research, improving river habitat, providing adequate streamflows, managing nonnative fish, and raising endangered fish in hatcheries for stocking. Ongoing activities include the development of recommended flow regimes for the Price River to benefit endangered fish populations. As of August 2009, the Recovery Program is in the final stages of developing these flow recommendations.[2]

### 1.6.6 Forest Plan

The 1986 Forest Land and Resource Management Plan for the Manti-La Sal National Forest, as amended, provides direction and standards for managing lands in and adjacent to the proposed Narrows Project. In fact, the Narrows Project is specifically mentioned and, in 2003, amended to the plan, along with a reference that water is the top concern of the residents of Sanpete and other counties included in the planning effort.

## 1.7 Environmental Issues Associated with the Proposed Action Alternative

The issues identified through the initial scoping effort are listed below. The issues are phrased as questions. Following a brief description of the issue, indicators or measures are suggested that may be used to compare how the alternatives answer the question. Indicators measure change from the present condition. Chapter 2 contains a comparison summary of the alternatives and their responses to the issues. Chapter 3 presents the affected environment and the predicted effects as they relate to the resource issues.

#### *Issue No. 1 – How would threatened and endangered species be affected by the Narrows Project?*

The project area and potentially affected offsite areas contain the habitat for several federally listed endangered and threatened species, including the Colorado pikeminnow, bonytail, humpback chub, razorback sucker, Canada lynx, Utah prairie dog, black-footed ferret, yellow-billed cuckoo, southwestern willow flycatcher, greater sage-grouse, heliotrope milk-vetch, Graham beard tongue, and the Uinta Basin hookless cactus. Due to the listing of these species as threatened, endangered, candidate, or proposed, the protection of a sensitive species habitat has become a matter of concern to the U.S. Fish and Wildlife Service (Service) and to the public.

[2] http://www.coloradoriverrecovery.org/general-information/about.html.

Indicators for this issue:

- Acre-feet of water annually depleted from the Colorado River system
- Loss of potential southwestern willow flycatcher habitat

### *Issue No. 2 – How would the Narrows Project affect wildlife resources?*

The project area provides habitat for a wide variety of wildlife species ranging from deer and elk to birds and small mammals. There is concern that the proposed project may disrupt the migration routes and feeding areas for some small animal and bird species, including some neotropical species.

Indicators for this issue:

- Number of habitat units lost for specific indicator wildlife species (i.e., ungulates, small mammals, neotropical migrants, and Utah State sensitive species)

### *Issue No. 3 – What effects would there be on water resources from the Narrows Project?*

The public expressed concerns about the hydrology, water yield, and supply of the Price River as well as whether the winter releases and instream flows from Scofield Reservoir would be affected as a result of current or future use.

Indicators for this issue:

- Acre-feet of depletion from the Price River drainage
- Acre-feet of water available to San Pitch River drainage

### *Issue No. 4 – How would the Narrows Project affect the fishery resource?*

The public expressed concern about the loss of Yellowstone cutthroat trout spawning habitat caused by inundation from the Narrows Project. Changes in the flow regime may cause increased water quality problems and, subsequently, affect the fisheries.

Concern for the fishery below Scofield Reservoir was expressed, and the question was asked if instream flows would be altered and if minimum flows would be required below Narrows Dam and Scofield Dam.

Indicators for this issue:

- Percent change in weighted usable area in fish habitat as measured by instream flow incremental methodology (IFIM)[3]
- Change in surface area in Scofield Reservoir
- Change in species composition above, below, and within Scofield Reservoir and the proposed reservoir
- Change in species composition and in population dynamics of existing species

### *Issue No. 5 – How would water quality be affected by the Narrows Project?*

Accelerated sedimentation (over natural levels of sediment production) is the most likely factor to affect water quality. Land-disturbing activities, such as road construction and dam building, usually increase sedimentation, at least in the short term.

[3] IFIM is a standard for measuring habitat.

Concerns were expressed over how the Proposed Action may affect the water quality as measured by phosphorus loading downstream.

The addition of many new recreationists to the Gooseberry Valley could create additional pollution from problems with trash and sewage. Additionally, road material (from rerouting SR-264) may have a temporary and adverse effect on riparian systems.

Indicator for this issue:

- Change in average phosphorus level in Scofield Reservoir based on external phosphorus loading

### *Issue No. 6 – What would the effect be on wetland resources from the Narrows Project?*

Construction of the Narrows Project would inundate existing wetlands. Change in flow (decrease or increase) may change the composition and structure of other existing wetlands.

Indicators for this issue:

- Acres of wetlands lost (function and value)
- Function and values measured by habitat evaluation procedures (HEP) analysis in terms of habitat units
- Change in species composition in wetland habitats

### *Issue No. 7 – What would the effect be on aquatic and riparian resources from the Narrows Project?*

Construction of the Narrows Project would inundate and affect wetlands and riparian areas. A decrease in flow may change the wetlands and lower the water table. High flows are needed to re-establish the riparian communities. Concern was expressed about the possibility of high peak flows causing a blowout of the stream channel (Cottonwood Creek).

Indicators for this issue include:

- Change in species composition in aquatic and riparian habitats
- Number of miles of stream lost due to inundation of the reservoir
- Number of miles of stream affected by increase in flow and decrease in flow

### *Issue No. 8 – How would the Narrows Project affect the recreation and visual resources within the project area?*

Currently, the area receives light, nonmotorized, dispersed recreation during the summer and fall, primarily from stream anglers. Moderate levels of winter recreation also occur. If the project is implemented, the nature of the recreational experience may be affected. Motor boating and related water sports, overnight family camping, large group reservation camping, all terrain vehicle (ATV) use, and reservoir fishing activities may replace the current recreation experience in the area inundated by the reservoir.

The surrounding USDA Forest Service lands in this area have been designated by the Forest Plan to have the visual quality objective (VQO) of Partial Retention. One concern is that, with developing the recreational area, associated gravel pits and soil scars may affect the visual quality of the area.

Indicators for this issue:

- Increase in developed recreation visitor days at Narrows (including fishing)
- Increase in dispersed recreation visitor days at Narrows (including fishing)
- Change in projected fisherman days
- Change in VQOs

### *Issue No. 9 – What effect would there be on cultural resources from the Narrows Project?*

Class I and Class III cultural resource inventories were conducted for the "primary impact area" of the proposed Narrows Dam and Reservoir in 1979 (Singer, 1979). As a result of the 1979 inventory, three cultural resource sites were identified. The sites, however, were not evaluated for *National Register of Historic Places* (NRHP) eligibility. Further, since the 1979 inventory, the design and, therefore, the area of potential effects (APE) associated with the Proposed Action has changed. These changes include the addition of the Upper Cottonwood Creek, Oak Creek, and East Bench pipeline alignments, new road alignments, borrow areas, staging areas, recreation facilities, marinas, wetland mitigation areas, haul roads, and other potential ancillary facilities associated with the Proposed Action. Prior to initiation of final design and construction, Class I and Class III cultural resource inventories of the entire APE, as well as consultations with various consulting parties, including Indian tribes, would need to be completed before a determination of effects to cultural resources from the Narrows Project could be made.

Indicators for this issue:

- Number of cultural resources inundated or otherwise impacted by construction of the reservoir and ancillary facilities
- Potential tribal concerns regarding traditional cultural properties or sacred sites within the APE

### *Issue No. 10 – What social and economic effects would be expected from the Narrows Project?*

Reclamation recognizes that implementing the alternatives may result in impacts on the local residential community in the vicinity of the Narrows damsite. Aside from the environmental issues previously identified above, local communities often are concerned with intangible quality of life impacts that implementing the alternatives may present. Key community concerns frequently include impacts downstream from Scofield Reservoir and the social and economic effects on Carbon and Sanpete Counties.

Indicators for this issue:

- Number of jobs (Carbon and Sanpete Counties) created during construction
- Change in farm income
- Change in available water supply in Sanpete and Carbon Counties

### *Issue No. 11 – What effect would there be on existing land uses, rights-of-way, and potential mineral leasing?*

Since more than half of the shoreline of the proposed reservoir would be on private land, there would be potential for development of the private land including subdivisions, roads, summer homes, lodges, and utilities. Development of this land

could cause problems such as erosion and ground and surface water pollution.

The project would be located within the boundaries of four USDA Forest Service grazing allotments. The reservoir, campgrounds, and additional roads may decrease available forage for livestock and wildlife.

Since the proposed dam and reservoir are in the vicinity of known mineable coal reserves, the project could affect the mineability of Federal and private coal resources.

Indicators for this issue:

- Percentage of shoreline in private ownership
- Change in number of animal unit months (AUMs) of forage use
- Acres of mineable coal reserves not available for mining

### *Issue No. 12 – What effects on public safety would there be from the Narrows Project?*

The finished reservoir would be an attraction to the public, which may increase recreational traffic on SR-31, SR-264, and local USDA Forest Service roads in the vicinity, leading to possible congestion and accidents. Local USDA Forest Service roads may need reconstruction to a higher standard if traffic levels increase appreciably.

Indicator for this issue:

- Percent of expected change in the volume of traffic in the project area

### *Issue No. 13 – What would be the effects upon air quality associated with constructing the Narrows Project?*

The Narrows Project is located in a remote and rugged mountainous terrain. The air quality associated with this area is generally excellent. Noise in the proposed project area is generally low and not disturbing. The construction activities potentially may affect the air quality of the Narrows basin during construction activities.

Indicator for this issue:

- Number of days project will exceed National Ambient Air Quality Standards (NAAQS) for particulate matter
- Noise indicator

### *Issue No. 14 – Would the slopes of Fairview Canyon be affected by construction and operation of the Narrows Project? What effects will there be on channel stability from the Narrows Project?*

Concern was expressed about the potential impacts from additional flows through Cottonwood Creek to the already unstable Fairview Canyon. Several landslides have been identified in the canyon. Concern was expressed about the adjacent slopes in Cottonwood Creek.

Indicators for this issue:

- Frequency of exceeding the 50-year channel-forming discharge
- Lateral and vertical slope degradation

### *Issue No. 15 – What would the geologic hazards and earthquake hazards be from the Narrows Project?*

The dam and reservoir would lie on the North Horn Formation and colluvium. The dam location and design must ensure long-term stability based on geologic conditions, including seismicity of the area, foundation conditions, permeability of the surrounding materials, and land stability.

Indicator for this issue:

- Number and severity of known geologic hazards within vicinity of dam and reservoir

### *Issue No. 16 – What would the effect be upon the soils of the area from the Narrows Project?*

Concern was expressed about soil erosion in the project area and sediment loads transported in Gooseberry Creek.

Indicators for this issue:

- Acres of new soil disturbance
- Change in sediment loads in Gooseberry Creek

### *Issue No. 17 – What would the effect be upon levels of trace elements in the ground water supply from constructing the Narrows Project?*

Concern was expressed about the salt pickup from the dissolution of salts from the soil and subsurface materials. Deep percolation from irrigation dissolves salts from the soils and shales and conveys them to natural drainages.

Indicator for this issue:

- Increase in levels of select trace elements in ground water

### *Issue No. 18 – What would the impact of the Narrows Project be on Indian trust assets (ITAs)?*

The United States has an Indian trust responsibility to protect and maintain rights reserved by, or granted to, Indian tribes or Indian individuals by treaties, statutes, and Executive orders, which rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires that all Federal agencies, including Reclamation, take all actions reasonably necessary to protect Indian trust assets.

Indicator for this issue:

- Number of ITAs affected

### *Issue No. 19 – What would the impact of the Narrows Project be on environmental justice?*

According to Executive Order No. 12898, agencies are required to analyze the environmental effects, including human health and economic and social effects of Federal actions, and effects on minority communities and low income communities.

Indicator for this issue:

- Number of low income or minority communities disproportionately affected by the Narrows Project

### *Issue No. 20 – What climate change and greenhouse gas emission issues might affect, or be affected by, the Proposed Action?*

Since publication of the DEIS in 1998, issues associated with climate change have received dramatically increasing national and international attention; and, in recent years, there has been increased research and an increasing database on the topic of how climate change might affect, or be affected

by, water supply systems and projects. The USGS report (2009) summarizes the issue as follows:

> "Observational evidence shows that many natural systems are being affected by regional climate changes, particularly temperature increases…Climate change is but one of many dynamic processes impacting water resources management. Other processes (for example, change in population size and location, economic development and land use, aging infrastructure, ground-water development, and changing social values) also have major influences on water resources and must be considered along with climate change in a holistic approach to water resources management. Climate change has the potential to affect many sectors in which water resource managers play an active role, including water availability, water quality, flood risk reduction, ecosystems, coastal areas, navigation, hydropower, and other energy sectors. These changes may have adverse or positive impacts on one or more sectors. Any or all of these changes could occur gradually or abruptly."[4]

In April 2011, Reclamation released its first report under the authorities of the SECURE Water Act and presents the current information available for the Colorado River Basin. Future reports will build upon the level of information currently available and the rapidly developing science relevant to address the authorities within the SECURE Water Act. Based on this and other climate change studies, we can expect much of the Western United States to experience warming with central estimates varying from roughly 5–7 degrees Fahrenheit (°F). As related to precipitation, the Colorado River Basin is projected to have roughly equal chances of becoming wetter or drier. With respect to this project, no models are currently available that would have sufficient detail or sensitivity to capture the future climate for the proposed Narrows Project, which involves storage and distribution of 5,400 acre-feet of water per year. Historic Utah records indicate that both temperatures and precipitation in Utah (http://www.ncdc.noaa.gov/oa/climate/research/cag3/ut.html) have been increasing. However, without verified models addressing climate change at this project level, Reclamation concludes that, at this time, data and modeling tools are not yet developed to the point that meaningful analysis of a small project can be achieved.

## 1.8 PERMITS, AUTHORIZATIONS, AND AGREEMENTS

Implementation of the Proposed Action could require a number of authorizations or permits from State and Federal agencies. These are summarized below.[5]

- Reclamation approval of the SRPA loan and congressional approval of the necessary funds to construct the Narrows Project.
- Reclamation authorization for SWCD use of withdrawn lands to construct and operate Narrows Dam and Reservoir.
- Utah Division of Water Quality authorization needed for a Storm Water

[4] *Climate Change and Water Resources Management: A Federal Perspective*, Circular 1331, U.S. Geological Survey, Reston, Virginia, 2009. p. 1.

[5] Before beginning activities under the Proposed Action, SWCD would consult with both the USACE and Utah Department of Natural Resources to determine which permits would be necessary.

Discharge Permit (Section 402 of the Clean Water Act, as amended).

- A USACE permit in compliance with Section 404 of the Clean Water Act, as amended, or Utah Department of Natural Resources authorization for a State Stream Alteration Permit (Section 404 of the Clean Water Act, as amended).
- Utah Division of Water Quality authorization for a Utah Pollution Discharge Elimination Permit (Section 402 of the Clean Water Act, as amended).
- Reclamation consultation with the State Historic Preservation Office (SHPO).
- Utah Division of Water Quality authorization needed for 401 Certification following a Level II Antidegradation Review.
- Utah Division of Water Quality authorization needed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.
- Utah Division of Water Quality authorization needed for Utah Pollutant Discharge Elimination System General Permit for Construction Dewatering if dewatering is required.

## 1.9 DOCUMENT ORGANIZATION

This document follows the requirements established in the CEQ regulations (40 Code of Federal Regulations [CFR] 1502.10 and the Interior NEPA regulations, 46 CFR Subpart E). The document consists of the following main chapters:

- Executive Summary
- Chapter 1 – Purpose of and Need for the Action
- Chapter 2 – The Alternatives Considered Including the Proposed Action Alternative
- Chapter 3 – Affected Environment and Environmental Consequences
- Chapter 4 – Consultation and Coordination
- Chapter 5 – List of Preparers
- Chapter 6 – Bibliography, Glossary of Terms, and List of Acronyms and Abbreviations
- Chapter 7 – Index
- Appendix A – 1984 Compromise Agreement
- Appendix B – Identification and Evaluation of Potential Damsites
- Appendix C – Biological Opinion for the Proposed Narrows Project – A Small Reclamation Project Act (SRPA) Loan
- Appendix D – Fish and Wildlife Coordination Act Report
- Appendix E – Cultural Resource Coordination
- Appendix F – 2006 Eutrophication Study
- Appendix G – Environmental Commitments
- Appendix H – Comments and Responses
- Appendix I – Narrows Environmental Impact Statement Modeling Methodology
- Appendix J – Small Reclamation Projects Act Loan Application
- Appendix K – Section 404(B)(1) Analysis Narrows Project, San Pete Water Conservancy District

CHAPTER 2

# The Alternatives Considered, Including the Proposed Action Alternative

## 2.0 INTRODUCTION

As the lead Federal agency for this FEIS, Reclamation's action under review is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow SWCD to use 304.5 acres of Reclamation withdrawn land. The USACE and USDA Forest Service also must make decisions based on this FEIS. To fully explore the effects of the proposed action and possible alternate courses of action, the SWCD, working with Reclamation and the other cooperating agencies, developed an array of alternatives to answer the issues raised in chapter 1. In chapter 2, you will find:

- A description of the Proposed Action and the other alternatives that were analyzed.
- A comparison of how the alternatives would achieve the purpose of and need for the action.
- A comparison of how the alternatives address the issues identified in chapter 1.

## 2.1 THE PROCESS USED TO DEVELOP THE ALTERNATIVES

The National Environmental Policy Act requires all agencies to write a detailed statement for major Federal actions having a significant effect on the environment, which must include a discussion of alternatives to the proposed action (see section 102(2)(c) of NEPA). In addition, all Federal agencies must study, develop, and describe appropriate alternatives to recommended courses of action in any proposal that involves unresolved conflicts concerning alternative uses of available resources. To be considered reasonable, each alternative in the array (except "no action") must meet the proposal objectives (chapter 1) and the environmental standards (selection criteria).

Reclamation, as the lead agency, formed an interdisciplinary team that consisted of various Federal and State agencies and the SWCD. This team was formed to develop a set of selection criteria that could be used to formulate alternatives to the Narrows Project that would meet the purpose of and need for the proposed non-Federal Narrows Project. The selection criteria are:

1. The project must include an agricultural and municipal irrigation water supply as a project purpose and provide expected project benefits for at least the duration of the loan repayment period.
2. The project must provide an additional water supply to north Sanpete County during the season when it is needed.
3. The project must comply with all statutory and regulatory requirements and guidelines including Section 404 of the Clean Water Act, the National Historic Preservation Act (NHPA), and the Endangered Species Act.
4. The project must satisfy Small Reclamation Project Act requirements. The SRPA requires that a project be technically and financially feasible and in

compliance with environmental requirements. To be considered financially feasible, the following would apply:

- The project sponsor should pay a minimum of 25% of the project costs at the time of construction.
- Loan repayment must use 100% of the project's irrigation amortization capacity (with certain exceptions), and repayment must be completed in 40 years or less. The amortization capacity is a measure of farmers' and ranchers' ability to repay.
- The loan factor (a measure of Federal interest subsidy) for the project must be 0.5 or less.

SRPA allows some flexibility in meeting the financial feasibility requirement. In some situations, the irrigation amortization capacity may result in a repayment period extending beyond 40 years or a loan factor that exceeds 0.5. The sponsor, at its discretion, may use other financial assets to either increase the annual payment or increase the upfront cost share to reduce the amount of the loan. Either, or a combination, of these options may reduce the repayment period and the loan factor to acceptable levels. In other words, the sponsor may contribute funds in excess of its ability to pay, relying then on a "willingness to pay" to ensure financial feasibility.

This willingness to pay component recognizes the limitations placed by Reclamation on computing the agricultural benefits component of the farm budget.[1] The farm budget limitations may underestimate the sponsor's irrigation amortization capacity, suggesting that the farmer's ability to repay the loan may be less than is actually the case. Willingness to pay also allows the sponsor to consider other intrinsic values of the water that normally would not be considered or would be difficult to consider in an economic evaluation (benefit-cost analysis). The sponsor is responsible to determine if the value of the water benefits justifies its cost. In SRPA cases, where Reclamation's involvement is limited to making a loan, use of willingness to pay is an appropriate approach. The SRPA requires the sponsor to demonstrate only that additional financial assets exist and that the sponsor commits to using these assets for the project.

5. The project must divert and store water under legal claim of right and priority in full compliance with State law.

## 2.2 Detailed Description of Alternatives

### 2.2.1 No Action Alternative

The No Action Alternative represents the conditions of the affected area if Reclamation does not approve the SRPA loan and use of withdrawn lands by SWCD for the non-Federal Narrows Project (figure 2-1). It establishes the baseline for evaluating the environmental impacts of providing a supplemental water supply to north Sanpete County. It also establishes anticipated conditions in the affected two-county area without further development and assumes that irrigation operations would continue according to historic use.

[1] The farm budget is used to compute the irrigation amortization capacity.

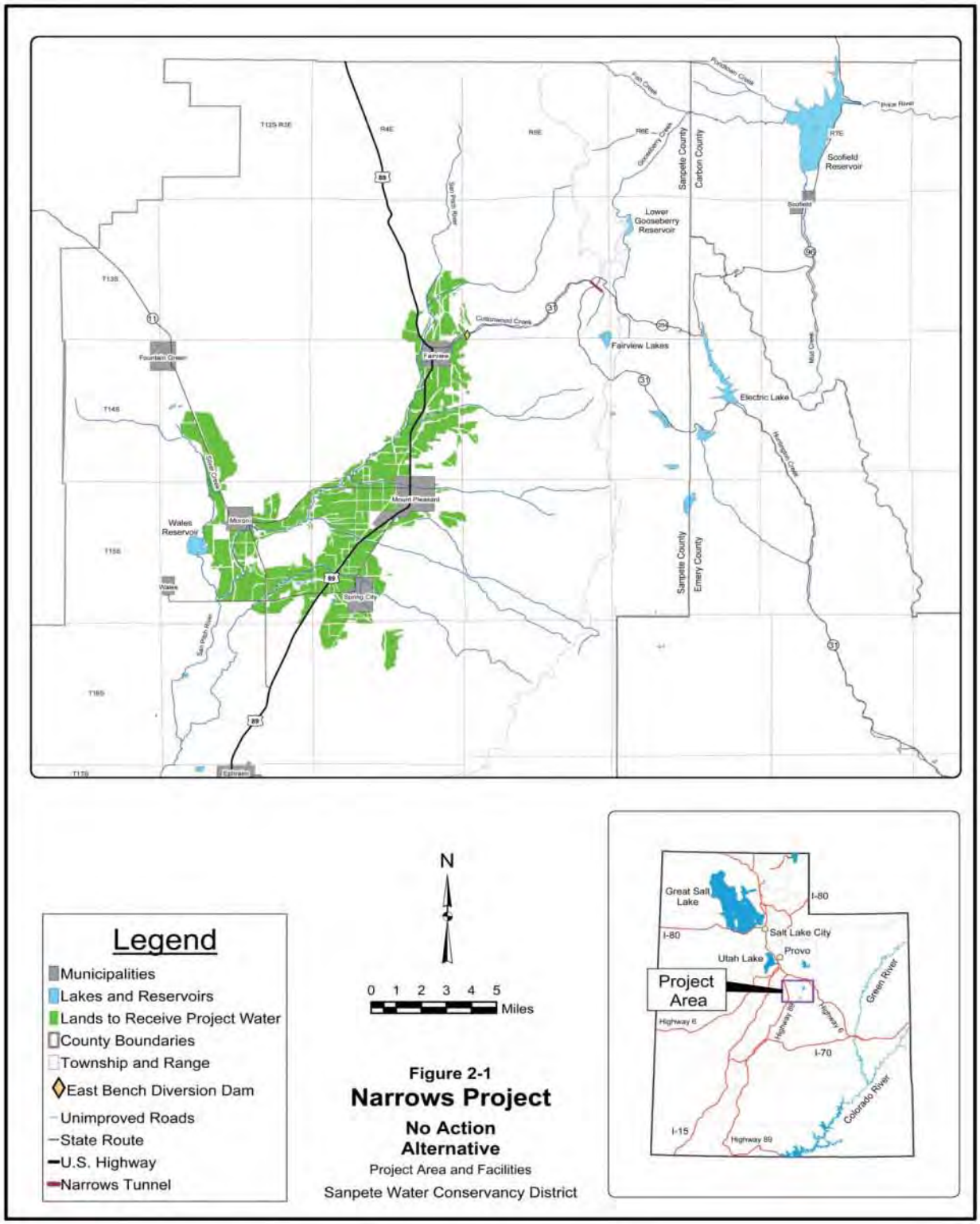



**Figure 2-1.—Narrows Project, No Action Alternative, Project Area and Facilities.**

Under this alternative, the Narrows Dam and Reservoir would not be constructed. Without the dam construction, there would be no need to relocate SR-264; and there would be no recreational facilities constructed at the reservoir site. The East Bench, Oak Creek, and Upper Cottonwood Creek Pipelines would not be built. The demand on municipal water supplies in Fairview, Mount Pleasant, Spring City, and Moroni would continue to increase as supplies for outdoor municipal uses run short and as the population increased. Most likely, there would be a conversion of agricultural water to municipal use as the demand for municipal water increased with a growing population.

Water conservation measures would continue to be implemented. These conservation measures would reduce average shortages on irrigated farmland to about 29.5% or about 15,250 acre-feet per year. Implementing new conservation measures most likely would reduce irrigation return flows now supplying wetlands, aquatic habitat, and downstream users by an estimated 3,500 acre-feet per year.

There would be no wetlands, wildlife, or fisheries mitigation measures implemented under the No Action Alternative because there would be no impact to existing wetlands and wildlife habitat. Streamflows in Gooseberry and Fish Creeks would remain unaltered from their present state. Under this plan, no flat water fishery would be developed in the proposed reservoir basin.

### 2.2.2 Proposed Action Alternative

If SWCD obtains its requisite financing, either through the SRPA loan or from other private funding source(s), and if Reclamation approves the land use, a supplemental water supply may be developed for presently irrigated lands and M&I water users in north Sanpete County. This additional water supply would satisfy the 1984 Compromise Agreement.

The Proposed Action would provide funding for and authorize the use of Federal lands by SWCD to build a private dam and reservoir to provide north Sanpete County an average annual supply of 4,281 acre-feet of supplemental irrigation water for 15,420 acres of presently irrigated farmland and 855 acre-feet of water for municipal use. The project facilities would include construction of the 17,000-acre-foot Narrows Dam and Reservoir on Gooseberry Creek, pipelines to deliver the water to existing water distribution systems, rehabilitation of the existing 3,100-foot Narrows Tunnel to control releases, and relocation of 2.9 miles of SR-264. The dam would be 120 feet high with a crest length of 550 feet and crest width of 30 feet.

SWCD's non-Federal Narrows Project would include a transmountain diversion of water from the Gooseberry Creek drainage of the Price-Green-Colorado River Basins to the San Pitch-Sevier River of the Great Basin. Geographically, the project facilities are located in close proximity to the drainage divide between the Price River system and the San Pitch River system. The general location is shown on the location map at the front of this document.

The Price River flows southeast to the Green River, a tributary of the Colorado River. The San Pitch River flows southwest to the Sevier River, which is completely consumed in the Bonneville Basin, a part of the arid Great Basin. The county line dividing Sanpete County and Carbon County is located more than 6 miles downstream from and about 3 miles east of the proposed Narrows damsite on Gooseberry Creek.

The proposed damsite, the transmountain Narrows Tunnel, and the project water distribution facilities are all located in Sanpete County. The source of the project

water supply generally arises in Sanpete County and naturally flows into Carbon County and the Price River system, unless the flows are captured and diverted transmountain to Sanpete County. The service area of the Narrows Project would be situated in the San Pitch River drainage.

A dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel to Cottonwood Creek. Pipelines would be constructed to deliver the water to existing water distribution systems located near Fairview, Utah. Recreation facilities would be developed at the reservoir, and a 2,500-acre-foot minimum pool for fish habitat would be maintained.

Mitigation measures would be implemented to offset adverse impacts to wetlands, terrestrial wildlife, and stream fisheries. In addition to mitigation measures to offset project impacts, other measures would be included to enhance or improve fish and wildlife habitat. Additional water conservation measures would be required independent of the Proposed Action. However, according to SWCD, only those water users who have implemented or would agree to implement water conservation measures would be eligible to receive project water. These practices would include improved water conveyances such as lined canals, pipelines, or improved irrigation practices such as sprinklers or gated pipe.

SWCD would develop a comprehensive mitigation plan including environmental monitoring and maintenance programs that would ensure that aquatic and wildlife habitat replacement needs are met.

#### 2.2.2.1 Water Supply and Use

The non-Federal Narrows Project water supply would come from Upper Gooseberry Creek and its tributaries. The Upper Gooseberry Creek drainage (including Fairview Lakes) has an average inflow of about 9,200 acre-feet of water. Of that amount, 2,300 acre-feet are diverted transmountain through the existing Narrows Tunnel by the Cottonwood-Gooseberry Irrigation Company (CGIC). This diversion consists of 1,900 acre-feet from Gooseberry Creek and 400 acre-feet from Boulger Canyon. The Fairview Lakes water (2,300 acre-feet) is not considered part of the Narrows Project water. The majority of the flow in Upper Gooseberry Creek comes from direct snowmelt. Peak flows in May and June are several times greater than flow during the remainder of the year.

Under existing water rights agreements, a maximum of 5,400 acre-feet per year of project water would be released through the Narrows Tunnel. The reservoir would provide long-term carryover storage for consecutive drought years. With the long-term carryover storage, the Proposed Action would produce an annual average yield of 5,136 acre-feet per year. Table 2-1, Water Allocation and Use for the Narrows Project, shows the allocation of project yield between irrigation and M&I uses.

**Table 2-1.—Water Allocation and Use for the Narrows Project**

| Water Source or Use | Acre-feet |
|---|---|
| Gooseberry Creek drainage | 5,136 |
| M&I[1] | 855 |
| Irrigation[1] | 4,281 |

[1] It is estimated that the balance between M&I and irrigation water will change as the demand for M&I use increases (M&I use will increase, and irrigation use will decrease).

For purposes of this EIS, the average annual M&I delivery is projected to be 855 acre-feet per year, although initially, it would be a lesser amount (probably 500 acre-feet per year) for the M&I allotment. Of the 5,136-acre-foot average annual project

yield, 855 acre-feet would be used for the M&I allotment and the remaining 4,281 acre-feet for the irrigation allotment. Future requirements for additional M&I water could be as high as 2,800 acre-feet per year.

The Narrows Project irrigation supplies, along with present irrigation supplies, are expected to be used primarily for production of crops such as alfalfa and grass hay to support beef and dairy enterprises. The Narrows Project irrigation supplies would be used primarily in the latter part of the growing season when existing water shortages are the most critical.

Figure 2-2 shows how the proposed Narrows Project's water supply would be used to augment existing local agricultural supplies. Curve 1 (crop consumptive use) shows the net irrigation requirement (crop water needs) for the project-eligible lands. This is the same as Curve 1 in figure 1-2. Curve 2 (diversion demand with efficiency improvements) shows the diversion demand that would result after implementing the planned efficiency improvements. (See Curve 3 in figure 1-2.) Curve 3 (local supply) shows the local supply, and Curve 4 (local and project supply) shows the local supply augmented by the project supply. Curves 5 (needs met local supply) and 6 (needs met local and project supply) show how the crop water needs would be satisfied by local supplies and local supplies augmented by project supplies. (Curve 5 is the same as Curve 6 in figure 1-2.)

As noted in section 1.5.2, under implementation of the Narrows Project, there would be an estimated 15,250-acre-foot average annual shortage in the diversion demand, assuming a portion of the nongrowing season precipitation was retained in the soil root zone to help meet early-season water needs. With the project water, the annual average shortage could be reduced to about 10,969 acre-feet per year or 21.1% of the diversion demand. With below average precipitation, the remaining shortage would be about 29,698 acre-feet per year or about 57.5%. In either case, the remaining shortage still would be considerably greater than the optimal 5% used for a planning target. Likewise, Curve 6 shows that, even though project supplies would provide additional water, significant soil moisture deficits still would be a serious concern. The remaining shortage is great enough to warrant the pursuit of other measures to further improve irrigation efficiencies or augment water supplies.

Section 1.5.2 discusses how implementing efficiency improvements would reduce the amount of irrigation water losses. The efficiency improvements would be expected to reduce water available to wetlands, aquatic habitat, and downstream users by up to 3,500 acre-feet per year. However, inefficiencies in project water would offset the 3,500-acre-foot-per-year reduction by about 1,820 acre-feet per year. This would result in a net loss to wetlands, aquatic habitat, and downstream users of about 1,680 acre-feet per year.

#### 2.2.2.2 Construction Features and Project Operations

##### *2.2.2.2.1 General*

The principal construction features of the Narrows Project would consist of one reservoir and three pipelines. Narrows Dam and Reservoir (figure 2-3) would be constructed on Gooseberry Creek and would provide storage for the project water supply. Oak Creek Pipeline would convey water from an existing diversion dam located on Cottonwood Creek northward to the Oak Creek Irrigation Company, north of the community of Fairview. The East Bench Pipeline would convey project water from the same existing diversion dam on Cottonwood

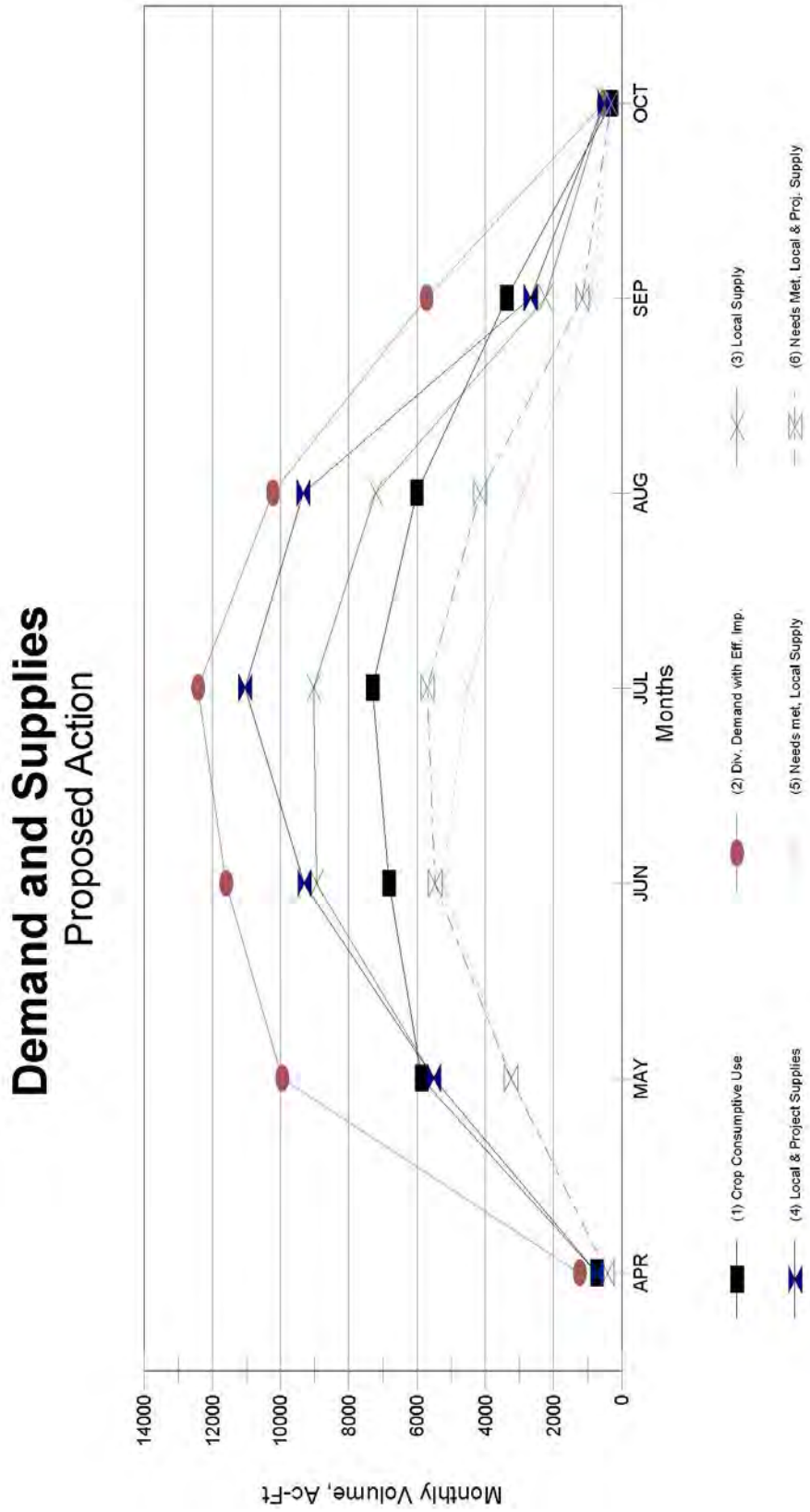



**Figure 2-2.—Demand and Supplies, Proposed Action.**

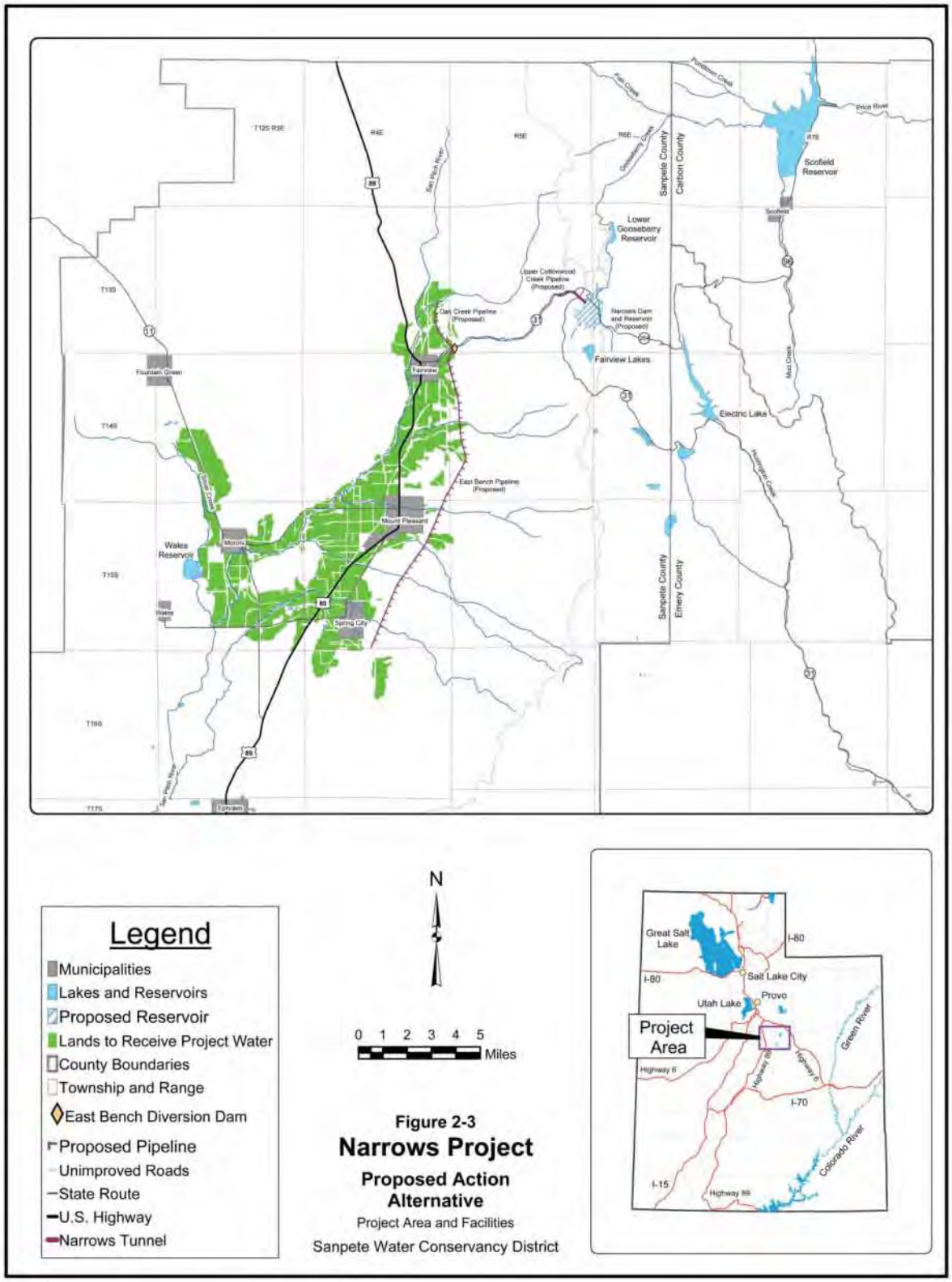



**Figure 2-3.—Narrows Project, Proposed Action, Project Area and Facilities.**

Creek southward to areas of use along the east bench. Upper Cottonwood Creek Pipeline would carry project water from the Narrows Tunnel outlet to a point 300 feet downstream from the confluence of Cottonwood Creek and Left Hand Fork to protect the stream channel above that point from increased flows that would occur without the pipeline.

Other important features of the project would include rehabilitating the existing Narrows Tunnel to control releases; relocating SR-264; modifying parts of Forest Development Road (FDR) Nos. 50124, 50150, and 50225; and modifying the snowmobile parking area along FDR No. 50150. Recreation facilities, primarily for boating, fishing, camping, and picnicking, would be provided at Narrows Reservoir to help satisfy projected recreation needs in the area. Title to the dam and appurtenant water facilities would be in the name of SWCD. Title to the land underlying those facilities and associated recreation facilities would remain in the name of the United States and under Reclamation management.

Specific proposed fish and wildlife mitigation measures include the following:

- Restoring year-round flows in two small tributaries to Gooseberry Creek (above the proposed Narrows Reservoir); providing minimum instream flows of 1.0 cfs in Gooseberry Creek below Narrows Dam.
- Providing a multiple-level outlet at Narrows Dam to regulate the temperature of releases to Gooseberry Creek from Narrows Reservoir.
- Modifying and/or stabilizing streambanks and associated riparian zones along Middle Gooseberry Creek.
- Providing releases from the Narrows Reservoir into Gooseberry Creek for flushing flows.
- Acquiring and/or improving stream channel for fish habitat (Middle Gooseberry Creek).
- Providing winter releases to Cottonwood Creek.
- Providing summer flows in lower Cottonwood Creek.
- Constructing a pipeline in the Upper Cottonwood Creek area to convey project water outside the stream channel (from the tunnel outlet to a point 300 feet downstream from the confluence of Cottonwood Creek and Left Hand Fork).
- Providing a minimum 2,500-acre-foot conservation pool in Narrows Reservoir for fish.
- Reducing external phosphorus loading to Scofield Reservoir.
- Providing mitigation and enhancement of upland habitat (quantified in terms of mule deer and Brewer's sparrow habitat units, each of which represent other wildlife species dependent on similar habitat) in the following ways:
  - Acquiring conservation easements around the Narrows Reservoir.
  - Acquiring and fencing land adjacent to the Price River below Scofield Reservoir to protect wildlife habitat.
  - Creating new wetlands and enhancing existing wetlands to mitigate for 100 acres of wetlands areas inundated by the reservoir and affected by changes in the stream channels.

#### *2.2.2.2.2 Design and Operation*

**2.2.2.2.2.1 Narrows Dam and Reservoir.—** Narrows Dam and Reservoir would be constructed on Gooseberry Creek, about 9 miles east of Fairview, Utah (see figure 2-3). The dam would be a zoned earthfill embankment structure using locally available earth material. The surface elevation of the proposed reservoir would be at 8,690 feet mean sea level (msl). The embankment would have 3:1 (horizontal to vertical) slopes upstream and downstream. The proposed crest width of 30 feet would allow SR-264 to cross the dam. The embankment zones would consist of a relatively impervious core, a random zone both upstream of and downstream from the core, and a rockfill zone on the upstream face for slope protection. The embankment would contain an estimated total volume of 363,000 cubic yards of material. The dam would be designed to withstand effects induced by seismicity associated with mining of the coal reserves east of the East Gooseberry Fault (approximately 1 mile away).

Narrows Reservoir would have two main outlets—the Gooseberry Creek outlet and the Narrows Tunnel outlet. The Gooseberry outlet would be constructed through the dam to provide downstream releases for fisheries and emergency evacuation of reservoir water. This outlet would have a 305-cubic-foot-per-second (cfs) capacity. Multiple intakes would be provided to allow temperature control of water released to Gooseberry Creek. The Narrows Tunnel outlet would control releases through the mountain ridge for the transmountain diversion.

Preliminary designs for the dam call for separate low flow intakes at three different levels within the reservoir. These intakes would have their own gates and would be able to deliver up to a 10-cfs release each, even when the main outlet was being inspected or maintained.

The spillway would be a drop inlet (morning glory, so called because of its resemblance to the shape of the flower) structure and would have a 775.0-cfs discharge capacity. The probable maximum thunderstorm flood could be safely stored in the reservoir without overtopping the dam. However, the spillway capacity, combined with that of the two outlet works, would protect the dam against the 100- and 10,000-year snowmelt floods.

The reservoir formed behind the dam would extend about 2 miles up Gooseberry Creek and would have a total capacity of 17,000 acre-feet and a water surface area of about 604 acres. All of the average annual storable flows (excluding Fairview Lakes) to the reservoir, about 8,185 acre-feet, would come from the Gooseberry Creek drainage.

Narrows Reservoir's active capacity, or that portion of stored water that would be used to satisfy project water needs, would consist of 14,500 acre-feet. Of this amount, 4,500 acre-feet would be dedicated to providing instream flows in Gooseberry Creek below the dam. The dead and inactive capacities of about 2,500 acre-feet would form the reservoir's minimum pool and would not be drawn upon to benefit recreation and fishing use at the reservoir (the 2,500 acre-feet of storage is inactive because it is below the elevation of the tunnel and cannot be diverted to Sanpete Valley).

The proposed reservoir is designed for long-term carryover storage. The dead and inactive storage would be more than adequate to store the 100-year inflow of sediment into the reservoir. Less than 20 acre-feet of sediment would accumulate in a 100-year period, which is less than 1% of the inactive capacity. A summary of the design data for the proposed Narrows Dam and Reservoir, two structural alternatives, and the No Action Alternative is shown in table 2-2.

Narrows Reservoir would fluctuate on a seasonal basis as water is released during the irrigation season. The drawdown would average 9 feet annually. On an average basis, the exposed shoreline area would be 113 acres. This is the difference between the average annual high water surface area and the average annual low water surface area.

Automated flow measurement devices would be installed to collect data in real time using radio or satellite communications. These devices would measure flow at the following locations:

- Discharges from Fairview Lakes
- Discharge from Narrows Dam to Gooseberry Creek
- Flow of Gooseberry Creek at USDA Forest Service campground
- Discharge from Narrows Tunnel
- Flow of Cottonwood Creek near the mouth of the canyon

These data would be made available to the public on an Internet Web site.

**2.2.2.2.2.2 Oak Creek Pipeline.—**The Oak Creek Pipeline would be a 10-inch-diameter polyvinyl chloride (PVC) buried pipeline with a capacity of 2.5 cfs and a length of 2.5 miles. The pipeline would convey water from an existing diversion dam on Cottonwood Creek to the Oak Creek Irrigation Company, north of Fairview. A right-of-way, 30 feet wide and 2.5 miles long, would be required.

**2.2.2.2.2.3 East Bench Pipeline.—**The East Bench Pipeline would convey project water from an existing diversion dam on Cottonwood Creek southward to areas of use along the east bench. The pressurized pipeline would have a total length of 13.5 miles (see figure 2-3) and would have a 21.5-cfs capacity at its head. The pipeline would include 1.4 miles of reinforced concrete pipe, 4.2 miles of concrete cylinder pipe, and 7.9 miles of PVC pipe. Pipe diameters would range from 27–18 inches.

The pipeline would deliver water to the Spring Creek, Birch Creek, North Creek, Pleasant Creek, Twin Creek, Cedar Creek, and Horseshoe Irrigation Companies. Water delivered to each irrigation company would be discharged from the pipeline into the existing regulating pond for each company's pressurized irrigation system. This pipeline also would have a 30-foot-wide right-of-way.

**2.2.2.2.2.4 Upper Cottonwood Creek Pipeline.—**A 50.0-cfs capacity, reinforced concrete pipeline would be constructed from the existing transmountain Narrows Tunnel outlet to a point 300 feet downstream from the confluence of Cottonwood Creek and Left Hand Fork. The 30-inch-diameter pipeline would carry project water outside the stream to prevent damage to the channel. The pipeline would be constructed in the shoulder of SR-31 and would have a length of about 0.8 mile.

At the Narrows tunnel outlet, a control structure would divide the flow, allowing releases into Cottonwood Creek to maintain minimum instream flows and improve the fishery, while the remainder of the flow would be conveyed to the pipeline. The pipeline flow would be discharged into Cottonwood Creek 300 feet downstream from the confluence with Left Hand Fork, where an energy dissipation structure would be constructed to reduce flow velocity and control streambed degradation. Energy dissipation would be provided before flows were discharged into Cottonwood Creek. A highway right-of-way 30 feet wide and 0.8 mile long would be required. About half of this right-of-way would be on Reclamation withdrawn lands and the other half on privately owned lands.

**Table 2-2.—Summary of Design Data for Narrows Project for All Alternatives**

| Item | Unit | No Action | Proposed Action | Mid-Sized Reservoir | Small Reservoir |
|---|---|---|---|---|---|
| Dam | | | | | |
| Height | feet | N/A | 120 | 110 | 100 |
| Crest length | feet | N/A | 550 | 475 | 425 |
| Crest width | feet | N/A | 30 | 30 | 30 |
| Material volume | cubic yards | N/A | 363,000 | 292,000 | 220,000 |
| Discharge capacity | | | | | |
| Outlet works | cfs | N/A | 305 | 258 | 210 |
| Spillway | cfs | N/A | 775 | 775 | 775 |
| Spillway elevation | msl | N/A | 8,690 | 8,680 | 8,670 |
| Reservoir capacity | | | | | |
| Active storage | acre-feet | N/A | 14,500 | 9,950 | 5,400 |
| Inactive and dead storage | acre-feet | N/A | 2,500 | 2,500 | 2,500 |
| Total | acre-feet | N/A | 17,000 | 12,450 | 7,900 |
| Surface area | | | | | |
| At top of active capacity | acres | N/A | 604 | 489 | 362 |
| At top of inactive and dead capacity | acres | N/A | 144 | 144 | 144 |
| Average during recreation season | acres | N/A | 454 | 277 | 238 |
| Drawdown | | | | | |
| Average annual | feet | N/A | 9 | 11 | 14 |
| Average during recreation season | feet | N/A | 8 | 10 | 11 |
| Maximum | feet | N/A | 26 | 30 | 22 |
| Average annual | acre-feet | N/A | 3,974 | 3,773 | 3,478 |
| Average during recreation season | acre-feet | N/A | 3,512 | 3,300 | 3,007 |
| Pipelines | | | | | |
| Oak Creek | | | | | |
| Length | miles | N/A | 2.5 | 2.5 | 2.5 |
| Capacity | cfs | N/A | 2.5 | 2.5 | 2.5 |
| Diameter | inches | N/A | 10 | 10 | 10 |
| East Bench | | | | | |
| Length | miles | N/A | 13.5 | 13.5 | 13.5 |
| Capacity | cfs | N/A | 21.5 | 21.5 | 21.5 |
| Diameter | inches | N/A | 27–18 | 27–18 | 27–18 |
| Upper Cottonwood Creek | | | | | |
| Length | miles | N/A | 0.8 | 0.8 | 0.8 |
| Capacity | cfs | N/A | 50 | 50 | 50 |
| Diameter | inches | N/A | 30 | 30 | 30 |
| Narrows Tunnel rehabilitation | | | | | |
| Length | feet | N/A | 3,100 | 3,100 | 3,100 |
| Capacity | cfs | N/A | 60 | 60 | 60 |
| Diameter | inches | N/A | 36 | 36 | 36 |
| SR-264 relocation | | | | | |
| Length | miles | N/A | 2.9 | 2.9 | 2.9 |
| Width | feet | N/A | 24 | 24 | 24 |

The possibility of extending Upper Cottonwood Creek Pipeline the entire length of the canyon was also explored; but, due to the topography and geology of the canyon, such a pipeline would be infeasible and potentially environmentally damaging. A total of 104 landslides, most of which are active, have been mapped in the canyon. The topography of the canyon suggests that the most likely location for the pipeline would be within the existing highway alignment. However, due to the landslides, the highway has continual stability problems; and repairs are needed on an annual basis. This instability would present unacceptable safety and maintenance problems for the high-pressure pipeline. Construction of the pipeline also would increase significantly project costs and costs to water users.

**2.2.2.2.2.5 Narrows Tunnel Rehabilitation.—**The Narrows Tunnel is an existing water conveyance tunnel approximately 3,100 feet long. The 8-foot-diameter tunnel, which was completed in 1968, was constructed to divert irrigation water to the Fairview area and eventually to serve as the outlet for Narrows Reservoir. The tunnel was not concrete-lined as planned; and since its construction, the tunnel has experienced severe stability problems. Steel sets with wooden lagging were installed in selected areas of the tunnel to support the unstable areas. The steel sets, however, were widely spaced; and loose rubble significantly loaded the wooden lagging between sets. With time, the lagging began to fail, permitting roof and rib sloughing over significant portions of the tunnel. When it became evident that the tunnel could eventually close, a 36-inch corrugated metal pipe was installed through the least stable tunnel sections to maintain a waterway. This measure is considered to be only a temporary fix because the corrugated metal pipe (CMP) eventually would collapse due to rust or excessive earth loads.

The tunnel was rehabilitated in 2011 to have a 60-cfs discharge capacity. A control gate would be installed near the tunnel inlet to regulate releases through the tunnel. Remote control of the Narrows Tunnel operating gate would be provided to regulate automatically the releases through the tunnel. These controls would be coupled to an automated stream gauging station on Cottonwood Creek. The streamflow in Cottonwood Creek would be monitored constantly by these controls. As the streamflow increased during high runoff events such as thunderstorms, the tunnel operation would be discontinued when the flow exceeded 100 cfs near the mouth of the canyon. An automated gauging station would measure flow data and communicate with an automated gate controller at the tunnel. Under this operating regime, the project flows through the tunnel would not increase streamflows above what is considered safe for channel stability. Increased flows under project conditions would be well below the 50-year channel-forming discharge.

**2.2.2.2.2.6 State Route 264 Relocation.—**Narrows Reservoir would inundate about 0.8 mile of SR-264, which provides access between Fairview and Scofield, Utah. Under the proposed project, this road would be routed around the perimeter of the existing snowmobile parking area. The road would be relocated to include 0.3 mile of FDR No. 50150 and No. 50124 (gravel road) to Lower Gooseberry Reservoir and by constructing 2.6 miles of new road and providing asphalt surfacing for the entire length of the relocation. This new road would cross Narrows Dam. The road relocation would increase the travel distance between Fairview and Scofield by 1.2 miles. The relocated road would have a total pavement width of 24 feet and would be designed to the same standard as the existing road.

**2.2.2.2.2.7 Recreation Facilities.—**Public recreation facilities for the Narrows Project would be located along the northwest shore of Narrows Reservoir (see figure 2-3). The facilities would include a boat ramp, boat slips, a day use area with 10 picnic sites, restroom facilities, and a 60-unit campground. Access for the handicapped would be provided. All recreation facilities and water systems (nonsurface source) would be constructed to USDA Forest Service standards. The water source for the recreation facilities would be required to meet State of Utah drinking water standards. Although a formal agreement has not been reached, it is anticipated that USDA Forest Service would administer the recreation facilities at the Narrows Reservoir under an operation agreement with SWCD and Reclamation. Title to the recreation facilities would remain in the name of the United States.

#### *2.2.2.2.3 Fishery Mitigation Measures*

A total of 11 fishery mitigation measures have been included in the project to mitigate for adverse impacts. To the extent possible, an attempt was made to mitigate "in place" and "in kind."

**2.2.2.2.3.1 Restore Streamflow in Gooseberry Creek Tributaries.—**Implementing this aquatic mitigation procedure would consist of altering the release of water from Fairview Lakes, which are owned and operated by CGIC. Presently, during the spring runoff period, water is stored in Fairview Lakes and released for irrigation use in the Fairview area. This release is a transbasin diversion of water to the San Pitch River drainage. With the historic operational pattern, the small unnamed tributaries to Gooseberry Creek located downstream from Fairview Lakes are dry several months each year. This mitigation measure involves providing year-round releases, averaging about 2.6 cfs, from Fairview Lakes into two of these tributaries to Gooseberry Creek. This amounts to a 1.3-cfs average flow per channel. The total annual amount of water that is released from Fairview Lakes would not be changed. However, the flow would be dispersed during the entire year rather than the present 18- to 20-week discharge period, resulting in a higher water level in the lakes for more of the irrigation season.

Water released from Fairview Lakes during the year would be captured and stored in Narrows Reservoir. Upon notification by CGIC, the Fairview Lakes water in Narrows Reservoir would be released through the Narrows Tunnel to the San Pitch River drainage.

This mitigation measure would provide not only aquatic mitigation benefits to the Narrows Project but also both aesthetic and recreational benefits to Fairview Lakes. These benefits would be a result of CGIC being able to maintain the lakes at higher water levels during more of the prime summer recreational season.

SWCD would be responsible for entering into operating agreements necessary to implement these year-round releases. SWCD also would ensure that the releases were made according to environmental commitments. Approval of a loan under the SRPA would be contingent upon securing these agreements with CGIC and an endorsement of the environmental commitments by SWCD.

Implementing this mitigation measure would result in creating approximately 2.3 stream miles of spawning and rearing habitat for cutthroat trout.

**2.2.2.2.3.2 Provide Minimum Flows Below Narrows Dam.—**The project plan calls for a 1.0-cfs minimum year-round release from Narrows Reservoir to Gooseberry Creek.

That flow, combined with flows from springs located immediately below the dam, would be expected to produce a streamflow of at least 1.5 cfs at the Gooseberry Campground. If the flow at the campground is less than the expected 1.5 cfs, then up to an additional 0.25 cfs would be released to help achieve that flow rate.

**2.2.2.2.3.3 Provide a Multiple-Level Intake at Narrows Dam.—**A multiple-level intake would be provided at Narrows Dam to regulate the temperature of water released to Gooseberry Creek. Each of the three intakes, planned at elevations 8,640; 8,660; and 8,680 feet, respectively, would be designed with a 10.0-cfs capacity.

**2.2.2.2.3.4 Stabilize Streambanks Along Middle Gooseberry Creek.—**This mitigation measure would involve modifying Gooseberry Creek channel between Lower Gooseberry Reservoir and Narrows Dam to provide better habitat with the reduced flows. It is expected that the channel eventually would narrow by itself due to the decreased flow. However, to expedite the process, certain manmade improvements would be made.

Two alternative methods of accomplishing this mitigation measure were considered. The first method, which was eliminated from consideration due to its more invasive approach, would involve using earthmoving equipment to place fill material within the existing high water line of the stream to narrow the channel.

The second and selected alternative method would involve a less intrusive approach, which would consist of installing a variety of fish habitat enhancement structures in the existing stream channel. These structures could include cover logs, depositional structures, organic riprap treatments, rock clusters, rock deflectors, and rock weirs. Example sketches of several of these enhancement structures are shown in figures 2-4 to 2-7. The objectives of these various structures would be to provide new pool habitat, hiding cover, high flow refuge area, scour holes, and spawning habitat for trout as well as a minimum level of channel erosion control.

Prior to SWCD constructing these improvements, SWCD would coordinate with the USDA Forest Service, Service, USACE, Utah Division of Wildlife, and Utah Division of Water Rights (UDWR). A qualified fluvial geomorphologist would develop a detailed plan based on the second alternative described above. A 200-foot-wide right-of-way corridor also would be acquired where the stream runs through private land. Fencing also would be provided where needed to protect the stream from livestock. Middle Gooseberry Creek would be used as spawning and rearing habitat for cutthroat trout.

**2.2.2.2.3.5 Provide Flushing Flows and Other Releases to Gooseberry Creek.—**The project would provide releases from Narrows Reservoir to Gooseberry Creek in excess of the minimum 1.0-cfs release described above. These additional releases would be used to provide additional instream flows or to flush accumulated silt and fine sediments from the streambed to enhance spawning habitat. UDWR has expressed interest in using this water to provide additional inflow to Lower Gooseberry Reservoir during the critical winter period when dissolved oxygen (DO) levels in the reservoir are low. The project would provide an average of 300 acre-feet per year of additional water from carryover storage in Narrows Reservoir for release to Gooseberry Creek. While this water could be used to either augment instream flows or flush sediment, the environmental effects analyses in chapter 3 assumes the entire volume is used annually for flushing the downstream channel.

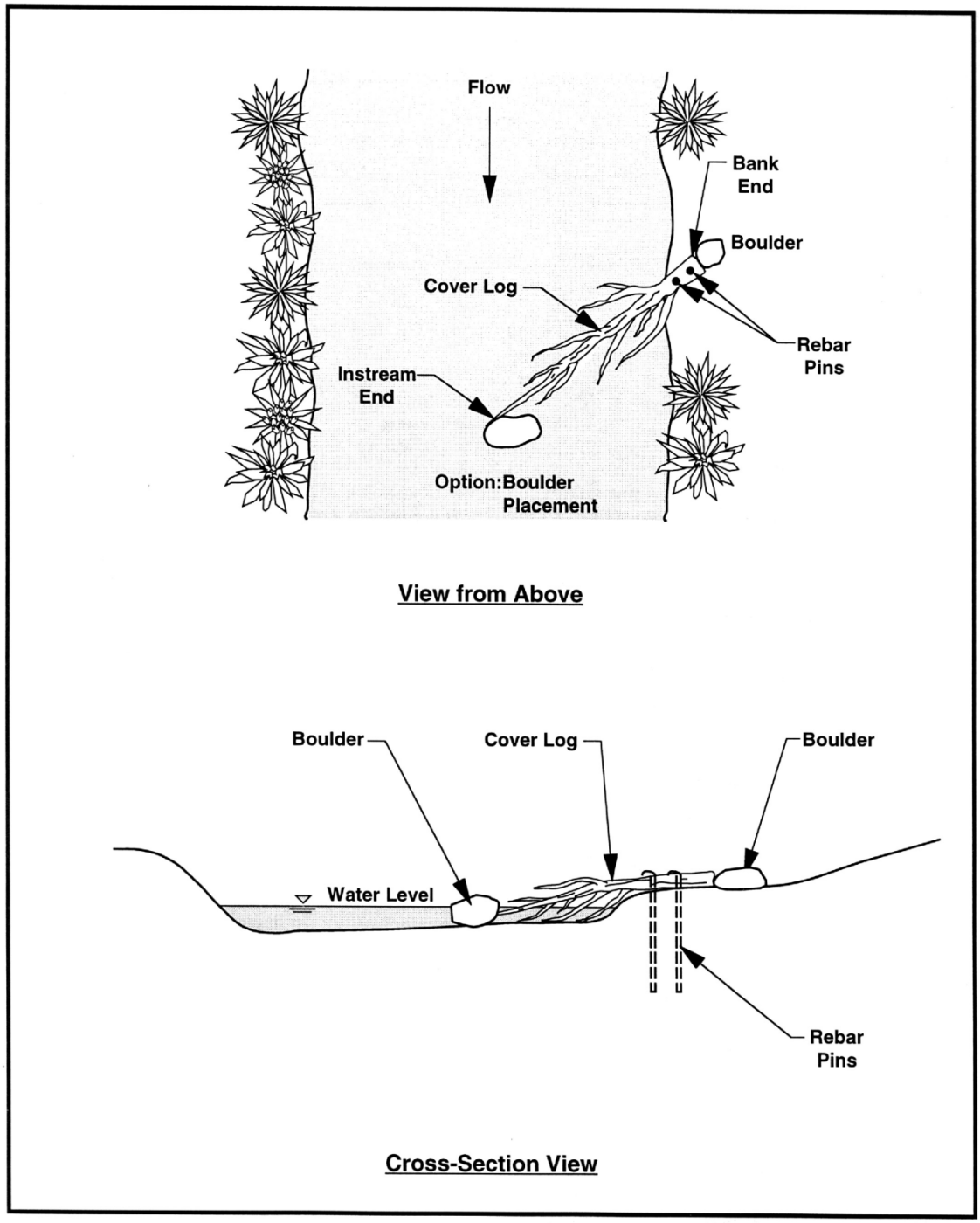



**Figure 2-4.—Schematic of Cover Log Structure.**

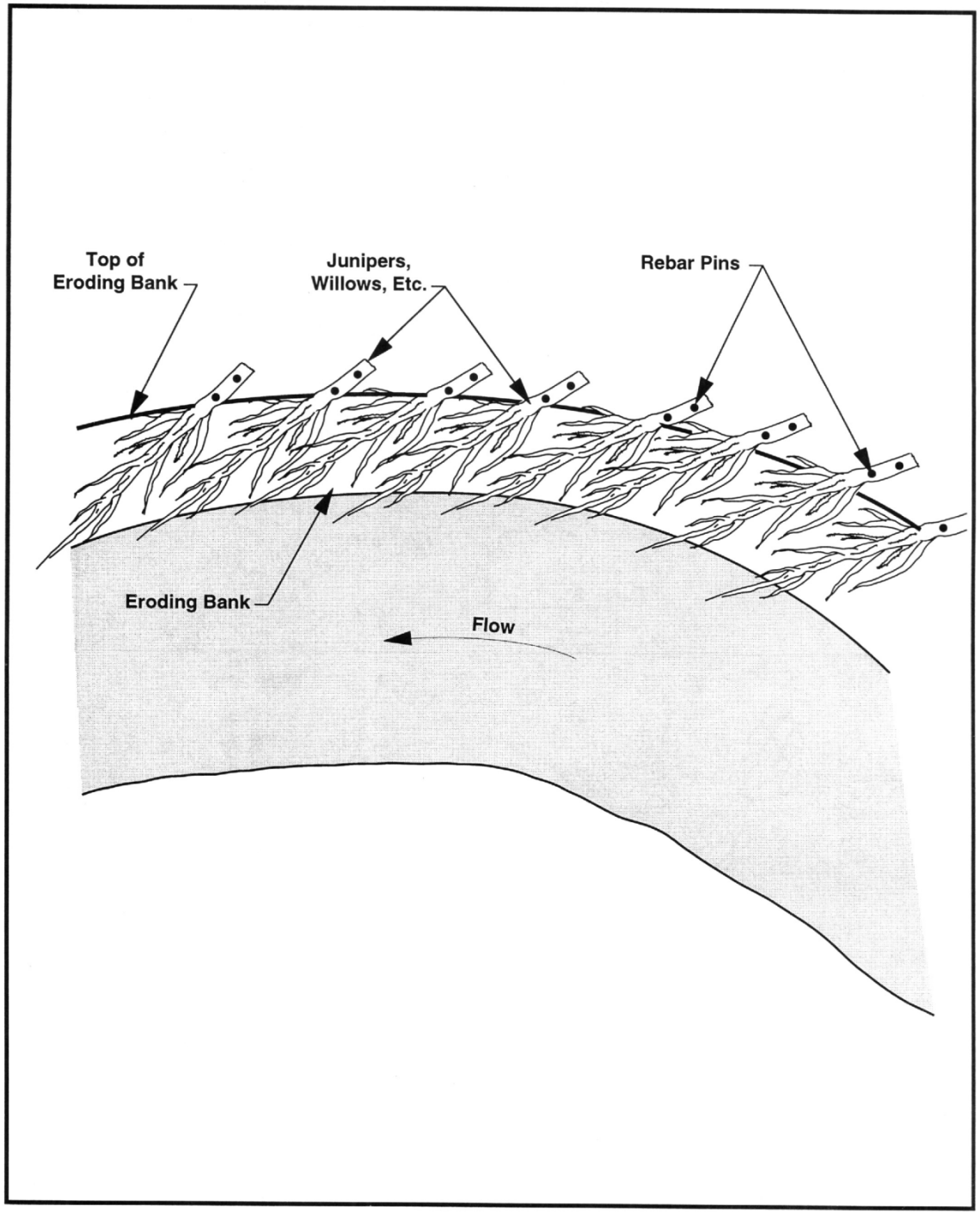



**Figure 2-5.—Schematic of Organic Riprap.**

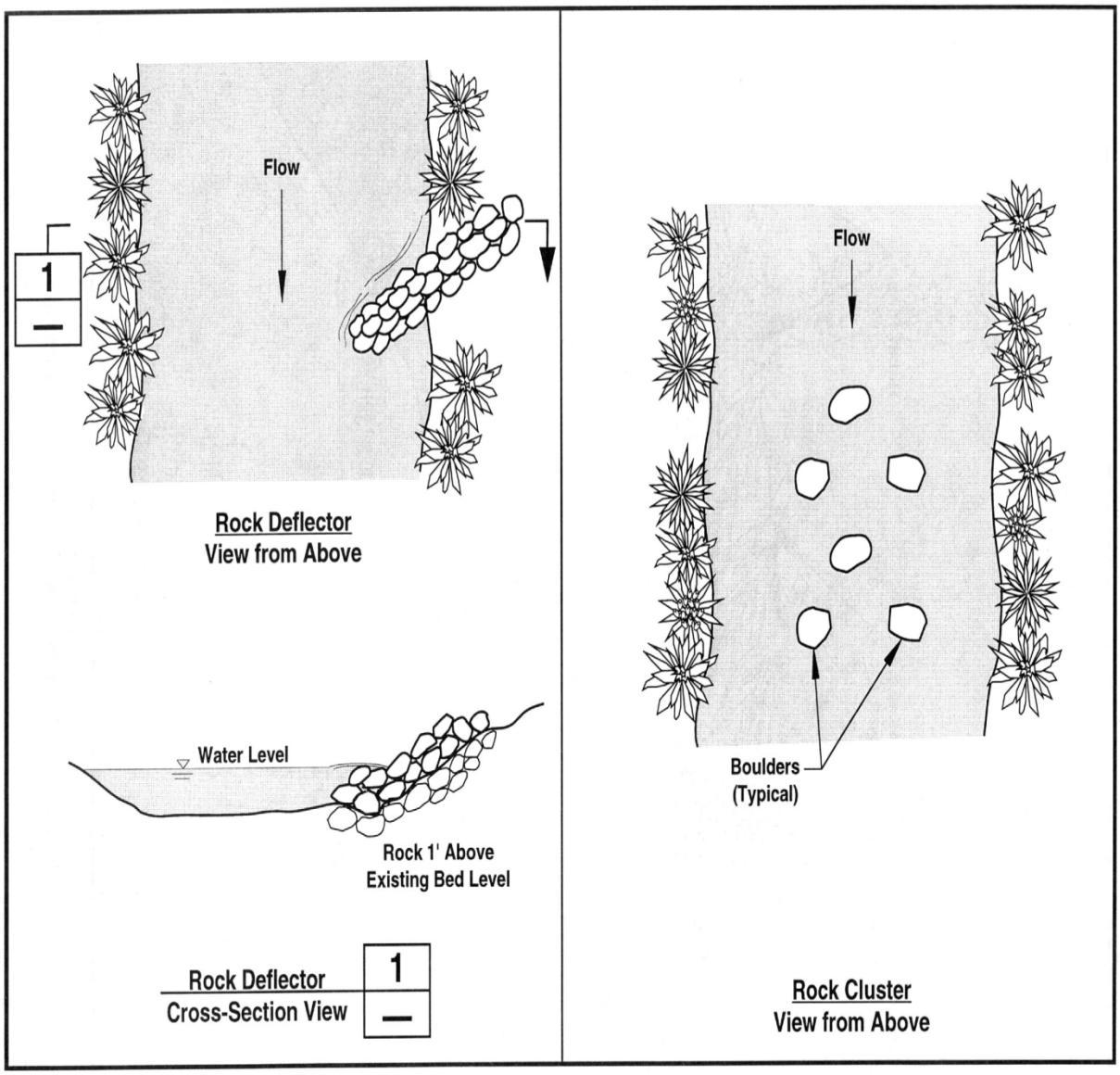



**Figure 2-6.—Schematic of Rock Deflector and Rock Cluster.**

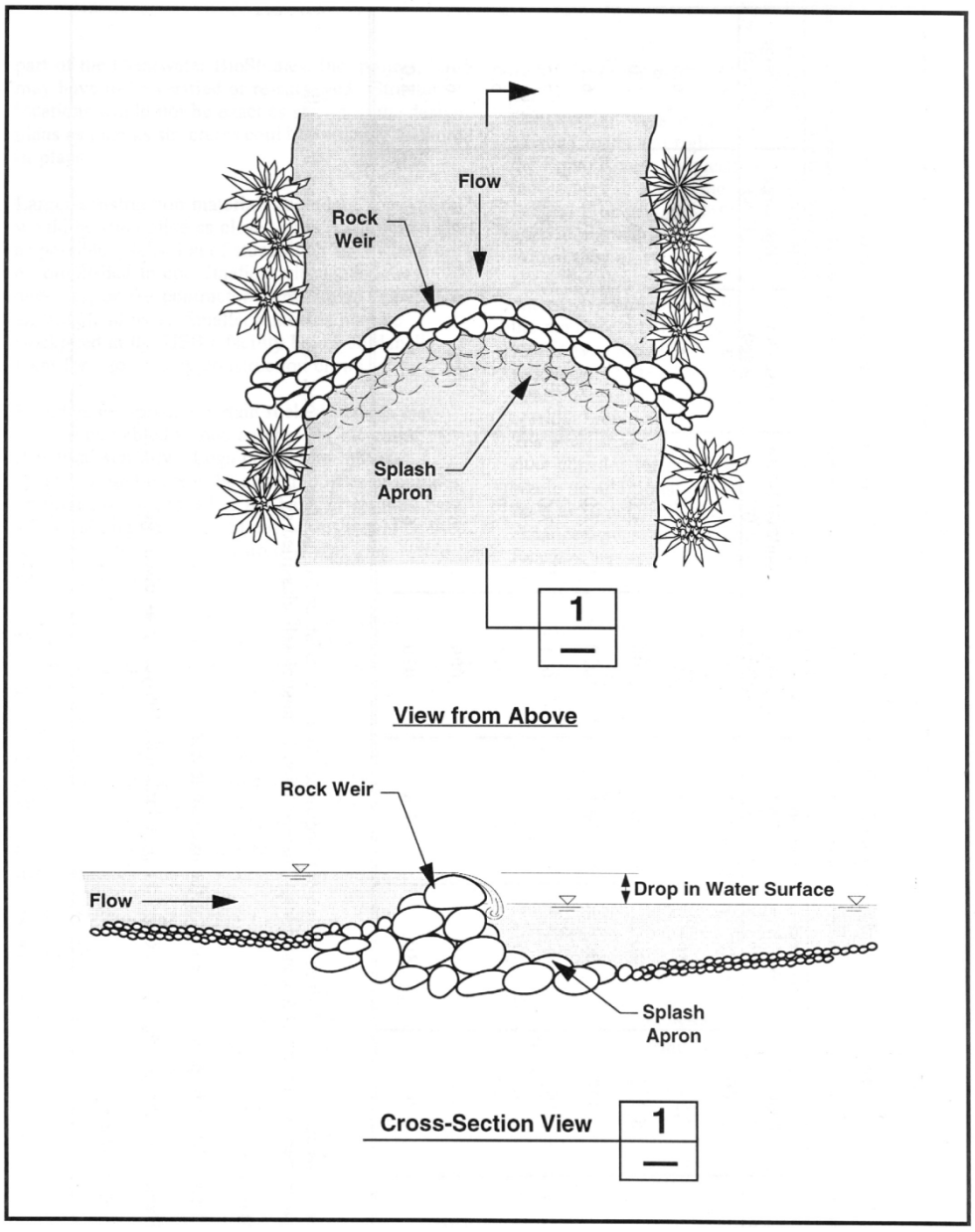



**Figure 2-7.—Schematic of Rock Weir.**

Therefore, the potential benefits of the flushing flows are claimed while the potential benefits from providing additional instream flows are not claimed. The ultimate use of the 300 acre-feet of water will be determined by SWCD in cooperation with UDWR and would likely be a combination of flushing releases and instream flows that would vary according to conditions and needs.

For the sediment flushing flow, the annual volume of 300 acre-feet could be released each year in a single event, or the water could be stored in the reservoir for multiple years to provide a larger magnitude or longer duration flush. In cooperation with UDWR, SWCD would determine the timing and quantity of water to be released each year. Because this water would be released to

Gooseberry Creek, it would not count against the 5,400-acre-foot maximum transbasin diversion.

**2.2.2.2.3.6 Acquire and/or Improve Stream Segments.—**This measure would involve improving fishery habitat and/or fencing 11.5 miles of stream in the Price River drainage. Most of these stream segments are on private land; therefore, approximately 206 acres of right-of-way, a corridor averaging approximately 200 feet wide, would need to be acquired. Fishery habitat improvements such as riparian plantings and some minor channel work would be performed. As part of the 11.5 miles of habitat improvement, about 2 miles of stream would be improved in conjunction with the wetland restoration; and 1 mile of stream would be improved by providing fencing in conjunction with acquiring 640 acres of wildlife habitat adjacent to the Price River below Scofield Reservoir. The various parcels of land would be contiguous with other public lands and would be managed in conjunction with those public lands. Memoranda of agreement (MOAs) would be required between the SWCD and the managing agencies.

Where appropriate, the corridor would be fenced with a four-strand, barbed wire fence, topped with a rail to protect the streambanks and riparian zone from damage caused by grazing. Where the adjacent land is used for grazing, selected stream access points for livestock watering or other alternative livestock watering means would be provided. Stream crossings also would be provided as needed. Table 2-3 lists stream segments that have been recommended for this measure and the proposed managing agencies. If necessary, additional parcels would be identified and evaluated to achieve the mitigation goal. The streams improved and protected under this measure would provide habitat for all life stages of cutthroat, rainbow, and/or brown trout. The improvements also would enhance wildlife habitat and water quality. A monitoring program would be established to ensure that the stream segments were acquired, improved, fenced, and maintained as planned.

**Table 2-3.—Stream Segments To Be Acquired and/or Improved for Fishery Habitat Proposed Action**

| Stream Reach | Length of Stream (miles) | Proposed Managing Agency |
|---|---|---|
| Price River Basin | | |
| Mud Creek | 4.0 | UDWR |
| Winterquarters Creek | 2.5 | UDWR |
| Pondtown Creek | 2.0 | USDA Forest Service |
| Fish Creek above Scofield Reservoir | 1.0 | USDA Forest Service |
| Price River below Scofield Reservoir | 2.0 | UDWR |

**2.2.2.2.3.7 Provide Winter Releases to Cottonwood Creek.—**A release sufficient to provide a 2.0-cfs minimum flow at the confluence of Cottonwood Creek and Left Hand Fork would be made from Narrows Reservoir to Cottonwood Creek to increase the available fish habitat. Water released during the winter months would be stored in Wales Reservoir on a space-available basis. Wales Reservoir is a small reservoir that stores winter runoff from the Upper San Pitch River drainage, including Cottonwood Creek drainage.

**2.2.2.2.3.8 Provide Summer Flows in Lower Cottonwood Creek.—**Water would be released in Lower Cottonwood Creek at the Cottonwood Canyon mouth to provide 2.0-cfs minimum instream flows at that location. This measure would provide year-round flows in the stream that would support fish habitat, create a fishery, and enhance the wetland and riparian corridor. In the past,

this segment of stream historically has been dewatered during the irrigation season.

**2.2.2.2.3.9 Construct Upper Cottonwood Creek Pipeline.—**Upper Cottonwood Creek Pipeline would be constructed as described in the previous section 2.2.2.2.2.4.

**2.2.2.2.3.10 Provide a 2,500 acre-feet Minimum Conservation Pool in Narrows Reservoir.—**A minimum pool of 2,500 acre-feet with a surface area of 144 acres would be provided in Narrows Reservoir for fish habitat and propagation. This pool would not be drawn upon for project use. At minimum pool, the reservoir would have a maximum depth of 58 feet; and approximately 53 acres of the reservoir would be at least 20 feet deep.

**2.2.2.2.3.11 Reduce External Phosphorus Loading to Scofield Reservoir.—**This measure would help improve water quality in Scofield Reservoir by reducing phosphorus loading and would be implemented in conjunction with improving stream segments on tributary streams above Scofield Reservoir. About 9.5 miles of stream segments would be improved. The improvements would consist of bank stabilization, primarily through riparian plantings. Where grazing would occur, the stream segments would be fenced to protect them from potential impacts.

This measure would reduce the amount of sediment and animal waste and, hence, the amount of phosphorus flowing into the reservoir. Historically, fish kills have occurred in Scofield Reservoir due to poor water quality. Phosphorus has been identified as the limiting nutrient in the eutrophication of the reservoir. Phosphorus loading occurs from several factors, including inflow of sediments that are naturally high in phosphorus and animal waste. In a report entitled *Scofield Reservoir Restoration Through Phosphorus Control*, the Utah Division of Water Quality concluded that:

> "The most pragmatic and effective means to control the further eutrophication of Scofield Reservoir, or possibly to effect a moderate reversal of the eutrophication process, appears to be a reduction of the phosphorus load to the lake."

SWCD would have primary responsibility for implementing all fishery measures described above. SWCD would be responsible for funding and acquiring all lands and rights-of-way and would fund and construct all improvements, such as fencing and stream channel improvements. SWCD would provide water from its water rights or enter into operating agreements for all instream flows described above. This work would be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way would be acquired, and initial construction of fishery measures would be completed prior to initial filling of the reservoir. SWCD would be responsible to fund all operation and maintenance (O&M) costs of mitigation facilities. SWCD would be responsible to enter into a MOA with UDWR and other appropriate agencies for all fishery measures. The MOA would define clearly the roles and responsibilities of SWCD, UDWR, and other parties for implementing, monitoring, and maintaining the fishery measures.

#### *2.2.2.2.4 Wetland Measures*

Wetland measures would be included in the project to mitigate unavoidable adverse impacts to wetlands that have been identified with the project. Four alternative wetland mitigation sites have been identified. The actual mitigation that is implemented could be from one alternative or a combination of alternatives. Proposed wetland mitigation areas are shown in figures 2-8, 2-9, and 2-10.

A brief description of each alternative follows. Alternatives are listed in order of priority.

**2.2.2.2.4.1 Enhance, Restore, and Create Wetlands Adjacent to Mud Creek Near Scofield Reservoir.—**This measure includes the purchase of approximately 220 acres of private land adjacent to Mud Creek, south of Scofield Reservoir. The approximate elevation of this site is 7,700 feet. Some of this land consists of former wetlands damaged by cattle, and the remainder is upland habitat. Existing wetland portions would revert to their natural wetland condition by removing the cattle and allowing the vegetation to grow. The remaining wetlands would be created by other methods (e.g., construction).

To implement wetland mitigation at the Mud Creek site, a preliminary study of the site would use the following steps:

1. Perform wetland delineation mapping of the site to determine the location and quantity of existing wetlands.
2. Install piezometers to determine ground water levels.
3. Install a temporary check dam with a series of piezometers to determine the effectiveness of using check dams to raise ground water levels.
4. Excavate test pits to determine soil types and stratification of soils.
5. Design mitigation measures based on data collection.
6. Perform HEP analysis to quantify premitigation habitat.

The proposed design concept is to raise ground water levels by installing a series of check dams as explained in step 3. If the preliminary study shows that this is not a feasible option, reverse underdrains (buried perforated pipes) may be needed. This would expand the extent of saturated soils. Some minor recontouring may be required at this site. Also, wetland vegetation growth would be encouraged by transplanting suitable wetland species. All or a portion of the required mitigation could be performed at this site. The wetland area would be maintained by SWCD under a MOA with UDWR (see figure 2-8).

**2.2.2.2.4.2 Area West of Lower Gooseberry Reservoir.—**This alternative would be developed near Lower Gooseberry Reservoir with an approximate elevation of 8,600 feet above msl. Approximately 120 acres of private land would be acquired west of the reservoir. The land currently is used for grazing sheep, and there are few existing wetlands. Water would be diverted from an existing diversion structure on Cabin Hollow, transported to the site through an existing open ditch, and would cause no additional adverse impacts to Cabin Hollow Creek.

The water planned for mitigation purposes is an existing diversion now used for pasture irrigation at the same site. The water would be diverted from the ditch at several locations and allowed to flow across the uplands and the surrounding wetlands. The existing wetlands on this site appear to have been created and maintained by the existing irrigation system.

Some earth work would need to be done to create small berms and swales that would create cells of wetlands. The area around the perimeter would be excavated somewhat deeper and to a 20-foot-minimum width (and a wider width in some areas) so that the edge of the swale is not abrupt but serpentine. This deeper area would allow willows and other shrubs to be planted to create a vegetation barrier to the interior wetlands. The area still would be available for grazing and wildlife use. However, sheep would be deterred from

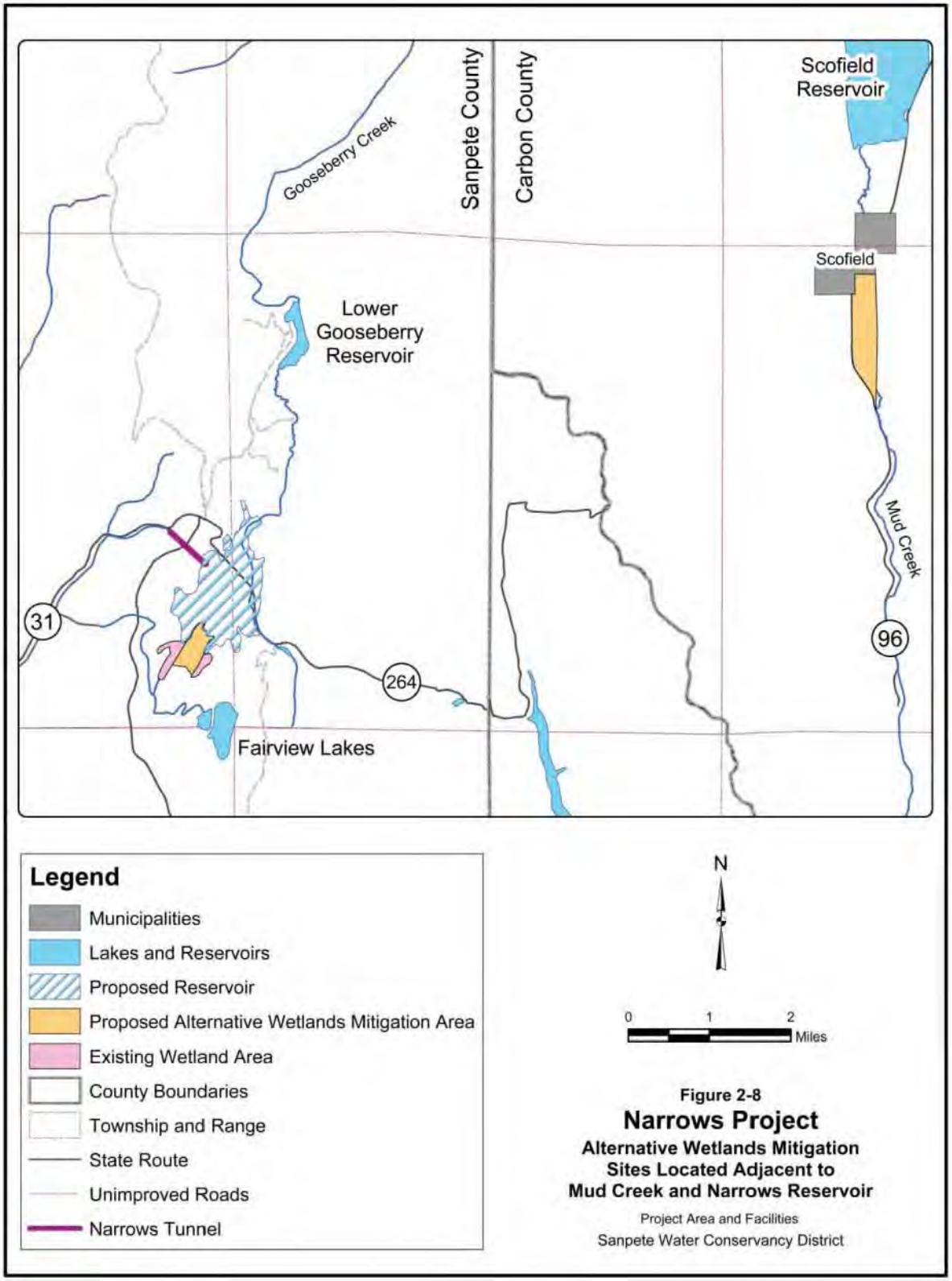



**Figure 2-8.—Alternative Wetlands Mitigation Sites Located Adjacent to Mud Creek and Narrows Reservoir.**

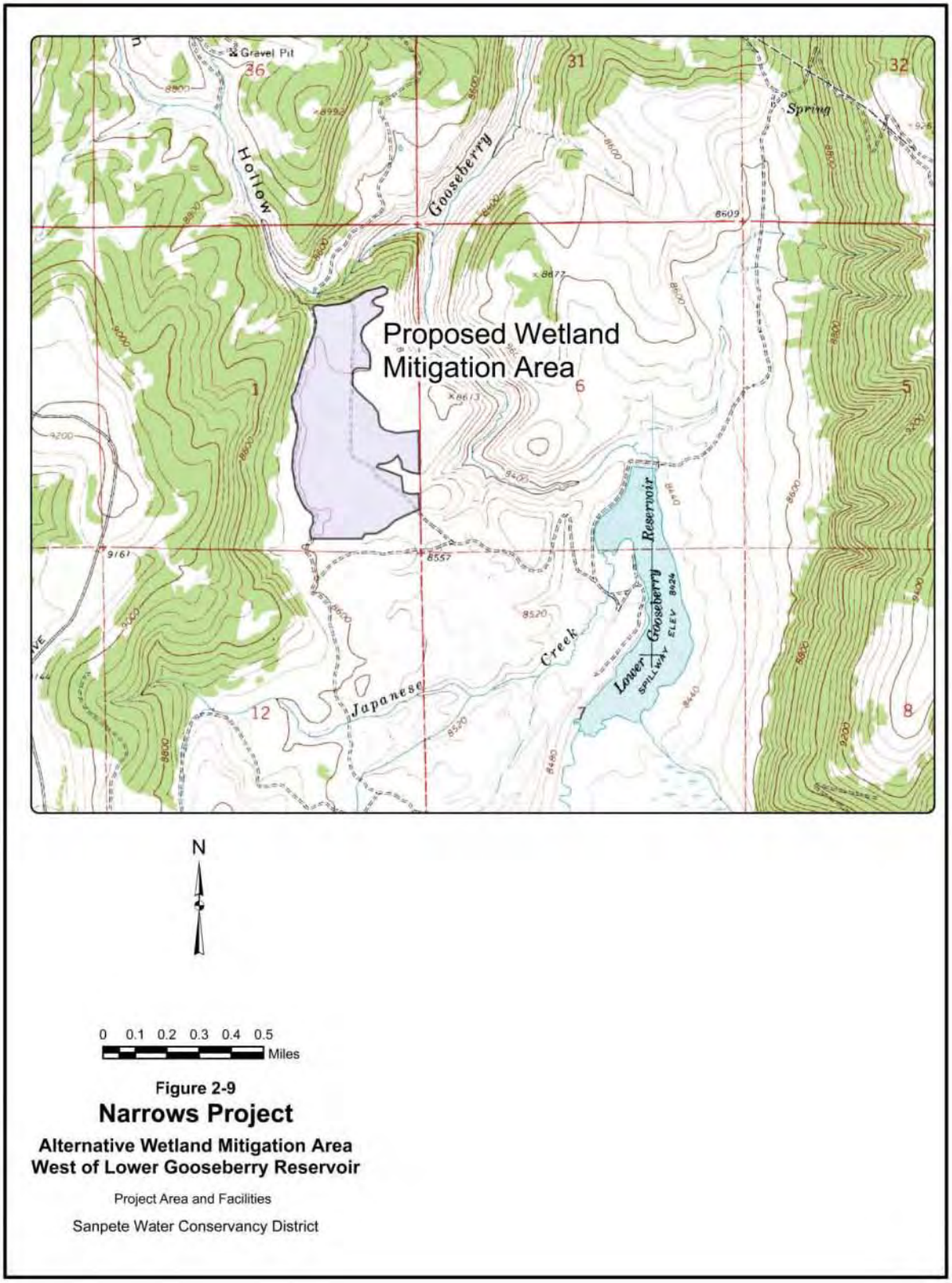



**Figure 2-9**
**Narrows Project**
**Alternative Wetland Mitigation Area**
**West of Lower Gooseberry Reservoir**

Project Area and Facilities

Sanpete Water Conservancy District

**Figure 2-9.—Alternative Wetland Mitigation Area West of Lower Gooseberry Reservoir.**

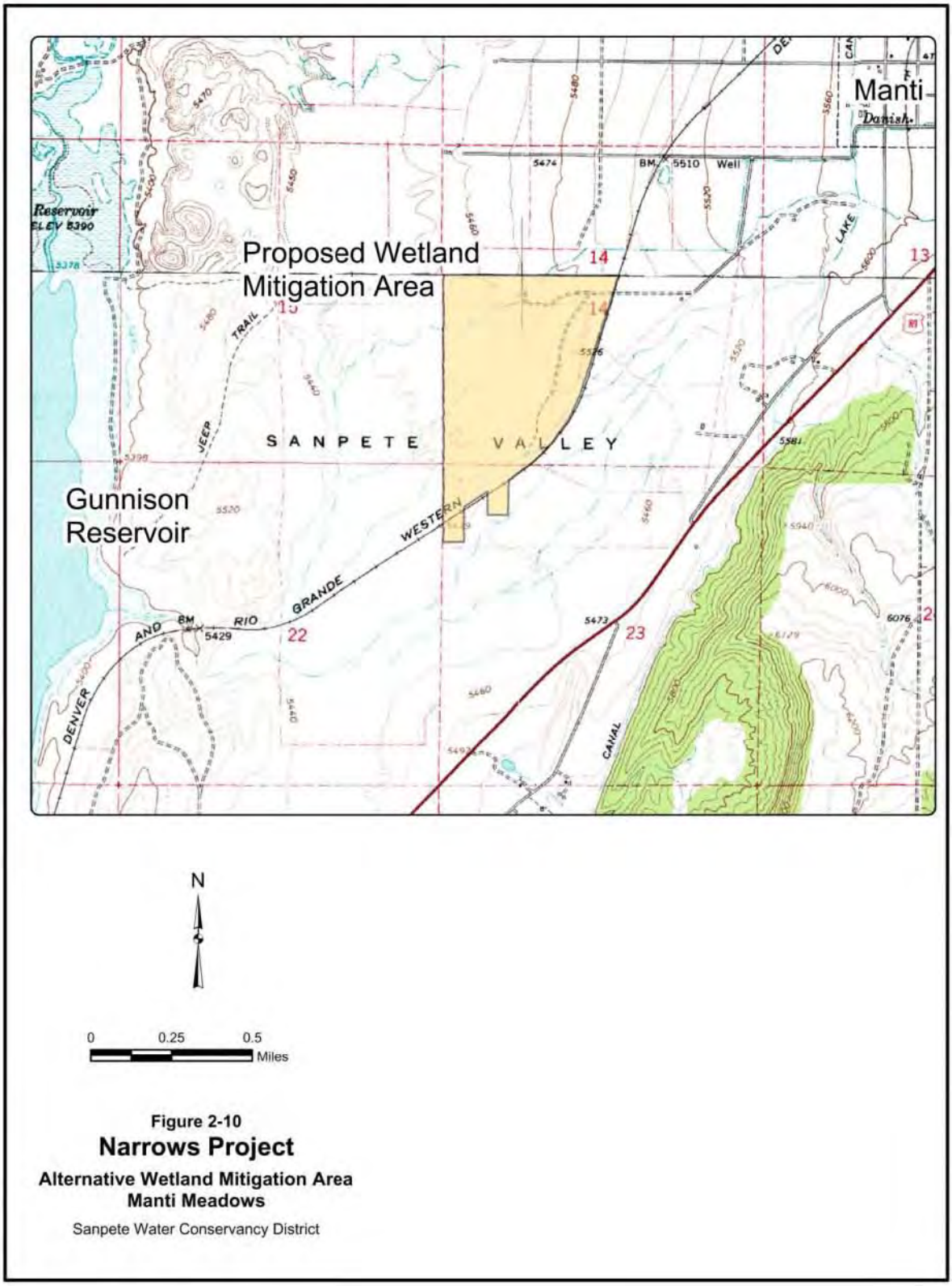



**Figure 2-10**
**Narrows Project**
**Alternative Wetland Mitigation Area**
**Manti Meadows**
Sanpete Water Conservancy District

**Figure 2-10.—Alternative Wetland Mitigation Area Manti Meadows.**

entering the wetland by perimeter swale, which would eliminate the need for fencing the area and would allow access for wildlife.

This wetland would be maintained by SWCD under a MOA with UDWR, USACE, and USDA Forest Service.

**2.2.2.2.4.3 Enlarge and Create New Wetlands Adjacent to Narrows Reservoir.—**This alternative would include enlarging existing wetlands areas and creating new wetlands adjacent to Narrows Reservoir. Elevation of this site is approximately 8,800 feet above msl. At least 100 acres of new wetlands would be created adjacent to Narrows Reservoir by releasing water from Fairview Lakes to irrigate lands adjacent to existing wetlands. A new outlet from Fairview Lakes would be provided. The outlet would be designed to begin releasing water automatically once Fairview Lakes reached a certain level. The releases would stop as the water level receded in the fall. SWCD and CGIC jointly would develop a policy establishing how seasonal releases from Fairview Lakes would be coordinated to optimize system benefits. The water would be conveyed to and distributed within the wetland area by a system of open ditches. Some recontouring would be performed to ensure that the soils became saturated. All or a portion of the required wetland mitigation could be performed at this site alone. This wetland area would be maintained by SWCD under a MOA with UDWR and CGIC.

**2.2.2.2.4.4 Manti Meadows.—**Under this alternative, return flows from the Narrows Project in the San Pitch River drainage would be made available to UDWR to use at the Manti Meadows Waterfowl Management Area located southwest of Manti. The elevation of this site is approximately 5,460 feet above msl. The water would be delivered by diverting Sixmile Creek water, which belongs to the Gunnison Irrigation Company and flows into Gunnison Reservoir, and delivering it to the Manti Meadows area through existing facilities belonging to the Manti Irrigation and Reservoir Company. Narrows Project return flows arising in the San Pitch River would be delivered to Gunnison Reservoir in exchange for the water delivered to Manti Meadows. The water would be used to create at least 100 acres of new wetlands and to improve wetland habitat values of existing wetlands in the area. Some excavation and ground recontouring of existing uplands would be required to control drainage and encourage wetland development.

Wetland mitigation sites would provide similar functional value to that provided by the 100 acres of wetlands that would be inundated by the reservoir. Careful monitoring of the mitigation sites would be conducted to ensure that the value of the mitigation sites was similar in function and equal in value to the wetlands lost. The method to determine this would be using HEP analyses or equivalent for the sites and comparing habitat values. The wetland monitoring plan would need to be designed to be re-evaluated after 4 years and continued for as long as necessary to ensure that, at a minimum, a replacement of lost habitat values had occurred.

SWCD would have primary responsibility for implementing wetland measures described above. SWCD would be responsible for funding and acquiring all lands and rights-of-way. SWCD would provide and transplant any plantings needed. SWCD would be responsible to ensure that all fences are in good repair and are maintained properly. SWCD also would be responsible to install and maintain any diversion and/or irrigation facilities. This work would be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way would be acquired, and initial construction of wetland measures would be completed prior to

initial filling of the reservoir. SWCD also would be responsible to fund the monitoring of the wetland mitigation. SWCD would be responsible to enter MOAs with UDWR, USACE, and other appropriate agencies for all wetland measures. The MOAs would define clearly the roles and responsibilities of the SWCD, UDWR, USACE, and other parties for implementing and maintaining the wetland measures, including timeframes for future commitments such as fence maintenance. The MOAs would be required to be in place before the SRPA construction funds were dispersed.

#### *2.2.2.2.5 Wildlife Mitigation Measures*

The wetland measures previously described would offset any losses to wetland habitat caused by inundation. Impacts to upland habitat (mule deer and Brewer's sparrow habitat) would be mitigated by SWCD in the following ways:

- Acquisition of 150 acres of conservation easements adjacent to the Narrows Reservoir. These easements would impose restrictions on land use that would benefit impacted species. In addition, the conservation easements would provide a setback of about 500 feet on the west side of the reservoir for any new development or construction on private land adjacent to the reservoir. The USDA Forest Service administers lands on the north and east side of the reservoir, and private developed lands are on the south side of the reservoir.
- Acquisition of 640 acres of private land adjacent to the Price River below Scofield Reservoir. Wildlife values would be enhanced by providing 4 miles of fencing to protect the land from livestock grazing.

As with fishery mitigation, the goal of the wildlife mitigation would be to provide at least full mitigation for each impacted species.

As part of the conservation easements for the 150 acres adjacent to Narrows Reservoir, certain restrictions on the landowners' use of their lands would be needed. These restrictions would include prohibiting actions such as further construction of residential structures; commercial uses such as motels, cafes, hunting or fishing clubs, subdivisions, including constructing sewers and septic tanks; livestock grazing; and storage or use of pesticides, herbicides, or chemical agents, either directly or indirectly lethal to wildlife. In addition, many of these lands would be made available to the general public for hunting, fishing, or other recreational uses without permit or fees charged by the landowners. Specific measures or restrictions would be developed individually as part of the easement negotiation process with each involved landowner.

As part of the wildlife mitigation plan, a monitoring program would be developed. Existing wildlife values on mitigation lands would be identified using the same models that were used to identify project impacts. These same models also would be used to measure the success of any wildlife mitigation programs. If the proposed mitigation programs are not as successful as anticipated, additional mitigation could be required. This procedure would apply to both wetland and upland wildlife habitat.

SWCD would have primary responsibility for implementing all wildlife measures described above. SWCD would be responsible for funding and acquiring all lands and easements. SWCD would provide native seed to supplement the USDA Forest Service-recommended seed mixture for the watershed and range improvement projects. SWCD would fund, construct, and maintain all improvements such as fencing. This work

would be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way would be acquired, and initial construction of wildlife measures would be completed prior to initial filling of the reservoir. SWCD also would be responsible for funding the mitigation monitoring. SWCD would be responsible for entering into MOAs with UDWR, USDA Forest Service, and other appropriate agencies for all wildlife measures. The MOAs would clearly define the roles and responsibilities of SWCD, UDWR, USDA Forest Service, and other parties for implementing and maintaining the wildlife measures. All parties would be required to sign the MOAs before SRPA construction funds were dispersed.

#### *2.2.2.2.6 Construction Materials*

Locations of materials necessary for constructing Narrows Dam and Reservoir are shown in figure 2-3. Most of the embankment material for the Narrows Dam would be obtained from the reservoir basin. Rockfill material for upstream slope protection would be obtained from an existing quarry on Reclamation withdrawn land near SR-264. An alternative rockfill material quarry site is located on private land. Granular material for drains within the dam would be hauled from commercial pits in Sanpete Valley near Wales, Utah. Concrete for the outlet works, spillway, and other structures would be batched in Sanpete Valley and hauled to the damsite in transit mixers. Other materials such as pipe, steel gates and structures, electric motors, and operating and control equipment would be manufactured or processed outside the project area. The materials would be hauled to the construction sites by truck.

#### *2.2.2.2.7 Lands for Project Features and Relocation*

About 1,931 acres of land would be required for project features, wetland mitigation, fish and wildlife enhancement and mitigation, and material source areas. About 0.8 mile of SR-264 would be inundated by Narrows Reservoir, as described in section 2.2.2.2.2.6. The amounts of land by present ownership or administration and proposed project use are shown in table 2-4.

There would be no relocation of persons, families, businesses, farms, or nonprofit organizations resulting from construction of the Narrows Project.

Approximately 304.5 acres of Reclamation withdrawn land would be used for project purposes. SWCD has acquired 366 acres of private lands for project uses from owners by perpetual easement or in fee. SWCD would purchase 1,340 additional acres of private and State School Trust lands for project needs.

The conservation area adjacent to the reservoir would be created through conservation easements. These lands would be administered by SWCD under a cooperative agreement with UDWR. To ensure proper management of easement lands needed to mitigate fish and wildlife losses attributed to the project, certain restrictions on the landowners' use of their lands would be needed. Specific measures or restrictions, including those to protect fish and wildlife values, would be developed by UDWR as part of the easement negotiation process with each involved landowner. If adequate easements cannot be secured, a fee-title acquisition of the lands would be made.

**Table 2-4.—Proposed Action Right-of-Way Requirements for Project Features**

| Project Feature Type of Acquisition | Ownership or Administration | | |
|---|---|---|---|
| | Private (acres) | Reclamation Withdrawal (acres) | Total (acres) |
| Narrows Dam and Reservoir | 349 | 255 | 604 |
| East Bench Pipeline | | | |
| Perpetual easement | 51 | 0 | 51 |
| Oak Creek Pipeline | | | |
| Perpetual easement | 9 | 0 | 9 |
| Upper Cottonwood Creek Pipeline | 1.5 | 1.5 | 3 |
| SR-264 relocation | 0 | 34 | 34 |
| Recreation area | 0 | 12 | 12 |
| Fishery mitigation | | | |
| Perpetual conservation easement | 206 | 0 | 206 |
| Wildlife mitigation | | | |
| Fee title purchase of fish and wildlife enhancement area | 640 | 0 | 640 |
| Perpetual conservation easement adjacent to reservoir | 150 | 0 | 150 |
| Wetlands mitigation | | | |
| Perpetual easement or fee title | 220 | 0 | 220 |
| Materials source area[1] | 0 | 2 | 2 |
| Total | 1,626.5 | 304.5 | 1,931 |

[1] Embankment material for the dam would be obtained from the reservoir basin. Rockfill material for upstream slope protection would be obtained from an existing quarry located on withdrawn land. An alternative rockfill material quarry site may be located on private land.

#### *2.2.2.2.8 Access to Features*

Construction access is fairly good for all project features. The proposed damsite is near an existing paved highway. This highway would be adequate for hauling materials and equipment to the site. Temporary haul roads would need to be constructed within the reservoir basin to move material from the borrow area to the damsite.

#### *2.2.2.2.9 Construction Program*

Construction of the Narrows Project would be under the supervision of SWCD. All recreational facilities would be built by SWCD. Temporary construction offices would be located within the proposed reservoir basin.

#### *2.2.2.2.10 Water Quality Protection Program*

Several water quality permits must be obtained prior to construction of the project. The Clean Water Act of 1972 (Public Law 95-217), as amended in 1977, requires that Section 402 permits be obtained from the State or EPA for the discharge of any waste water or process water into a waterway. A Section 402 permit would be required for storm water runoff or dewatering during construction of the dam. A storm water pollution prevention plan also would be developed as a requirement of the storm water permit. In accordance with Section 404

of Public Law 95-217, permits must be obtained from USACE to discharge dredge and fill material below the normal high water level of streams, associated wetlands, and other water bodies as well as dam construction. A Section 404 permit would be required for construction of the project. SWCD has applied for that permit (Section 404(B)(1) Analysis, appendix K).

Approval by the Utah Division of Water Quality is required before installing any sanitary or industrial pollution control facilities, including turbidity control equipment. This approval also would be obtained before dewatering, diversion, and other such facilities could be constructed. In addition, a temporary waiver of the turbidity standard would be requested from the Utah Division of Water Quality during those periods of construction when it is physically impossible to provide turbidity control. A State Engineer's permit to alter a natural stream channel also would be requested for the proposed dam. Driving, fueling, and parking of heavy equipment would be controlled so as to avoid wetland and stream areas, precluding downstream sedimentation and other water quality impacts.

#### *2.2.2.2.11 Public Safety*

The final design of Narrows Dam would be based on additional and extensive geologic investigation and would include full consideration of such factors as seismic history, geology, induced seismicity from coal mining, and the dam's material composition. In addition, final design data and specifications for the dam would be reviewed by Reclamation and the State Engineer to ensure that it would be a safe and well-designed structure, fitting geological conditions of the site.

During construction, excavations would be mapped and studied to determine whether geologic conditions were the same as had been indicated from preliminary subsurface investigations. If actual geologic conditions were found to differ from what previously had been predicted, designs would be changed to accommodate the existing conditions. Also, geologists and inspectors would report such hazardous conditions as potential slide or slump areas that might pose a danger to workers and equipment. All hazardous areas would be roped off, and appropriate signs would be displayed to prevent accidents.

SWCD would develop a safety of dams program that would satisfy the State of Utah requirements. SWCD, with supervision by the State Engineer, would be responsible for monitoring structural performance and conducting safety inspections during construction and initial filling of the reservoir. Criteria would be developed and strictly followed for filling the reservoir and monitoring the safety of the dam. Marker buoys and float lines would be installed around spillway intake structures and other areas that might be hazardous to boaters. In accordance with State Engineer requirements, a standard operating procedure would be prepared to ensure that the dam was operated in a safe manner. In addition, an emergency action plan would be prepared and distributed to public safety officials. This plan would describe procedures to be followed if an emergency involved the dam.

### 2.2.2.3 Costs and Financing

The Proposed Action would cost approximately $36.2 million and would be funded by SWCD, the State of Utah, and a loan from the Federal Government. Of the $36.2-million cost, about $5.3 million would be allocated to fish and wildlife enhancement and recreation (table 2-5). These costs are anticipated to be

**Table 2-5.—Narrows Project Cost Comparison of Storage Alternatives Evaluated in Detail**[1]

| | Proposed Action | Mid-Sized Reservoir Alternative | Small Reservoir Alternative |
|---|---|---|---|
| Narrows Dam and Reservoir | $ 12,292,000 | $ 10,752,000 | $ 9,212,000 |
| Upper Cottonwood Creek Pipeline | 677,000 | 677,000 | 677,000 |
| Oak Creek Pipeline | 341,000 | 341,000 | 341,000 |
| East Bench Pipeline | 7,997,000 | 7,997,000 | 7,997,000 |
| Recreation area | 1,065,000 | 937,000 | 801,000 |
| Highway SR-264 relocation | 3,292,000 | 3,292,000 | 3,292,000 |
| Wetlands, wildlife, and fishery mitigation | 4,274,000 | 4,274,000 | 4,147,000 |
| Reclamation participation (EIS and planning) | 950,000 | 950,000 | 950,000 |
| SWCD's costs to date | 2,818,000 | 2,818,000 | 2,818,000 |
| Total construction cost | $33,706,000 | $32,038,000 | $30,235,000 |
| Estimated interest during construction (IDC) | 2,528,000 | 2,447,000 | 2,386,000 |
| Total project costs | $36,234,000 | $34,485,000 | $32,621,000 |
| Average annual water yield of project (acre-feet) | 5,308 | 5,171 | 4,935 |
| Capital cost per acre-foot of yield | $7,584 | $7,447 | $7,425 |

[1] Cost estimates have been indexed from July 2006 to 2008.

nonreimbursable to the project sponsor. Total financing would be through provisions of the SPRA.

#### 2.2.2.4 Project Administration

On completion of construction, the Narrows Project would be administered by SWCD. SWCD would have overall responsibility for administration and would contract with the water users for repayment of reimbursable project costs.

Although a formal agreement has not been reached, it is anticipated that the USDA Forest Service would administer the recreation facilities at the Narrows Reservoir under an operation agreement with SWCD and Reclamation.

A fishery management plan also would be developed, and a MOA would be agreed to between SWCD, USDA Forest Service, Reclamation, and UDWR. This plan would outline goals for fish species and angling opportunities that would be provided by the proposed reservoir and determine funding sources or contributions needed for reservoir fishery management. Any fish species released into the reservoir eventually could escape downstream. These species must not interfere with downstream fisheries. Species native to the Gooseberry drainage or that have already been introduced to this drainage would be acceptable for introduction into the proposed reservoir.

### 2.2.3 Mid-Sized Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 12,450 acre-feet. Of that amount, 9,950 acre-feet would be active capacity, and 2,500 acre-feet would be

inactive storage. The 110-foot-high dam, with a crest length of 475 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-3). Other features of the project would be the same as those for the Proposed Action and would include the construction of pipelines, rehabilitation of the existing Narrows Tunnel to control releases, relocation of SR-264 and would provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are described below.

#### 2.2.3.1 Water Supply and Use

The average annual water supply under the Mid-Sized Reservoir Alternative would be reduced to 4,964 acre-feet because there would be less carryover storage. In years with average or above average precipitation, the full 5,400-acre-foot water right would be available. In 10 of 46 years studied, this alternative could not provide the full 5,400 acre-feet of water supply. However, in years with below average precipitation, the available water supply could be reduced by as much as 79% because of the reduced long-term carryover storage. This means less than 1,138 acre-feet of water could be available for transmountain diversion during those years when the water is needed most.

Of the average annual yield of 4,964 acre-feet, 855 acre-feet would be used for M&I purposes, and the remaining 4,109 acre-feet would be used for agriculture. As noted in section 1.5.2, there would be an estimated 15,250-acre-foot average annual shortage in the diversion demand assuming a portion of the nongrowing season precipitation was retained in the soil root zone to help meet early season water needs. On the average, the Mid-Sized Reservoir Alternative would reduce the average annual shortage to about 11,141 acre-feet per year or 21.6% of the diversion demand. With below average precipitation, the remaining shortage would be about 30,017 acre-feet per year or 58.1%. In either case, shortages still would be considerably greater than the 5% optimum shortage for irrigation projects.

As with the Proposed Action, local water users would be expected to employ efficient water use practices or agree to implement them as a condition for receiving project water.

#### 2.2.3.2 Construction Features and Project Operations

##### *2.2.3.2.1 General*

As in the Proposed Action, construction features of the Mid-Sized Reservoir Alternative would include one reservoir, three pipelines, rehabilitation of the existing Narrows Tunnel to control releases, the relocation of SR-264, and the relocation of some FDRs. Recreation facilities also would be provided at Narrows Reservoir. Design data for the construction features were presented earlier in table 2-2 for this alternative. The changes that would occur are depicted in table 2-2 and are described in more detail in section 2.2.3.2.2.

Specific fish and wildlife measures under the Mid-Sized Reservoir Alternative would remain the same as those stated under the Proposed Action.

Additionally, mitigation and enhancement of upland habitat would be the same as that described for the Proposed Action. New wetlands totaling about 81 acres would be created to mitigate for wetlands areas inundated by the reservoir rather than the 100 acres under the Proposed Action.

##### *2.2.3.2.2 Design and Operation*

**2.2.3.2.2.1 Narrows Dam and Reservoir.—** The design of Narrows Dam under the Mid-Sized Reservoir Alternative would be

similar to that of the Proposed Action, but the height of the dam would be 10 feet lower. The embankment would contain an estimated total volume of 292,000 cubic yards of material.

Narrows Reservoir still would have two main outlets. A stream-level outlet would be constructed through the dam to provide downstream releases for fisheries and emergency evacuation of the reservoir. This outlet would have a 258-cfs capacity. The existing transmountain Narrows Tunnel, with the 60.0-cfs capacity, would serve as the other reservoir outlet and would accommodate releases through the mountain ridge for the transmountain diversion. The outlets would be designed and operated the same as in the Proposed Action.

The reservoir formed behind the dam would have a total capacity of 12,450 acre-feet and a water surface area of about 489 acres.

The reservoir's active capacity, or that portion of stored water that would be used to satisfy project water needs, would be 9,950 acre-feet. In all other respects, the Mid-Sized Reservoir would be designed and operated in the same manner as the Proposed Action.

**2.2.3.2.2.2 Oak Creek Pipeline.—**Under this alternative, this feature is identical to the same feature as that described in the Proposed Action.

**2.2.3.2.2.3 East Bench Pipeline.—**Under this alternative, this feature is identical to the same feature as that described in the Proposed Action.

**2.2.3.2.2.4 Upper Cottonwood Creek Pipeline.—**Under this alternative, this feature is identical to the same feature as that described in the Proposed Action.

**2.2.3.2.2.5 Narrows Tunnel Rehabilitation.—**Under this alternative, this feature is identical to the same feature as that described in the Proposed Action.

**2.2.3.2.2.6 SR-264 Relocation.—**Under this alternative, this feature is identical to the same feature as that described in the Proposed Action.

**2.2.3.2.2.7 Recreation Facilities.—**For this alternative, public recreation facilities would be similar to those provided for in the Proposed Action. The facilities would include a boat ramp, boat slips, and a day-use area. The day-use area would include 8 picnic sites, restroom facilities, and a 50-unit campground. USDA Forest Service would participate in the recreation facility design, and the facilities would be constructed to their standards. USDA Forest Service would operate and maintain the facilities under agreement with SWCD and Reclamation. Title to the recreation facilities would remain in the name of the United States.

#### *2.2.3.2.3 Fishery Measures*

A total of 11 fishery measures have been included in the project to mitigate for adverse impacts that have been identified with the project. To the extent possible, an attempt was made to mitigate "in place" and "in kind." Under this alternative, these measures are identical to the same measures as those described in the Proposed Action.

#### *2.2.3.2.4 Wetland Measures*

Wetland measures would be included in the project to mitigate for unavoidable adverse impacts to wetlands that have been identified with the project. Four alternative wetland mitigation sites have been identified. The actual mitigation that is implemented could be from one alternative or a combination of alternatives. Proposed wetland mitigation areas have been shown previously in figures 2-8, 2-9, and 2-10. A complete

description of each alternative was provided in the discussion of the Proposed Action. Modifications unique to the Mid-Sized Reservoir Alternative are discussed below.

**2.2.3.2.4.1 Wetlands Adjacent to Mud Creek Near Scofield.—**This measure would entail purchasing about 190 acres of private land adjacent to Mud Creek, south of the town of Scofield, rather than the 220 acres described in the Proposed Action.

**2.2.3.2.4.2 Area West of Lower Gooseberry Reservoir.—**Under this alternative, about 105 acres of private land west of Lower Gooseberry Reservoir would be acquired, rather than the 120 acres under the Proposed Action. This land would be treated in the same manner as in the Proposed Action.

**2.2.3.2.4.3 New Wetlands Adjacent to Narrows Reservoir.—**This alternative would be identical to that described in the Proposed Action, except that the target acreage for mitigation would be reduced from 100 to 81 acres.

**2.2.3.2.4.4 Manti Meadows.—**This alternative would be identical to that described in the Proposed Action, except that the target acreage for mitigation would be reduced from 100 to 81 acres.

Wetland measures would be needed to provide similar wildlife values as those in the 81 acres of wetlands that would be inundated by the reservoir. Careful monitoring of the mitigation sites would be conducted to ensure that the value of the mitigation sites was at least equal to the value of the wetlands lost. This determination would be accomplished by performing HEP analyses of the sites and comparing habitat values.

SWCD would have primary responsibility for implementing the wetland measures described above and would assume all other responsibilities associated therewith, as described in connection with the Proposed Action.

#### *2.2.3.2.5 Wildlife Measures*

The wetland measures described above would offset any losses to wetland habitat caused by inundation. Impacts to upland habitat (mule deer and Brewer's sparrow habitat) were described earlier in connection with the Proposed Action, and the mitigation measures discussed there also would be implemented under the Mid-Sized Reservoir Alternative.

#### *2.2.3.2.6 Construction Materials*

Locations of materials necessary for constructing Narrows Dam and Reservoir are shown in figure 2-3. In all other respects, the description of the construction materials is the same for this alternative as that described in connection with the Proposed Action.

#### *2.2.3.2.7 Lands for Project Features and Relocation*

About 1,516 acres of land would be required for project features, wetland mitigation, fish and wildlife enhancement and mitigation, and material source areas. The amounts of land by present ownership or administration and proposed project use for this alternative are shown in table 2-6.

#### *2.2.3.2.8 Construction Program*

The construction program would be similar to that incorporated into the Proposed Action.

#### *2.2.3.2.9 Water Quality Protection Program*

The water quality protection program would be the same as that incorporated into the Proposed Action.

**Table 2-6.—Mid-Sized Reservoir Alternative Right-of-Way Requirements for Project Features (Acres)**

| Project Feature Type of Acquisition | Ownership or Administration | | |
|---|---|---|---|
| | Private | Reclamation Withdrawal | Total |
| Narrows Dam and Reservoir | 234 | 255 | 489 |
| East Bench Pipeline | | | |
| Perpetual easement | 51 | 0 | 51 |
| Oak Creek Pipeline | | | |
| Perpetual easement | 9 | 0 | 9 |
| Upper Cottonwood Creek Pipeline | 1.5 | 1.5 | 3 |
| SR-264 relocation | 0 | 34 | 34 |
| Recreation area | 0 | 7 | 7 |
| Fishery mitigation | | | |
| Perpetual conservation easement | 206 | 0 | 206 |
| Wildlife mitigation | | | |
| Fee title purchase of fish and wildlife enhancement area | 385 | 0 | 385 |
| Perpetual conservation easement adjacent to reservoir | 150 | 0 | 150 |
| Wetlands mitigation | | | |
| Perpetual easement or fee title | 180 | 0 | 180 |
| Materials source area[1] | 0 | 2 | 2 |
| Total | 1,216.5 | 299.5 | 1,516 |

[1] Embankment material for the dam would be obtained from the reservoir basin. Rockfill material for upstream slope protection would be obtained from an existing quarry located on withdrawn land. An alternative rockfill material quarry site may be located on private land.

#### *2.2.3.2.10 Public Safety*

The public safety measures for this alternative would be the same as those incorporated into the Proposed Action.

#### 2.2.3.3 Costs and Financing

The Mid-Sized Reservoir Alternative would cost about $34.5 million and would be funded by SWCD, the State of Utah, and a loan from the Federal Government (table 2-5). Of the $34.5-million cost, about $5.2 million would be for fish and wildlife enhancement and recreation. These costs are nonreimbursable to the project sponsors. Total financing would be through provisions of the SPRA. Because of a smaller storage capacity, the cost of project water would be approximately 31% higher than the Proposed Action.

#### 2.2.3.4 Project Administration

Under the Mid-Sized Reservoir Alternative, project administration would be the same as that described for the Proposed Action.

### 2.2.4 Small Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 7,900 acre-feet. Of that amount, 5,400 acre-feet would be active capacity, and 2,500 acre-feet would be inactive storage. The 100-foot-high dam, with a crest length of 425 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-3). Other features of the project would be the same as those for the Proposed Action and would include the construction of pipelines,

rehabilitation of the existing Narrows Tunnel to control releases, and the relocation of SR-264 and would provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are discussed below.

#### 2.2.4.1 Water Supply and Use

The average annual water supply under the Small Reservoir Alternative would be reduced to 4,710 acre-feet because there would be less carryover storage. In years with average or above average precipitation, the full 5,400-acre-foot water right would be available. In 17 of 46 years studied, this alternative could not provide the full 5,400-acre-foot water supply. However, in years with below average precipitation, the available water supply could be reduced by as much as 74% because of the lack of long-term carryover storage. This means that less than 1,427 acre-feet of water could be available for transmountain diversion during those years when the water is most needed.

Of the average annual 4,710-acre-foot yield, 855 acre-feet would be used for M&I purposes; and the remaining 3,105 acre-feet would be used for agriculture. As noted in section 1.5.2, there would be an estimated 15,250-acre-foot average annual shortage in the diversion demand, assuming a portion of the nongrowing season precipitation was retained in the soil root zone to help meet early-season water needs. On the average, the Small Reservoir Alternative would reduce the average annual shortage to about 11,395 acre-feet per year or 22.1% of the diversion demand. With below average precipitation, the remaining shortage would amount to 29,728 acre-feet per year or 57.5%.

In either case, shortages are still considerably greater than the 5% optimum shortage for irrigation projects.

As with the Proposed Action, local water users would be expected to employ efficient water use practices or agree to implement them as a condition for receiving project water.

#### 2.2.4.2 Construction Features and Project Operations

##### *2.2.4.2.1 General*

As in the Proposed Action, construction features of the Small Reservoir Alternative would include one reservoir, three pipelines, rehabilitation of the existing Narrows Tunnel to control releases, the relocation of SR-264, and the relocation of some FDRs. Recreation facilities also would be provided at Narrows Reservoir. Design data for this alternative was presented earlier in table 2-2.

Of the 11 specific fish and wildlife measures included in the Proposed Action, 9 would be employed under the Small Reservoir Alternative. Those measures, some with modifications, include:

- Provide minimum flows of 1.0 cfs in Gooseberry Creek below Narrows Dam
- Provide a multiple-level outlet at Narrows Dam to regulate the temperature of releases to Gooseberry Creek from Narrows Reservoir
- Modify and/or stabilize streambanks and associated riparian zones along Middle Gooseberry Creek
- Acquire and/or improve stream segments to provide additional fish habitat
- Provide winter releases to Cottonwood Creek
- Provide summer flows in Lower Cottonwood Creek

- Construct a pipeline in the Upper Cottonwood Creek area to convey project water outside the stream channel
- Provide a minimum pool in Narrows Reservoir for fish
- Reduce external phosphorus loading to Scofield Reservoir

Because of the reduced reservoir capacity, there would not be enough storage to include the following measures that would be part of the Proposed Action:

- Provide year-round flows in two tributaries of Gooseberry Creek that are presently dewatered
- Provide an additional 300 acre-feet per year of releases from the Narrows Reservoir for channel maintenance and/or fish habitat

In lieu of providing year-round flows in the Gooseberry Creek tributaries, 1.8 miles of spawning and rearing habitat would be replaced. (This mitigation would require additional coordination with UDWR and the USDA Forest Service. If improvement of existing stream segments is used as the method of replacing the habitat, as much as 5.4 miles of stream may need to be improved.)

Mitigation and enhancement of upland habitat would be the same as that described for the Proposed Action. New wetlands totaling about 72 acres would be created to mitigate for wetlands areas inundated by the reservoir.

#### *2.2.4.2.2 Design and Operation*

**2.2.4.2.2.1 Narrows Dam and Reservoir.—** Under the Small Reservoir Alternative, the design of Narrows Dam would be similar to that of the Proposed Action; but the dam would be 20 feet lower in height. The embankment would contain an estimated total volume of 220,000 cubic yards of material.

Narrows Reservoir would have two main outlets. A stream-level outlet would be constructed through the dam to provide downstream releases for fisheries and emergency evacuation of the reservoir. This outlet would have a 210-cfs capacity. The existing transmountain Narrows Tunnel, with the 60.0-cfs capacity, would serve as the other reservoir outlet and would accommodate releases through the mountain ridge for the transmountain diversion. The outlets would be designed and operated the same as in the Proposed Action.

The reservoir formed behind the dam would have a total capacity of 7,900 acre-feet and a water surface area of about 362 acres.

The reservoir's active capacity, or that portion of stored water that would be used to satisfy project water needs, would be 5,400 acre-feet. In all other respects, the Small Reservoir Alternative would be designed and operated in the same manner as under the Proposed Action.

**2.2.4.2.2.2 Oak Creek Pipeline.—**Under this alternative, this feature is identical to the same feature as described in the Proposed Action.

**2.2.4.2.2.3 East Bench Pipeline.—**Under this alternative, this feature is identical to the same feature as described in the Proposed Action.

**2.2.4.2.2.4 Upper Cottonwood Creek Pipeline.—**Under this alternative, this feature is identical to the same feature as described in the Proposed Action.

**2.2.4.2.2.5 Narrows Tunnel Rehabilitation.—**Under this alternative, this feature is identical to the same feature as described in the Proposed Action.

**2.2.4.2.2.6 SR-264 Relocation.—**Under this alternative, this feature is identical to the same feature as described in the Proposed Action.

**2.2.4.2.2.7 Recreation Facilities.—**For this alternative, public recreation facilities would be similar to those provided for in the Proposed Action. The facilities would include a boat ramp, boat slips, and a day-use area. The day-use area would include 6 picnic sites, restroom facilities, and a 40-unit campground. USDA Forest Service would participate in the recreation facility design, and the facilities would be constructed to their standards. USDA Forest Service would operate and maintain the facilities under agreement with SWCD and Reclamation. Title to the recreation facilities would remain in the name of the United States.

#### *2.2.4.2.3 Fishery Measures*

A total of nine fishery measures have been included in the project to mitigate for adverse impacts identified with this alternative for the project. These nine measures are the same as nine of the measures included as part of the Proposed Action. Two of the Proposed Action measures, however, would not be possible under the Small Reservoir Alternative. To the extent possible, an attempt was made to mitigate "in place" and "in kind." The two mitigation measures not included under this alternative are the restoration of streamflow in the Gooseberry Creek tributaries below Fairview Lakes and the provision for flushing flow releases to Gooseberry Creek below Narrows Reservoir. These two fishery mitigation measures could not be included due to the absence of capacity for carryover storage in the reservoir. If this alternative is chosen, additional mitigation measures would be developed in coordination with the Service and UDWR.

#### *2.2.4.2.4 Wetland Measures*

Wetland measures would be included in the project to mitigate for unavoidable adverse impacts to wetlands that have been identified with the project. Four alternative wetland mitigation sites have been identified. The actual mitigation that is implemented could be from one alternative or a combination of alternatives. Proposed wetland mitigation areas have been shown previously in figures 2-8, 2-9, and 2-10. A complete description of each alternative was provided in the discussion of the Proposed Action. Modifications unique to the Small Reservoir Alternative are discussed below. Alternatives listed are in order of priority.

**2.2.4.2.4.1 Wetlands Adjacent to Mud Creek Near Scofield.—**This measure would entail purchasing about 160 acres of private land adjacent to Mud Creek, south of the town of Scofield, rather than the 220 acres described in the Proposed Action.

**2.2.4.2.4.2 Area West of Lower Gooseberry Reservoir.—**Under this alternative, about 86 acres of private land west of Lower Gooseberry Reservoir would be acquired rather than the 120 acres under the Proposed Action. This land would be treated in the same manner as in the Proposed Action.

**2.2.4.2.4.3 New Wetlands Adjacent to Narrows Reservoir.—**This alternative would be identical to that described in the Proposed Action, except that the target acreage for mitigation would be reduced from 100 to 72 acres.

**2.2.4.2.4.4 Manti Meadows.—**This alternative would be identical to that described in the Proposed Action, except that the target acreage for mitigation would be reduced from 100 to 72 acres.

The wetland measures would need to include similar wildlife values as the 72 acres of

wetlands that would be inundated by the reservoir. Careful monitoring of the mitigation sites would be conducted to ensure that the value of the mitigation sites is at least equal to the value of the wetlands lost. This determination would be accomplished by performing HEP analyses of the sites and comparing habitat values.

SWCD would have primary responsibility for implementing the wetland measures described above and would assume all other responsibilities associated therewith and described in connection with the Proposed Action.

#### *2.2.4.2.5 Wildlife Measures*

The wetland measures described above would offset any losses to wetland habitat caused by inundation. Impacts to upland habitat (mule deer and Brewer's sparrow habitat) were described earlier in connection with the Proposed Action, and the mitigation measures discussed there also would be implemented under the Small Reservoir Alternative.

#### *2.2.4.2.6 Construction Materials*

Locations of materials necessary for constructing Narrows Dam and Reservoir are shown in figure 2-3. In all other respects, the description of the construction materials is the same for this action as that described in connection with the Proposed Action.

#### *2.2.4.2.7 Lands for Project Features and Relocation*

About 1,345 acres of land would be required for project features, wetland mitigation, fish and wildlife enhancement and mitigation, and material source areas. The amounts of land by present ownership or administration and proposed project use for this alternative are shown in table 2-7.

**Table 2-7.—Small Reservoir Alternative Right-of-Way Requirements for Project Features (Acres)**

| Project Feature<br>Type of Acquisition | Ownership or Administration | | |
|---|---|---|---|
| | Private | Reclamation Withdrawal | Total |
| Narrows Dam and Reservoir | 108 | 255 | 363 |
| East Bench Pipeline | | | |
| Perpetual easement | 51 | 0 | 51 |
| Oak Creek Pipeline | | | |
| Perpetual easement | 9 | 0 | 9 |
| Upper Cottonwood Creek Pipeline | 1.5 | 1.5 | 3 |
| SR-264 relocation | 0 | 34 | 34 |
| Recreation area | 0 | 7 | 7 |
| Fishery mitigation | | | |
| Perpetual conservation easement | 206 | 0 | 206 |
| Wildlife mitigation | | | |
| Fee title purchase of fish and wildlife enhancement area | 385 | 0 | 385 |
| Perpetual conservation easement adjacent to reservoir | 150 | 0 | 150 |
| Wetlands mitigation | | | |
| Perpetual easement or fee title | 135 | 0 | 135 |
| Materials source area[1] | 0 | 2 | 2 |
| Total | 1,045.5 | 299.5 | 1,345 |

[1] Embankment material for the dam would be obtained from the reservoir basin. Rockfill material for upstream slope protection would be obtained from an existing quarry located on withdrawn land. An alternative rockfill material quarry site may be located on private land.

#### *2.2.4.2.8 Access to Features*

Construction access would be the same as that described for the Proposed Action.

#### *2.2.4.2.9 Construction Program*

The construction program would be similar to that incorporated into the Proposed Action.

#### *2.2.4.2.10 Water Quality Protection Program*

The water quality protection program would be the same as that incorporated into the Proposed Action.

#### *2.2.4.2.11 Public Safety*

The public safety measures for this alternative would be the same as those incorporated into the Proposed Action.

### 2.2.4.3 Costs and Financing

The Small Reservoir Alternative would cost about $32.6 million and would be funded by SWCD, the State of Utah, and a loan from the Federal Government (table 2-5). Of the $32.6-million cost, about $4.9 million is for fish and wildlife enhancement and recreation. These costs are nonreimbursable to the project sponsor. Total financing would be through provisions of the SPRA. Because of a smaller storage capacity, the cost of project water would be approximately 96% higher than the Proposed Action.

### 2.2.4.4 Project Administration

Under the Small Reservoir Alternative, project administration would be the same as that described for the Proposed Action.

## 2.3 ALTERNATIVES CONSIDERED AND ELIMINATED FROM THE STUDY

Several alternatives considered were determined to be unviable. In general, alternatives considered and eliminated from further study did not meet Reclamation's criteria for providing a SRPA loan or licensing the use of Federal land. It is important to note that, in addition to not meeting Reclamations purpose and need, these alternatives do not meet SWCD's water development objectives:

Those alternatives are summarized below.

### 2.3.1 Direct Diversion Without Reservoir Alternative

- The Direct Diversion Without Reservoir Alternative was formulated to avoid impacts to wetlands in the Narrows Reservoir basin and does not require constructing a dam and reservoir. Water would be diverted from Gooseberry Creek according to water demands within the project service area to the extent it is available in the natural runoff pattern (figure 2-11). Key features and elements of this alternative include: A diversion structure and pumping plant on Gooseberry Creek located about 1,000 feet downstream from the SR-264 highway crossing of Gooseberry Creek
- An electrical transmission line
- A 1,000-foot-long discharge pipeline
- An open canal about 0.8 mile long
- Narrows Tunnel rehabilitation
- Upper Cottonwood Creek Pipeline

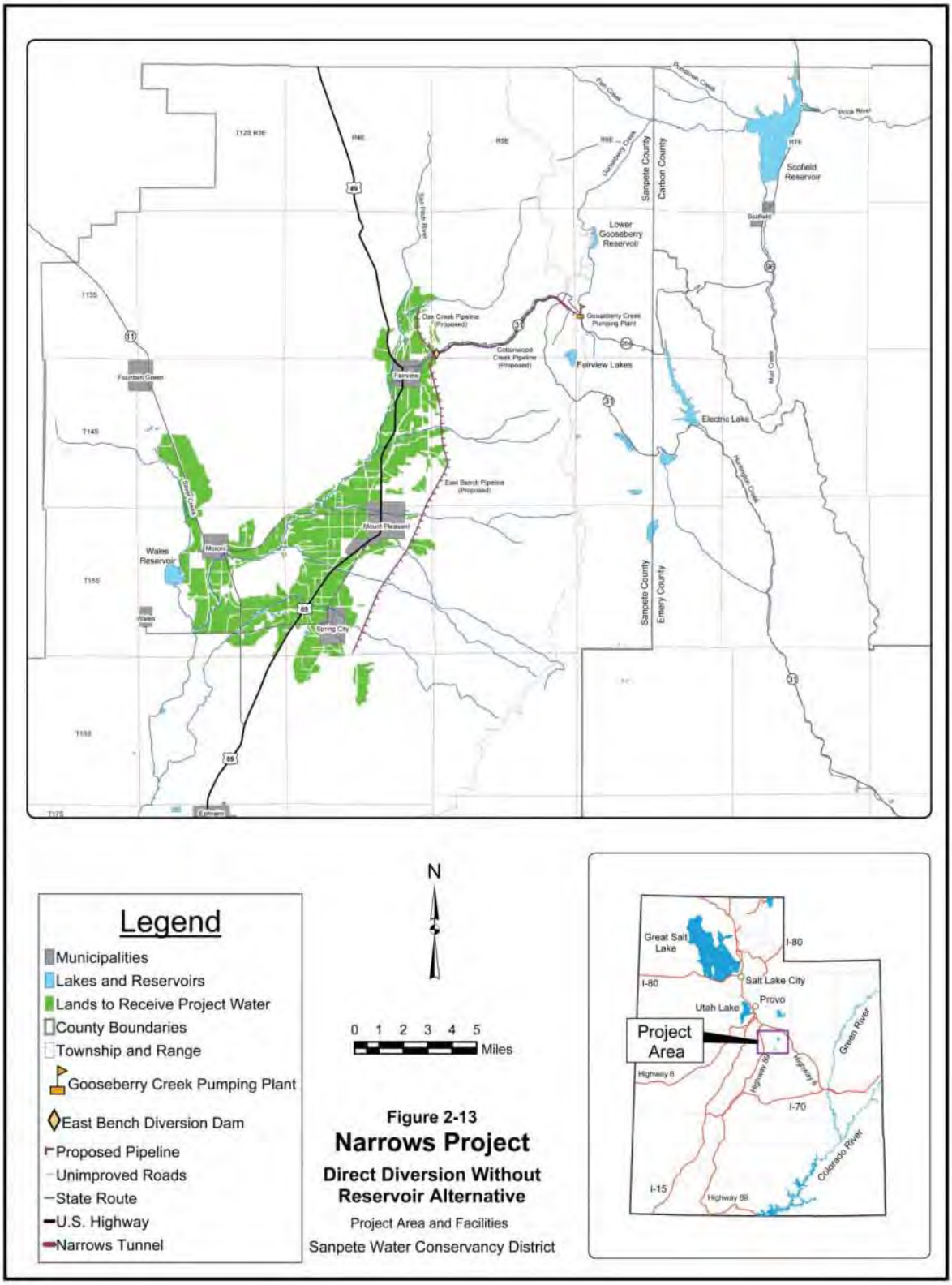



**Figure 2-11.—Narrows Project, Direct Diversion Without Reservoir Alternative.**

- Oak Creek Pipeline
- East Bench Pipeline

A hydrologic operation study indicates that an average of 1,373 acre-feet per year could be diverted from Gooseberry Creek to Cottonwood Creek. This analysis is based on 1960–92 flow records and takes into consideration the maximum annual transbasin diversion of 5,400 acre-feet, the 1.0-cfs minimum streamflow requirement at the Narrows damsite, and the demand for supplemental irrigation water. The majority of flow on Gooseberry Creek occurs in May and June. However, the demand for supplemental irrigation water generally occurs in July, August, and September. Therefore, the high flows of May and June would not be diverted because there would be no place to store the water to use later in the irrigation season. During low flow periods, natural flows in Gooseberry Creek would not be great enough to meet the 1.0-cfs minimum streamflow in Cottonwood Creek. Similarly, the project could not provide water as needed in the late irrigation season.

The total cost of the Direct Diversion Without Reservoir Alternative would be about $12.1 million. Since this alternative would provide neither recreation nor fish and wildlife benefits, there would be no grants available for those purposes; and the total project cost would be borne by the water users. In addition to capital costs, an annual pumping cost of about $7,200 would be incurred.

#### 2.3.1.1 Reasons Eliminated from Further Consideration

For the following reasons, the Direct Diversion Without Reservoir Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

The Direct Diversion Without Reservoir Alternative does not supply irrigation water when it is needed during the mid- and late-summer months.

During low flow periods, this alternative cannot provide the 1.0-cfs minimum streamflow in Gooseberry Creek at the Narrows damsite as required by the project water rights.

Because this alternative would provide neither recreation nor fish and wildlife benefits for SWCD, there would be no grants available for those purposes that would offset some of the project costs.

### 2.3.2 Direct Diversion with Reservoir in Sanpete Valley Alternative

This alternative would include the same facilities in Gooseberry Creek as the Direct Diversion Without Reservoir Alternative, but a storage reservoir would be provided at a lower elevation in Sanpete Valley. The storage would allow the water to be delivered at times during the irrigation season when it is needed (figure 2-12).

A hydrologic operation study indicates that an average of 4,671 acre-feet per year could be diverted from Gooseberry Creek to Cottonwood Creek. This analysis is based on 1960–92 flow records and takes into consideration the maximum annual transbasin diversion of 5,400 acre-feet and the 1.0-cfs minimum streamflow requirement at the Narrows damsite. The majority of the divertible flow occurs in May and June. This flow would be added to the usual spring peak flows in Cottonwood Creek and could result in considerable degradation of the stream channel. During low flow periods, natural

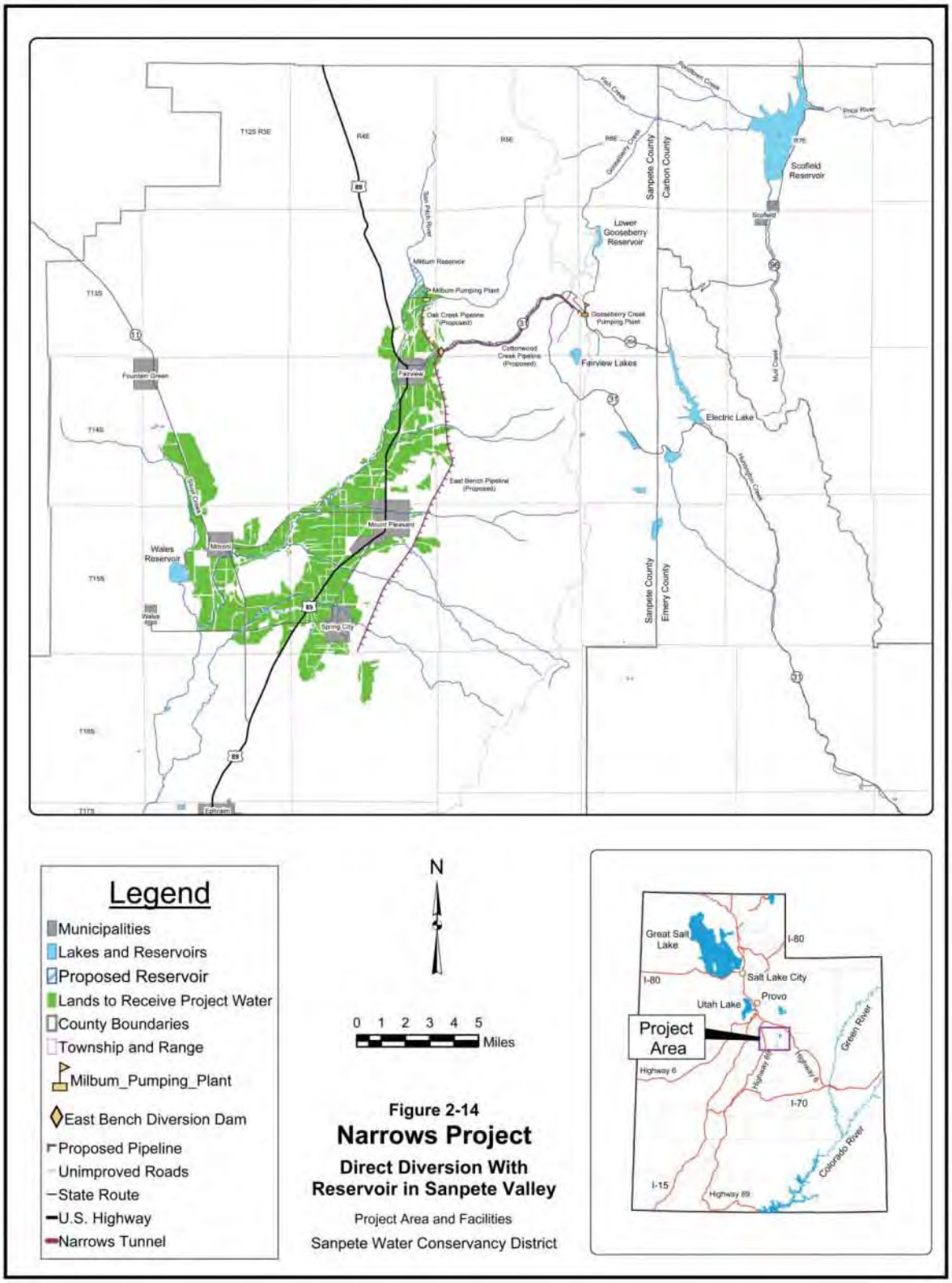



**Figure 2-12.—Narrows Project, Direct Diversion with Reservoir in Sanpete Valley.**

flows in Gooseberry Creek would not be great enough to meet the 1.0-cfs minimum streamflow in Gooseberry Creek or to provide the 2.0-cfs minimum year-round flow in Cottonwood Creek, as required by the 1984 Compromise Agreement.

To avoid severe degradation of the stream channel, the flow would need to be conveyed through a pipeline (the Cottonwood Creek Pipeline) for the entire length of the canyon. Proper placement of the pipeline is critical because a total of 104 landslides, most of which are active, have been mapped in the canyon. The topography of the canyon suggests that the most likely location for the pipeline would be within the existing highway alignment. However, due to the landslides, the highway has continual stability problems; and repairs are needed on an annual basis. The instability would present continual safety and maintenance problems for the high-pressure pipeline. The terminus of the Cottonwood Creek Pipeline would require a control/energy dissipation structure.

To identify the best damsite available, a reconnaissance-level study was performed in which all potentially practicable reservoir sites within the project area were identified (see appendix B). Preliminary estimates of storage capacity, dam height, and dam length were made. A total of 10 damsites were included in this evaluation. Of these damsites, a site located near Milburn appeared to be the most feasible. This determination was made based on the amount of embankment material required to construct the dam versus the volume of water that could be stored. The other damsites were eliminated because they were either technically or economically infeasible. The reservoir basin at the Milburn site contains about 60 acres of high quality wetlands, including willow thickets, cattails, and sedges that would be impacted.

In addition to the dam, the Oak Creek Pipeline would need to be enlarged to deliver water from the reservoir to the project area. A pumping plant also would be needed to lift the water into the pipeline. Key features and elements of this alternative include the following:

- A diversion structure and pumping plant on Gooseberry Creek located about 1,000 feet downstream from the SR-264 highway crossing of Gooseberry Creek.
- An electrical transmission line.
- A 1,000-foot-long discharge pipeline.
- An open canal about 0.8 mile long.
- Narrows Tunnel rehabilitation.
- Cottonwood Creek Pipeline.
- Milburn dam and reservoir (5,400-acre-foot capacity). The dam would have a maximum height of 64 feet and a crest length of 2,185 feet.
- A pumping plant near Milburn dam.
- An enlarged Oak Creek Pipeline.
- East Bench Pipeline.

Total project cost would be about $50 million or about $18.4 million higher than the Proposed Action. However, this alternative does not have any carryover storage and would not provide SWCD with recreation or fish and wildlife benefits. As a result, it would not be eligible for State or Federal grants for these purposes. All costs would be allocated to and repaid by the local water users. Costs allocated to the water users would be about 2.8 times those under the Proposed Action while the yield would be about 13% less than the Proposed Action. In addition, annual O&M costs would be

increased by about $155,000 per year to provide for pumping power at two locations.

#### 2.3.2.1 Reasons Eliminated from Further Consideration

For the following reasons, the Direct Diversion with Reservoir Alternative in Sanpete Valley fails to generate sufficient benefits to justify a SRPA loan and use of Federal lands, making the project unviable and, therefore, ineligible for SRPA funding;

The proposal is financially infeasible. With the substantially higher initial cost and higher annual costs, the sponsor lacks resources to meet SRPA cost-sharing requirements. In addition, annual costs exceed the sponsor's repayment capacity.

The feasibility of constructing the Cottonwood Creek Pipeline is highly doubtful due to the geologic instability of the canyon. The safety concerns and maintenance problems posed by this instability would be unacceptable.

The water right for this plan is questionable. During low flow periods, natural flow in Gooseberry Creek is insufficient to maintain the 1.0-cfs minimum streamflow required to establish and maintain the water right, as provided in the 1984 Compromise Agreement.

This proposal would still inundate about 60 acres of high quality wetlands.

### 2.3.3 Conservation Without Development of Other Water Supplies Alternative

Instead of developing new water supplies, implementing conservation measures has been suggested to extend existing water supplies. Under this alternative, the Narrows Dam and Reservoir would not be constructed. Without the dam construction, there would be no need to relocate SR-264; and there would be no recreational facilities constructed at the reservoir site. The East Bench, Oak Creek, and Upper Cottonwood Creek Pipelines would not be built. Irrigators in the project area have already implemented extensive efficiency improvements (conservation measures) to extend their scarce water supplies. Approximately 60% of the irrigated land within the project area is irrigated with sprinklers. About 75% of the land is served by improved conveyance facilities such as pipelines and lined canals and ditches. Based upon these conditions, the diversion requirement was computed to be an average of about 62,900 acre-feet per year for the 15,420 acres of project-eligible lands (see section 1.5.2). With average annual water supplies of 34,200 acre-feet per year, this would leave a shortage of about 28,700 acre-feet per year.

Because of this shortage, certain individuals and canal companies were planning to install, or were currently installing, a variety of efficiency improvements on much of the unimproved portions of project lands. These improvements would be expected to be in place by the projected date of completion for the proposed Narrows Project. These improvements would consist mainly of additional pipe delivery and sprinkler irrigation systems. Land leveling is often used as a technique to improve onfarm efficiency; however, due to the topography and shallow depth of soil, land leveling is generally not practical or economically feasible in the project area. Drip irrigation systems, which are highly efficient, are not considered practical for the alfalfa/grain rotation crops that are grown in the project area. With completion of these improvements, most of the cost-effective measures would have been implemented. There still could be limited opportunities for some localized improvements.

As a result of these efficiency improvements, diversion demands would be expected to be reduced from an average of 62,900 to about 51,700 acre-feet per year. This would be an average reduction in diversion demand of about 11,200 acre-feet per year. (In previous documents, this reduction has been reported to be 8,000 acre-feet per year but now has been revised based upon updated crop consumptive use data.) Even with these improvements in place, remaining shortages would be estimated at about 15,250 acre-feet per year. With this amount of shortage, significant soil moisture deficits would continue to seriously impact crop growth and production.

It should be noted that the 11,200-acre-foot reduction in diversion demand is not new water. New water would become available only if demands could be reduced below available supplies. In this case, efficiency improvements would make more use of the existing water supply available to the plants by reducing the amount of water lost to the plants because of evaporation, seepage, and spills from the carriage system; deep percolation through the root zone; and runoff from the ends of the fields. There would be two consequences of implementing efficiency improvements:

1. More of the existing water supplies would become available to support plant growth and development. Here, an additional 3,500 acre-feet per year of existing water supplies would be available to the plants.

2. Conversely, 3,500 acre-feet per year, less the amount previously lost by evaporation, no longer would be available as return flows to support wetlands, aquatic habitat, and downstream users.

As mentioned previously, most of the remaining cost-effective efficiency improvements would be implemented within a relatively short timeframe independent of the Narrows Project or any other organized program. In essence, their implementation would be a component of the No Action Alternative and would not satisfy the need for additional supplemental water.

#### 2.3.3.1 Reasons Eliminated from Further Consideration

This is an ongoing activity that is a component of the No Action Alternative, the Proposed Action, and any other alternative that might be considered.

For the following reasons, the Conservation Without Development of Other Water Supplies Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal lands, making the project unviable and, therefore, ineligible for SRPA funding;

Implementing efficiency improvements does not adequately satisfy SWCD's need for additional supplemental irrigation water.

Efficiency improvements do not provide SWCD with significant relief for water shortages during the late irrigation season when supplemental water is needed the most.

With implementing the planned efficiency improvements, the opportunity for additional large-scale conservation programs is nonexistent.

### 2.3.4 Mammoth Damsite Alternative

Several alternative damsite locations were evaluated and studied during the early stages of project planning. Because of the topography of many of these alternative damsites and technical difficulties relating to dam length and height and storage capacity, only two of the sites were further evaluated.

The first of these is the damsite contemplated in the original Gooseberry Project Plan.

The original Gooseberry Project Plan contemplated a reservoir site generally located in the south half of section 6 and part of sections 7 and 18, T. 13 S., R. 6 E., Salt Lake Base and Meridian, commonly referred to as the Mammoth reservoir site (figure 2-13). Through direct diversions and storage in the Mammoth reservoir, the original project plan contemplated a transmountain diversion of up to 30,000 acre-feet of water per year.

Through public reviews, the Service, among others, requested moving the Gooseberry damsite from the proposed Mammoth site to the proposed Narrows site to protect fishery values. In 1984, UDWR made a similar request and specifically requested the exclusion of Cabin Hollow Creek from the Gooseberry Project. Next, using Brooks Canyon Creek water became impractical because the existing wetlands are dependent upon its water supply. The amount of water available from this source did not justify the impact on the wetlands.

In 1984, Reclamation, SWCD, the Price River Water Users Association, and the Carbon Water Conservancy District entered into a Compromise Agreement that set forth conditions upon which water rights for both the Scofield Project and the Narrows Project would be established. The 1984 Compromise Agreement established priorities, quantities of flow, storage capacities, location of storage facilities, and points of diversion for these projects. The agreement recognized the above environmental concerns and expressly excluded the Mammoth damsite as a location for project storage facilities. The 1984 Compromise Agreement was a resolution of many years of disagreement between Carbon and Sanpete water interests over the Gooseberry Project. In 1985, the Utah State Engineer approved both the Narrows portion and the Scofield portion of the Gooseberry Project Plan water rights. Both approvals were expressly made subject to terms of the 1984 Compromise Agreement. Thus, no water right is now or likely would be approved in the future for a project constructed at the Mammoth damsite without amendment to the compromise agreement and approval of associated water right changes.

#### 2.3.4.1 Reasons Eliminated from Further Consideration

For the following reasons, the Mammoth Damsite Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

The Mammoth damsite was specifically eliminated from consideration during negotiations leading to the 1984 Compromise Agreement because the environmental impacts of a project constructed at that location were unacceptable to the Service and UDWR.

The alternative is technically infeasible. The sponsor cannot secure the water rights necessary to establish project water supplies as required by SRPA.

### 2.3.5 Valley Damsite Alternative

Several alternative damsite locations were evaluated and studied. Because of the topography of many of these alternative damsites and technical difficulties relating to dam length and height as well as storage capacity, only two of the sites were further evaluated. The Valley damsite is the second of the two sites evaluated.

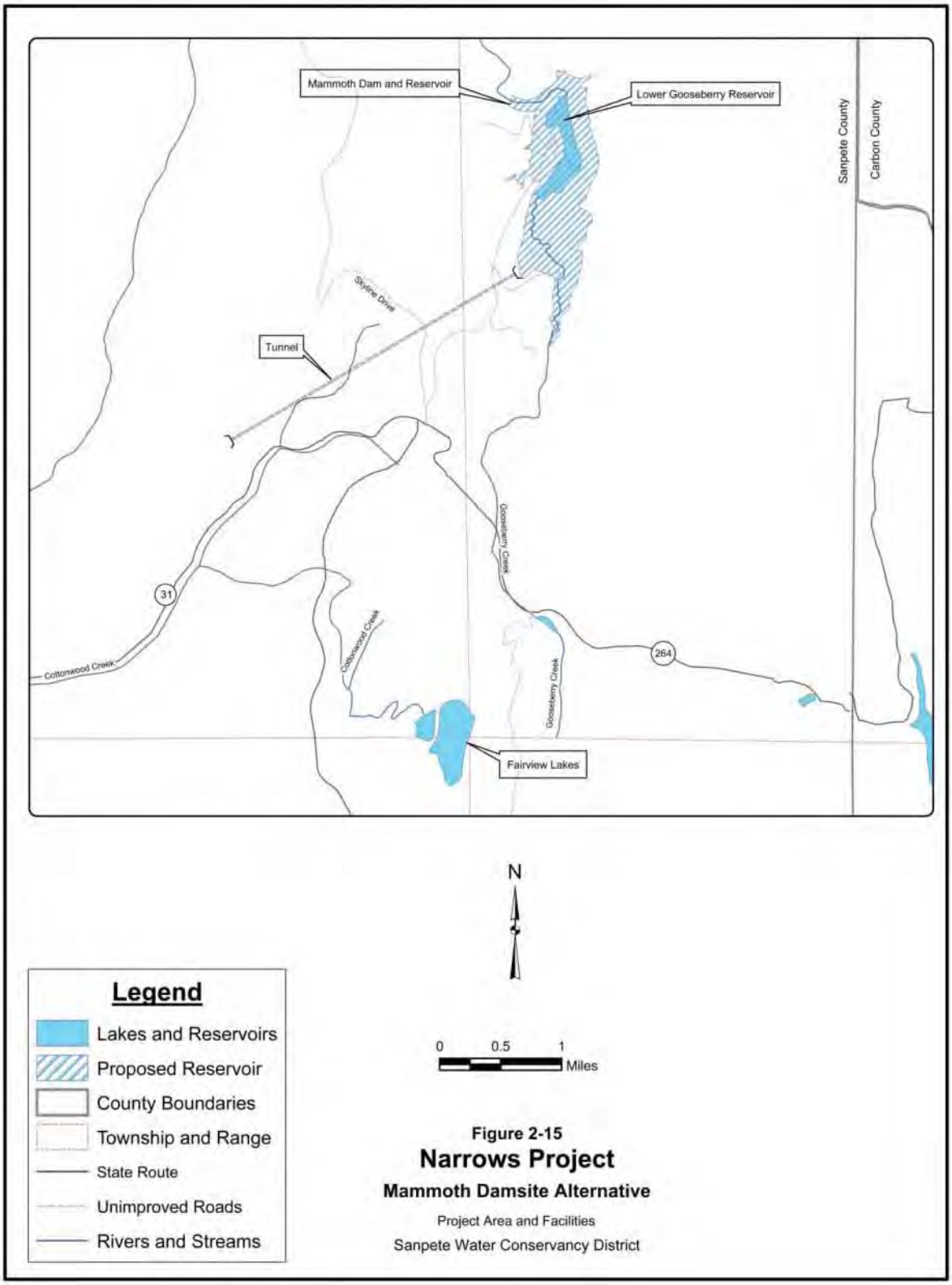



**Figure 2-13.—Narrows Project Mammoth Damsite Alternative.**

An alternative damsite for the Narrows Dam was evaluated and presented at the public scoping meetings. That dam would be located in the valley upstream of the Narrows damsite (figure 2-14). The dam, having a crest length of about 5,000 feet, would be located upstream of SR-264. The reservoir, with a 4,500-acre-foot capacity, would produce an annual average yield of about 4,376 acre-feet. This alternative would produce only about 82% of the yield of the Proposed Action. The dam and reservoir would be located off stream, so a diversion structure and feeder canal would be required to convey flows from Gooseberry Creek into the reservoir. The Narrows Tunnel would be required to convey project water transmountain into Cottonwood Creek. The East Bench and Oak Creek Pipelines would deliver water to the users. Total estimated cost of this alternative is about $31.1 million.

The reservoir would not have sufficient capacity for any carryover storage. Without the carryover storage, this alternative would not produce any of SWCD's recreation or fish and wildlife benefits; and the alternative would, therefore, be ineligible for grants for these purposes. SWCD would be responsible for the entire cost of the alternative. The lack of eligibility for grants increases the capital cost per acre-foot of yield attributed to SWCD to about 2.1 times the capital cost per acre-foot of yield of the Proposed Action. Based upon SRPA's financial feasibility requirements, SWCD would be eligible for a loan of about $16,900,000 and would be required to provide $7,200,000 in local funds toward project construction. The loan would be repaid in 30 years with annual payments of about $563,000.

This alternative does not conform to the terms of the 1984 Compromise Agreement as to location, storage capacity, or point of diversion. This alternative would not be eligible for an approved water right unless terms of the 1984 Compromise Agreement and the approved water rights were modified.

#### 2.3.5.1 Reasons Eliminated from Further Consideration

For the following reasons, the Valley Damsite Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

The average annual yield would be about 18% less than the Proposed Action; whereas, the absence of any carryover storage would mean that this shortage would be felt most severely in an extended drought and would, in that sense, provide virtually no water when it is most needed.

Water rights for this alternative are questionable. Lacking modification to the 1984 Compromise Agreement, SWCD would not be able to secure the water rights necessary to establish project water supplies as required by SRPA. Without an approved water right, the alternative would be technically infeasible and ineligible for SRPA funding. Under Utah law, a change of water right cannot be filed on an approved application to appropriate; a change application can be filed only on a certificated water right that only can be acquired after the applied-for application has taken place and the water in question placed to beneficial use. Moving to another site, such as the Valley damsite, would require abandonment of the existing approved application and establishment of a new one, with a much junior priority date and associated complications relating to the downstream rights on Gooseberry Creek and Scofield Reservoir.

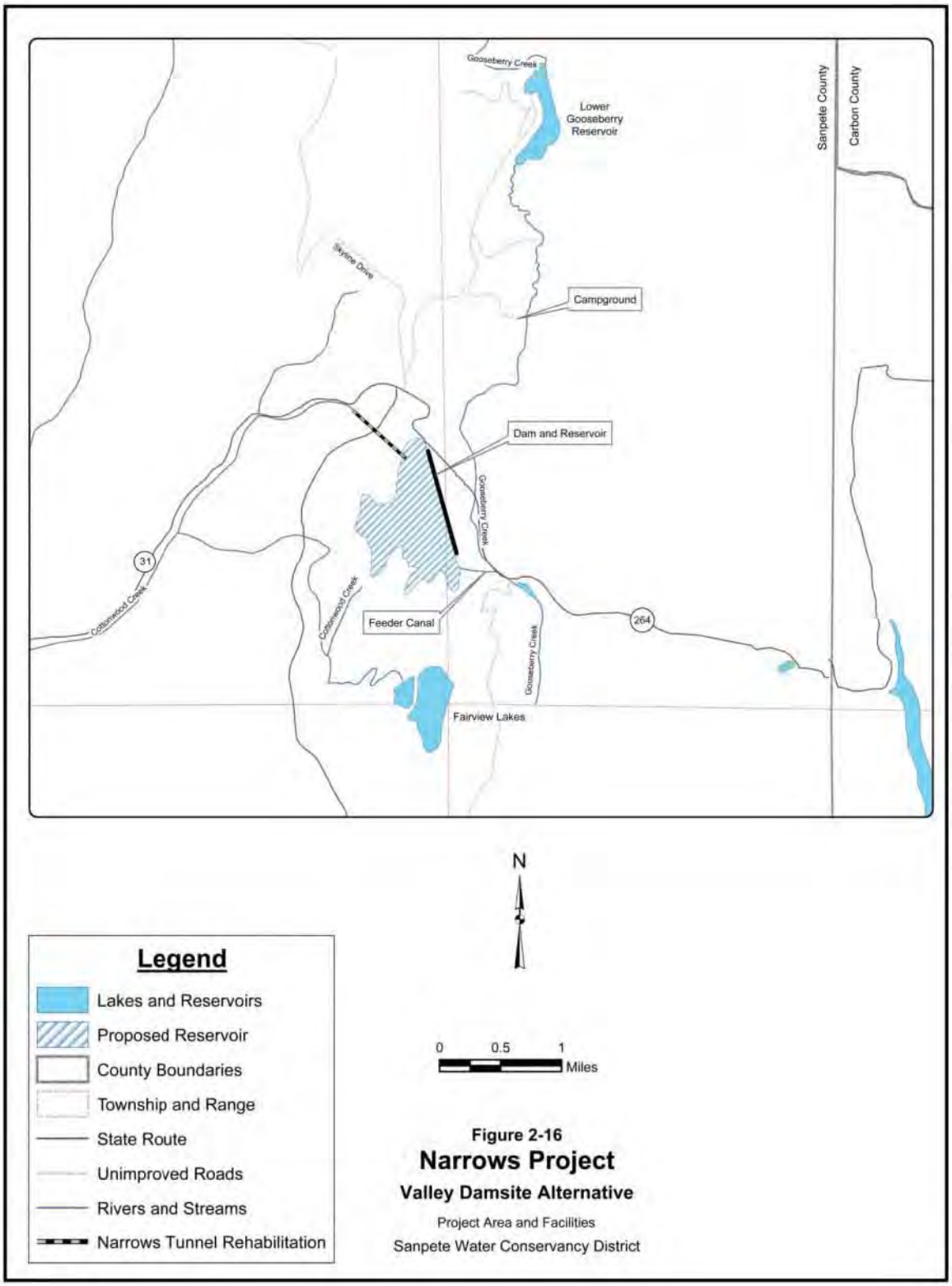



**Figure 2-14.—Narrows Project Valley Damsite Alternative.**

This alternative does not eliminate most of the impacts to wetlands and Gooseberry Creek that are objectionable aspects of the Proposed Action

## 2.3.6 Skyline Mine Alternative

Under this alternative, ground water would be developed in the Flat Canyon area, located east of the proposed Narrows Reservoir basin, by drilling deep wells and pumping the ground water from bedrock. This plan originally was developed and proposed by Canyon Fuel Company, the owner of the Skyline Coal Mine.

On August 16, 2001, coal miners in central Utah's Skyline Mine inadvertently tapped into a saturated sandstone formation. As a result, 4,700 gallons per minute of water began flowing into the mine. The coal company, in turn, spent $6 million on pipe and pumping equipment to remove the water from the mine and drain it into Scofield Reservoir. Additional wells were drilled near Electric Lake and were pumped into the Huntington Creek drainage.

Early investigations performed by the mine identified the water as \ being a potentially new unappropriated source from a prehistoric aquifer. The mine developed a theory that, if the water was a new source, development of this source would not interfere with any existing water rights—therefore, this ground water could be developed as a new source of water supply. The idea was that the mine would help pay the capital cost of the project if the surrounding counties (Carbon, Emery, and Sanpete) would pay the cost of pumping the water and then use it for a temporary water supply. The mine would, in turn, benefit by having the ground water levels adjacent to the mine lowered, which would make it economical for Canyon Fuel to mine the remainder of the coal deposit. Some individuals suggested that the water supply developed by this project could be an alternative to the Narrows Project.

However, before the logistics of this alternative could be coordinated among Carbon, Emery, and Sanpete Counties, Utah Power claimed ownership of the water. Utah Power asserted that, since the miners had tapped into the aquifer, Electric Lake, owned by Utah Power, began losing 700 acre-feet of water per month.

In discussions with mine officials, Utah Power, water users, and county officials, the State Engineer gave his opinion that it would be difficult, if not impossible, to prove that the water pumped from the mine is unappropriated.

Recently, Canyon Fuel has abandoned the Flat Canyon portion of the mine where the ground water was encountered and has expanded its operations to the north. It has sealed off that portion of the mine and does not have plans to resume mining operations in the Flat Canyon area.

### 2.3.6.1 Reasons Eliminated from Further Consideration

For the following reasons, the Skyline Mine Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

Preliminary studies performed by Canyon Fuel showed that water developed by the project would be very expensive, even with Canyon Fuel's assistance with capital costs. The project would be cost prohibitive without Canyon Fuel's participation.

The source of the water and the impact on existing water rights has not been established. The State Engineer maintains the position that

all water in the area is fully appropriated; without a water right, this alternative is not feasible.

Since it would have provided only a temporary water supply, it was not considered to be a viable alternative.

### 2.3.7 Year-round Release with Ground Water Exchange and Pumping Alternative

The purpose and intent of this alternative is to avoid impacts to Cottonwood Creek by making releases from the Narrows Reservoir on a year-round basis. Year-round releases would eliminate SWCD's need for much higher releases during the latter part of the irrigation season. Water would be released through the Narrows Tunnel and would flow down Cottonwood Creek to the San Pitch River and be stored in Gunnison Reservoir. This water would be exchanged with ground water pumped from wells during the irrigation season.

Under the Ground Water Exchange Alternative, a total of about 50.0 cfs would be required to satisfy project demands. Based on typical hydraulic transmissivity of the alluvial material in the northern Sanpete Valley aquifers, it is estimated that properly engineered wells could produce only about 2.0–3.0 cfs each. At this capacity, about 20 wells would be required to deliver the water to the various irrigation companies within the project area. These wells would be located strategically near the existing distribution systems. Under this alternative, the Narrows Reservoir and Tunnel would still be needed by SWCD. The Upper Cottonwood, East Bench, and Oak Creek Pipelines would be eliminated.

Ground water occurs in northern Sanpete Valley in the unconsolidated alluvial fill under water table (unconfined) and artesian (confined) conditions. Depth to water ranges from 10 feet in the center of the valley to about 88 feet near the alluvial slopes at the base of the Wasatch Plateau. The hydraulic transmissivity ranges from less than 1,000 square feet per day ($ft^2$/day) to about 20,000 $ft^2$/day. Formations with the lowest transmissivity generally are located in the center of the valley. Typical well depths range from about 50–500 feet. There are about 55 pumped wells and about 185 flowing wells in the entire Sanpete Valley. Most of the ground water currently is being used for irrigation.

As noted, in addition to the Narrows Reservoir and Tunnel, approximately 20 wells would be required by SWCD to produce a total capacity of 50.0 cfs. These would be 20-inch-diameter rotary-drilled wells. Because they would be drilled in unconsolidated alluvial fill, the wells would need to be fully cased and screened with gravel packing. The wells would cost about $6.5 million at a cost of approximately $325,000 per well. O&M costs for pumping would be about $52 per acre-foot or $281,000 per year to deliver 5,400 acre-feet. The total estimated cost of this alternative is about $26,632,000 or about 0.85 times the cost of the Proposed Action. However, with the added cost of pumping, the average annual cost for water is about 1.07 times the cost for the Proposed Action.

As noted above, the productivity of the aquifer as reflected by the range in transmissivity varies considerably from location to location throughout the valley. This suggests some risk associated with the site selection and the associated uncertainty as to whether SWCD's required flow could be developed with the 20 wells for the estimated cost. In addition, the 20 new, high-capacity wells coupled with the relatively large number of existing wells and low transmissivity in parts of the valley

suggest that the potential for interference with other wells would be significant.

Change applications would need to be approved by the State Engineer to exchange the imported water from the Narrows Project to the new wells. Historically, the State Engineer has been reluctant to approve change applications or new applications where there is a possibility of significant interference with existing wells. With the high potential for interference, it is unlikely that extensive changes as proposed by this alternative would be approved by the State Engineer.

An additional alternative configuration would be to implement this alternative without constructing the Narrows Dam and Reservoir, diverting approximately 4,671 acre-feet of water. This configuration is simply a variation of the Year-Round Release Alternative and would suffer from the same deficiencies. Therefore, this configuration has been eliminated from further study for the same reasons as the Year-Round Release with the Ground Water Exchange and Pumping Alternative.

#### 2.3.7.1 Reasons Eliminated from Further Consideration

For the following reasons, the Year-Round Release with Ground Water Exchange and Pumping Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

Technical feasibility of the alternative is uncertain. The range of transmissivity of the aquifer formation introduces significant risk and suggests that more than 20 wells might be required for SWCD to produce the 50.0-cfs capacity. The potential for SWCD's ability to obtain an approved change application is equally uncertain because of the potential for significant interference with existing wells.

Water right uncertainties cloud eligibility for SRPA funding. This alternative does not eliminate most of the impacts to wetlands and Gooseberry Creek that are aspects of the Proposed Action.

### 2.3.8 New Ground Water Development Alternative

Some suggestions received in scoping meetings proposed developing local ground water sources in lieu of constructing the Narrows Dam and Reservoir. Under this alternative, there would be no need for the Narrows Dam and Reservoir or the pipelines included in the Proposed Action. A total well capacity of about 50.0 cfs would be required to supply project needs. As discussed in the previous alternative, about 20 wells with a capacity of 2.0–3.0 cfs would be required. Total cost of the wells would be about $6,500,000; and annual pumping costs would be about $281,000.

This alternative would require approval by the State Engineer. However, the State Engineer considers the ground water aquifer in north Sanpete County to be fully appropriated. Further development of ground water in the area without import would impact existing water rights in downstream locations. In a November 5, 1997, policy memorandum, entitled Water Rights Policy, Sevier River Basin Areas 61, 63, 65, 66, 67, 68, and 69, the State Engineer published the following:

> "As of March 19, 1997, the Sevier River Basin was closed to all new appropriations of ground water. . . All new ground-water development will be based on the acquisition and changing of existing valid water rights

from surface (including direct flow and reservoir storage) and underground sources."

No new water is available for development of the magnitude required here by SWCD. The only water that might be made available to SWCD would be through purchasing existing water rights. Purchasing existing water rights is essentially the same as the proposal to retire irrigated lands, which is discussed subsequently.

#### 2.3.8.1 Reason Eliminated from Further Consideration

For the following reasons, the New Ground Water Development Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

This alternative is technically infeasible. No water supply exists for the proposal.

### 2.3.9 New Surface Water Development in Sanpete County Alternative

Several suggestions have been made to expand the use of local streams to satisfy SWCD's project needs. These suggestions include storing excess spring flows either in a new reservoir built in Sanpete County or using these flows to recharge the ground water basin for later use. Another version of this alternative would be for SWCD to purchase existing water rights to meet its needs. Under this alternative, there would be no need for SWCD to construct the Narrows Dam and Reservoir or the pipelines included in the Proposed Action.

While it is true that there are excess flows in the local streams during the spring runoff, this water is not available for use in northern Sanpete County. On November 30, 1936, a final decree was entered by Judge LeRoy Cox adjudicating the water and water rights of the Sevier River system. Under the terms of the Cox Decree, all of the waters within the project area, located in the Sevier River drainage, are fully appropriated; and no additional local supplies are available for appropriation or development. Any water, either underground or surface water, in the project area is either fully appropriated by local water right owners or is necessary to satisfy the water rights of downstream appropriators. Thus, no new surface water is available for local development.

Even though the local surface water supplies are fully appropriated, the State Engineer would consider applications to transfer water rights and change points of diversion. To be approved, the change in points of diversion must not adversely impact third party water rights holders. With the complexity of water rights in the Sevier River Basin involving direct and return flows, the possibility of adverse impacts is substantial with almost any conceivable change in points of diversion.

The suggested purchase of water rights and transfer of points of diversion imply that certain irrigated lands would be removed from production with the transfer of the water right. This proposal is essentially the retirement of irrigated lands, which is discussed subsequently.

#### 2.3.9.1 Reason Eliminated from Further Consideration

For the following reasons, the New Surface Water Development in Sanpete County Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water

rights, making the project unviable and, therefore, ineligible for SRPA funding;

The alternative is technically infeasible. There is no adequate surface water supply for the project.

## 2.3.10 Central Utah Project Water Alternative

Use of CUP water has been suggested to meet SWCD's project needs. The CUP originally intended to deliver CUP water to southern Sanpete County, south of the city of Gunnison. It is suggested that this water be made available to northern Sanpete County by exchange or through a new pipeline constructed from the outlet of Syar Tunnel to northern Sanpete County. An exchange is not technically possible. No water could be retained in northern Sanpete County to be exchanged for CUP water. As a result, CUP water would need to be delivered directly from Syar Tunnel.

Under this proposal, 50 cfs of CUP water would be delivered from the outfall of Syar Tunnel through a series of pipes and tunnels using the available pressure head from Strawberry Reservoir. This 38.8-mile-long pipeline would start at Syar Tunnel and end at the mouth of Cottonwood Creek Canyon in Sanpete County. It would require three tunnels and pressure pipe with ratings as high as 750 pounds per square inch.

The hydraulics require a minimum of 48-inch-diameter pipe through the reach between the Syar Tunnel and the outfall of the third tunnel, a length of 116,600 feet. From this point on, the pipeline is reduced to a 36-inch-diameter pipe for an additional 88,300 feet. A total of 13,300 feet of tunnel would be required. Costs were developed using 1987 estimates for steel pipe and tunnels for the CUP and indexing them to April 1994. The total cost for the Syar-Cottonwood Pipeline is estimated to be $146,600,000. This includes the cost of the East Bench Pipeline that still would be required to deliver project water.

To be eligible for funding under terms of the SRPA, total project costs must be under $15 million indexed from 1956 to the present or about $50 million in today's dollars. The total cost of the Syar-Cottonwood Pipeline proposal exceeds the maximum limit by over 2.5 times and is more than 8 times that of the Proposed Action. Thus, the proposal would not be eligible for SRPA funding.

The Central Utah Project Completion Act, which authorized completion of the remaining features of the CUP, placed certain restrictions on delivery of project water. It restricted development of the CUP to the Wasatch Front area of central Utah if certain Utah counties withdrew from the CUP. Since passage of the CUPCA, Millard and Sevier Counties formally have withdrawn from the CUP. As a result, delivery of water to Sanpete County has been dropped from the CUP plan in compliance with the CUPCA.

### 2.3.10.1 Reasons Eliminated from Further Consideration

For the following reasons, the Central Utah Project Water Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal land and fails to meet the minimum requirements of SWCD's non-Federal water rights, making the project unviable and, therefore, ineligible for SRPA funding;

The plan is financially infeasible because the proposal does not qualify for SRPA funding.

Costs exceed the estimated cost of the Proposed Action by more than 8 times.

CUP water cannot be legally delivered to Sanpete County under present law.

### 2.3.11 Conservation Through Retirement of Irrigation Lands Alternative

Retirement of irrigated lands is one method of reducing water shortages where local supplies are inadequate to meet all demands for irrigation water. In practice, certain irrigated lands are retired; and the water is transferred to other irrigated lands. The shortage on the active lands, thereby, is reduced by some corresponding increment. If storage is available, water originally allocated to the retired lands would be held until needed on the active lands. In the absence of storage, only the existing streamflow allocated to the retired lands would be available for diversion to the active lands. Where snowmelt is the major component of local supplies, flows diminish during the irrigation season. Thus, absent storage, water would be available only for transfer to the remaining active lands when it would normally be applied to the retired land. Since any land that might be considered for retirement is already water short during the mid- to late-summer, little additional water would be available when it is needed most.

It has been suggested that sufficient irrigated lands be retired to reduce the demand by 4,900 acre-feet per year, the amount of irrigation water that would be produced by the Proposed Action. Local water supplies amounting to about 1.78 acre-feet per acre are available in the late irrigation season to lands proposed for retirement. To make 4,900 acre-feet of water available to the active lands, about 2,760 acres of land would need to be retired. This represents about 18% of the 15,420 acres of project-eligible lands. Project-ineligible lands normally do not receive water during most of the water-short portion of the growing season, so there would be no advantage in retiring project-ineligible lands.

To achieve this benefit for the lands remaining in production, the lands (18%) removed from production would be taken out of production in their entirety. An 18% reduction of project-eligible farmland is contrary to one of the stated needs for the project. Agriculture is one of the major components of the economy of north Sanpete County and is seriously impacted by persistent water shortages. Land retirement would not materially improve the overall water supply situation in the project area. It would improve only the water supply for selected farmland, and then only marginally.

It should be noted that the suggested land retirement still would not provide a full water supply to the remaining active lands. To put land retirement in perspective, consider how many acres of land must be retired to provide a full water supply to the remaining active lands. In a typical June when local supplies are still relatively abundant, available local water supplies could supply only the June demands on about 11,900 acres of project-eligible farmland—a reduction of about 3,500 acres from what is now farmed. The typical September demands are considerably lower, but local supplies also have dwindled to the point that they could provide a full water supply only to about 6,000 acres of land—a reduction of about 9,400 acres.

Reduced water shortages on active irrigated lands definitely would provide an incremental improvement in production and yield on those lands. The economic impact of land retirement is detrimental to the local economy and is politically unacceptable to local residents.

Major sources of funding for the proposed project would be from the SRPA and a State loan and grant. However, land retirement is a local land use issue that does not qualify as a water development feature under requirements of the SRPA loan program. Similarly, land retirement does not provide

benefits that would be eligible for State funding. Without State and SRPA funding, local funds would be inadequate to retire 2,760 acres of irrigated farmland.

The concept of land retirement also presupposes that there are willing sellers and willing buyers of land, forbearance, or water rights. There seems to be little indication that local farmers are willing to forgo farming on 20% of their irrigated farmland. To the contrary, local farmers appear to be more willing to support the Proposed Action to improve the water supply for their irrigated lands.

The purchase of land or rights for retirement would have to be accomplished either by the project sponsor or by individual farmers. In either case, prospective purchasers most likely would not have the resources to make such extensive land purchases. Land and rights purchases are not eligible for funding under terms of the SRPA, and most banks would not accept idle, nonproductive land as collateral for a bank loan. Further, no buyers have announced any interest in making such purchases. Lacking willing sellers, there may be no equitable or acceptable means for determining which lands would be retired.

#### 2.3.11.1 Reasons Eliminated from Further Consideration

For the following reasons, the Conservation Through Retirement of Irrigation Lands Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal lands, making the project unviable and, therefore, ineligible for SRPA funding;

This plan does not meet SWCD's stated need for supplemental water supplies to support existing farmland; rather, it proposes taking farmland out of production to reduce the need for supplemental water.

Any water made available for late season irrigation under this proposal would be only that fraction of the water formerly used on retired lands during the late irrigation season; most of the water formerly used on these lands would flow past without being used locally.

### 2.3.12 Purchase of Sanpete County's Water Rights by Carbon County Water Interests Alternative

Scoping comments suggested that Carbon County water interests could purchase Sanpete's rights to Gooseberry Creek water. This would eliminate impacts to Carbon County that would occur as a result of constructing the Narrows Project and diverting Gooseberry Creek water. Since the inception of the Gooseberry Project, this alternative has been available to Carbon County water interests.

#### 2.3.12.1 Reasons Eliminated from Further Consideration

For the following reasons, the Purchase of Sanpete County's Water Rights by Carbon County Water Interests Alternative fails to generate sufficient benefits to justify a SRPA loan and use of Federal lands, making the project unviable and, therefore, ineligible for SRPA funding;

The proposal does not provide any relief from the persistent water shortages that prompted northern Sanpete County water users to pursue developing additional water supplies.

The proposal is infeasible without the presence of both willing sellers and willing buyers.

### 2.3.13 Carbon County Proposed Recharge Alternative

In September 2006, Carbon County proposed an alternative for review consisting of diverting transbasin water through a rehabilitated Narrows Tunnel and down Cottonwood Creek to a proposed ground water recharge aquifer at the mouth of the canyon. The alternative also would include construction of production wells and a delivery system. Following coordination with the Utah State Engineer to verify feasibility of the alternative from a water rights perspective, Sanpete County agreed to an analysis of the alternative overseen by the Central Utah Water Conservancy District. CH2MHill, under contract to the CUWCD, analyzed this alternative and included it in the June 2008 draft update to the *Sanpete County Master Plan*, which was distributed for public review and comment, including a public meeting on June 26, 2008, hosted by CUWCD in Orem, Utah. Following consideration of comments received on the draft plan, the final *Update to the Sanpete County Master Plan* was published in August 2008.

#### 2.3.13.1 Reasons Eliminated from Further Consideration

For the following reasons, the Carbon County Recharge Alternative fails to generate sufficient benefits to justify a SRPA loan, making the project unviable and, therefore, ineligible for SRPA funding. It is important to note that, in addition to not meeting Reclamation's purpose and need, this alternative does not meet SWCD's water development objectives:

There are several technical reasons why this alternative was not considered.

It is unlikely that an aquifer with a capacity to hold over 4,000 acre-feet of water could be found in northern Sanpete County.

Direct diversion of flows would require extensive construction of diversion dams and canals within the reservoir basin, potentially negating the avoidance of impacts by not building the proposed reservoir.

Water would have to be treated to drinking water standards before injection; or alternately, a large infiltration pond and settling basin, equivalent to a small reservoir, would be required to hold water diverted during spring runoff.

The nature and location of available aquifers and apparent separation of bedrock and shallow aquifers poses technical problems due to the requirement to inject and remove water from the same aquifer.

High drawdown from the proposed high capacity wells could affect adjacent wells and water rights.

## 2.4 COMPARISON OF ALTERNATIVES

Table 2-8 compares the closely examined alternatives against the issues associated with the Proposed Action that are outlined in chapter 1. The scientific and analytical basis for these comparisons can be found in chapter 3.

### 2.4.1 Preferred Alternative

Based on the comparison of alternatives provided in this section, Reclamation has selected the proposed action alternative (the large reservoir) as the preferred alternative.

**Table 2-8.—Comparison of the Narrows Project Alternatives and the Project Issues**

| Issues | No Action | Proposed Action | Mid-Sized Reservoir | Small Reservoir |
|---|---|---|---|---|
| **Water Resources** | | | | |
| Acre-feet of depletion to the Price River drainage | 0 | 5,491 acre-feet | 5,124 acre-feet | 4,703 acre-feet |
| Acre-feet of water available to San Pitch River drainage | 0 | 5,136 acre-feet | 4,964 acre-feet | 4,710 acre-feet |
| **Water Rights** | | | | |
| Appropriations | No change | No change | No change | No change |
| **Water Quality** | | | | |
| Change in Scofield Reservoir Trophic State Index | 0 | +3.5 | +3.5 | +3.5 |
| Change in average phosphorus level in Scofield Reservoir based on external phosphorus loading (milligrams per liter) | 0 | +0.003 (+10.8%) | +0.003 (+10.8%) | +0.003 (+10.8%) |
| **Air Quality**[1] | | | | |
| Number of days project will exceed National Ambient Air Quality Standards for $PM_{10}$ | 0 | 0 | 0 | 0 |
| **Slopes and Channel Stability** | | | | |
| Exceed 50-year channel-forming discharge | 0 | 0 | 0 | 0 |
| Lateral and vertical degradation | 0 | 0 | 0 | 0 |
| **Geologic Hazards** | | | | |
| Known geologic hazards within vicinity of dam and reservoir | 3 | 3 | 3 | 3 |
| **Paleontological Resources** | | | | |
| Paleontological resources inundated or otherwise impacted | 0 | Undetermined until completion of environmental commitments | Undetermined until completion of environmental commitments | Undetermined until completion of environmental commitments |
| **Soils** | | | | |
| Acres of new soil disturbance | 0 | 668 acres | 547 acres | 426 acres |
| Change in sediment loads in Gooseberry Creek | 0 | -400 tons | -400 tons | -400 tons |
| **Trace Elements** | | | | |
| Increase in levels of select trace elements in ground water | 0 | 0 | 0 | 0 |

[1] Particulate matter of 10 microns in diameter or smaller.

**Table 2-8.—Comparison of the Narrows Project Alternatives and the Project Issues (Continued)**

| Issues | No Action | | Proposed Action | | Mid-Sized Reservoir | | Small Reservoir | |
|---|---|---|---|---|---|---|---|---|
| **Fisheries** | | | | | | | | |
| *Instream*<br>Change in weighted usable area in fish habitat as measured by instream flow incremental methodology for the following life stages: | Preproject | | Postproject (Percent Change) | | Postproject (Percent Change) | | Pos-project (Percent Change) | |
| Adult | 11,932.32 | | 10,958.04 | (-8.17) | 10,958.04 | (-8.17) | 10,958.04 | (-8.17) |
| Juvenile | 2,623.93 | | 2,312.67 | (-11.86) | 2,312.87 | (-11.86) | 2,312.87 | (-11.86) |
| Spawning | 69.14 | | 69.9 | (+1.11) | 69.91 | (+1.11) | 69.91 | (+1.11) |
| Fry | 427.44 | | 373.25 | (-12.68) | 373.25 | (-12.68) | 373.25 | (-12.68) |
| *Reservoir*<br>Change in surface area in Scofield Reservoir (average) | 0 | | -290 | | -284 | | -258 | |
| **Wildlife** | Species | Without Mitigation (with Mitigation) | Species | Without Mitigation (with Mitigation) | Species | Without Mitigation (with Mitigation) | Species | Without Mitigation (with Mitigation) |
| Change in habitat units for the following species: mule deer, Brewer's sparrow, beaver, Richardson vole, yellow warbler | Mule deer | 0 (0) | Mule deer | -135 (0) | Mule deer | -109 (0) | Mule deer | -78 (0) |
| | Brewer's sparrow | 0 (0) | Brewer's sparrow | -477 (0) | Brewer's sparrow | -386 (0) | Brewer's sparrow | -263 (0) |
| | Beaver | 0 (0) | Beaver | -13 (0) | Beaver | -11 (0) | Beaver | -9 (0) |
| | Richardson vole | 0 (0) | Richardson vole | -63 (0) | Richardson vole | -57 (0) | Richardson vole | -45 (0) |
| | Yellow warbler | 0 (0) | Yellow warbler | -26 (0) | Yellow warbler | -24 (0) | Yellow warbler | -19 (0) |
| **Threatened and Endangered** | | | | | | | | |
| Acre-feet depletion from Colorado River system | 0 | | 5,491 acre-feet | | 5,124 acre-feet | | 4,703 acre-feet | |
| **Vegetative Resources** | | | | | | | | |
| Miles of stream lost due to inundation of the reservoir | 0 | | 5.3 miles | | 4.8 miles | | 4.8 miles | |
| Number of miles of stream affected by flow: | | | | | | | | |
| Increase in flow | 0 | | 4.9 miles | | 4.9 miles | | 4.9 miles | |
| Decrease in flow | 0 | | 16.1 miles | | 16.1 miles | | 16.1 miles | |
| **Wetland Resources** | | | | | | | | |
| Acres of wetlands lost | 0 acres (without mitigation)<br>0 acres (with mitigation) | | 100 acres (without mitigation)<br>0 acres (with mitigation) | | 81 acres (without mitigation)<br>0 acres (with mitigation) | | 72 acres (without mitigation)<br>0 acres (with mitigation) | |

**Table 2-8.—Comparison of the Narrows Project Alternatives and the Project Issues (continued)**

| Issues | No Action | Proposed Action | Mid-Sized Reservoir | Small Reservoir |
|---|---|---|---|---|
| **Recreation and Visual** | | | | |
| Change in projected fisherman days in Scofield | 0 | -6,800 | -6,400 | -5,800 |
| Increase in developed recreation visitor days at Narrows (including fishing) | 0 | +46,400 | +37,600 | +27,800 |
| Increase in dispersed recreation visitor days at Narrows (including fishing) | 0 | +910 | +740 | +560 |
| Change in visual quality objective | Partial retention | Partial retention | Partial retention | Partial retention |
| **Cultural Resources** | | | | |
| Cultural resources inundated or otherwise impacted | 0 | Undetermined until implementation of environmental commitments | Undetermined until implementation of environmental commitments | Undetermined until implementation of environmental commitments |
| **Economic and Social Resources** | | | | |
| Number of jobs (Carbon, Sanpete) created during construction | 0 | 50–100 | 50–100 | 50–100 |
| Change in farm income | 0 | 11% increase | 10% increase | 10% increase |
| Change in available water supply | | | | |
| Sanpete County | 0 | +5,318 acre-feet | +5,157 acre-feet | +4,935 acre-feet |
| Carbon County | 0 | -439 acre-feet | -457 acre-feet | -457 acre-feet |
| **Land Resources** | | | | |
| Change in number of AUMs of forage | 0 | -240 AUMs | -203 AUMs | -166 AUMs |
| Acres of mineable coal reserves not available for mining | 0 | 0 | 0 | 0 |
| **Health and Safety** | | | | |
| Percent change in the volume of traffic in the project area | 0 | 19% increase | 15% increase | 11% increase |
| **Indian Trust Assets** | | | | |
| Number of Indian trust assets affected | None | None | None | None |
| **Environmental Justice** | | | | |
| Number of minority communities disproportionately affected by the Narrows Project | None | None | None | None |

CHAPTER 3

# Affected Environment and Environmental Consequences

## 3.0 INTRODUCTION

This chapter discusses the affected environment and environmental consequences that would result from the construction, operation, and maintenance of the project features associated with the Proposed Action and alternatives of the Narrows Project should Reclamation approve the loan application and the use of the Federal land. The affected environment discussions describe existing conditions for resources within the project area. The impact analyses focus on potential direct, indirect, and cumulative impacts on these resources. Potentially significant impacts, together with criteria developed at the beginning of this study for assessing the significance of potential impacts, are identified. Resource specialists reviewed all data and results of the March 1998 DEIS analysis and updated information based on available data and the substantive public comments received, where appropriate, in this FEIS. Mitigation measures that would reduce or avoid certain adverse impacts or would compensate for some unavoidable adverse impacts also are identified. The final section of this chapter describes the irreversible and irretrievable commitment of resources associated with the Proposed Action.

## 3.1 WATER RESOURCES

### 3.1.1 Affected Environment

Water resources affected by the Proposed Action include Gooseberry Creek and its three unnamed tributaries located high in the Price River drainage. Gooseberry Creek, a tributary of Fish Creek, flows directly into Scofield Reservoir (see figure 1-1). Scofield Reservoir is included in the affected environment, as is the segment of the Price River immediately below the reservoir down to the first diversion at the town of Heiner, some 25 miles below the dam. Cottonwood Creek, located in the San Pitch River Basin, is located on the opposite side of the divide from Gooseberry Creek. The water from the Narrows Tunnel is diverted into Cottonwood Creek. Cottonwood Creek and the San Pitch River are located in the Sevier River subbasin of the Great Basin.

Typical of Wasatch Mountain streams, flows in these creeks are greatest in the spring, when snowmelt runoff is peaking. Peak flows during May and June are estimated to range from 15 to over 100 cfs in Upper Gooseberry Creek near the proposed damsite. The flow declines considerably in late summer and reaches a minimum in late fall or winter. Late-season flows are estimated to be 1.5–5 cfs in Upper Gooseberry Creek.

The average annual natural runoff volume of Upper Gooseberry Creek, near the proposed damsite, is 9,032 acre-feet. Of this amount, an average of 1,815 acre-feet presently is stored in Fairview Lakes and diverted transmountain to Cottonwood Creek through the Narrows Tunnel. The remaining water continues down Gooseberry Creek to Fish Creek. An average of 35,800 acre-feet per year enters Scofield Reservoir from Fish Creek. The total annual inflow to Scofield Reservoir from all tributaries averages 57,500 acre-feet. The average total contents

of Scofield Reservoir are about 42,360 acre-feet. Averages are based on the 1960–2002 hydrologic period of record.

The Price River below Scofield Reservoir, referred to as lower Fish Creek, has a wide range of flows that vary according to downstream water demands and hydrologic conditions. Releases consist of direct flow right bypasses and Scofield Reservoir storage deliveries for Scofield Project users. Spills occur when the reservoir is full and water flows over the spillway or when releases are made in excess of downstream demands. These total releases and spills have averaged 51,815 acre-feet for 1960–2002 but historically have varied from 13,762–154,475 acre-feet. Low flow conditions generally occur from November–March. There are no minimum flow requirements in the Price River, and it is not unusual for the flow below the dam to be completely shut off during winter months. Peak flows below the dam occur in wet years when the reservoir spills. While normal dam releases in June are about 150 cfs, the total releases with these spills have ranged up to more than 1,100 cfs. Because spills are in excess of downstream consumptive use requirements, they usually increase river flows throughout the lower Price River to the confluence with the Green River. From 1960–2002, the reservoir filled and spilled 17 times.

About 25 miles downstream from Scofield Reservoir near the small community of Heiner, the average annual flow of the Price River is about 74,800 acre-feet based on 1960–2002 data. Within 5 miles of Heiner, numerous diversions from the river occur. The largest diversion is the head of the Carbon and Price Wellington Canals, located about 1.5 miles south of Spring Glen. Except during high water conditions when the flow of the river exceeds the capacity of the canals, the river is essentially dry below this diversion. In addition to irrigation water, winter flows also are diverted for stock watering.

Irrigation return flows in this area discharge back to the river, and the flow of the river increases after passing through the Price-Wellington area. Near its confluence with the Green River, measured at the Price River at Woodside, the average annual flow of the river is 94,929 acre-feet, based on 1960–92 records. The stream gauging station on the Price River at Woodside was discontinued in September 1992 and renewed in July 2000.

### 3.1.2 Methodology and Impact Indicators

Impacts to water resources were determined by using six distinct and detailed operation studies, which simulate streamflows and reservoir operations under historical, future without project, and project conditions.

Averages are based on the 1960–2002 hydrologic period of record. The hydrologic analysis uses USGS stream gauge data, and a majority of the USGS stream gauge data was discontinued in 1989 and 2003. The additional effort to add 1 year of stream gauge data results in an insignificant improvement in the overall analysis.

While these operation studies originally were prepared by Franson Noble Engineering, contractors for SWCD, they have been reviewed carefully and revised by Reclamation. These revisions primarily involved reconciling the State of Utah, USGS, and Reclamation flow data below Scofield Dam using daily flow records. Operation studies then were rerun, and output graphs and tables were revised. These operation studies are briefly described as follows:

- **Scofield Reservoir Historical Operation Study –** This study simulates the historical operation of Scofield Reservoir and is used to calculate ungauged inflow to the reservoir.

- **Scofield Reservoir Demand Study –** This study was performed to segregate the outflow from Scofield Reservoir to separate the releases for downstream demands from the spills and operational releases (releases made in anticipation of a large spill or releases not needed for downstream demands). The study also segregates the bypass of direct flow water rights from releases from storage.

- **Future Without Project Operation Study –** This study shows the flows of Gooseberry and Fish Creeks and the Price River below Scofield Dam and the operation of Scofield Reservoir under the future without Narrows Project conditions. These conditions are the same as the No Action Alternative. Demands identified in the Scofield Reservoir Demand Study are used to operate Scofield Reservoir. Controlled releases from storage are limited to the 30,000-acre-foot water right, which does not include bypasses for direct flow rights.

- **Future with Narrows Project Operation Study –** This study shows the flows of Gooseberry and Fish Creeks and the Price River below Scofield Dam and the operation of Scofield Reservoir under the Proposed Action. Transmountain releases to Cottonwood Creek also are modeled.

- **Mid-Sized Reservoir Alternative Operation Study –** This study is similar to the Future with Narrows Project Operation Study, except that it is based on the Mid-Sized Reservoir Alternative instead of the Proposed Action.

- **Small Reservoir Alternative Operation Study –** This study is similar to the Future with Narrows Project Operation Study, except that it is based on the Small Reservoir Alternative instead of the Proposed Action.

Impact indicators for water resources previously were identified in chapter 1, including the following:

- Acre-feet of depletion to the Price River drainage

- Acre-feet of water available to the San Pitch River drainage

## 3.1.3 Predicted Effects

### 3.1.3.1 No Action Alternative

Under the No Action Alternative, streamflows would remain as they are in Gooseberry Creek, Lower Fish Creek, Price River to Heiner, Cottonwood Creek, and about 3 miles of the San Pitch River. There would be no additional depletion of water from these rivers. Water supplies for Sanpete and Carbon Counties would remain at present levels. Water shortages in northern Sanpete County would be reduced with continued implementation of water conservation measures.

Carbon Water Conservancy District would continue to operate Scofield Reservoir, and the storage levels and releases would continue to fluctuate under existing operating parameters (see figure 3-1). Flows below Scofield Reservoir in the Price River to the town of Heiner would see the same occurrence of spills during wet years and dry river conditions when releases are shut off during the nonirrigation season.

Cottonwood Creek would have typical flow conditions. After spring runoff flows subside in late May or early June, natural flows are supplemented with releases from Fairview

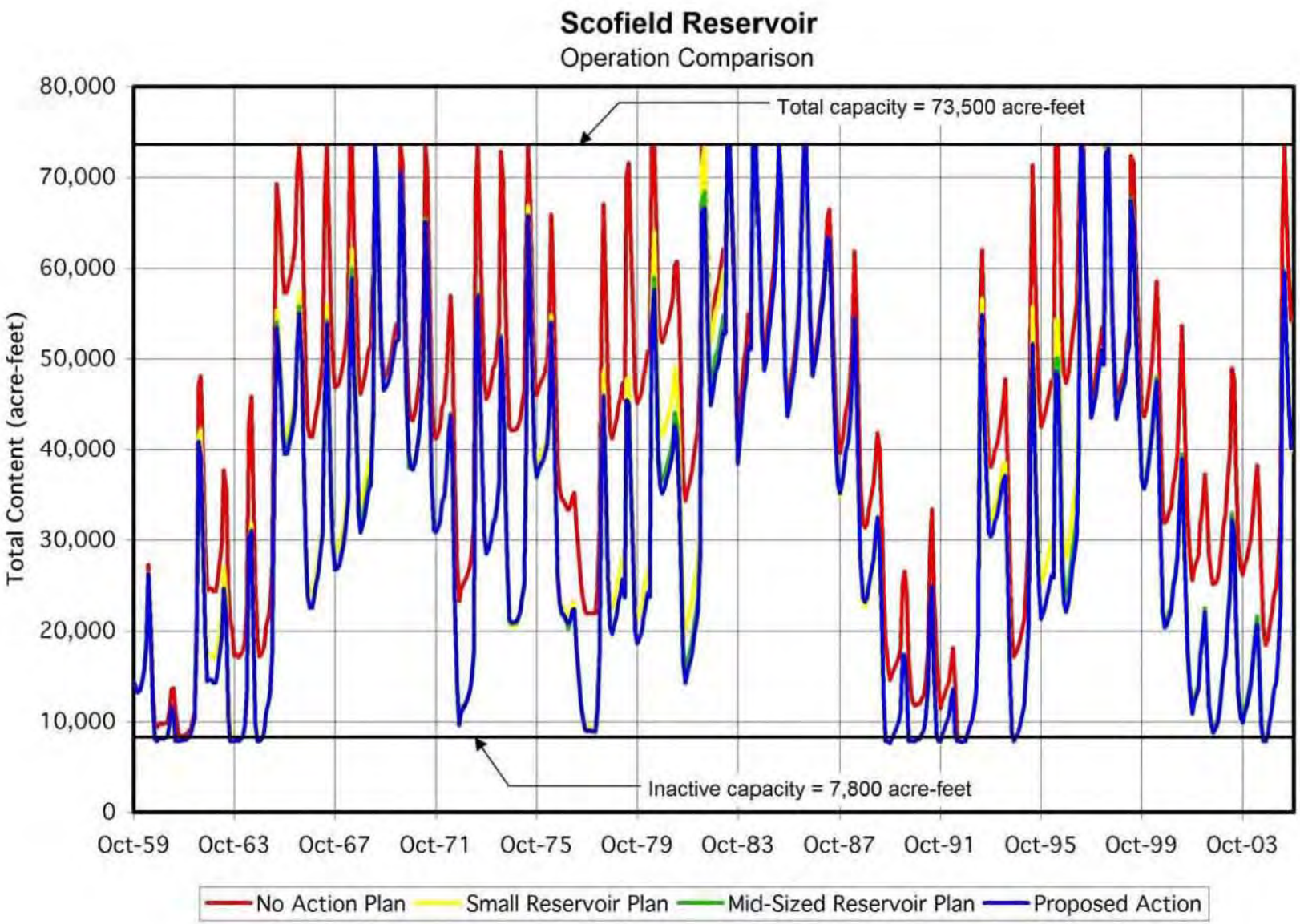



**Figure 3-1.—Scofield Reservoir Operation Comparison Proposed Action.**

Lakes. These releases are made through an existing transmountain tunnel. Flows from Fairview Lakes are used by the Cottonwood-Gooseberry Irrigation Company as a source of supplemental irrigation water in the Fairview area. These supplemental releases generally occur in July and August. The historic average annual flow volumes at the tunnel outlet and the mouth of Cottonwood Creek have been 2,055 and 8,600 acre-feet, respectively.

There would be no streamflow mitigation measures under the No Action Alternative because there would be no project-induced impacts.

There would be no residual impacts to water resources under the No Action Alternative.

Climate change has the potential to impact the No Action Alternative flows with either wetter or drier conditions. Models that could predict the potential impacts of climate change on the scale of this project have not yet been developed.

#### 3.1.3.2 Proposed Action Alternative

Operation of the Narrows Project would affect streamflows in Gooseberry Creek, Lower Fish Creek, Scofield Reservoir, Price River to Heiner, Cottonwood Creek, and about 3 miles of the San Pitch River. Table 3-1 provides a comparison of average monthly streamflows under the four project alternatives evaluated. Monthly streamflow data were used to develop this table because reliable daily streamflow data were not available.

Impacts to Lower Gooseberry Creek and Fish Creek would occur primarily during the spring snowmelt period as water is stored in Narrows Reservoir for release later in the summer. Impacts to Lower Gooseberry Reservoir would consist of reduced inflow. However, the effect would be negligible because the reservoir is not operated as a storage reservoir. As a result, the outflow would be reduced in the same proportion as the inflow would be reduced. Impacts to Scofield Reservoir would be in the form of reduced inflows, resulting in a lowering of average reservoir storage. Impacts to releases from Scofield Reservoir for Scofield Project use would occur only during multiple successive drought years, such as occurred in the early 1960s, 1990s, and 2000s. Impacts to the Price, Green, and Colorado Rivers would result primarily in reduced spills from Scofield Reservoir.

The impacts of the Narrows Project on water resources are most pronounced near the reservoir. About 1 mile of Upper Gooseberry Creek and 4.3 miles of small streams in the proposed reservoir basin would be inundated by the reservoir. In addition, annual flows in the middle 3 miles of Gooseberry Creek between Narrows Reservoir and inflow into Lower Gooseberry Reservoir would be reduced by about 74%. Under the Proposed Action, a 1.0-cfs minimum flow would be made from Narrows Reservoir to Gooseberry Creek to provide a 1.5-cfs minimum flow at the USDA Forest Service campground ⅛ mile downstream from the proposed damsite. If the 1.5-cfs flow at the campground is not met, up to an additional 0.25 cfs would be released from the reservoir to meet the required flow. Minimum streamflow releases from Narrows Reservoir would eliminate periodic dry stream channels in the Middle Gooseberry Creek segment. An average of 300 acre-feet per year also would be released for channel maintenance (flushing flows).

Flows in Cottonwood Creek would increase during the irrigation season, with the import of project water through the Narrows Tunnel. However, during the irrigation season, these flows would be less than peak flows that occur naturally during the spring snowmelt period. The Upper Cottonwood Creek Pipeline would convey these increased flows outside the stream channel between the tunnel

**Table 3-1.—Average Monthly Streamflow Comparison (cfs)**

| Month | Proposed Action | | | Mid-Sized Reservoir Alternative | | | Small Reservoir Alternative | | | No Action Alternative | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) |
| **Gooseberry Creek at Proposed Narrows Damsite** | | | | | | | | | | | | |
| October | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.2 | 5.3 | 1.7 |
| November | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.6 | 3.9 | 1.5 |
| December | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.6 | 4.6 | 0.8 |
| January | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.4 | 2.6 | 1.0 |
| February | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 | 2.6 | 1.2 |
| March | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 | 2.8 | 1.2 |
| April | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.9 | 5.8 | 5.4 |
| May | 5.9 | 81.0 | 5.9 | 5.9 | 84.1 | 5.9 | 1.0 | 88.2 | 1.0 | 49.8 | 106.0 | 17.9 |
| June | 8.4 | 100.5 | 1.0 | 28.1 | 101.3 | 1.0 | 38.7 | 102.3 | 1.0 | 67.8 | 105.0 | 6.9 |
| July | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 7.9 | 15.3 | 3.3 |
| August | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 5.4 | 6.7 | 1.6 |
| September | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.5 | 4.8 | 1.0 |
| **Gooseberry Creek Below Lower Gooseberry Reservoir** | | | | | | | | | | | | |
| October | 2.9 | 5.8 | 2.4 | 2.9 | 5.8 | 2.4 | 2.9 | 5.8 | 2.4 | 4.1 | 10.2 | 3.0 |
| November | 3.1 | 5.9 | 2.2 | 3.1 | 5.8 | 2.2 | 3.1 | 5.9 | 2.2 | 3.8 | 8.8 | 2.7 |
| December | 3.2 | 5.4 | 2.1 | 3.2 | 5.4 | 2.1 | 3.2 | 5.4 | 2.1 | 3.8 | 9.0 | 1.9 |
| January | 3.6 | 6.2 | 2.1 | 3.5 | 6.2 | 2.1 | 3.6 | 6.2 | 2.1 | 4.0 | 7.8 | 2.1 |
| February | 3.7 | 6.1 | 2.2 | 3.7 | 6.1 | 2.2 | 3.7 | 6.1 | 2.2 | 4.1 | 7.6 | 2.4 |
| March | 3.7 | 5.2 | 2.3 | 3.7 | 5.2 | 2.3 | 3.7 | 5.2 | 2.3 | 4.2 | 7.0 | 2.6 |
| April | 4.6 | 6.4 | 6.5 | 4.6 | 6.4 | 6.5 | 4.6 | 6.4 | 6.5 | 7.5 | 11.2 | 10.9 |
| May | 38.2 | 174.3 | 0.8 | 38.2 | 177.4 | 0.8 | 33.3 | 181.4 | 0.9 | 82.1 | 199.3 | 12.9 |
| June | 32.7 | 157.4 | 3.9 | 52.4 | 158.2 | 3.9 | 63.0 | 159.2 | 3.9 | 92.1 | 162.0 | 9.8 |
| July | 5.9 | 9.9 | 1.5 | 5.9 | 9.9 | 1.5 | 5.9 | 9.9 | 1.5 | 12.8 | 24.1 | 3.8 |
| August | 5.6 | 4.9 | 1.4 | 5.6 | 4.9 | 1.3 | 5.6 | 4.9 | 1.3 | 10.0 | 10.7 | 2.0 |
| September | 3.9 | 3.6 | 1.9 | 3.9 | 3.6 | 1.9 | 3.9 | 3.6 | 1.9 | 6.4 | 7.4 | 1.9 |
| **Fish Creek Above Scofield Reservoir** | | | | | | | | | | | | |
| October | 9.4 | 18.9 | 7.6 | 9.4 | 18.9 | 7.6 | 9.4 | 18.9 | 7.6 | 10.6 | 23.3 | 8.2 |
| November | 9.5 | 17.3 | 7.9 | 9.5 | 17.3 | 7.9 | 9.5 | 17.3 | 7.9 | 10.2 | 20.2 | 8.4 |
| December | 8.4 | 15.6 | 7.5 | 8.4 | 15.6 | 7.5 | 8.4 | 15.6 | 7.5 | 9.1 | 19.2 | 7.3 |
| January | 9.1 | 16.3 | 5.5 | 9.1 | 16.3 | 5.5 | 9.1 | 16.3 | 5.5 | 9.5 | 17.9 | 5.6 |
| February | 10.6 | 19.0 | 5.3 | 10.6 | 19 | 5.3 | 10.6 | 19.0 | 5.3 | 11.1 | 20.6 | 5.5 |
| March | 14.1 | 17.3 | 5.4 | 14.1 | 17.2 | 5.4 | 14.1 | 17.3 | 5.4 | 14.6 | 19.1 | 5.7 |
| April | 17.8 | 43.7 | 24.5 | 17.8 | 43.6 | 24.5 | 17.8 | 43.7 | 24.5 | 20.7 | 48.5 | 29.0 |
| May | 211.7 | 616.3 | 11.4 | 211.7 | 619.4 | 11.4 | 206.8 | 623.4 | 6.5 | 255.6 | 641.3 | 23.5 |
| June | 171.4 | 361.3 | 8.5 | 191.1 | 362.1 | 8.5 | 201.7 | 363.1 | 8.5 | 230.8 | 365.8 | 14.4 |
| July | 29.6 | 51.4 | 4.6 | 29.6 | 51.3 | 4.6 | 29.6 | 51.4 | 4.6 | 36.5 | 65.7 | 6.8 |
| August | 17.6 | 21.6 | 3.5 | 17.5 | 21.6 | 3.5 | 17.6 | 21.6 | 3.5 | 22.0 | 27.4 | 4.1 |
| September | 12.2 | 17.3 | 3.5 | 12.2 | 17.2 | 3.5 | 12.2 | 17.3 | 3.5 | 14.7 | 21.0 | 3.5 |

**Table 3-1.—Average Monthly Streamflow Comparison (cfs) (continued)**

| Month | Proposed Action | | | Mid-Sized Reservoir Alternative | | | Small Reservoir Alternative | | | No Action Alternative | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) |
| **Price River Below Scofield Dam** | | | | | | | | | | | | |
| October | 49.5 | 204.0 | 26.9 | 49.4 | 210.4 | 26.9 | 49.5 | 204.0 | 26.9 | 49.5 | 204.0 | 26.9 |
| November | 13.8 | 15.0 | 11.4 | 13.8 | 15.0 | 11.4 | 13.8 | 15.0 | 11.4 | 13.8 | 15.0 | 11.4 |
| December | 15.0 | 0.0 | 9.1 | 15.0 | 0.0 | 9.1 | 15.0 | 0.0 | 9.1 | 15.0 | 0.0 | 9.1 |
| January | 5.4 | 0.0 | 8.0 | 5.4 | 0.0 | 8.0 | 5.4 | 0.0 | 8.0 | 5.4 | 0.0 | 8.0 |
| February | 5.5 | 0.0 | 7.1 | 5.5 | 0.0 | 7.1 | 5.5 | 0.0 | 7.1 | 5.5 | 0.0 | 7.1 |
| March | 5.1 | 15.0 | 5.8 | 5.1 | 15.0 | 5.8 | 5.1 | 15.0 | 5.8 | 5.1 | 15.0 | 5.8 |
| April | 4.7 | 74.4 | 27.7 | 4.7 | 74.3 | 27.7 | 4.7 | 74.4 | 27.7 | 4.7 | 74.4 | 27.7 |
| May | 0.0 | 646.2 | 111.6 | 0.0 | 648.2 | 111.6 | 0.0 | 653.3 | 111.6 | 59.2 | 733.5 | 111.6 |
| June | 186.0 | 941.3 | 52.6 | 211.3 | 940.4 | 52.6 | 211.7 | 943.1 | 52.6 | 316.1 | 945.8 | 52.6 |
| July | 212.7 | 278.8 | 63.2 | 212.3 | 278.3 | 63.2 | 212.7 | 278.8 | 63.2 | 212.7 | 278.8 | 63.2 |
| August | 94.0 | 126.2 | 39.1 | 93.9 | 126.0 | 39.1 | 94.0 | 126.2 | 39.1 | 94.0 | 126.2 | 39.1 |
| September | 177.5 | 132.4 | 22.0 | 177.2 | 132.2 | 17.6 | 177.5 | 132.4 | 22.0 | 177.5 | 132.4 | 22.0 |
| **Price River at Confluence of White River** | | | | | | | | | | | | |
| October | 50.9 | 207.4 | 27.5 | 50.9 | 207.4 | 27.5 | 50.9 | 207.4 | 27.5 | 50.9 | 207.4 | 27.5 |
| November | 14.8 | 17.8 | 12.1 | 14.8 | 17.8 | 12.1 | 14.8 | 17.8 | 12.1 | 14.8 | 17.8 | 12.1 |
| December | 17.1 | 2.4 | 9.2 | 17.1 | 2.4 | 9.2 | 17.1 | 2.4 | 9.2 | 17.1 | 2.4 | 9.2 |
| January | 7.1 | 2.0 | 8.0 | 7.1 | 2.0 | 8.0 | 7.1 | 2.0 | 8.0 | 7.1 | 2.0 | 8.0 |
| February | 7.1 | 2.8 | 7.1 | 7.1 | 2.8 | 7.1 | 7.1 | 2.8 | 7.1 | 7.1 | 2.8 | 7.1 |
| March | 7.1 | 18.7 | 5.9 | 7.1 | 18.7 | 5.9 | 7.1 | 18.7 | 5.9 | 7.1 | 18.7 | 5.9 |
| April | 9.3 | 86.2 | 30.0 | 9.3 | 86.2 | 30.0 | 9.3 | 86.2 | 30.0 | 9.3 | 86.2 | 30.0 |
| May | 33.4 | 730.6 | 113.0 | 33.4 | 730.6 | 113.2 | 33.4 | 730.6 | 113.0 | 92.5 | 817.7 | 113.0 |
| June | 214.3 | 970.5 | 52.7 | 240.0 | 970.5 | 52.8 | 240.0 | 970.5 | 52.7 | 344.2 | 975.1 | 52.7 |
| July | 218.9 | 289.1 | 63.2 | 218.9 | 289.1 | 63.3 | 218.9 | 289.1 | 63.2 | 218.9 | 289.1 | 63.2 |
| August | 97.5 | 131.3 | 39.1 | 97.5 | 131.3 | 36.4 | 97.5 | 131.3 | 36.4 | 97.5 | 131.3 | 39.1 |
| September | 179.2 | 135.7 | 22.0 | 179.2 | 135.7 | 4.5 | 179.2 | 135.7 | 8.9 | 179.2 | 135.7 | 22.0 |
| **Price River at Woodside** | | | | | | | | | | | | |
| October | 45.4 | 399.1 | 39.4 | 45.4 | 399.1 | 39.4 | 45.4 | 399.1 | 39.4 | 45.4 | 399.1 | 39.4 |
| November | 38.8 | 112.2 | 31.7 | 38.8 | 112.2 | 31.7 | 38.8 | 112.2 | 31.7 | 38.8 | 112.2 | 31.7 |
| December | 46.0 | 96.5 | 34.2 | 46.0 | 96.5 | 34.2 | 46.0 | 96.5 | 34.2 | 46.0 | 96.5 | 34.2 |
| January | 33.0 | 69.4 | 20.0 | 33.0 | 69.4 | 20.0 | 33.0 | 69.4 | 20.0 | 33.0 | 69.4 | 20.0 |
| February | 47.5 | 71.8 | 20.0 | 47.5 | 71.8 | 20.0 | 47.5 | 71.8 | 20.0 | 47.5 | 71.8 | 20.0 |
| March | 71.8 | 35.0 | 26.8 | 71.8 | 35.0 | 26.8 | 71.8 | 35.0 | 26.8 | 71.8 | 35.0 | 26.8 |
| April | 109.5 | 396.2 | 16.8 | 109.5 | 396.2 | 16.8 | 109.5 | 396.2 | 16.8 | 109.5 | 396.2 | 16.8 |
| May | 269.6 | 1,568.0 | 21.6 | 269.6 | 1,568.0 | 21.8 | 269.6 | 1,568.0 | 21.6 | 328.7 | 1,655.2 | 21.6 |
| June | 333.0 | 1,054.0 | 3.8 | 358.7 | 1,054.0 | 3.9 | 358.7 | 1,054.0 | 3.8 | 463.0 | 1,058.5 | 3.8 |
| July | 105.3 | 271.3 | 120.2 | 105.3 | 271.3 | 120.3 | 105.3 | 271.3 | 120.2 | 105.3 | 271.3 | 120.2 |
| August | 295.2 | 276.4 | 32.3 | 295.2 | 276.4 | 29.6 | 295.2 | 276.4 | 29.6 | 295.2 | 276.4 | 29.6 |
| September | 71.2 | 192.0 | 21.0 | 71.2 | 192.0 | 3.5 | 71.2 | 192.0 | 7.9 | 71.2 | 192.0 | 8.4 |

**Table 3-1.—Average Monthly Streamflow Comparison (cfs) (continued)**

| Month | Proposed Action | | | Mid-Sized Reservoir Alternative | | | Small Reservoir Alternative | | | No Action Alternative | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) |
| **Fairview Tunnel at Outlet** | | | | | | | | | | | | |
| October | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| November | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| December | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| January | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.2 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| February | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.2 | 2.0 | 2.0 | 1.2 | 0.0 | 0.0 | 0.0 |
| March | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.2 | 2.0 | 2.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| April | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| May | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| June | 4.0 | 11.8 | 8.8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 3.7 | 11.6 | 8.6 |
| July | 45.3 | 45.0 | 43.4 | 30.6 | 32.6 | 43.0 | 30.6 | 32.6 | 25.5 | 14.7 | 12.3 | 0.3 |
| August | 43.5 | 45.5 | 33.1 | 30.1 | 29.2 | 18.2 | 30.1 | 29.2 | 0.0 | 13.3 | 16.3 | 0.2 |
| September | 17.3 | 24.9 | 0.2 | 15.8 | 14.6 | 0.0 | 15.8 | 14.6 | 0.0 | 1.6 | 10.3 | 0.1 |
| **Cottonwood Creek at Mouth of Canyon** | | | | | | | | | | | | |
| October | 3.3 | 5.1 | 3.1 | 3.3 | 5.1 | 3.1 | 3.3 | 5.1 | 3.1 | 1.3 | 3.1 | 1.1 |
| November | 3.6 | 5.0 | 3.3 | 3.6 | 5.0 | 3.3 | 3.6 | 5.0 | 3.3 | 1.6 | 3.0 | 1.3 |
| December | 3.4 | 4.8 | 3.2 | 3.4 | 4.8 | 3.2 | 3.4 | 4.8 | 3.2 | 1.4 | 2.8 | 1.2 |
| January | 3.4 | 4.7 | 3.0 | 3.4 | 4.7 | 2.2 | 3.4 | 4.7 | 3.0 | 1.4 | 2.7 | 1.0 |
| February | 3.6 | 4.6 | 3.2 | 3.6 | 4.6 | 2.2 | 3.6 | 4.6 | 2.4 | 1.6 | 2.6 | 1.2 |
| March | 4.0 | 4.7 | 3.3 | 4.0 | 4.7 | 1.5 | 4.0 | 4.7 | 1.5 | 2.0 | 2.7 | 1.3 |
| April | 3.7 | 8.1 | 3.2 | 3.7 | 8.1 | 3.2 | 3.7 | 8.1 | 3.2 | 3.7 | 8.1 | 3.2 |
| May | 45.0 | 117.1 | 4.9 | 44.8 | 117.1 | 4.9 | 44.8 | 117.1 | 4.9 | 45.0 | 117.1 | 4.9 |
| June | 46.7 | 63.5 | 12.8 | 42.9 | 51.9 | 4.2 | 42.9 | 51.8 | 4.2 | 46.4 | 63.2 | 12.6 |
| July | 49.4 | 53.5 | 44.6 | 34.7 | 20.9 | 44.2 | 34.7 | 41.1 | 26.8 | 18.8 | 20.9 | 1.6 |
| August | 46.0 | 49.2 | 34.0 | 32.6 | 32.9 | 19.1 | 32.6 | 32.9 | 0.9 | 15.9 | 20.0 | 1.1 |
| September | 19.1 | 27.9 | 1.1 | 17.6 | 17.6 | 0.9 | 17.5 | 17.6 | 0.9 | 3.3 | 13.3 | 1.0 |
| **San Pitch River Below Cottonwood Creek Confluence[1]** | | | | | | | | | | | | |
| October | 31 | 33 | 22 | 31 | 33 | 22 | 31 | 33 | 22 | 29 | 31 | 20 |
| November | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | n/a | n/a | n/a |
| December | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | n/a | n/a | n/a |
| January | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +3 | n/a | n/a | n/a |
| February | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | n/a | n/a | n/a |
| March | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +2 | +0 | n/a | n/a | n/a |
| April | 49 | 63 | 58 | 49 | 63 | 58 | 49 | 63 | 58 | 49 | 63 | 58 |
| May | 73 | 113 | 51 | 73 | 113 | 51 | 73 | 113 | 51 | 73 | 113 | 51 |
| June | 80 | 109 | 32 | 76 | 97 | 23 | 76 | 97 | 23 | 80 | 109 | 32 |
| July | 79 | 98 | 25 | 64 | 65 | 25 | 64 | 86 | 25 | 79 | 98 | 25 |
| August | 74 | 88 | 24 | 61 | 72 | 24 | 61 | 72 | 24 | 74 | 88 | 24 |
| September | 73 | 80 | 23 | 72 | 70 | 23 | 71 | 70 | 23 | 73 | 80 | 23 |

[1] Based on historical diversion records. Streamflow records are not available at this location. Actual streamflows for wet year may have been higher than indicated by diversion records. No data for winter flows is available. November–March values indicate changes from No Action flows.

outlet and the confluence with Left Hand Fork. About 300 feet below the Left Hand Fork confluence, the project flows would be discharged to the stream. At this point, the increase in average July and August flows from current conditions would be about 200%.

Depletions to the Price River drainage would average 5,597 acre-feet per year. This amount would consist of 5,227 acre-feet of transbasin diversions and 370 acre-feet of increased evaporation in the Price River Basin. When measured in Gooseberry Creek below Narrows Reservoir, the reduction in annual streamflow varies between 1,760 and 10,200 acre-feet, depending on the storage level of Narrows Reservoir and the magnitude of the streamflow into the reservoir. As shown in table 3-1, the greatest impact would occur during the spring snowmelt runoff period. Releases from Narrows Reservoir to Gooseberry Creek would remain at a minimum of 1.0 cfs; and when the reservoir is spilling or when flushing releases are made, the flow would be greater.

As a result of constructing Narrows Reservoir, the operation of Scofield Reservoir would be altered within the normal historic range. Scofield Reservoir would operate at a lower level with implementing the Proposed Action as shown in figure 3-1. Under project conditions, the average total contents of Scofield Reservoir would be reduced from about 42,400 acre-feet to about 31,900 acre-feet. Average reduction in storage releases to irrigators in the Price area would be about 753 acre-feet per year. Total depletions to the Price River drainage would average 5,597 acre-feet per year. Both the volume and frequency of spills from the reservoir would be reduced. With the No Action Alternative, the average reservoir surface area would be reduced from 2,370 acres to about 2,125 acres. This is about a 10% reduction or about 245 acres of the surface area of the No Action Alternative. Since Scofield Reservoir would operate at a lower level, there is an increased potential for the reservoir to be drained to the bottom of its active storage. The frequency of this occurrence increases from 3 times in 43 years for the No Action Alternative to 12 times in 43 years with the Proposed Action. An example of this type of problem occurred during 1992. The lowest water surface elevation at Scofield Reservoir that year was 7,587 feet with a reservoir active capacity of 1,102 acre-feet. A major concern was that the reduced water level would lower water temperature, causing ice to form on the lake. This caused the potential for a blockage at the site of the old dam near the middle of the reservoir, not allowing water to pass from the upstream portion of the reservoir to the dam. Channel improvements and an electrical system to prevent freezing around the outlet structures were put in place. Other measures also were put on standby in case reservoir levels dropped lower. The crises were finally averted by restricting reservoir releases, rationing irrigation water, eliminating the use of water for lawns and yards, and monitoring water tank levels downstream in Carbon County. While such drought periods are not frequent, they do have significant impacts and would occur more often with implementing the proposed project.

During most years, controlled releases from Scofield Reservoir to meet Scofield Project demands would remain unaltered. This was the case in 77% of the years in the model simulation. However, under prolonged drought conditions, irrigation releases from Scofield Reservoir would be reduced due to lack of water in the reservoir. These reductions occurred in 10 of the 43 simulated years. Reductions for 1960–2002 averaged about 753 acre-feet or about 3% of the historical release from storage; whereas during drought periods, the reductions were much larger, as in 1992, when reductions would have been 8,346 acre-feet

or 20% of the average annual historical release from storage.

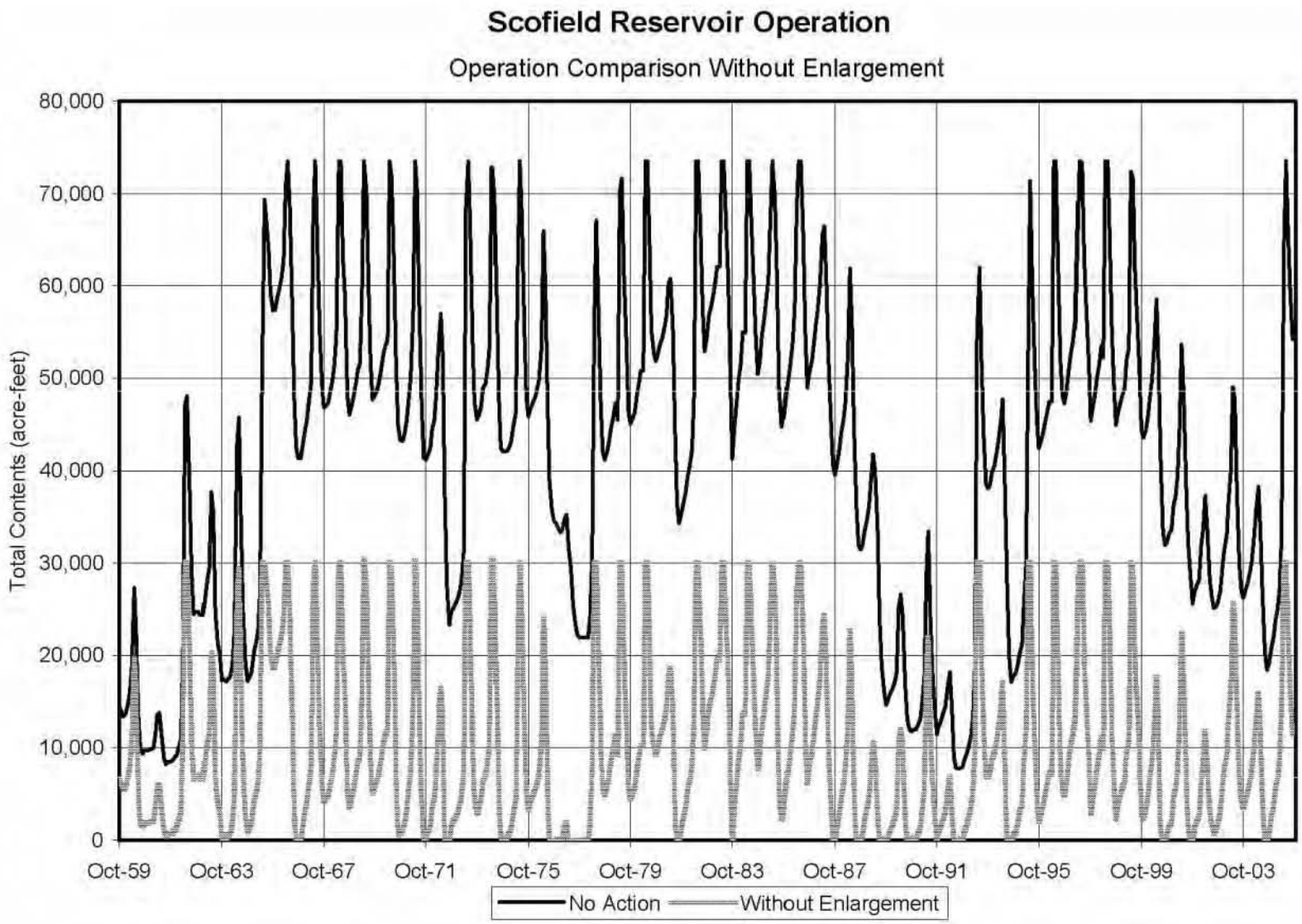
The Proposed Action would impact only storage releases. Direct flow rights that have a senior priority date to the Narrows water rights would be unaffected by the project. During the spring filling period, Scofield Reservoir releases typically are made to prevent the over filling or to ensure downstream senior water rights are fully satisfied. During average and wet hydrological years, senior water rights often are satisfied by tributary flows below Scofield Reservoir, and spring time releases from Scofield Reservoir are governed primarily by filling concerns for both the No Action and Proposed Action Alternatives. Under dry hydrologic conditions, tributary flows generally do not meet the required downstream direct flow rights, and additional releases from Scofield Reservoir are necessary under both the No Action and Proposed Action Alternatives.

It should be noted, however, that the above reductions in storage releases are based on the 73,500-acre-foot Scofield Reservoir, which was enlarged specifically to accommodate the Gooseberry Project (Narrows Project). Without this enlargement and the associated water rights agreements, the usable capacity of Scofield Reservoir would have remained at 30,000 acre-feet. As part of the reservoir enlargement, 7,800 acre-feet of inactive capacity was added to provide a minimum pool for fish habitat. An additional 35,700 acre-feet of active capacity was included to facilitate developing the remainder of the Gooseberry Project Plan without impacting water supplies in Carbon County. In conjunction with the reservoir enlargement, the Carbon County water interests signed an agreement that they would operate the reservoir according to the Gooseberry Project Plan.

If the reservoir capacity had remained at 30,000 acre-feet without the Narrows Project, the storage releases would have been reduced by an average of 2,253 acre-feet as a result of these same drought cycles, which is about 5% of the average annual supply. These reductions would have occurred in 19 of the 43 years simulated, with the largest single-year reduction being over 15,809 acre-feet, about 60% of the average annual storage release. Therefore, the reductions in current Scofield Reservoir storage caused by the Narrows Project would be less, in fact, than the reductions that would have occurred without the enlargement of Scofield Reservoir and the associated water right agreements; Scofield Reservoir water users realize a significant net benefit from the Narrows Project.

Figure 3-2 provides a comparison of the operation of Scofield Reservoir under the No Action Alternative and a simulated operation of the reservoir had it not been enlarged to accommodate the Gooseberry Project Plan. Figure 3-2 also shows that there would be no minimum pool for fishery in Scofield Reservoir had it not been enlarged. Downstream from Wellington, where most of the significant diversions occur on the lower Price River, the effects of the Narrows Project would be much different from those predicted near the Narrows Reservoir. In this stretch of river, Scofield Reservoir controls about 35% of the annual flow. High spring flows characteristic of unregulated hydrographs are contributed by undammed tributaries downstream from Scofield Dam, but spills from Scofield Dam are still the controlling factor in high spring flows.

Flow reductions in the Price River and the Colorado River downstream due to the Narrows Project would occur primarily as a result of decreased spills out of Scofield Reservoir. These effects are illustrated in figure 3-3, which displays average monthly flows of the Price River at Woodside under




Graph based on monthly data.

**Figure 3-2.—Scofield Reservoir Operation Comparison Without Enlargement.**

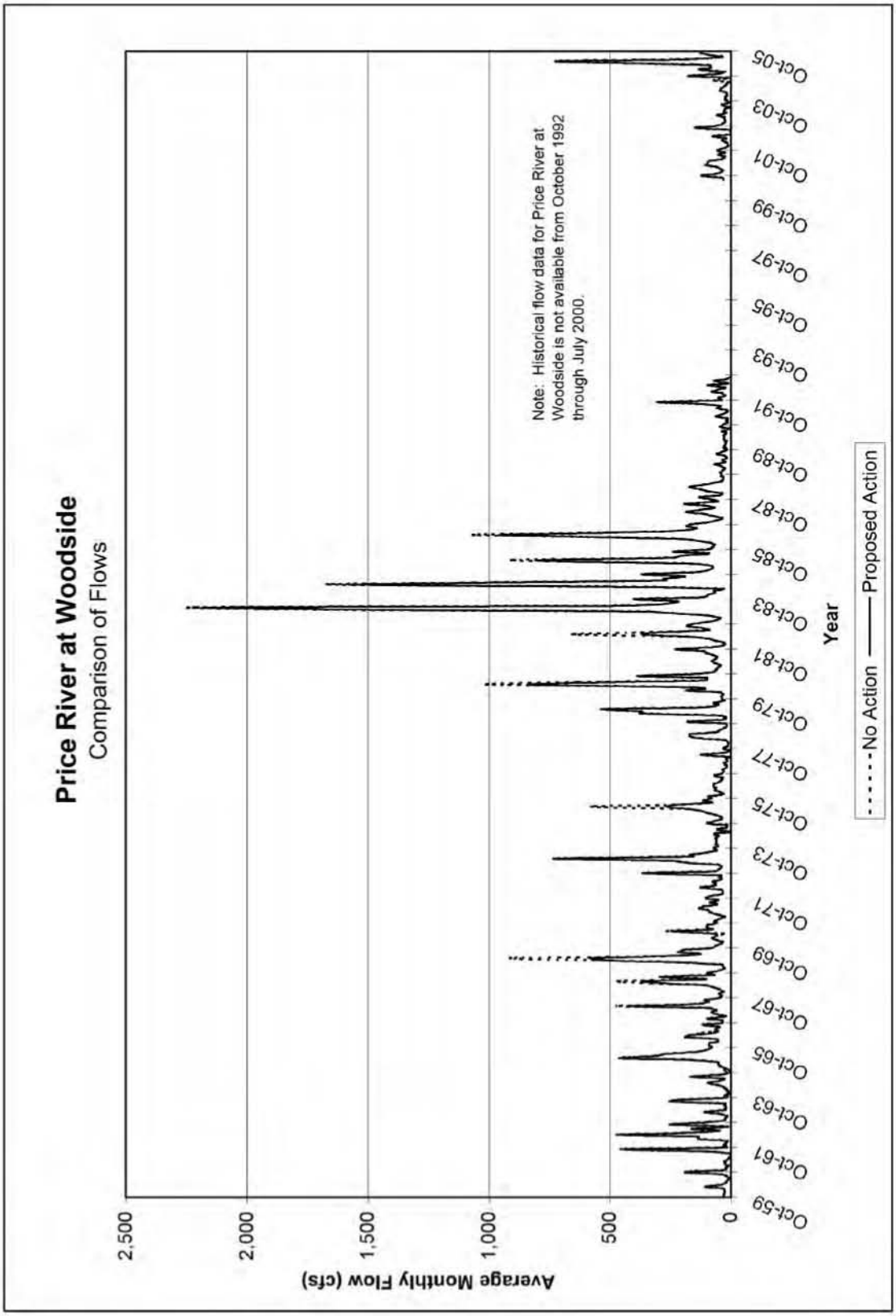



**Figure 3-3.—Scofield Reservoir Operation Comparison, Price River at Woodside.**

the No Action Alternative and the Proposed Action. This figure is based on data from 1960–92. The stream gauging station at the Price River at Woodside was discontinued in September 1992 and renewed in July 2000. The frequency of spills decreases from 42 to 12% in the years simulated. As seen in figure 3-3, spills in very large runoff years, such as 1983–86, would not be greatly affected; rather, it is the spills in moderate runoff years that would be affected most.

Releases through the Narrows Tunnel would increase under the Proposed Action. In comparison to the natural base flow and the existing channel capacity in Cottonwood Creek, the percent increase in flow due to project releases is reduced as the flow travels downstream. Most of the project water that would be released to Cottonwood Creek during the irrigation season would be diverted by an existing diversion structure near the mouth of Fairview Canyon for use along the east bench area of northern Sanpete Valley. Winter releases would be stored in Wales Reservoir, to the extent of available storage capacity, and would be used on project lands closer to the San Pitch River.

About 1,820 acre-feet of additional return flow to the San Pitch River would result from the Narrows Project, entering the river at various locations between Fairview and Chester and most probably then would be re-diverted from the river by other downstream water users within a short distance after entering the river. The river would continue to be dry-dammed at several locations during irrigation season.

Construction of the Upper Cottonwood Creek Pipeline would convey project releases outside the creek and would prevent degradation of the stream channel. Winter flows of 2.0 cfs in the upper reach of Cottonwood Creek and summer flows of 2.0 cfs in the lower reach of Cottonwood Creek also would be provided.

Under the Proposed Action, water supplies in the San Pitch River Basin would increase by an average of 5,227 acre-feet per year due to releases from Narrows Reservoir. Irrigation water shortages would be reduced to about 10,878 acre-feet per year or about 21.1% of the diversion demand.

In summary, the residual impacts (after mitigation) of the Proposed Action include the inundation of 1.0 mile of Gooseberry Creek and 4.3 miles of unnamed tributaries. Flows in Gooseberry Creek below Narrows Reservoir, Fish Creek, and the Price River would be reduced as shown in table 3-1. The flow in Cottonwood Creek below the confluence with Left Hand Fork would be increased during the nonrunoff portions of the irrigation season. Scofield Reservoir would operate at a lower level in most years, and reductions in storage releases to irrigators in the Price area would occur only after several successive years of drought and would average about 753 acre-feet per year. However, on the average, these reductions would be about 1,500 acre-feet less than the reductions that would have occurred if Scofield Reservoir had not been enlarged to accommodate the Gooseberry Project (Narrows Project).

#### 3.1.3.3 Mid-Sized Reservoir

The impacts to water resources under the Mid-Sized Reservoir Alternative would be similar to those resulting from construction of the Proposed Action. About 1 mile of Upper Gooseberry Creek and 4.0 miles of small streams in the proposed reservoir basin would be inundated. Because Narrows Reservoir would be smaller, it would spill more often, causing higher flows in certain years in Gooseberry and Fish Creeks in May and June. Because of the smaller reservoir, in drought years, there would not be enough water stored to meet the maximum transbasin diversion of 5,400 acre-feet. The long-term, average transbasin diversion to the San Pitch

River drainage would be 5,095 acre-feet. During those years, the flow in Cottonwood Creek would be lower, and project shortages would be greater. These differences in streamflows are shown in table 3-1.

As shown in figure 3-1, Scofield Reservoir Operation Comparison Proposed Action, Scofield Reservoir would operate at a slightly higher level than it would under the Proposed Action. The average contents would consist of about 32,084 acre-feet. Average reductions in storage releases to irrigators in the Price area would be about 753 acre-feet per year. Total depletions to the Price River drainage would average 5,298 acre-feet per year, rather than the 5,597 acre-feet under the Proposed Action.

Streamflow mitigation measures under the Mid-Sized Reservoir Alternative would be the same as those described for the Proposed Action.

Under the Mid-Sized Reservoir Alternative, water supplies in the San Pitch River Basin would increase by an average of 5,095 acre-feet per year due to releases from Narrows Reservoir. Irrigation water shortages would be reduced to about 11,027 acre-feet per year or about 21.2% of the diversion demand.

In summary, the residual impacts of the Mid-Sized Reservoir Alternative would be similar to those of the Proposed Action, except that slightly fewer miles of stream would be inundated, and Scofield Reservoir would operate at a slightly higher level. Annual reductions in storage releases to irrigators in the Price area would occur only after several successive drought years and would average 753 acre-feet per year.

#### 3.1.3.4 Small Reservoir Alternative

The impacts to water resources under the Small Reservoir Alternative would be similar to those resulting from construction of the Proposed Action. About 1 mile of Upper Gooseberry Creek and 3.8 miles of small streams in the proposed reservoir basin would be inundated. Because Narrows Reservoir would be smaller, it would spill more often, causing higher flows in certain years in Gooseberry and Fish Creeks in May and June. Because of the smaller reservoir, in drought years, there would not be enough water stored to meet the maximum transbasin diversion of 5,400 acre-feet. The long-term average transbasin diversion to the San Pitch River drainage would be 4,815 acre-feet. During those years, the flow in Cottonwood Creek would be lower, and project shortages would be greater. These differences in streamflows are shown in table 3-1.

As shown in figure 3-1, Scofield Reservoir Operation Comparison Proposed Action, Scofield Reservoir would operate at a slightly higher level than under the Proposed Action. The average contents would be about 33,049 acre-feet. Average reductions in storage releases to irrigators in the Price area would be about 732 acre-feet per year, rather than 753 acre-feet in the Proposed Action. Total depletions to the Price River drainage would average 4,841 acre-feet per year as compared to 5,597 acre-feet under the Proposed Action and 5,298 acre-feet under the Mid-Sized Alternative.

Streamflow mitigation measures under the Small Reservoir Alternative would be the same as those described for the Proposed Action, with the exception that no year-round flows would be provided in the tributaries to Gooseberry Creek above the proposed Narrows Reservoir site, and no flushing flows would be provided to Gooseberry Creek.

Under the Small Reservoir Alternative, water supplies in the San Pitch River Basin would increase by an average of 4,815 acre-feet per year due to releases from the proposed Narrows Reservoir. Irrigation water shortages would be

reduced to about 11,290 acre-feet per year or about 21.8% of the diversion demand.

The residual impacts of the Small Reservoir Alternative would be similar to those of the Proposed Action, except that slightly fewer miles of stream would be inundated, and Scofield Reservoir would operate at a slightly higher level. Annual reductions in storage releases to irrigators in the Price area would occur only after several successive drought years and would average about 21 acre-feet less than under the Proposed Action (i.e., 732 acre-feet rather than 753 acre-feet as in the Proposed Action).

## 3.2 WATER RIGHTS

### 3.2.1 Affected Environment

Utah water use is governed by the prior appropriation doctrine. Under this doctrine, Utah's water resources are owned by the State for the welfare of the public; and individuals, corporations, and public entities can acquire conditional rights to beneficial use this resource. Water rights are established either through historic water use prior to the enactment of State water laws or through an application to appropriate water. All water rights are assigned a priority date based upon when the water right was first established, either by use or by application. In times of water shortages, water is allocated to water rights based on their priority dates with senior rights being able to divert ahead of junior water rights—hence, the maxim "first in time, first in right." In river systems, a water right can typically only divert water when all downstream senior water rights have all the water they currently need or are entitled to.

SWCD holds Water Right Numbers (Nos.) 91-130(A14025), 91-131(A14026), and 91-132 (A14477) for the Narrows Project. These water rights were established by Applications to Appropriate Nos. A14025, A14026, and A14477 filed by Reclamation in January and September 1941. Reclamation later transferred these applications, still unapproved, to SWCD in July 1975 for use in the Narrows Project. These applications have been involved in several agreements, the most significant of which is the 1984 Compromise Agreement that was mediated by the Utah State Engineer. The conditions of the 1984 Compromise Agreement, which were incorporated into the January 7, 1985, approval of these applications to appropriate, subordinated certain Price River Water Users Association's water rights to the Narrows Project, limited the annual transbasin diversion and storage allowed by the Narrows Project, and specified how stored water from Scofield Reservoir would be used to satisfy the downstream water rights that are senior to the Narrows Project.

### 3.2.2 Predicted Effects

#### 3.2.2.1 No Action Alternative

The north Sanpete water users would continue to hold valid water rights in Gooseberry Creek and would be entitled to develop these rights under Utah water law. If the Narrows Project water rights were amended to allow their development without Federal approval, they could be developed outside the scope of this FEIS. Whether or not the Narrows Project is constructed, the distribution of water between the Carbon and Sanpete water users will be based on the priority dates of the individual water rights (except as stipulated in the 1984 Compromise Agreement) that each water user holds.

#### 3.2.2.2 Proposed Action Alternative

Sanpete County's water rights would be allowed to divert water in accordance to their respective priority dates and according to the terms of the 1984 Compromise Agreement. Sanpete County is allowed to develop their

approved water rights, even if doing so impairs previously developed junior water rights.

Although the development of the Narrow's Project could impair junior Carbon County water rights holders, it is anticipated that this impairment would be minimal. First, the 5,400-acre-foot annual depletion of the Narrows water rights represents only about 6.6% of the average annual yield of the Price River above the city of Price. Secondly, the Proposed Action should have no or minimal effect because of how Scofield Reservoir is operated (i.e., it is shut off completely for flood control when the White River is running high and then opened as needed to meet the downstream agricultural demands). Scofield Reservoir was enlarged in 1946 by 35,000 acre-feet of additional storage, in part at Federal expense, to offset or provide a buffer to the potential effects of the proposed development of Gooseberry Creek to benefit Sanpete Valley. The two facilities were originally conceived as components of a single project. The Scofield Reservoir enlargement was intended as compensatory storage for the anticipated effects of the transbasin diversion to the Sanpete Valley. Therefore, because of this additional storage in Scofield Reservoir, there should be limited adverse impacts to the direct flow water right holders in the Price River system.

#### 3.2.2.3 Mid-Sized Reservoir Alternative

This alternative is nearly identical to the Proposed Action, except Narrows Reservoir is limited to 10,000 acre-feet. The effects to other water right holders are nearly identical to the Proposed Action except the potential impairment to Carbon County water users would be slightly less than that of the full size reservoir.

#### 3.2.2.4 Small Reservoir Alternative

This alternative is nearly identical to the Proposed Action except Narrows Reservoir is limited to 5,400 acre-feet. The effects to other water right holders are also nearly identical to the Proposed Action except the potential impairment to Carbon County water users would be slightly less than that of the Mid-Sized Reservoir.

## 3.3 WATER QUALITY

### 3.3.1 Affected Environment

#### 3.3.1.1 Upper Gooseberry Creek

On the basis of data collected from Upper Gooseberry Creek and Cottonwood Creek, where much of the flow is from Gooseberry Creek through the Narrows Tunnel, the water is considered very good quality. As shown in table 3-2, the dominant chemical constituents are calcium and bicarbonate, with other common ions being minor in concentration. Total dissolved solids (TDS) are low, ranging from 184–258 milligrams per liter (mg/L) in Gooseberry Creek and 160–316 mg/L in Cottonwood Creek. Trace elements are very low in concentration, with most below detection limits.

Although most of the phosphate levels in these samples were considerably less than 0.05 mg/L, previous studies conducted by UDWR indicate that the 0.05-mg/L guideline for streams is often exceeded in Cottonwood Creek. Existing soil and rock erosion may be the major sources of phosphates exceeding this pollution indicator, with livestock grazing, recreation, and wildlife also contributing. At levels of 0.05 mg/L or greater, the Utah Department of Environmental Quality (UDEQ) indicates that investigations should be conducted to develop more information concerning phosphate sources.

**Table 3-2.—Water Quality Data Summary of Project Inflows and Lower Gooseberry Reservoir (mg/L) (Conductivity in microhos per centimeter [µmhos/cm])**

| Constituents | Gooseberry Creek[1] | Gooseberry Creek at Narrows[2] | Cottonwood Creek[3] | Lower Gooseberry Reservoir[4] |
|---|---|---|---|---|
| Calcium | 62 | 38 | 55 | 38 |
| Magnesium | 10 | 12 | 18 | 10 |
| Potassium | <1.0 | <1.0 | <1.0 | <1.0 |
| Sodium | 1.0 | <1.0 | 9.4 | <1.9 |
| Alkalinity (as $CaCO_3$)[5] | 193 | 147.5 | 201 | 128 |
| Bicarbonate | 236 | 180 | 245 | 148 |
| Carbonate | | <10.0 | | 4.9 |
| Chloride | <1.0 | <0.5 | 15 | <4.0 |
| Conductivity | 337 | 330 | 463 | 263 |
| Nitrate/nitrite | <0.146 | <0.01 | <0.218 | <0.099 |
| Ammonia as N | <0.053 | | <0.055 | <0.068 |
| Phosphate, total | <0.019 | 0.04 | <0.075 | <0.022 |
| Phosphate, total, dissolved. | <0.021 | 0.04 | <0.01 | <0.020 |
| Sulfate | 8.0 | <5.0 | <16.3 | <12.8 |
| Total dissolved solids | 215 | 220 | 248 | 152 |
| Total suspended solids | <8.0 | | 92 | <20.4 |
| Aluminum | | | <0.03 | <0.03 |
| Arsenic | <0.003 | | <0.005 | <0.003 |
| Barium | <0.046 | | 0.067 | <0.047 |
| Boron | | | | <0.039 |
| Cadmium | <0.001 | | <0.001 | <0.001 |
| Chromium | <0.005 | | <0.005 | <0.005 |
| Copper | <0.015 | | <0.012 | <0.015 |
| Iron | 0.22 | | <0.02 | 0.167 |
| Lead | <0.005 | | <0.003 | <0.004 |
| Manganese | 0.034 | | <0.005 | <0.029 |
| Mercury | <0.0002 | | <0.0002 | <0.0002 |
| Selenium | <0.001 | | <0.001 | <0.002 |
| Silver | <0.002 | | <0.002 | <0.002 |
| Zinc | <0.033 | | <0.03 | <0.033 |

[1] Averages based upon 34 samples collected by the Utah Division of Water Quality on Gooseberry Creek above Lower Gooseberry Reservoir (5932250) between June 1981 and July 2007.

[2] Averages based upon two samples collected by Franson-Noble & Associates, Inc. within the proposed reservoir basin at the crossing of road SR-264, in June and October 1993.

[3] Averages based upon 17 samples collected by the Utah Division of Water Quality on Cottonwood Creek east of Fairview at the USDA Forest Service boundary (4946770) between April 1996 and June 1997.

[4] Averages based upon 61 samples collected by the Utah Division of Water Quality on Lower Gooseberry Reservoir above the dam (5932240) between October 1980 and July 2007.

[5] $CaCO_3$ = calcium carbonate.

#### 3.3.1.2 Lower Gooseberry Reservoir

The Utah Division of Water Quality completed a limnological assessment of Lower Gooseberry Reservoir that indicates it is a fairly stable mesotrophic (moderate levels of organic and mineral nutrients) system with good water quality (UDEQ, Division of Water Quality, 2008). The only parameters to exceed State water quality standards for defined beneficial uses are phosphorus, pH, and DO. The average concentration of total phosphorus in the water column has not exceeded the recommended pollution indicator for phosphorus of 0.025 mg/L; but occasionally, higher values are reported at various depths in the water column. Occasionally, DO levels and pH values have violated State standards near the bottom of the reservoir, mainly during winter ice coverage. The extensive macrophyte coverage of the bottom of the reservoir is the primary factor in the reservoir responsible for this phenomenon. The reservoir is shallow, with a mean depth of 3.7 feet; has good light penetration throughout the water column; and does not stratify. The UDWR has expressed concern about nutrient loading of Lower Gooseberry Reservoir and its effect upon DO levels in the reservoir. The oxygen depletion of the reservoir during the winter is believed to result from low winter inflows combined with decomposition of organic material resulting from the extensive macrophyte growth during the summer, as mentioned above.

#### 3.3.1.3 Scofield Reservoir

Recent water quality assessment indicates that Scofield Reservoir is mesotrophic in its present state. Data collected in 1990 and 1991 depicted the reservoir as hypereutrophic, while data in 1992, after treatment and eradication of trash fish, indicated a moderately eutrophic system. Data collected between 1992 and 2007 indicate an overall mesotrophic system (UDEQ, Division of Water Quality, 2010). Eutrophication is a term applied to the organic degradation of a body of water and is associated with elevated levels of carbon, nitrogen, phosphorus, and other inorganic nutrients. The degree of eutrophication generally is exhibited by the growth and appearance of large colonies of algae in highly eutrophic waters, coupled with a green cast or color to the water. This generally occurs during the warm summer months.

Trophic State Index (TSI) is a general measure of the level of eutrophication in a reservoir. The Carlson TSI is determined using measures of secchi depth, chlorophyll, and phosphorus (Carlson, 1977). TSI values greater than 50 are indicative of a eutrophic system, and TSI values between 40–50 are indicative of a mesotrophic system. The average TSI value for Scofield Reservoir of 53.3 (for 1979–80) was reported by UDEQ in a report entitled *Scofield Reservoir Restoration Through Phosphorus Control*. For 1981–2007, the average TSI value was computed to be 47.1 (see figure 3-4).

Scofield Reservoir typically does not stratify during the summer and only weakly when it does stratify. Stratification in Scofield is largely influenced by its shallow depth (mean depth of 26 feet) and reservoir operations, which withdraw water from near the bottom of the reservoir. For these reasons, Scofield Reservoir is often mixed from top to bottom. During periods of weak stratification, oxygen levels near the bottom of the reservoir become depleted. Low dissolved oxygen increases phosphorus leaching from the bottom sediments (Judd, 1992).

The water quality of Scofield Reservoir is considered fair. Average constituent levels of the reservoir and its tributaries are listed in table 3-3. The average detention time is about 1.4 years. The maximum depth is

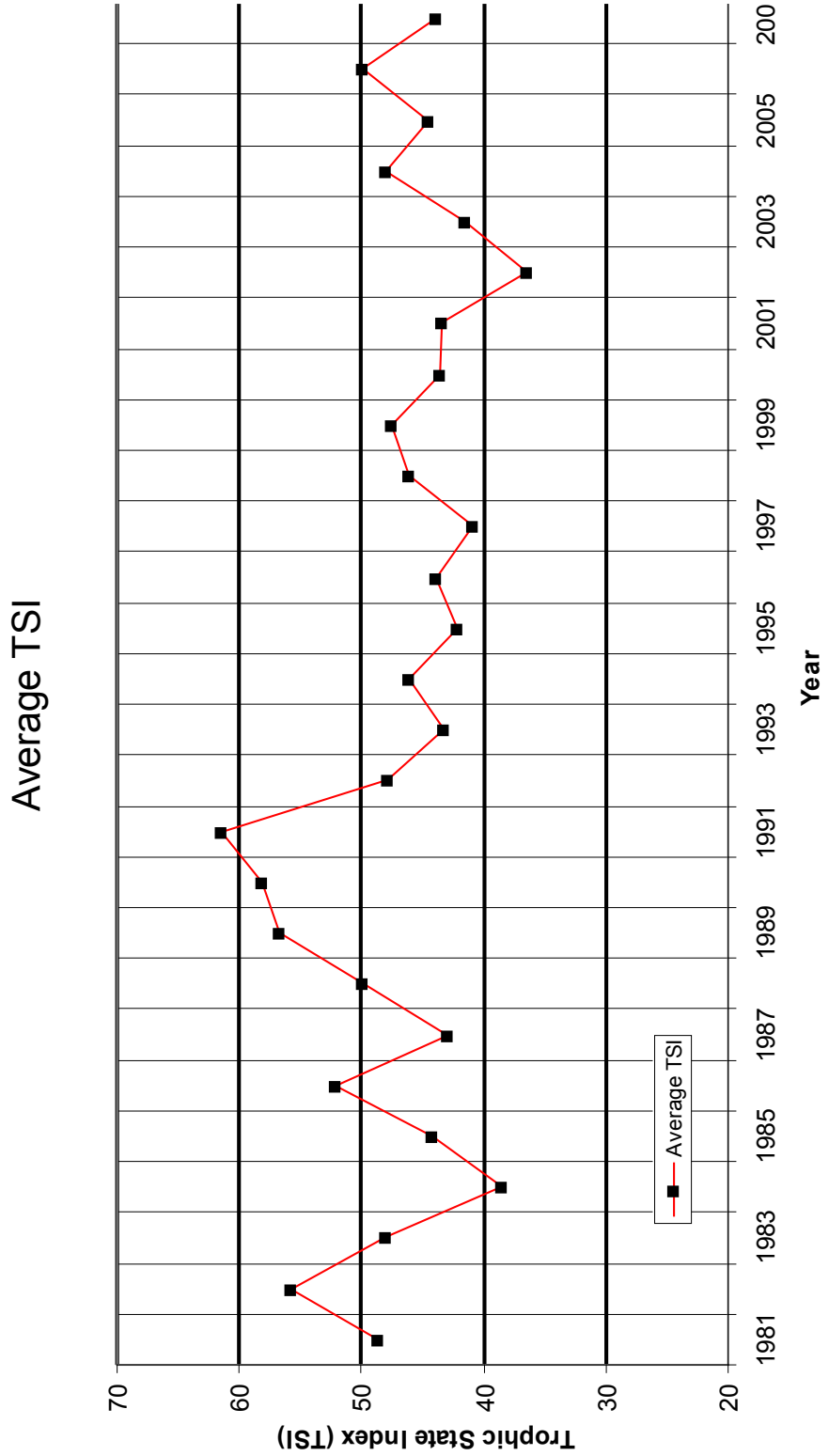



**Figure 3-4.—Scofield Reservoir Average TSI.**

**Table 3-3.—Water Quality Data Summary of Scofield Reservoir and Inflows (mg/L) (Conductivity in µmhos/cm)**

| Constituents | Scofield Reservoir[1] | Fish Creek[2] | Mud Creek[3] | Pondtown Creek[4] |
|---|---|---|---|---|
| Calcium | <46 | 53 | 66 | 64 |
| Magnesium | 15 | 13 | 26 | 15 |
| Potassium | <1.3 | <1.1 | 3.1 | <1.4 |
| Sodium | <5.8 | 3.1 | 24 | 5.8 |
| Alkalinity (as $CaCO_3$) | 160 | 173 | 210 | 205 |
| Bicarbonate | 192 | 210 | 257 | 249 |
| Carbonate | 1.3 | 1.2 | 0.5 | 0.6 |
| Chloride | <5.6 | <4.7 | 30 | 7.5 |
| Conductivity | 365 | 341 | 592 | 425 |
| Nitrate/Nitrite | <0.078 | 0.203 | <0.326 | <1.484 |
| Ammonia as N | <0.099 | <0.084 | <0.078 | <0.086 |
| Phosphate, total | <0.049 (top)<br><0.103 (bottom) | <0.034 | <0.084 | <0.097 |
| Phosphate, total, dissolved | <0.034 (top)<br><0.041 (bottom) | <0.041 | <0.02 | <0.027 |
| Sulfate | <24.1 | <17.8 | 69 | 22 |
| Total dissolved solids | 201 | 193 | 359 | 244 |
| Total suspended solids | <5.6 | <21.1 | <93.7 | <138.9 |
| Aluminum | <0.030 | <0.026 | <0.028 | |
| Arsenic | <0.002 | <0.001 | <0.002 | <0.001 |
| Barium | <0.053 | <0.059 | <0.064 | <0.075 |
| Boron | <0.053 | <0.058 | 0.102 | <0.071 |
| Cadmium | <0.001 | <0.001 | <0.001 | <0.001 |
| Chromium | <0.005 | <0.006 | <0.007 | <0.006 |
| Copper | <0.012 | <0.010 | <0.011 | <0.011 |
| Iron | <0.133 | <0.417 | <0.563 | <1.217 |
| Lead | <0.005 | 0.005 | <0.005 | <0.007 |
| Manganese | <0.092 | <0.036 | 0.072 | 0.184 |
| Mercury | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Selenium | <0.001 | <0.001 | <0.001 | <0.001 |
| Silver | <0.002 | <0.002 | <0.002 | <0.002 |
| Zinc | <0.022 | <0.032 | <0.032 | <0.029 |

[1]Averages based upon 542 samples collected by the Utah Division of Water Quality on Scofield Reservoir (5930980, 5930990, and 5931000) between July 1978 and July 2007.

[2]Averages based upon 124 samples collected by the Utah Division of Water Quality on Fish Creek above Scofield Reservoir (5931650) between July 1978 and November 2007.

[3]Averages based upon 66 samples collected by the Utah Division of Water Quality on Mud Creek in Scofield Town (5931480) between February 1981 and January 2008.

[4]Average based upon 94 samples collected by the Utah Division of Water Quality on Pondtown Creek above Scofield Reservoir (5931680) between September 1978 and August 2006.

66 feet, and the mean depth is 26 feet. The shallow areas with water less than about 15 feet deep normally are covered with extensive macrophyte growth, although these are normally submergent. This adds to the oxygen deficit problem during parts of the year.

The principal pollutants are nutrients, sediments, and trace elements associated with erosion and mining and nonpoint sources such as construction of roads and mine portals, domestic waste disposal, animal grazing, and natural deposits of rock containing phosphates (table 3-3).

Several independent water quality studies of Scofield Reservoir (listed in the "Bibliography") show that phosphorus is the limiting nutrient. This means that all available phosphorus is used up in producing algae or other cell bodies, while there remains a surplus of carbon, nitrogen, and other nutrients. Thus, without the input of additional phosphorus into the system, no additional algal cells can form. About 53% of the phosphorus loading to Scofield Reservoir enters from Fish Creek, according to a 1983 Utah Department of Health study. Indications are that the source of most of the phosphorus consists of naturally occurring, phosphorus-laden soils in the upper watershed.

Fishkills in Scofield Reservoir have been reported during 14 of the 46 years from 1960–2005. These fishkills are minor and generally occur in late summer. They are an indicator of water quality problems with low DO levels being the most probable cause of the fish dying.

In 1984, UDEQ received a Clean Lakes Phase II grant pursuant to the Clean Water Act, Section 314, to rehabilitate Scofield Reservoir through a program to reduce total phosphorus loading to the reservoir. UDEQ had concluded that:

> "the most pragmatic and effective means to control the further eutrophication of Scofield Reservoir, or possibly to effect a moderate reversal of the eutrophication process, appears to be a reduction of the phosphorus load to the lake."

The restoration project consisted of installing stream revetments and checkdams, revegetating denuded streambanks, replacing water diversion systems for irrigation, providing a fish cleaning station, and developing a public awareness and education program to alert people of the pollution problem and solicit their support in reducing phosphorus loads to the reservoir. Streambank rehabilitation activities occurred on segments of Mud Creek and Fish Creek. The overall streambank work was designed to reduce stream sediments and erosion through streambank stabilization and revegetation of denuded soils in highly eroded areas.

A postproject monitoring program indicated that the project was initially effective. Streambank stabilization and revegetation occurred in the project area. Visual observations indicated that sediments were being removed from the streams. Although there is insufficient empirical data to conclusively support the effects of the implementation effort, the data indicated a decline in total phosphorus concentrations. However, many aspects of the project were voluntary on the part of the landowners. Since project completion, many of the project measures have not been maintained. In particular, one aspect included fencing Mud Creek to prevent cattle from entering the stream, damaging the streambanks, and defecating in the stream. This was initially effective, but the landowners currently keep the gates open, thus allowing cattle access to the stream.

Total organic carbon (TOC) data collected by the Utah Division of Water Quality from

1979–91 indicated higher concentrations were present in the reservoir during 1980–81 and 1984–85 when the reservoir was near capacity. Data collected during 1989–91 when the reservoir's capacity was much less have lower TOC concentrations. Similar patterns for TOC data are observed for data collected from the Price River above Willow Creek (STORET ID 7932810).

Utah Division of Water Quality officials believe that the presence of "rough fish," such as carp and suckers, also contribute to the water quality problems in Scofield Reservoir. These fish feed on the reservoir bottom and stir up sediments. This agitation could increase the internal phosphorus loading of the reservoir. In critical water quality years, removal of these fish species might improve the water quality of the reservoir. For example, 1992 was a critical year for Scofield Reservoir operation. Reservoir levels were extremely low, and fishkills were anticipated. However, a fish eradication program was conducted the previous year that killed the undesirable fish. No fishkills were observed in 1992, even though water levels were critically low.

During the 1992 drought year, residents of Price asked the State of Utah to investigate an apparent increase in gastrointestinal disease. Residents believed the increase in disease was caused by either residual bacterial coliforms in the treated water or the superchlorination that was necessary to render the water safe. The State thoroughly reviewed all the required monitoring (chlorine residual and coliform counts) by the water treatment entities. There were no documented problems with the treated water, nor was the water superchlorinated, because it was not needed. Likewise, neither the State nor local Health Departments documented any increased gastrointestinal illnesses during that time period.

In 2000, the Utah Department of Water Quality submitted, and EPA approved, a phosphorus total maximum daily load (TMDL) for Scofield Reservoir (UDEQ, Division of Water Quality, 2000). The TMDL identifies total phosphorus and DO as pollutants of concern that have attributed to the impairment Scofield Reservoir's Class 3A beneficial use for cold water species of game fish. The TMDL focuses on total phosphorus as the pollutant of concern because low DO is linked to high phosphorus levels. The loading assessment quantified the current total phosphorus load to the reservoir at 6,723 kilograms per year (kg/yr). The TMDL identified three endpoints to improve reservoir water quality:

1. Shift in phytoplankton dominance from blue-green algae
2. DO level of no less than 4.0 mg/L in 50% of water column
3. TSI values between 40 and 50

These endpoints are to be met by reducing the total phosphorus load to the reservoir by 1,881 kg/yr.

#### 3.3.1.4 Price River

Water in the Price River suffers major water quality deterioration as the stream crosses the irrigated sectors of the river basin. The deterioration results from both geologic and human factors. From about November–April, little water is released from Scofield Reservoir, and the upper portion of the basin contributes little water to the river. During this period, irrigation return flow is not significantly diluted by better quality water. Although major releases are made from Scofield Reservoir from May–October, a large part of the flow is diverted during this period into major irrigation canals in the upstream part of the basin. Significant amounts of irrigation return flow of poor

quality enter the river downstream from points where most of the flow is diverted from the river.

Accordingly, during most of the year, the flow in Price River in the central basin is composed of relatively small amounts of good quality water from the upper basin and variable amounts of irrigation return flow and natural flow from tributaries that drain the marine shales. This increases the TDS level from about 300 mg/L to about 2,000 mg/L as measured above and below the areas of principal use. Although some deterioration in the chemical quality of the Price River probably would occur in the absence of stream regulation and irrigated agriculture in the central basin, deterioration is intensified with the presence of both.

The Price River from its confluence with the Green River upstream to its confluence with Soldier Creek is listed as impaired for TDS. A TMDL has been completed and approved for these segments (UDEQ, Division of Water Quality, 2004). The TMDL established target daily TDS concentrations of 1,200 mg/L for all flow regimes.

#### 3.3.1.5 Colorado River Salinity

At its headwaters in the mountains of north-central Colorado, the Colorado River has a salinity concentration of 50 mg/L. As a tributary to the Colorado River, the Price River contributes to the salinity load of the river system. The concentration progressively increases downstream as a result of water diversions and salt contributions from a variety of sources. Near Yuma, Arizona, the Imperial Dam, built in the 1930s, diverts Colorado River water into three different canals and holds the river water until it can be directed into a desilting plant. Annual salinity concentrations at Imperial Dam are expected to decrease from the 2007 measured average level of 702 mg/L, assuming continuing successful implementation of the salinity control program (Colorado River Basin Salinity Control Forum, 2008).

Congress established the Colorado River Water Quality Improvement Program (CRWQIP), which includes numerous salinity control projects to mitigate the salinity impacts of water development as the Upper Basin States develop their existing Compact apportionments and water supplies.

#### 3.3.1.6 Cottonwood Creek and San Pitch River

As indicated above, Cottonwood Creek has good water quality and generally meets all of its present beneficial use classifications. The San Pitch River is also generally good quality water above Fairview. However, the San Pitch River degrades downstream since most of the water is diverted; and near Moroni, the river is composed mostly of return flows from irrigation and municipal waste water. However, the TDS levels are generally below 500 mg/L in this reach, and the water is very suitable for irrigation. Most of the water is diverted from the stream about 2.5 miles west of Mt. Pleasant. Table 3-4 summarizes the water quality in this reach of the San Pitch River. Levels of trace elements (metals) in both streams are normally below detection levels.

Table 3-5 summarizes the water quality in the lower section of the San Pitch River and in Sixmile Creek near the mouth. Water in Sixmile Creek is very good quality with TDS levels averaging about 350 mg/L. Waters in the lower San Pitch River consist of mostly return flows and are further degraded below the proposed project area. The average TDS in the San Pitch River above Gunnison Reservoir is about 1,050 mg/L and 1,635 mg/L below Gunnison Reservoir, respectively. The recommended TDS criterion for irrigation water is

**Table 3-4.—Water Quality Data Summary of San Pitch River in the Project Area (mg/L) (Conductivity in µmhos/cm)**

| Constituents | San Pitch at Highway U.S. 89 North of Fairview[1] | San Pitch 2.5 Miles West of Mt. Pleasant[2] | San Pitch Above Moroni Wastewater Treatment Plant Outfall[3] |
|---|---|---|---|
| Calcium | 63 | 70 | 64 |
| Magnesium | 40 | 50 | 56 |
| Potassium | <1.6 | 2.9 | 3.3 |
| Sodium | 13 | 22 | 33 |
| Alkalinity (as $CaCO^3$) | 307 | 337 | 345 |
| Bicarbonate | 370 | 413 | 420 |
| Carbonate | 1.8 | 4.5 | 0.1 |
| Chloride | <12.0 | 22 | 29 |
| Conductivity | 627 | 749 | 817 |
| Nitrate/nitrite | <0.461 | <0.575 | <1.159 |
| Ammonia as N | <0.056 | <0.065 | <0.074 |
| Phosphate, total | <0.019 | <0.046 | <0.095 |
| Phosphate, total, dissolved | <0.017 | <0.024 | <0.034 |
| Sulfate | <25.5 | <59.8 | <78.1 |
| Total dissolved solids | 361 | 446 | 502 |
| Total suspended solids | <15.2 | <52.6 | <81.9 |
| Aluminum | <0.03 | <0.032 | <0.042 |
| Arsenic | <0.004 | <0.004 | <0.032 |
| Barium | 0.147 | 0.18 | <0.576 |
| Boron | 0.05 | 0.133 | 0.102 |
| Cadmium | <0.0009 | <0.001 | <0.001 |
| Chromium | <0.005 | <0.005 | <0.006 |
| Copper | <0.011 | <0.015 | <0.017 |
| Iron | <0.022 | <0.179 | <0.405 |
| Lead | <0.003 | <0.004 | <0.005 |
| Manganese | <0.008 | <0.036 | <0.047 |
| Mercury | <0.0002 | <0.0002 | <0.0002 |
| Nickel | <0.001 | <0.002 | <0.001 |
| Selenium | <0.002 | <0.003 | <0.002 |
| Silver | <0.030 | <0.025 | <0.019 |
| Zinc | 63 | 70 | 64 |

[1]Averages based upon 56 samples collected by the Utah Division of Water Quality on San Pitch River at U.S. 89 crossing north of Fairview (4946790) between April 1986 and June 2007. The trace element (metal) samples were filtered or dissolved metals.

[2]Averages based upon 194 samples collected by the Utah Division of Water Quality on San Pitch River 2.5 miles west of Mt. Pleasant at U16 crossing (4946750) between July 1976 and June 2007. Most trace element (metal) samples were filtered or dissolved.

[3]Averages based upon 166 samples collected by the Utah Division of Water Quality on San Pitch River above Moroni Wastewater Treatment Plant (4946960) between November 1975 and May 2006. Trace element (metal) samples were filtered or dissolved.

**Table 3-5.—Water Quality Data Summary of Lower San Pitch River and Sixmile Creek (mg/L) (Conductivity in µmhos/cm)**

| Constituents | Six Mile Creek near Mouth near San Pitch[1] | San Pitch Above Gunnison Reservoir[2] | San Pitch 2 Miles East of Gunnison[3] |
|---|---|---|---|
| Calcium | 48 | 77 | 88 |
| Magnesium | 35 | 123 | 80 |
| Potassium | <1.5 | 4.7 | 5.0 |
| Sodium | 32 | 155 | 385 |
| Alkalinity (as $CaCO_3$) | 250 | 445 | 351 |
| Chloride | 301 | 537 | 424 |
| Conductivity | 2.6 | 6.2 | 2.0 |
| Nitrate/nitrite | <26.9 | 161 | 527 |
| Ammonia as N | 655 | 1,713 | 2,635 |
| Phosphate, total | 1.433 | <0.451 | <2.026 |
| Phosphate, total, dissolved | <0.074 | <0.098 | <0.070 |
| Sulfate | <0.065 | <0.095 | <0.076 |
| Total dissolved solids | <0.020 | <0.042 | <0.022 |
| Total suspended solids | <47.9 | 371 | 264 |
| Aluminum | 351 | 1,147 | 1,635 |
| Arsenic | <395.5 | <83.9 | <130.1 |
| Barium | <0.055 | <0.036 | <0.045 |
| Boron | <0.003 | <0.009 | <0.005 |
| Cadmium | 0.117 | 0.127 | <0.093 |
| Chromium | <0.083 | 0.186 | 0.361 |
| Copper | <0.0009 | <0.001 | <0.001 |
| Iron | <0.006 | <0.008 | <0.006 |
| Lead | <0.011 | <0.012 | <0.016 |
| Manganese | <0.073 | <0.121 | <0.257 |
| Mercury | <0.003 | <0.004 | <0.005 |
| Selenium | <0.008 | <0.013 | <0.022 |
| Silver | <0.0002 | <0.0002 | <0.0002 |
| Zinc | <0.001 | <0.002 | <0.002 |

[1]Averages based upon 71 samples collected by the Utah Division of Water Quality on Six Mile Creek above confluence with San Pitch River northwest of Sterling (4946360) between September 1976 and June 2007. The trace element (metal) samples were filtered or dissolved metals.

[2]Averages based upon 143 samples collected by the Utah Division of Water Quality on San Pitch River west of Manti above Gunnison Reservoir at CR crossing (4946450) between September 1976 and June 2007. The trace element (metal) samples were filtered or dissolved.

[3]Averages based upon 228 samples collected by the Utah Division of Water Quality on San Pitch River 2 miles east of Gunnison at U137 crossing (4946150) between October 1976 and June 2007. The trace element (metal) samples were filtered or dissolved.

1,200 mg/L. The San Pitch River from its confluence with the Sevier River upstream to the U132 crossing was listed as impaired for TDS. A TMDL has been completed and approved for these segments (UDEQ, Division of Water Quality, 2003). The TMDL determined that cause of impairment was natural sources and that current TDS criteria could not be obtained. The TMDL further recommended site-specific criteria and that the impaired status be removed. Levels of trace elements (metals) in both streams normally are below detection levels.

## 3.3.2 Methodology and Impact Indicators

Impacts on water quality were analyzed using a comparison of phosphorus mass balance analysis. Scofield Reservoir was the primary focus of the water quality impact analysis since this was the predominant water quality issue identified in scoping.

### 3.3.2.1 Phosphorus Mass Balance Analysis

A recent study of impacts of Narrows Reservoir operations on Scofield Reservoir phosphorus loading is described in the report by Franson Noble Engineering entitled, *Eutrophication Study, Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir* (October 2006, revised) (appendix F). This recent study (based on the 1978–2005 period) accounts for flow and phosphorus routing through Lower Gooseberry and Scofield Reservoirs under existing conditions and includes the proposed Narrows Reservoir under project conditions. Phosphorus export and uptake in the reservoirs are included.

Reservoir eutrophication models have been developed for both existing and project conditions. This mass-balance mathematical modeling of Scofield Reservoir, based on external phosphorus loading, indicates that the average probability of eutrophication is about 68% under existing conditions. The average in-lake total phosphorus was 0.0279 mg/L during the 28 years modeled (1978–2005). The average annual inflow of phosphorus to Scofield Reservoir during that period was 4,434 kilograms (kg). Project impacts were determined by comparing the total modeled in-lake phosphorus under the various alternatives. In interpreting the results of this study, it should be noted that the study is based on external phosphorus loading only. In addition to external phosphorus loading, other factors, including internal phosphorus loading, affect the water quality of Scofield Reservoir.

## 3.3.3 Predicted Water Quality Effects

Water quality impacts of main concern that might occur as a result of construction and operation of the proposed Narrows Project are as follows:

- Degradation of existing water quality in the current nondegradation segments of project area streams during construction
- Potentially decreased DO levels and increased fishkills in Lower Gooseberry Reservoir due to decreased inflow
- Increased phosphorus concentrations in Scofield Reservoir that would increase potential for eutrophication and blue-green algal dominance and would result in an overall decrease in water quality
- Increased potential for fishkills in Scofield Reservoir as a result of possible decreases in water quality due to reduced inflows
- Increase in average salinity levels in the Colorado River at Imperial Dam of

0.54 mg/L due to an average annual depletion of 5,597 acre-feet

#### 3.3.3.1 No Action Alternative

Under the No Action Alternative, there would be no temporary water quality impacts to Gooseberry and Fish Creeks because there would be no heavy construction in the area. Low DO levels would continue to occur in Lower Gooseberry Reservoir. The total in-lake phosphorus level in Scofield Reservoir would not change. The average probability of eutrophication would remain about 68%. The TSI would average about 47.1, and the reservoir would continue to be mesotrophic. Fishkills would continue to occur in about 14 of 46 years.

Salinity levels in the Colorado River would continue as at present under this alternative.

There would be no water quality mitigation under the No Action Alternative since there are no net impacts to water quality.

There would be no residual or cumulative impacts to water quality under the No Action Alternative.

#### 3.3.3.2 Proposed Action Alternative

Under the Proposed Action, there could be some water quality impacts during construction; however, measures would be implemented to minimize those impacts. The contractor would be required to comply with applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution. The contractor's construction activities would be performed by methods that would prevent solid matter, contaminants, debris, and other objectionable pollutants and wastes from entering and accidentally spilling into streams, lakes, and underground water sources. Sanitary wastes would be disposed of by approved methods.

The construction contract would require the contractor to develop and implement a Water Quality Management Plan (Erosion Control Plan) and a Storm Water Pollution Prevention Plan. The contractor also would be required to implement the best management practices (BMPs) specified in the *Nonpoint Source Water Pollution Control Plan for Hydrologic Modifications in Utah*, which is an addendum to the *Utah Nonpoint Source Management Plan*. Specifically, applicable sections such as Hydromod Planning Process, Measures to Control Construction Activities, and Impoundments would be followed and implemented. Implementation of these measures would be expected to limit construction-related impacts on water quality to temporary sediment and turbidity impacts. Under a worst case scenario, if sediment control facilities temporarily failed and any stream sections were significantly impaired, remediation/restoration work would be implemented to the satisfaction of the appropriate government agencies.

Any construction work occurring in streams or associated wetlands would be conducted in compliance with USACE's 404 Permit and/or the Utah State Engineer's stream alteration permit, which would include the State 401 certification process.

##### *3.3.3.2.1 Lower Gooseberry Reservoir*

The average annual inflow (based on 1978–2005 data) to Lower Gooseberry Reservoir would be reduced by 40%. The average annual phosphorus load levels below the proposed Narrows Reservoir would be reduced by about 113 kg/yr, resulting from phosphorus export and uptake in the Narrows Reservoir. This would result in a 45% reduction in the average nutrient load in the total inflowing water. The average in-lake phosphorus concentration would be reduced from 0.0131 to 0.0119 mg/L, and the probability of eutrophication would be reduced from 24.3 to 19.7%. Because the

DO levels are greatest near the stream inlet, a decrease in inflow is expected to decrease the overall DO level of the reservoir in winter during iced-over conditions, thus increasing the potential for fishkills unless mitigation is implemented. Mitigation for this would include minimum streamflow releases as discussed in section 3.10, "Fisheries."

#### *3.3.3.2.2 Scofield Reservoir*

As a result of the Proposed Action, the inflow to Scofield Reservoir would be reduced by an annual average of 5,726 acre-feet (about 9.2%). This means that Scofield Reservoir generally would operate at a lower elevation and smaller surface area.

Shallower conditions in Scofield Reservoir would decrease periods of weak stratification, and reservoir turnover would occur earlier in the fall. Water temperatures at the surface of the reservoir, which is a function of solar input and wind mixing, would not be expected to change. Water temperature throughout the water column would increase slightly as the volume of water in the hypolimnion, or bottom temperature zone in the water column, would be reduced. Oxygen depletion at depth in the reservoir would occur less frequently due to shallower depths and increased mixing. Shallower conditions may lead to reduced water clarity as a result of wind-induced mixing.

The results of the eutrophication study (Franson-Noble Engineering) (appendix F) with the Narrows Dam and Reservoir show that, under the Proposed Action, there would be a reduction of average annual phosphorus mass loading into Scofield Reservoir (105 kg/yr) and an increase by 10.8% in phosphorus in-lake concentration from 0.0279 to 0.0309 mg/L. The reduction in phosphorus loading results from basin export and uptake in Narrows and Lower Gooseberry Reservoirs. The increase in phosphorus in-lake concentrations results from decreased dilution caused by water depletion from the Proposed Action. Figure 3-5 shows a comparison of the future without project and project phosphorus level in Scofield Reservoir based on external loading.

Increased phosphorus concentrations would be expected to lead to increased algal blooms, particularly blue-green algae, and increased eutrophication. The overall probability of eutrophication for the period studied shows an increase from 68.3 to 73.5% (about a 5.2% increase). The probability of eutrophication was increased every year except 1984.

Increased algal blooms also may lead to increased organic matter in the reservoir and in releases. Significant increases in organic matter would impact drinking water treatment processes.

The increase of in-lake phosphorus concentration and increased probability of eutrophication indicates that the overall water quality in Scofield Reservoir would be degraded by the Proposed Action without mitigation. Mitigation measures to offset these potential impacts are described in section 3.3.3.2.6.

#### *3.3.3.2.3 Proposed Narrows Reservoir*

The overall water quality in the proposed Narrows Reservoir is projected to be good. The probability of eutrophication would be about 12% (compared to 73.5% for Scofield Reservoir and 19.7% for Lower Gooseberry Reservoir). The proposed Narrows Reservoir is not expected to strongly stratify due to its shape, water budget, and location. The active pool (the storage above the inactive pool) would only be 45 feet deep, with an average drawdown of 9 feet during the recreation season and 12 feet annually. The proposed plan is to have three outlets spaced 20 feet apart, at elevations 8,640; 8,660; and 8,680 feet, respectively. The normal water surface elevation is 8,690 feet. If a mild

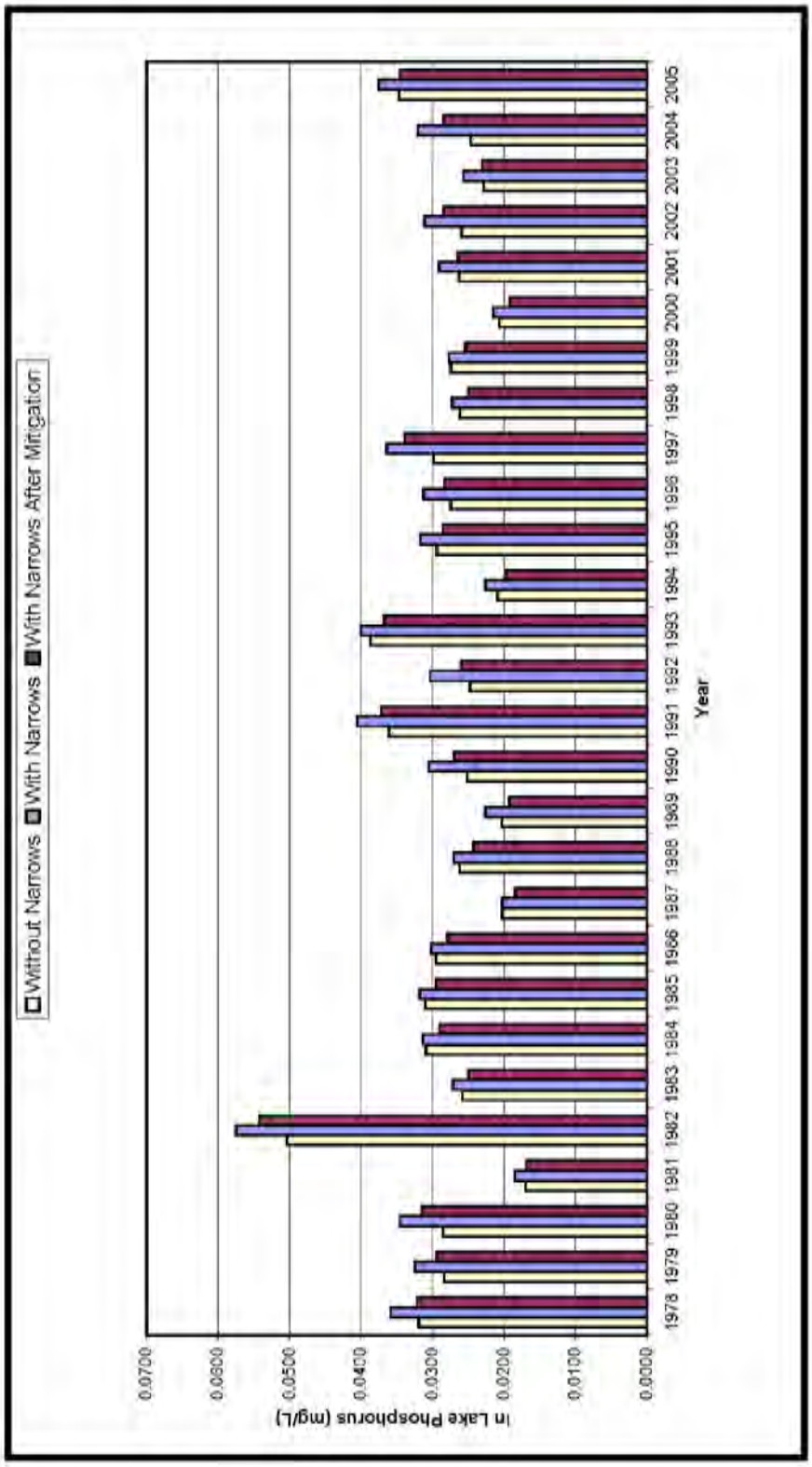



**Figure 3-5.—Scofield Reservoir – Average Annual In-Lake Phosphorus Comparison.**

thermocline develops, it normally would start at about 16 to 20 feet and, over the summer season, migrate down to a depth of 32 to 45 feet, depending upon the release pattern, level of water withdrawn, and type of year. Once the reservoir was constructed, filled, and operated for several years, an operating plan would be developed jointly with the State and Federal agencies to enhance habitat for fish and wildlife downstream. As a result of the small releases and stream channel conditions downstream, the water would reach ambient conditions within the first ¼ to 2 miles downstream, relative to temperature and dissolved oxygen, even if conditions were less than optimum in waters released. Releases from the Narrows Reservoir would be expected to meet or exceed water quality standards of the State of Utah as found in UAC R317-2 for downstream designated beneficial uses.

Water quality at the proposed Narrows Reservoir would be protected by establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.

#### *3.3.3.2.4 Price and Colorado Rivers*

The Narrows Project would have virtually no effect on the lower Price River water quality during the November–April high TDS period because the effects of depletions caused by the proposed Narrows Project would consist primarily of reduced spills from Scofield Reservoir during the snowmelt runoff period.

Reduced spills from Scofield Reservoir would slightly increase exceedances of the TMDL established for TDS on the lower Price River (UDEQ, Division of Water Quality, 2004).

Implementing the Proposed Action would have a slight detrimental impact on Colorado River salinity. While operation of the proposed Narrows Dam and Reservoir would remove about 1,520 tons of salt per year from the Colorado River system, depletions from the project would increase salinity concentrations. The project would cause a depletion of about 5,597 acre-feet of water, which would result in an increase in salinity concentration by about 0.54 mg/L at Imperial Dam.

#### *3.3.3.2.5 Cottonwood Creek and San Pitch River*

The overall water quality of Upper Gooseberry Creek is better than that of Cottonwood Creek (see table 3-2), so the additional water imported to Cottonwood Creek would improve its quality slightly. The exception may include temporary periods of slightly higher turbidity from the increased summer flows. Flows in Cottonwood Creek (below Left Hand Fork) would increase in July and August due to the increased irrigation releases, but these flows would be significantly less than peak flows that naturally occur during the spring snowmelt period. As discussed in Section 3.5, “Slope and Channel Stability,” the Narrows Tunnel operating gate would be automated to regulate releases through the tunnel so that, even during thunderstorms, the channel forming discharge would not increase above historical conditions. Consequently, even though the Proposed Action would increase the summer base flow, it would have no effect on Cottonwood Creek channel stability because the increase would be well below the 50-year channel forming discharge.

Except during spring runoff and winter conditions, flows in the San Pitch River below the project area consist mostly of return flows from irrigation and municipal waste water. The project would increase the volume of return flows from both of these sources; however, since no new lands receive project water, the quality of return flows would be similar to existing flows or possibly

would be of slightly better quality because lands would receive a more complete water supply. Consequently, the concentration of dissolved salts should be more diluted in the increased volume of return flows. The potential decrease in irrigation return flows, resulting from increasing agricultural efficiencies, would be offset by the increase of return flow from the additional project irrigation water. Even if the overall volume of return flow were reduced significantly due to increased efficiencies, the quality of the return flows probably would not change significantly, nor would the existing quality of the San Pitch River change significantly since it mostly is composed already of return flows.

As shown in table 3-5, the salinity of lower San Pitch River is about 1,150–1,635 mg/L TDS compared to about 350 mg/L in Sixmile Creek. If the Manti Meadows Alternative wetland mitigation area is selected, and if water is delivered from Sixmile Creek and replaced with project return flows delivered to Gunnison Reservoir in exchange, there could be some impact to affected irrigated lands.

Diversions to the wetland area would have to be timed to not significantly affect the exchanged irrigation water supply, or replacement waters would need to be blended with higher quality Sixmile water to avoid impact to crops using the water. Under worst case conditions, an agreement with the Manti Irrigation Company might be needed, and minimal compensation might be required.

#### *3.3.3.2.6 Proposed Mitigation Measures*

Under the Proposed Action, water quality measures would be implemented to offset any measurable impacts to water quality in Lower Gooseberry and Scofield Reservoirs. These measures include stabilizing the Gooseberry Creek channel and making improvements to 9.5 miles of stream segments tributary to Scofield Reservoir to reduce external phosphorus loading. These proposed mitigation measures are identified and discussed in section 2.2.2.

The channel of Gooseberry Creek between Lower Gooseberry Reservoir and Narrows Dam would be narrowed to stabilize the banks and provide better fish habitat with the reduced flows. It is expected that, in time, the channel would narrow by itself due to the decreased flow. However, to expedite the process, certain manmade improvements would be made. These improvements also would decrease the inflow of phosphorus-laden sediments to Lower Gooseberry Reservoir and would reduce historical water quality problems. Prior to construction of these improvements, a detailed design would be developed by SWCD in coordination with the USDA Forest Service, Service, USACE, UDWR, and the Utah Division of Water Rights. Where the stream passes through private land, a right-of-way corridor adjacent to the stream would be acquired to protect the streambanks and water quality. The right-of-way corridor would be acquired in the name of the United States. Fencing also would be provided where needed to protect the stream from livestock. In addition, a high percentage of the nutrients flowing into Lower Gooseberry Reservoir would be caught in Narrows Reservoir.

These stream stabilization measures also would tend to improve the water quality in Scofield Reservoir by reducing phosphorous loading and, thereby, reducing the potential for eutrophication including blue-green algal blooms. This improvement would be realized in conjunction with the improvement of stream segments on tributary streams above Scofield Reservoir. About 9.5 miles of stream segments would be improved, consisting of bank stabilization, primarily through riparian planting. The stream segments also would be fenced to protect them from grazing impacts. This measure would reduce the amount of sediment and

animal waste and, hence, the amount of phosphorous flowing into the reservoir. Historically, fishkills have occurred in Scofield Reservoir due to poor water quality. Phosphorous has been identified as the limiting nutrient in the eutrophication of the reservoir (UDEQ, Division of Water Quality, 2000). Phosphorous loading occurs through several methods, including inflow of sediments, which are naturally high in phosphorous and animal waste. The Utah Division of Water Quality concluded that:

> "…the most pragmatic and effective means to control the further eutrophication of Scofield Reservoir, or possibly to effect a moderate reversal of the eutrophication process, appears to be a reduction of the phosphorous load to the lake." (Judd, 1992)

As mentioned earlier, the phosphorus loading and eutrophication models indicate that there would be an increase in the phosphorus concentration in Scofield Reservoir as a result of the Proposed Action. The future without the project model shows a concentration of 0.0279 mg/L of phosphorus in Scofield Reservoir. The Proposed Action phosphorus concentration is estimated to be 0.0309 mg/L for the study period of 1978–2005, an increase of 10.8%.

To offset this impact on Scofield Reservoir, phosphorus loading to the reservoir will be reduced through mitigation measures to achieve preproject in-lake phosphorus concentrations. The model used in the eutrophication study estimates phosphorus loading would need to be reduced by 530 kg/yr. However, the model underestimates both the phosphorus loading to the reservoir and the in-lake phosphorus concentrations. The phosphorus load reduction required to achieve preproject conditions in the lake is calculated from a ratio of the model phosphorus load (4,434 kg/yr) and the TMDL estimated phosphorus load (6,723 kg/yr). The necessary phosphorus load reduction is estimated to be 805 kg/yr.

An interagency team of water quality specialists proposed mitigation measures on 9.5 miles of stream segments to achieve the required phosphorus load reduction of 805 kg/yr. Mud Creek would account for 6.5 miles of the mitigation stream segments, with 2.0 miles on Pondtown Creek and 1.0 mile on Fish Creek. Water quality monitoring on each tributary would be implemented to identify specific locations of stream restoration efforts and type and to quantify phosphorus reductions from proposed mitigation measures. All mitigation measures would be implemented prior to storage and diversion of water in the Proposed Alternative. Monitoring also would continue following implementation of mitigation measures to verify continued effectiveness in reducing phosphorus loading. If the estimated phosphorus reduction of proposed mitigation measures does not equal or exceed the required reduction of 805 kg/yr, then additional mitigation measures would be identified and implemented until the required reduction is reached. The development and implementation of the water quality monitoring program and identification of mitigation measure locations would be coordinated with and approved by the Utah Division of Water Quality.

Water quality monitoring of Scofield Reservoir also would be implemented to ensure the effectiveness of the proposed mitigation measures and to verify that other water quality impacts do not occur. The proposed monitoring method would be to compare future water quality samples once the project is in operation, with the samples taken before that time. Calculated TSI values, phytoplankton samples, and an average of the phosphorus concentration in

these water samples over time would indicate the effectiveness of the mitigation measures.

Salinity of the Colorado River has been increased by developing water resources in two major ways:

1. The addition of salts from water use
2. The consumption (depletion) of water

The combined effects of water use and consumption have had a significant impact on salinity in the Colorado River Basin. The net effect of this project on Colorado River salinity is anticipated to be an increased salinity concentration of about 0.54 mg/L at Imperial Dam.

The Colorado River Basin States have agreed to limit this impact and adopted numeric criteria, requiring that salinity concentrations not increase (from the 1972 levels) due to future water development. The goal of the Colorado River Basin Salinity Control is to offset (eliminate) the salinity effects of additional water development (U.S. Department of the Interior, 2005).

Although it is not possible to accurately quantify the net effect of the project plan on water quality in Lower Gooseberry and Scofield Reservoirs, it is believed that the mitigation measures described above, along with the nutrient capture and export due to the project, would offset any adverse impacts caused by the water reduction and other consequences of the project, leaving essentially no residual project impact.

#### 3.3.3.3 Mid-Sized Reservoir Alternative

Water quality impacts under the Mid-Sized Reservoir Alternative would be similar to those of the Proposed Action. The Price River depletion would be 5,298 acre-feet instead of 5,597 acre-feet under the Proposed Action, which would indicate a slightly reduced impact to water quality in the Lower Gooseberry and Scofield Reservoirs. This would be a reduction of 39% of the annual inflow to Lower Gooseberry Reservoir and 8.8% to Scofield Reservoir. The depletion to the Colorado River would be reduced slightly to 5,298 acre-feet, removing about 1,470 tons of salt per year from the Colorado River system but increasing salinity concentration at Imperial Dam by about 0.51 mg/L.

Water quality mitigation measures under the Mid-Sized Reservoir Alternative would be the same as those under the Proposed Action.

After mitigation, there would be effectively no residual project impact on water quality in Lower Gooseberry and Scofield Reservoirs.

#### 3.3.3.4 Small Reservoir Alternative

Water quality impacts under the Small Reservoir Alternative would be similar to those of the Proposed Action. The Price River depletion would be 4,841 acre-feet instead of 5,597 acre-feet under the Proposed Action, which would indicate a slightly reduced impact to water quality in the Lower Gooseberry and Scofield Reservoirs—a reduction of 36% of the annual inflow to Lower Gooseberry Reservoir and 8.3% to Scofield Reservoir. This depletion would remove about 1,380 tons of salt per year from the Colorado River system but would increase salinity concentration at Imperial Dam by about 0.46 mg/L.

Water quality mitigation measures under the Small Reservoir Alternative would be the same as those under the Proposed Action.

After mitigation, there would be no residual project impact on water quality in Lower Gooseberry and Scofield Reservoirs.

# 3.4 AIR QUALITY RESOURCES

## 3.4.1 Affected Environment

Utah air quality is monitored by UDEQ, Division of Air Quality, but there are no monitoring sites near the proposed Narrows Project located in Sanpete County. The closest monitoring station is located in Utah County, which has poor air quality in terms of carbon monoxide, nitrogen dioxide, and particulate matter (www.epa.gov/air/data).

## 3.4.2 Methodology and Impact Indicators

Under the 1970 Clean Air Act, the EPA established National Ambient Air Quality Standards (NAAQS) for particulate matter and five other criteria pollutants considered harmful to public health and the environment. The NAAQS specify maximum concentrations below which the air quality is considered acceptable, meaning an area below these thresholds are "in attainment" for EPA standards.

Sanpete County is generally in attainment for all but particulate matter. The standards for particulate matter, expressed as micrograms per cubic meter ($\mu g/m^3$), are as follows: 150 $\mu g/m^3$ (24-hour), 50 $\mu g/m^3$ (annual arithmetic average). The impact indicator for this issue is the number of days the project would exceed NAAQS for particulate matter ($PM_{10}$ levels).

## 3.4.3 Predicted Effects

### 3.4.3.1 No Action Alternative

Under the No Action Alternative, Sanpete County ranks among the cleanest 20% of all counties in the United States for total annual average emissions, but for particulate matter ($PM_{10}$), it ranks among the dirtiest 40% of all counties in the United States (based on the EPA's National Emissions Trends database at www.scorecard.org). The existing sources of particulate matter would continue to be present, but particulates are not expected to significantly increase under the No Action Alternative (table 3-6).

### 3.4.3.2 Proposed Action Alternative

Typical $PM_{10}$ emissions associated with construction activities described in the Proposed Action were estimated, using emission factors from the EPA's *Compilation of Air Pollutant Emission Factors* (EPA, 1985). Approximately 232 pounds per day (lb/day) of construction dust $PM_{10}$ emissions would be produced from activities described in the Proposed Action.

**Table 3-6.—Number of Days $PM_{10}$ Dust Emissions Exceed NAAQS in Sanpete County During Construction of Narrows Project**

| Alternative | Ambient Standard for $PM_{10}$ ($\mu g/m^3$) | Daily Emissions (pounds per $\mu g/m^3$) | Number of Days $PM_{10}$ Emissions Exceed Standards |
|---|---|---|---|
| No Action | 150 | 150 | 0 |
| Proposed Action | 150 | 150 | 0 |
| Mid-Sized Reservoir | 150 | 150 | 0 |
| Small Reservoir | 150 | 150 | 0 |

Most of these emissions would be from vehicle and equipment travel over unpaved roads or direct disturbance of the soil by excavating, grading, and compacting. Application of standard dust suppression techniques (for example, soil stabilization or watering of stockpiled materials) would reduce daily $PM_{10}$ emissions from 232 lb/day to less than the national standard of 150 lb/day. Short-term increases of particulate matter would occur during construction of the Proposed Action. Fugitive dust emissions and emissions from internal combustion engines would be generated by excavation and earth-moving vehicle traffic on unpaved surfaces. The contractor would be required to meet all applicable regulations concerning exhaust and dust control.

Following construction, long-term impacts on air quality would include some increased vehicle emissions and campfires due to additional recreational facilities that would result from the project. This, along with the increased use associated with project O&M, would contribute to some increased level of air pollutants. This impact would not be expected to exceed NAAQS in the Narrows Project area.

Wherever and whenever necessary, the contractor would be required to comply with all Federal regulations and take proper and efficient measures to reduce dust and exhaust pollution that might originate from construction to prevent it from becoming a nuisance to people or causing damage to crops, cultivated fields, or dwellings. The contractor would be required to control particle pollution resulting from the manufacture of concrete aggregate or excessive exhaust pollution resulting from improperly tuned engines or improperly equipped vehicles and equipment.

#### 3.4.3.3 Mid-Sized Reservoir Alternative

Air quality effects associated with this alternative would be the same as those described above for the Proposed Action; however, once the construction phase of the project is completed, the long-term effects on criteria pollutants, especially particulate matter, would be proportionately reduced due to the reduced number of mobile emission sources (vehicles) that would be attracted to the reservoir.

#### 3.4.3.4 Small Reservoir Alternative

Air quality effects associated with this alternative would be the same as those described above for the Proposed Action; however, given the smaller size of the reservoir, it would attract fewer visitors and the future mobile sources of air pollution would be proportionately reduced.

## 3.5 SLOPE AND CHANNEL STABILITY

### 3.5.1 Affected Environment

Fairview Canyon, which contains Cottonwood Creek, is a steep, narrow canyon located east of Fairview, Utah. Highway SR-31 is located in the canyon. The canyon is approximately 7 miles long. The stream elevation at the mouth of the canyon is about 6,300 feet and about 8,800 feet near the summit. Typical slopes of the canyon wall are 2:1 to 2.5:1 (ratio of horizontal to vertical distance). Numerous landslides are located throughout the canyon on both sides. In several places, continual road maintenance is required to repair damage caused by landslides.

A total of 104 landslides were identified from aerial photographs and during a 1991 field review along the slopes of a 6-mile reach of Cottonwood Creek. The review team was

comprised of individuals from various government agencies and private consulting firms. The review was to determine the impact of projected flow increases from Narrows Tunnel on adjacent slopes of Cottonwood Creek. The state of activity of the slides was noted, with 85 slides classified as "active" and 19 classified as "dormant." The certainty of landslide identification included 89 slides as "definite," 13 as "probable," and 2 as "questionable." The distances of the landslides from the tunnel portal ranged from 0.3 mile to 6.1 miles. Dominant types of slope movement of the 104 landslides are shown in table 3-7.

**Table 3-7.—Fairview Canyon Slope Movement[1]**

| Type of Movement | Number of Landslides |
|---|---|
| Slump earthflow | 8 |
| Debris slide | 64 |
| Debris flow | 8 |
| Earthflow | 1 |
| Slump | 22 |
| Debris cone | 1 |

[1] Based on the type of material involved in the movement (soil, rock, or debris) and the dominant type of movement (whether the material is sliding, flowing, falling) or a combination thereof.

Based on observations during the review, it was determined that landslide activity is not related to stream channel stability or the flow in Cottonwood Creek but is caused by saturation from water sources on the hillsides.

Over the majority of the reach between the confluence with Left Fork and the mouth of the canyon near Site 7 (figure 3-6), Cottonwood Creek is a small, steep, step-pool stream that is confined in a narrow canyon.

The natural drainage area upstream of Left Hand Fork is relatively small, and the size of the channel between Left Fork and the Narrows Tunnel outlet is primarily a product of the flows that have been imported to the reach since construction of the tunnel in the 1930s. Between the mouth of the canyon and the confluence with the San Pitch River, Cottonwood Creek flows across an alluvial fan through the town of Fairview (refer to figure 3-6 for location of stream reaches and features).

Upstream, in approximately 0.3 mile of the 0.9-mile-long reach, the tunnel outlet and Left Fork cross a relatively wide, mountain meadow area at a gradient of about 5% and have a slightly sinuous planform. The bed material in this area is primarily angular cobbles and gravel, and the banks are well defined and root-reinforced. A surface sediment sample collected at approximately the midpoint of the reach had a median size of 69 millimeters (mm) in size. A series of log-drop check structures have been installed in this portion of the stream. Large, angular cobbles have been placed around many of the structures to provide additional stability. Some of this material likely has been transported away from the structures and is represented in the bed material sample. Some of the structures have been flanked due to lateral movement of the channel. At the downstream end of the meadow reach, the valley bottom narrows considerably, and the stream gradient steepens.

In the approximately 5.3-mile reach between Left Fork and the mouth of the canyon, the planform and gradient of the reach are controlled by the bedrock geology of the canyon and by material that has been delivered to the valley bottom by the numerous landslides that occur along the reach. Steep, colluvial slopes that are underlain by bedrock outcrop consisting of interbedded layers of moderately cemented sandstones and shales extend to the edge of the channel in many locations.

Based on the USGS 72-minute quadrangle maps, the channel gradient averages about

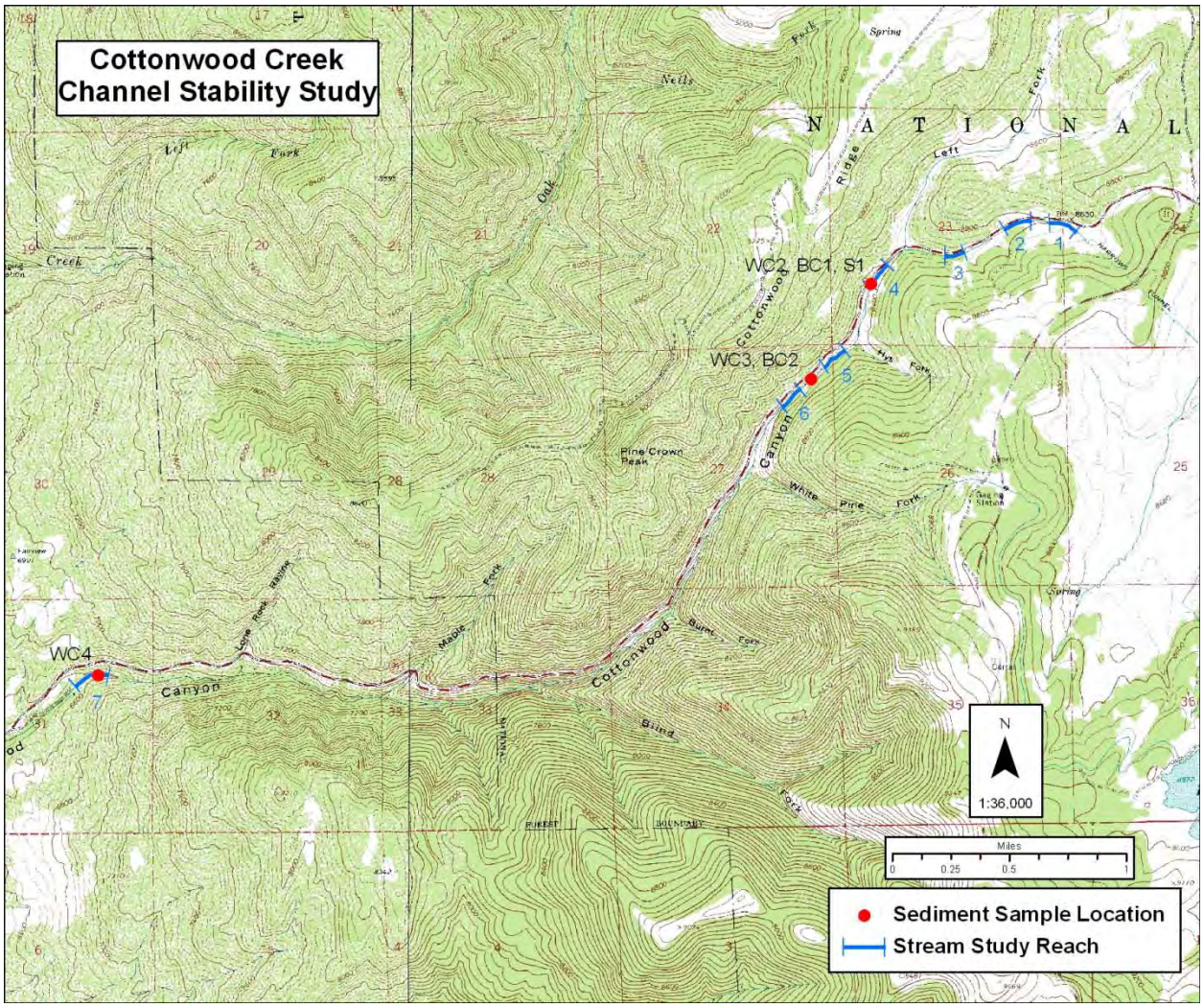



**Figure 3-6.—Cottonwood Creek Channel Stability Study Reaches.**

4.2% between the mouths of Left Fork and Hys Fork, steepens to about 9.1% between Hys Fork and Maple Fork, and then flattens to about 6.6% between Maple Fork and the mouth of the canyon. In several locations below Left Fork, beaver activity significantly affects the planform and profile, creating depositional areas behind the dams, deflecting the stream alignment at the dams, and, in some locations, creating split-flow reaches. The bed material along this portion of the reach consists of particles ranging in size from sand to boulders exceeding 2 feet in diameter.

The finer-grained gravel and cobble-sized material are found in the flatter-gradient portions of the reach where depositional zones are created by beaver activity and in-channel bars along the margins of the channel, while the boulder steps tend to occur in steeper, more confined reaches. A subsurface sediment sample, taken from the bank-attached gravel bar at the same location as surface sample WC2 (approximately 0.2 mile downstream from Left Fork), contained particles ranging in size from fine sand to coarse gravel and had a median size of 14 mm, while the surface sample had a median size of about 50 mm. This relatively fine-grained material is representative of the

material that deposits in depositional zones, while the coarser surface layer is indicative of the typical mobile surface pavement that occurs in gravel bed streams to regulate transport of the relatively low supply of finer-grained material. Steeper, step-pool reaches that provide a positive vertical control for the channel profile also occur between the flatter areas. The median size of the boulders in the step-pool reach just upstream of WC2 was about 380 mm and ranged up to 900 mm in diameter.

In portions of the reach where the valley bottom is wider than the stream (e.g., between Left Fork and Hys Fork), the overbank sediment contains a mixture of gravel, cobbles, and fines (sands, silts, and some clays) that support thick stands of willows and other riparian species. In the confined, steeper portions of the reach between approximately the mouth of Hys Fork and the mouth of the canyon, the channel is primarily boulder step, with a narrow riparian corridor along the channel. Upland species (e.g., evergreen trees) grow very near the channel edge in many locations. A surface bed material sample that was taken about 0.25 mile downstream from Hys Fork had a median size of 103 mm and contained particles up to 250 mm in diameter. The boulder steps in this area had a median size of about 300 mm and ranged up to 750 mm in diameter. There is little evidence of a flood plain along this portion of the reach. Where a flat overbank surface that can be inundated by relatively frequent flows occurs, this feature is very localized and discontinuous and is typically the result of a local deposition zone caused by a downstream obstruction or by an expansion zone caused by bedrock outcrop or debris along the valley margins. The lack of a well-developed flood plain indicates that the stream is laterally very stable, due to the confinement in the bottom of the canyon. There is some minor, localized bank erosion; however, in most cases, the toe of the banks is armored with coarse-grained material, much of which likely is composed of colluvium from the adjacent valley walls or by bedrock outcrop. In some locations, angular cobbles and boulders in the right (north) bank are likely side-case material associated with construction of SR-31.

In the downstream portions of the reach near Site 7, the stream has incised within terraces created by debris flow deposits and colluvium near the head of the alluvial fan. Bank heights in this reach range from 6–10 feet, and the overbank material is composed of a heterogeneous mixture of sands to boulders. The stream profile is controlled by bedrock outcrop and large, woody debris jams in portions of this reach and has a step-pool character in other areas. A surface sediment sample (WC4) taken in the depositional area upstream of the large, woody debris jam had a median size of 113 mm and contained particles up to 450 mm in diameter. Bed material in the reach downstream from the mouth of the canyon is very coarse-grained and appears to be very stable. As is typical on coarse grained alluvial fans, this portion of the reach likely loses a significant amount of flow to infiltration. (Upstream diversions also reduce the surface flow in this portion of the reach.)

The processes associated with the step-pool morphology, such as that in most of the reaches in Cottonwood Creek downstream from the tunnel outlet, had been studied by numerous researchers (Ashida et al., 1976, 1982; Griffiths, 1980; Whittaker and Jaeggi, 1982; Whittaker and Davies, 1982; Whittaker, 1987a, 1987b; Chin, 1989; Grant et al., 1990; Montgomery and Buffington, 1997). This morphology "is generally associated with steep gradients, small width-to-depth ratios, and pronounced confinement by valley walls" (Montgomery and Buffington, 1997). Step-pool channels are sediment supply limited, which means that their capacity to transport sediment is much

greater than the supply (Grant et al., 1990; Mussetter, 1989). Step spacing typically varies from one to four channel widths (Bowman, 1977; Whittaker, 1987b; Chin, 1989; Grant et al., 1990) and corresponds to maximum flow resistance, providing stability for a bed that would otherwise be mobile (Whittaker and Jaeggi, 1982; Abrahams et al., 1995). In these types of channels, the grain sizes that are found in the bed are mobile only during extreme floods; and the step-pool morphology is re-established during the falling limb of the flood hydrograph (Sawada et al., 1983; Whittaker, 1987b; Warburton, 1992).

Discharges of the 50-year flood or larger typically are required to form or modify the steps (Grant et al., 1990). Tracer studies have demonstrated that transport of the finer-grained material stored in the pools between the steps is mobilized during frequent flow events, but the transport of this material is strongly supply limited (Schmidt and Ergenzinger, 1992). Because of the above described characteristics, step-pool streams are resilient to changes in discharge and sediment supply (Montgomery and Buffington, 1997).

As is clearly shown in the above cited literature, the channel forming or dominant discharge in creeks such as Cottonwood Creek is not related to frequently occurring flows associated with the mean annual (or 1.5- to 2-year) flood peak. The concept of the dominant discharge is derived from work on self-formed, alluvial channels in which the boundary material is mobilized over a broad range of discharges, including those that occur for a few to several days per year. These channels typically are able to adjust their cross-sectional shape, planform, and gradient to achieve a state of dynamic equilibrium with the water and sediment supply. The self-formed alluvial streams on which the dominant discharge concept is based typically have well-developed flood plains in which there is a distinct top of bank with a relatively flat overbank area (i.e., bankfull).

Portions of the relatively short reach of Cottonwood Creek between the mouths of Left Fork and Hys Fork have areas that, at a superficial level, appear to fit the definition of a flood plain. (For example, there is a relatively flat overbank area in the narrow valley bottom that is two to three times wider than the channel, and there is a well-defined bankline. The channel capacity in this area appears to be of the 2- to 5-year flood peak.) Closer examination, however, shows that these areas are primarily the result of beaver activity in this locally flatter reach of the stream. As previously discussed, the overbank material is a heterogeneous mixture of materials ranging in size from cobbles to silt and clay. The finer-grained areas are depositional zones that developed behind beaver dams, and much of the nonlinear planform is caused by flow deflection around the remnants of breached dams.

In the step-pool reaches of Cottonwood Creek, the processes that control the size, gradient, and planform are very different from those that control these features in the self-formed streams that have well-developed flood plains. The channel is confined between the valley walls, occupying essentially the entire valley bottom. The lateral and vertical accretion processes that create flood plains do not occur because the channel is laterally confined, and the concept of the bankfull discharge is essentially meaningless. The bed shear stresses in the step-pool reaches of the stream, indicated by a hydraulic analysis of the peak of the 2-year flood, are substantially less than are required to mobilize the boulder steps that locally control the profile of the channel.

## 3.5.2 Methodology and Impact Indicators

Because the review team determined that existing landslides in the canyon are not related to stream channel stability or the flow in Cottonwood Creek, it was determined that the project would have no effect on the landslides. Therefore, no additional analysis of the landslides was performed.

As mentioned previously, the majority of Cottonwood Creek is a step-pool stream. This determination is based on a detailed field review. The project effects on channel stability are based on physical characteristics of the stream, the processes associated with step-pool morphology, and the impacts of the project on the flow characteristics. The impact indicator is flows exceeding the 50-year channel forming flow because of project operation.

## 3.5.3 Predicted Effects

### 3.5.3.1 No Action Alternative

Under the No Action Alternative, there would be no change in channel forming discharge in Cottonwood Creek over its present value; therefore, there would be no impact to Cottonwood Creek channel stability.

### 3.5.3.2 Proposed Action Alternative

Under the Proposed Action, increased flows in Cottonwood Creek will occur due to releases from Narrows Reservoir through the Narrows Tunnel and Upper Cottonwood Creek Pipeline. These increased flows will occur below Left Hand Fork where the Upper Cottonwood Creek Pipeline will discharge into the creek. Figure 3-7 is a hydrograph based on daily flow data that compares present, or No Action Alternative, flows in Cottonwood Creek with flows that will occur under the Proposed Action. The figure is based on 1968 data, which is an average year. As shown in the figure, the peak discharge of about 112 cfs occurs during the snowmelt runoff period. Presently, summer base flows are about 18 cfs. Under the Proposed Action, the summer base flows would increase to about 50 cfs. The maximum flow possible through the tunnel was increased in 2011 by 45 cfs, from a capacity of 15 cfs to a capacity of 60 cfs.

The 50-year rainfall peaks expected in the canyon range from 330 cfs below Left Fork to 570 cfs near the mouth of the canyon. The possible maximum increase in tunnel flows is less than 15% of the rainfall peaks. The snowmelt peak is not a consideration because the tunnel will not operate during the snowmelt runoff. Based on the physical characteristics of Cottonwood Creek and the impacts of the proposed project on the flow characteristics, the project is unlikely to have a significant impact on the stability of the creek. To ensure that the tunnel releases will not cause an impact, the measures described below will be implemented.

As described previously in chapter 2, remote control of the Narrows Tunnel operating gate would be provided to automatically regulate the releases through the tunnel. These controls would be coupled to an automated stream gauging station on Cottonwood Creek near the mouth of the canyon. The streamflow in Cottonwood Creek would be constantly monitored by these controls. As the streamflow increases during high runoff events such as thunderstorms, the tunnel operation would be discontinued when the flow exceeds 100 cfs. The project releases would not resume until after the flows drop below 100 cfs. Under this operating regime, the project flows through the tunnel would not increase streamflows above what is considered safe for channel stability.

Increased flows under project conditions would be well below the 50-year channel-forming discharge.

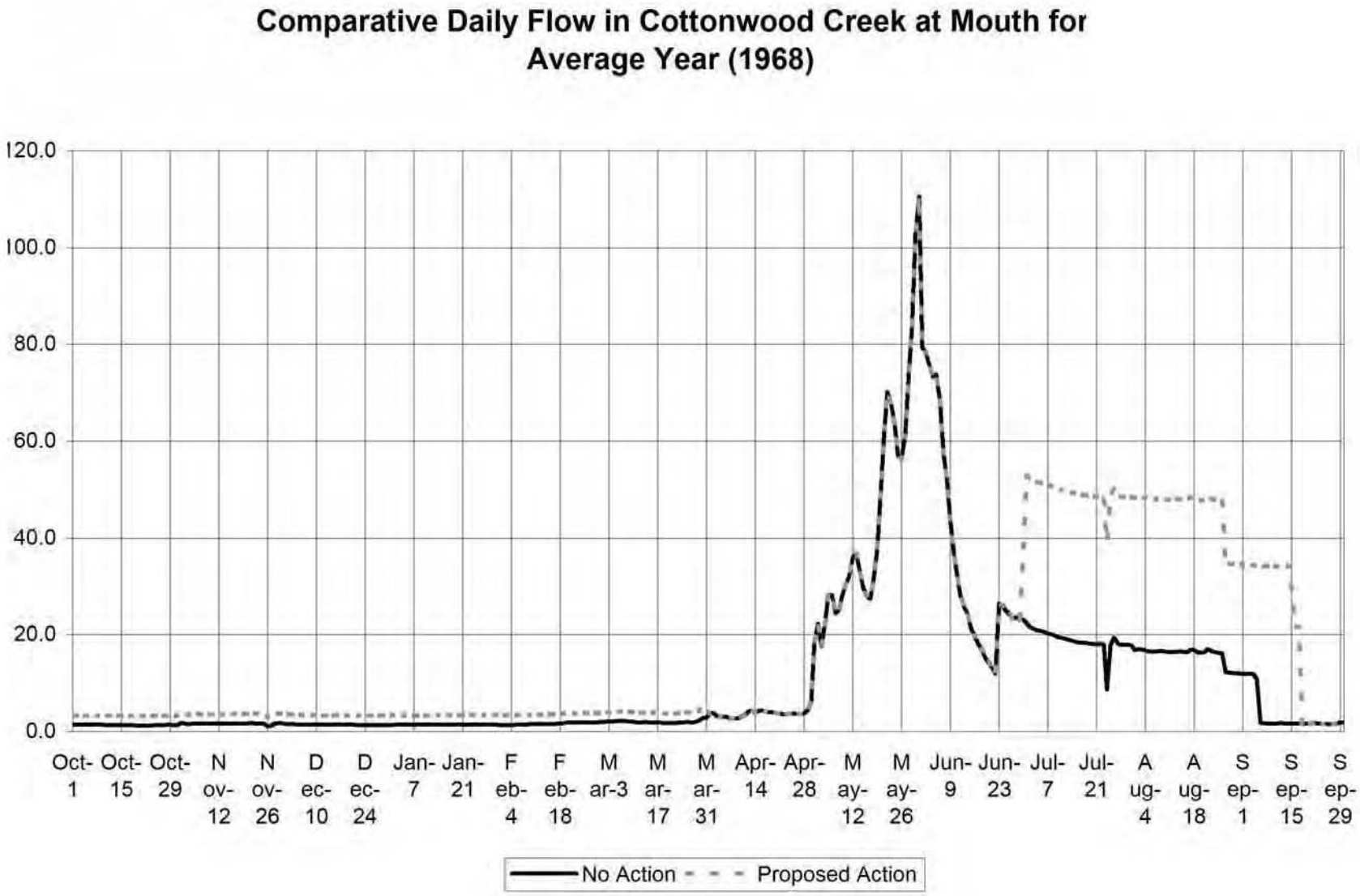



**Figure 3-7.—Comparative Daily Flow in Cottonwood Creek at Mouth for Average Year (1968).**

Erosion along the banks of Cottonwood Creek would be carefully monitored, especially during the first year of operation, to verify that the project has no effect on Cottonwood Creek channel stability.

Appropriate action would be taken if additional erosion above background levels is observed during project operation. Remedial actions could include placing additional armoring materials in the channel or along the bank or revising project operation to avoid more widespread stability problems.

#### 3.5.3.3 Mid-Sized Reservoir Alternative

Channel flows in Cottonwood Creek with the Mid-Sized Reservoir Alternative would be similar to the Proposed Action; therefore, there would be no impact to Cottonwood Creek channel stability. Monitoring of Cottonwood Creek channel stability would take place to ensure that there are no measurable impacts as described in the Proposed Action.

#### 3.5.3.4 Small Reservoir Alternative

Channel flows in Cottonwood Creek with the Small Reservoir Alternative would be similar to the Proposed Action; therefore, there would be no impact to Cottonwood Creek channel stability. Monitoring of Cottonwood Creek channel stability would take place to ensure that there are no measurable impacts, as described in the Proposed Action.

## 3.6 GEOLOGIC RESOURCES

### 3.6.1 Affected Environment

The reservoir basin lies within a high elevation, shallow valley in the Wasatch Plateau subprovince of the Colorado Plateau. This subprovince represents the transition between the Colorado Plateau to the east and the Basin and Range Province to the west. Several ridges isolate the valley basin, which lies about 8,680 feet above sea level.

The proposed Narrows Dam and Reservoir area is underlain by the Cretaceous age North Horn Formation. This formation consists primarily of interbedded sandy, clayey siltstone, silty claystone, silty sandstone, and limestone with occasional thin seams of coal. Bedrock crops out on the steeper slopes of the left abutment and in the drainage located immediately upstream of the left abutment. There is less exposure of bedrock on the right abutment. Unconsolidated sediments overlying bedrock consist primarily of a mixture of residual soil (weathered rock) and colluvium that generally consists of silty sand with some fine to coarse gravel. A geologic study performed by SWCD indicates that there is low potential for reservoir-induced landslide activity in the reservoir basin.

The North Horn Formation is overlain by the Flagstaff Limestone Formation that consists primarily of microcrystalline limestone with thinly bedded shale and silty claystone. Abundant fossils are common within the limestone, and the boundary between the formations is transitional. The Flagstaff Limestone Formation generally is present in the higher elevations and beyond the actual limits of the proposed dam and reservoir.

The Flagstaff Limestone Formation is present at the downstream portal area of the existing Narrows Tunnel.

Bedrock generally is covered by a mantle of residual soils and/or colluvium. These unconsolidated sediments are about 5–10 feet thick with some areas in excess of 27 feet. The unconsolidated sediments are composed of a mixture of clay, silt, and sand with minor amounts of organic deposits. Within the active stream channel of Gooseberry Creek and its tributaries, there are limited deposits of recent alluvial sand and gravel.

The structure of the Wasatch Plateau is dominated by a series of north-trending faults across the broad, west-dipping monocline of the plateau. The Sevier fault zone lies closest to the damsite at a distance of about 20 miles. The local structure is dominated by north-trending faulting around the site area. The dam and reservoir sites are located entirely on a down-dropped block between two fault traces, which is known as the Gooseberry Graben. Variation in orientation of beds indicates that the dam area is located on a westward-plunging synclinal fold with the axis running about 1,000 feet south of the proposed dam axis.

Three faults have been mapped in the vicinity of the Narrows Project. These faults, shown in figure 3-8, are all north-trending normal faults; and the West Gooseberry Fault, the Fairview Lakes Fault, and the East Gooseberry Fault are from west to east.

Observed earthquakes in the region of the Narrows damsite date back to 1853, giving a historical database of about 158 years. A network of seismograph stations throughout the region currently provides the accurate location of any seismic event. Geologic evaluation of the Wasatch Plateau area indicates that existing faults are not active. Maximum seismic events for the area are, therefore, projected to be controlled by random background earthquakes—that is, events not attributable to specific faults or geologic structures.

The largest earthquake recorded in the Wasatch Plateau Province is a magnitude 4.9 event. The maximum random earthquake event postulated for the Wasatch Plateau is a 5.5 event, occurring beneath the site at a depth of 3 miles. Such an event would produce a maximum acceleration of approximately 0.35 g (acceleration of gravity). Seismic activity related to mining activities would not be expected to produce events that exceed magnitude 4.5 and, therefore, would not produce the maximum earthquake. Earthquake epicenters are shown on figure 3-9.

## 3.6.2 Methodology and Impact Indicators

Geologic hazards are not of notable concern in the project area; however, earthquake epicenters have been mapped adjacent to the project area. The highest recorded magnitude earthquake recorded for the Wasatch Plateau Province is 4.9.

The impact indicator for this issue is number of known geologic hazards within the vicinity of the dam and reservoir.

## 3.6.3 Predicted Effects

### 3.6.3.1 No Action Alternative

Geologic conditions and seismic hazards would remain the same as at present under this alternative.

### 3.6.3.2 Proposed Action Alternative

From a geoseismic standpoint, the recommended Narrows damsite is suitable for construction. No significant geologic hazards were found in the embankment or reservoir area, and no seismic activity would be expected to occur from, or be induced by, this reservoir. Faults that occur in the site vicinity are believed to be inactive; however, design of project facilities would be based on a “maximum credible earthquake” (MCE). Preliminary studies indicate that the appropriate MCE would be of magnitude 5.5. Further review of the appropriate MCE would be performed prior to final design of the dam. Additional geologic field evaluation and assessment of the dam and reservoir site would be completed that addresses the proximal active faults associated with the site and further characterizes the earth materials underlying the damsite, reservoir, and

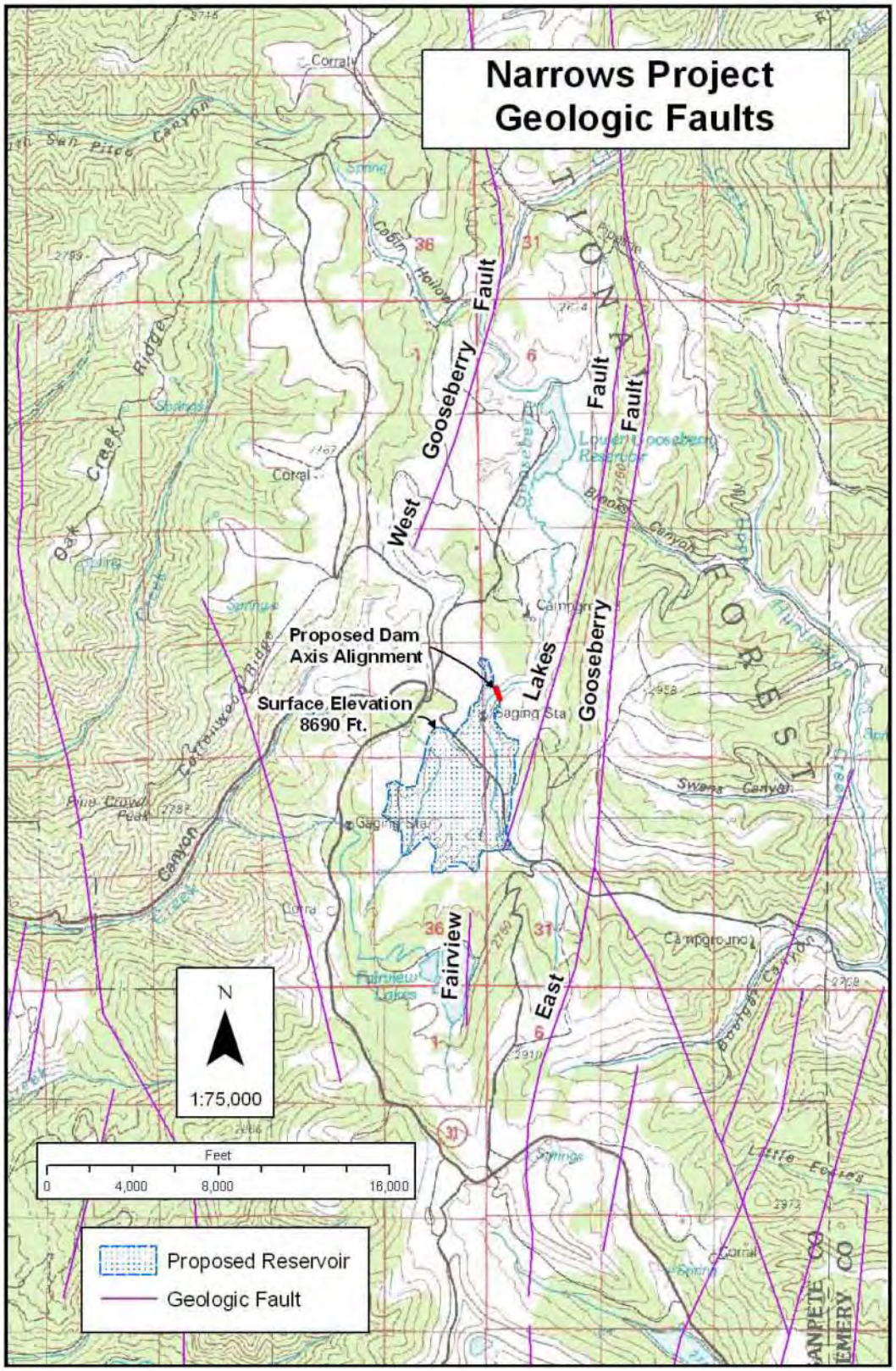



**Figure 3-8.—Narrows Project Geologic Faults Location Map.**

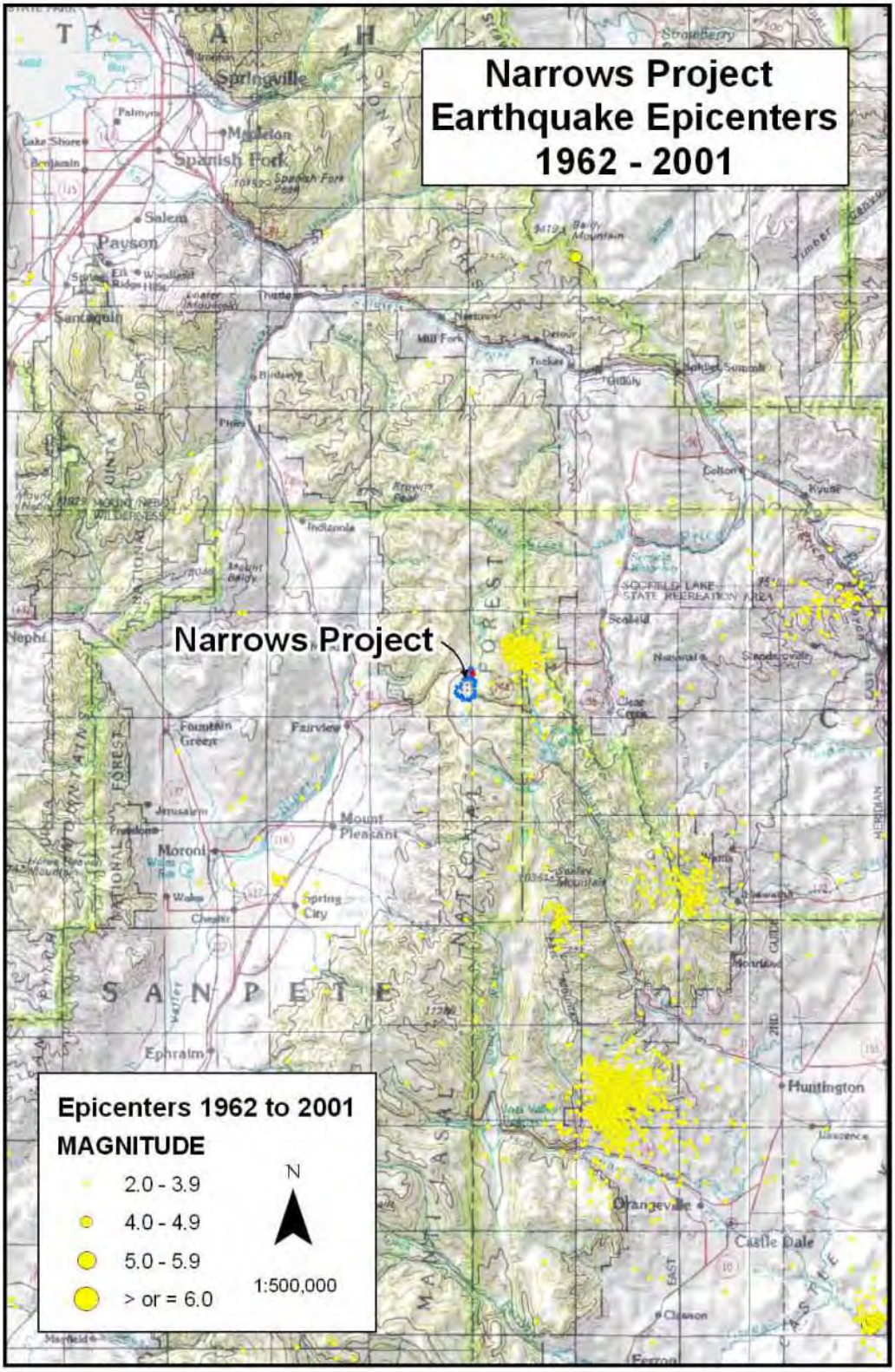



**Figure 3-9.—Narrows Project Earthquake Epicenters Location Map.**

reservoir rim to evaluate their engineering properties to ensure adequate design of features associated with the dam and reservoir. Designs would incorporate maximum accelerations associated with natural and or manmade seismic events that are determined or probable that could potentially occur in the area. Mitigation for other potential geologic hazards also would be integrated into design.

During construction, detailed observations of the subsurface conditions would be monitored by qualified personnel.

There would be no residual geology or seismicity impacts under the Proposed Action. There would be no geology or seismicity mitigation measures under the Proposed Action.

#### 3.6.3.3 Mid-Sized Reservoir Alternative

As described for the Proposed Action, no significant geologic hazards were found in the embankment or reservoir area; and no seismic activity would be expected to occur from, or be induced by, this alternative. Design of project facilities would be based on a MCE.

Detailed observations of the subsurface conditions would be monitored by qualified personnel during construction.

There would be no residual geology or seismicity impacts measures under the Mid-Sized Reservoir Alternative. There would be no geology or seismicity mitigation measures under the Mid-Sized Reservoir Alternative.

#### 3.6.3.4 Small Reservoir Alternative

As described for the Proposed Action, no significant geologic hazards were found in the embankment or reservoir area; and no seismic activity would be expected to occur from, or be induced by, this alternative. Design of project facilities would be based on a MCE.

Detailed observations of the subsurface conditions would be monitored by qualified personnel during construction.

There would be no residual geology or seismicity impacts measures under the Small Reservoir Alternative. There would be no geology or seismicity mitigation measures under the Small Reservoir Alternative.

## 3.7 PALEONTOLOGICAL RESOURCES

Paleontological resources are defined as any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth. Section 6302 of the Paleontological Resources Preservation Act (PRPA) of 2009 (Sections 6301–6312 of the Omnibus Land Management Act of 2009 [Public Law 111-11 123 Stat. 991-1456]) requires the Secretary of the Interior to manage and protect paleontological resources on Federal land using scientific principles and expertise.

### 3.7.1 Affected Environment

The affected environment for paleontological resources is represented by the same APE that corresponds to cultural resources as described in section 3.16.1 (Cultural Resources, Affected Environment).

### 3.7.2 Methodology

Reclamation will be responsible for ensuring the completion of paleontological resource compliance, as stated in the environmental commitments (see appendix G), as a means to fulfill the requirements of the PRPA. The commitment requires a paleontological literature search through the Utah Geological Survey (UGS). This process involves a

search of the statewide paleontological resource locality database as well as an examination of geologic maps of the APE and its immediate vicinity. Through the literature search process, the UGS will determine the potential for discovering paleontological resources as a result of the Proposed Action. Based on the determined potential, the UGS will either make a determination of no effect or require that a paleontological survey be conducted.

### 3.7.3 Predicted Effects

Predicted effects to paleontological resources as a result of the Proposed Action will be definitively determined following the paleontological literature search and survey of the APE and its immediate vicinity.

#### 3.7.3.1 No Action Alternative

Under the No Action Alternative, there likely would be no effects to paleontological resources. There would be no need for ground-disturbing activities associated with the Proposed Action. The existing conditions would remain intact and would not be affected.

#### 3.7.3.2 Proposed Action Alternative

Under the Proposed Action, there would be ground disturbing activities associated with the Proposed Action. These activities have the potential to effect subsurface fossil material.

#### 3.7.3.3 Mid-Sized Reservoir Alternative

Paleontological resource effects under this alternative would be the same as those described above in the Proposed Action.

#### 3.7.3.4 Small Reservoir Alternative

Paleontological resource effects under this alternative would be the same as those described above in the Proposed Action.

## 3.8 SOIL RESOURCES

### 3.8.1 Affected Environment

Soils in the project service area and along the Oak Creek and East Bench Pipelines alignments have developed under semiarid conditions. They are highly calcareous, are high in inherent plant nutrients, have weak to moderate developed soil profiles, and have a wide range of soil textures. They are derived principally from both old and recent alluvial materials eroded from geologic materials of the Wasatch Plateau. The lands are found on benches and terraces formed by the coalesced alluvial fans of the stream's tributary to the San Pitch River. A broad area of valley fill material of deeper soils is found west of Mount Pleasant and in small cove areas at the base of the large alluvial fans. Valley fill also is found in the flat valley or river bottom areas west and southwest of Moroni.

Soils within the vicinity of the proposed Narrows Reservoir are formed mostly in colluvial, alluvial, and residuum materials weathered from sedimentary rocks, limestone, sandstone, and shale. Soils on the high ridges along the west side of the area are formed in materials derived primarily from limestone, while soils in the central and eastern sections of the project area are formed in materials dominated by sandstone, (silty) shale, and some limestone.

Soils are dark colored, rich in bases, freely drained, and cold. Mean annual soil temperature is less than 47 °F, and the mean summer soil temperature is less than 59 °F. Average annual precipitation ranges from 20–25 inches, and the growing season is approximately 90–100 days. All but two of

the soil series described are in the Cryoboroll Great Group, Boroll Suborder, and Mollisol Order of soil classification. The two exceptions, Fairview and Gooseberry series, are classified as being in the Cryaquoll Great Group, Aquoll Suborder, and Mollisol Order.

The erosion hazard for the soils within the vicinity of the proposed reservoir ranges from severe to low, with over 80% of the area being classified as having a moderate or low erosion potential. Precipitation runoff rates range from rapid to slow, with most of the area having a moderate to slow runoff rate. Average sediment yields in the vicinity of the proposed reservoir are estimated to be 73 tons per square mile per year. With a drainage area of about 5.5 square miles, there is an estimated sediment load of 400 tons per year at the proposed damsite. This drainage area excludes the area that drains into Fairview Lakes.

## 3.8.2 Methodology and Impact Indicators

Project effects on soils resources were determined by determining the number of acres of soils that would be disturbed by construction activities or project operation and by the amount of sediment entering Gooseberry Creek. These two items serve as impact indicators.

## 3.8.3 Predicted Effects

### 3.8.3.1 No Action Alternative

Under this alternative, soil erosion would continue at historical rates, with about 73 tons per square mile per year of sediment entering Gooseberry Creek. This would continue to generate a sediment load of about 400 tons per year at the proposed damsite. Soil disturbance due to construction would not occur, and soils within the study area would not be inundated.

### 3.8.3.2 Proposed Action Alternative

Under the Proposed Action, about 604 acres of land would be inundated by Narrows Reservoir. An additional 32.4 acres would be disturbed by construction of SR-264 relocation and recreation area. Development of a rockfill material source area outside of the reservoir basin would disturb another 2.0 acres. Earthfill material source areas would be developed within the reservoir basin, and contractor staging areas and tunnel spoil areas also would be located below the low water level of the reservoir basin.

The alignment of the proposed highway relocation crosses relatively gentle terrain, and cut and fill slopes would be minimal. All cut and fill slopes would be revegetated to minimize erosion. Roadways in the recreation area would be paved to minimize dust and soil erosion. Following construction, the rockfill material source area would be recontoured, topsoil would be replaced, and the area would be revegetated. Virtually all runoff from disturbed areas would flow into Narrows Reservoir that would act as a trap for all upstream sediment. The current sediment load in Gooseberry Creek downstream from the proposed Narrows Reservoir would be reduced by about 400 tons per year with construction of the Proposed Action. This sediment would accumulate in the reservoir.

The Upper Cottonwood Creek Pipeline would be constructed in a previously disturbed area along the shoulder of SR-31. Construction of the Oak Creek and East Bench Pipelines would disturb about 30 acres. As part of the construction process, the ground would be recontoured and revegetated with native plants to minimize erosion and to restore the natural appearance.

Mitigation for disturbances to soils under the Proposed Action would be accomplished by revegetating all cut and fill slopes to

minimize erosion. Roadways in the recreation area would be paved to minimize dust and soil erosion. Following construction, the rockfill material source area would be recontoured, topsoil would be replaced, and the area would be revegetated.

Residual impacts to soils under the Proposed Action would include inundating 604 acres by Narrows Reservoir and the 32.4 acres that would be covered by relocating SR-264.

#### 3.8.3.3 Mid-Sized Reservoir Alternative

Under the Mid-Sized Reservoir Alternative, about 489 acres of land would be inundated by Narrows Reservoir. The reservoir would reduce the sediment load to Gooseberry Creek by about 400 tons per year. Other impacts such as those caused by SR-264 relocation, pipeline construction, and development of material source areas would be the same as under the Proposed Action.

Mitigation for disturbances to soils under the Mid-Sized Reservoir Alternative would be similar to that proposed under the Proposed Action.

Residual impacts to soils under the Mid-Sized Reservoir Alternative would include inundating 489 acres by Narrows Reservoir and the 32.4 acres that would be covered by relocating SR-264.

#### 3.8.3.4 Small Reservoir Alternative

Under the Small Reservoir Alternative, about 362 acres of land would be inundated by Narrows Reservoir. The reservoir would reduce the sediment load to Gooseberry Creek by about 400 tons per year. Other impacts such as those caused by SR-264 relocation, pipeline construction, and development of material source areas would be the same as under the Proposed Action.

Mitigation for disturbances to soils under the Small Reservoir Alternative would be similar to that proposed under the Proposed Action.

Residual impacts to soils under the Small Reservoir Alternative would include inundating 362 acres by Narrows Reservoir and the 32.4 acres that would be covered by relocating SR-264.

## 3.9 TRACE ELEMENTS

### 3.9.1 Affected Environment

A trace element survey was conducted in accordance with current Reclamation practices to identify where concentrations of potentially toxic elements such as selenium, arsenic, and mercury likely would be to occur in irrigation return flows under project conditions. Accumulations of these substances can be harmful to humans and wildlife. A total of 11 soil samples, collected in 1990, were analyzed by the USGS. The results are shown in table 3-8 for arsenic, mercury, and selenium from three representative sites in the project area.

Study results indicate that all three elements analyzed are present in low to moderate concentrations; therefore, further testing for these elements was not considered necessary.

Data also were gathered from the National Geochemical Database that contained extensive information on soils in the vicinity of the survey area. Most of the data was from the National Uranium Resource Evaluation Surveys conducted from 1976–80. The primary objective of these surveys was to prospect for uranium; however, many other trace elements also were analyzed in the survey. Located in the vicinity of the survey area were 59 soil sampling sites from this. Almost all sites were in Quaternary alluvium.

**Table 3-8.—Narrows Project Trace Elements Data Summary Total Concentrations in Soil**

| Site and Sample Number | Arsenic (ppm)[1] | Mercury (ppm) | Selenium (ppm) |
|---|---|---|---|
| Upper Alluvial Fans Shallow Phase | | | |
| 1 | 6.4 | 0.02 | 0.2 |
| 2 | 7.6 | N0.02 | 0.2 |
| Alluvial Fans Moderate to Deep Phase | | | |
| 3 | 6.2 | 0.02 | 0.2 |
| 4 | 6.3 | 0.02 | 0.2 |
| 5 | 5.3 | N0.02 | 0.2 |
| 6 | 4.9 | N0.02 | 0.1 |
| Valley Fill Deep Phase | | | |
| 7 | 4.0 | N0.02 | 0.2 |
| 8 | 3.7 | 0.02 | 0.2 |
| 9 | 4.5 | N0.02 | 0.2 |
| 10 | 5.0 | N0.02 | <0.1 |
| 11 | 5.6 | N0.02 | <0.1 |
| Geometric Mean Concentration of 733 Western Soils[2] | 5.5 | 0.046 | 0.23 |
| Common Range in Western Soils[3] | 1.2–22.0 | 0.0085–0.25 | 0.039–1.4 |

[1] ppm = parts per million.
[2] Shacklette and Boerngen, USGS Paper 1270, 1984.
[3] Values chosen to represent an expected 95% range (Tidball and Ebens, 1976).

The data indicate that most trace elements are present in concentrations within the common range for western soils. Cobalt was the only element consistently present in concentrations outside the common range; however, the levels observed were trace amounts. Cobalt in nature at the levels observed in the National Uranium Resource Evaluation Survey for the area is considered a nutrient and nonhazardous. Limited water analysis data indicate cobalt was not detected in the San Pitch River.

Table 3-9 summarizes the number of soil samples with noteworthy concentrations of trace elements. Although these elements were found at elevated concentrations at scattered sites, it appears that none of the elements are present in concentrations of concern in the existing project return flows.

**Table 3-9.—Sanpete Valley Soil Samples with Uncommonly High Trace Element Concentrations**

| Element | Number of Samples | Number at Uncommonly High Concentration |
|---|---|---|
| Silver | 59 | [1]20 |
| Molybdenum | 59 | [2]23 |
| Uranium | 59 | [2]6 |
| Selenium | 59 | [2]5 |

[1] Used 1,000 parts per billion as threshold value.
[2] Exceeds the expected 95% range (Tidball and Ebens, 1976).

The data presented in table 3-10 indicate that trace elements are present in low concentrations in ground water in or near the proposed Narrows Project. A review of the STORET data for the San Pitch River indicated low concentrations of the same trace elements present in the surface water in the Narrows Unit.

The data presented in table 3-11, from the EPA STORET database, indicate that water quality of the San Pitch River in the project area is generally acceptable. The San Pitch River shows some improvement in water quality through the project area, possibly due to high quality inflows from the Manti-La Sal drainage.

Data gathered from the National Geochemical Database have been used as a baseline for concentrations of select trace elements in the soils and ground water within the project area. The impact indicator for this issue is measured by the increase in levels of select trace elements in ground water due to the construction and operation of the Narrows Project.

### 3.9.2 Methodology and Impact Indicators

Data gathered from the National Geochemical Database have been used as a baseline for concentrations of select trace elements in the soils and ground water within the project area. The impact indicator for this issue is measured by the increase in levels of select trace elements in ground water due to the construction and operation of the Narrows Project.

### 3.9.3 Predicted Effects

#### 3.9.3.1 No Action Alternative

An increase of potentially toxic trace elements is not expected under the No Action Alternative.

#### 3.9.3.2 Proposed Action Alternative

Lands in the project area have been irrigated for more than 50 years, and the results of the data gathered showed no significant quantities of trace or toxic elements in the ground water and in the San Pitch River; therefore, no increase of potentially toxic trace elements is anticipated under project conditions. There would be no residual impacts associated with potentially toxic trace elements under the Proposed Action.

#### 3.9.3.3 Mid-Sized Reservoir Alternative

No increase of potentially toxic trace elements is anticipated under implementation of the Mid-Sized Reservoir Alternative. There would be no residual impacts associated with potentially toxic trace elements under the Mid-Sized Reservoir Alternative.

#### 3.9.3.4 Small Reservoir Alternative

No increase of potentially toxic trace elements is anticipated under implementation of the Small Reservoir Alternative. There would be no residual impacts associated with potentially toxic trace elements under the Small Reservoir Alternative.

## 3.10 FISHERIES

### 3.10.1 Affected Environment

Most of the Narrows Project alternatives have the potential to affect aquatic resources in Gooseberry Creek, Fish Creek, three unnamed headwater tributaries to Gooseberry Creek, Cottonwood Creek, Lower Gooseberry Reservoir, Fairview Lakes, and Scofield Reservoir (see the location map). Cottonwood Creek is in the San Pitch River Basin, whereas all of the others are in the Price River drainage. Cottonwood Creek flows into the San Pitch River downstream

**Table 3-10.—Comparison of Ground Water in the Narrows Project with Selected Standards**

| Element | EPA Standards (micrograms per liter [µg/L]) | | | Ground Water Concentrations (µg/L) | | |
|---|---|---|---|---|---|---|
| | Drinking Water[1] | Aquatic Life[2] | Irrigation Water[3] | Number of Samples | Range | Mean |
| Aluminum | | 87 | 5,000 | | | |
| Arsenic | 50 | 190 | 100 | 2 | 1-2 | 1.5 |
| Barium | 1,000 | | | 2 | 80-100 | 90 |
| Beryllium | | 5.3 | 100 | | | |
| Boron | | | 750 | 23 | 20-450 | 112 |
| Cadmium | 10 | 1.1 | 10 | 2 | <1 | <1 |
| Chromium | 50 | 210 | 100 | 2 | <5 | <5 |
| Hex. Cr. | | 11 | | | | |
| Cobalt | | | 50 | | | |
| Copper | 1,000 | 12 | 200 | 2 | <20-29 | 24.5 |
| Cyanide | 200 | 5.2 | | | | |
| DBCP | 1 | | | | | |
| Fluoride | 1,400-2,400 | | | 28 | <100-2,700 | 382 |
| Iron | | | 5,000 | 12 | 3-190 | 27.6 |
| Lead | 50 | 3.2 | 5,000 | 2 | <5 | <5 |
| Lithium | | | 75 | 2 | <10-20 | 15 |
| Manganese | 50 | | 200 | 2 | <5-41 | 23 |
| Mercury | 2 | 0.012 | | 2 | <.0.5 | <0.5 |
| Molybdenum | | | 10 | | | |
| Nickel | | 96 | 200 | | | |
| Nitrate | 45,000 | | | 37 | 0-43,000 | 12,100 |
| Selenium | 10 | 5 | 20 | 9 | <1-5 | 2 |
| Silver | 50 | 0.12 | | 2 | <2 | <2 |
| Strontium | | | | 2 | 460-1,800 | 1,130 |
| Uranium[5] | 20 | [4]300 | | 12 | 1.1-23.6 | 5.3 |
| Vanadium | | | 100 | | | |
| Zinc | 5,000 | 47 | 2,000 | 2 | <20 | <20 |

[1] Primary or secondary standards.
[2] Freshwater criteria.
[3] Adapted from *Water Quality Criteria for Agriculture*, 1972.
[4] Canadian criteria.
[5] Data from National Geochemical Database.

**Table 3-11.—Water Quality Data for the San Pitch River[1]**

| STORET Station Location | EC at 25 °C | SAR | Soluble Cations, (meq/L) | | | | Soluble Anions (meq/L) | | | | Toxic Elements, (µg/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ca | Mg | Na | K | $CO_3$ | $HCO_3$ | $SO_4$ | Cl | Arsenic | Boron | Mercury | Selenium |
| Above Narrows Project | | | | | | | | | | | | | | |
| San Pitch River 1 mile west of Milburn | 1,300.8 | .025 | 11.41 | 4.36 | 0.70 | 0.10 | 0.03 | 5.36 | 10.93 | 0.24 | 1.70 | 121 | 0.06 | 0.38 |
| Cottonwood Creek 1.5 miles east of Fairview | 459.0 | .019 | 2.63 | 1.80 | 0.29 | 0.04 | 0.00 | 4.38 | 0.58 | 0.09 | 0.93 | 89 | 0.05 | 0.40 |
| Fountain Green Hatchery - east outflow | 426.0 | 1.00 | 1.70 | 1.48 | 1.26 | 0.03 | 0.00 | 4.36 | 0.10 | 0.14 | 1.00 | 50 | 0.10 | 1.00 |
| Fountain Green Hatchery - west outflow | 431.9 | 0.28 | 2.30 | 1.48 | 0.39 | 0.03 | 0.00 | 4.30 | 0.16 | 0.11 | 1.00 | 50 | 0.10 | 1.00 |
| Within Narrows Project | | | | | | | | | | | | | | |
| San Pitch River above Moroni Wastewater Treatment Plant outfall | 791.8 | 0.64 | 3.06 | 4.50 | 1.25 | 0.09 | 0.01 | 6.76 | 1.41 | 0.81 | 2.47 | 75 | 0.14 | 0.97 |
| San Pitch River 2.5 miles west of Mt. Pleasant | 771.4 | 0.56 | 3.33 | 4.23 | 1.09 | 0.08 | 0.00 | 6.72 | 1.47 | 0.54 | 3.09 | 155 | 0.14 | 1.32 |
| Just below Narrows Project | | | | | | | | | | | | | | |
| San Pitch River 1 mile west of Chester | 1,111.0 | 1.07 | 3.55 | 5.08 | 2.22 | 0.21 | 0.08 | 7.02 | 2.09 | 1.34 | 3.42 | 220 | 0.00 | 0.45 |
| Below Narrows Project | | | | | | | | | | | | | | |
| San Pitch River northwest of Manti | 1,272.0 | 2.28 | 4.28 | 8.31 | 5.71 | 0.13 | 0.00 | 8.12 | 6.15 | 2.20 | 5.00 | 260 | 0.07 | 1.00 |
| San Pitch River below Gunnison Reservoir | 1,630.8 | 2.46 | 2.61 | 10.26 | 6.23 | 0.14 | 0.28 | 9.26 | 6.17 | 3.86 | 6.00 | No data | 0.10 | 1.00 |
| San Pitch River at U-137 crossing | 2,591.3 | 6.78 | 4.26 | 6.85 | 15.99 | 0.14 | 0.07 | 6.87 | 5.73 | 11.59 | 5.54 | 349 | 0.15 | 1.07 |

[1] °C = degrees Celsius; SAR = specific absorption rate; meq/L = milliquivalent per liter.

from Fairview, Utah; but the San Pitch River, within the project area, does not support a sport fishery because of low summer flows.

Flows in Gooseberry Creek, its unnamed tributaries, and Cottonwood Creek presently are affected by the operation of Fairview Lakes that store water during spring runoff. Water from the lakes is delivered during the irrigation season via one of the unnamed tributary streams and a canal to the Narrows Tunnel that discharges into Cottonwood Creek. The released water then is diverted for irrigation in Sanpete County.

Lower Gooseberry Creek and Fish Creek, downstream from the confluence with Gooseberry Creek, also are affected by the operation and limited regulation offered by Fairview Lakes. If the project is approved, an operating agreement would have to be negotiated between SWCD and CGIC to regulate seasonal releases from Fairview Lakes in connection with downstream discharges from Narrows Reservoir.

Cutthroat trout (*Oncorhynchus clarkii*) exist within the streams potentially affected by the proposed project. Identification of these populations to the subspecies level is problematic. It is clear that various non-native subspecies of cutthroat trout as well as rainbow trout (*Oncorhynchus mykiss*), which interbreed with cutthroat trout, have been transplanted and stocked in these drainages in the past. Also, fish eradication activities have been carried out in the past. No genetic analysis has been attempted to determine the level of hybridization found in the current fish assemblages. Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*are) are endemic to Gooseberry Creek. Bonneville cutthroat trout (*Oncorhynchus clarki utah*) are endemic to Cottonwood Creek.

Cutthroat trout within the Gooseberry Drainage are predominantly Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*). The Bear Lake strain of Bonneville cutthroat trout (*Oncorhynchus clarki utah*) also have been transplanted into Schofield Reservoir. These fish spawn in Fish Creek and Gooseberry Creek and likely have hybridized with other subspecies present. Both Yellowstone and Bear Lake cutthroat trout are not native to these drainages.

Upper Cottonwood Creek does not support a self-sustaining trout population. Lower Cottonwood Creek may contain endemic Bonneville cutthroat trout; however, genetic analysis to determine the degree of hybridization within this population has not been done.

The existing Lower Gooseberry Reservoir acts as a fish barrier that helps to limit the occurrence of transbasin cross breeding between the populations.

Diseases may be spread between the basins within the project area. Currently, these drainages are not known to be infected with whirling disease.

The transbasin diversion has been functioning for decades, and any diseases or fish species present could have crossed the divide between the drainages in either direction numerous times in the past. The proposed project likely would not increase the occurrence of these events and may act as a barrier to these events.

Aquatic resources vary considerably between the different reservoirs and stream segments that could be affected by the Narrows Project. Fish habitat study reaches are shown in figure 3-10. A summary of aquatic resources present in the different stream segments and reservoirs is provided in the following sections of this document.

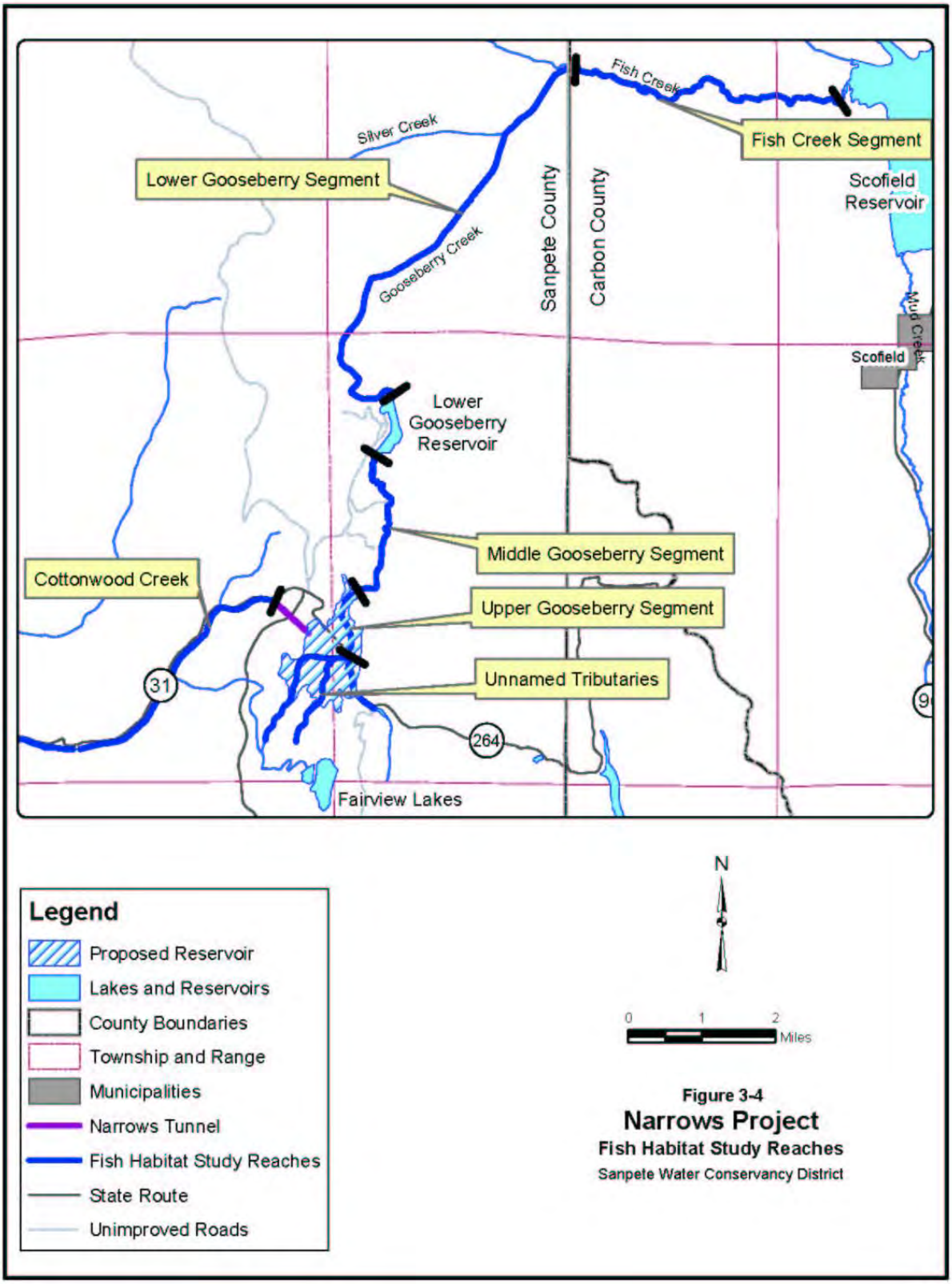



**Figure 3-10.— Narrows Project Fish Habitat Study Reaches.**

#### 3.10.1.1 Gooseberry Creek (UDWR Class 3B – Unique)

Class 3 streams support the bulk of the stream fishing in Utah. Gooseberry Creek provides important spawning, nursery, and unique habitat for cutthroat trout (*Oncorhynchus clarkii*). The entire length of Gooseberry Creek has the potential to be affected either by reservoir inundation or by flow alterations. Gooseberry Creek is a tributary to Scofield Reservoir. Other fish populations found in creeks tributary to Scofield Reservoir include rainbow trout (*Oncorhynchus mykiss*), tiger trout (*Salmo trutta X Salvelinus fontinalis*), redside shiner (*Richardsonius balteatus*), Utah chub (*Gila atraria*), and mountain sucker (*Catostomus platyrhynchus*). For ease of discussion, the stream has been divided conceptually into three segments—Upper Gooseberry Creek, Middle Gooseberry Creek, and Lower Gooseberry Creek.

The Upper Gooseberry Creek segment extends from the confluence of the three unnamed tributaries near SR-264 downstream 1 mile to Narrows Gorge and averages approximately 11 feet in width. Average monthly flows for average, wet, and dry years are shown in table 3-1. This stream segment supports a natural reproducing cutthroat trout population. The population is comprised of adult, juvenile, and young-of-year (YOY) fish. The standing crop of cutthroat trout in this stream segment averages about 38 pounds per acre. This stream segment contains numerous riffle areas that provide cutthroat trout spawning habitat. The value of this stream segment in providing yearling habitat is shown in population estimates of over 450 fish per mile (most were YOY) since 1971. The amount of weighted usable area (WUA)[1] for the various cutthroat trout life stages in this stream segment is shown in table 3-12.

**Table 3-12.—WUA for Cutthroat Life Stages in Upper Gooseberry Creek with Existing Flows**

| Month | Life Stage | Average Weighted Usable Area (1,000 units) |
|---|---|---|
| January | Adult | 8.4 |
| | Juvenile | 1.9 |
| February | Adult | 8.4 |
| | Juvenile | 1.9 |
| March | Adult | 8.7 |
| | Juvenile | 1.9 |
| April | Adult | 11.3 |
| | Juvenile | 3.3 |
| May | Adult | 11.7 |
| | Juvenile | 2.7 |
| | Spawning | 0.0 |
| June | Adult | 10.7 |
| | Juvenile | 2.5 |
| | Spawning | 0.0 |
| July | Adult | 13.2 |
| | Juvenile | 3.5 |
| | Spawning | 1.5 |
| August | Adult | 12.2 |
| | Juvenile | 3.7 |
| | Spawning | 1.3 |
| | Fry | 4.7 |
| September | Adult | 11.1 |
| | Juvenile | 3.0 |
| | Fry | 4.8 |
| October | Adult | 10.2 |
| | Juvenile | 2.0 |
| November | Adult | 8.9 |
| | Juvenile | 2.0 |
| December | Adult | 8.7 |
| | Juvenile | 1.9 |

As shown, this stream segment provides only extremely limited overwinter habitat for adult cutthroat trout. Major factors contributing to the poor habitat include low winter flows and limited pool habitat.

The Middle Gooseberry Creek segment is 3.0 miles in length and extends from the Narrows Gorge downstream to Lower Gooseberry Reservoir. The Middle Gooseberry Creek segment has more flow than the upper segment because of inflow from numerous springs and seeps within and

[1] The impact indicator used to determine effects on stream fisheries.

immediately downstream from Narrows Gorge. In addition, this stream segment receives flow from several tributary streams, including Brooks and Charlie Creeks. Average monthly flows that presently occur at the upper end of this stream segment are shown in table 3-1. This stream segment also supports a self-reproducing population of cutthroat trout.

Aquatic habitat studies have been conducted on this stream segment, and the total amount of WUA for the segment is provided in table 3-13. As shown, the amount of adult and juvenile cutthroat trout habitat available in this stream segment during September–March is extremely limited.

The Lower Gooseberry Creek segment is the longest of the three segments and extends downstream 7.1 miles from Lower Gooseberry Reservoir to the confluence with Fish Creek. Vehicle access to this segment is limited to two or three locations. As shown in table 3-2, flow in this segment is approximately double the flow of the upper and middle segment. The total WUA for cutthroat and rainbow trout for the segment is provided in tables 3-13 and 3-14, respectively. As shown, spawning habitat for cutthroat trout currently is limited in this stream segment. Although the amount of spawning habitat appears to be low, it is not a limiting factor since YOY cutthroat trout have been plentiful whenever UDWR sampled the fish population. The amount of adult and juvenile cutthroat trout habitat is less during September–March than the amount of habitat available during April–August. Past fish population studies conducted by UDWR indicate that the cutthroat trout standing crop normally ranges from 40–50 pounds per acre and that the stream segment supports a fair cutthroat population. Since 1971, cutthroat trout numbers have ranged from about 400–750 fish per mile. Sampling prior to 1991 did not indicate the presence of rainbow trout; however, sampling of the stream prior to eradicating undesirable fish species in Scofield Reservoir resulted in the collection of adult and juvenile rainbow trout.

#### 3.10.1.2 Fish Creek (UDWR Class 2 - Unique)

Class 2 waters are of great importance to the State fishery. These are productive streams with high aesthetic value and, according to UDWR policy, should be preserved. This segment of Fish Creek extends 6 miles from the confluence of Gooseberry Creek downstream to Scofield Reservoir. In addition to being a self-reproducing cutthroat trout population, this stream segment also is used as a spawning and rearing area by rainbow trout that migrate upstream of Scofield Reservoir (a limited number of adult rainbow trout remain in the stream). Therefore, this stream segment provides habitat for adult, juvenile, spawning, and fry life stages of both cutthroat trout and rainbow trout.

As shown in table 3-1, flow in this segment of Fish Creek is considerably greater than the flow of Gooseberry Creek. The amount of rainbow and cutthroat trout WUA in the segment is provided in tables 3-15 and 3-16, respectively. As shown in table 3-16, the existing flow regime provides only limited spawning habitat for cutthroat trout during 2 of the 4 months that spawning habitat is used. Population data indicate fair numbers of all cutthroat trout life stages in this segment of Fish Creek.

As shown in table 3-15, this segment of Fish Creek also supplies a desirable habitat for rainbow trout. The amount of habitat for juvenile fish remains fairly uniform, with the lowest amount of habitat available during the low flow months (October–March). Fish population surveys have shown a wide range in standing crop estimates (3.5–105.7 pounds per acre); and overall, the estimates have averaged almost

**Table 3-13.—Monthly Preproject and Postproject Cutthroat Trout Habitat In Middle and Lower Gooseberry Creek During Average Water Year[1]**

| | | Middle Gooseberry Creek | | | Lower Gooseberry Creek | | |
|---|---|---|---|---|---|---|---|
| Month | Life Stage | Preproject | Postproject | Change (%) | Preproject | Postproject | Change (%) |
| January | Adult | 62.9 | 57.6 | 8.4 | 355.4 | 344.7 | -3.0 |
| | Juvenile | 18.0 | 16.7 | 7.2 | 61.6 | 60.9 | -1.1 |
| February | Adult | 62.9 | 57.6 | -8.4 | 359.0 | 348.5 | -2.9 |
| | Juvenile | 18.0 | 16.7 | -7.2 | 63.0 | 61.1 | -3.0 |
| March | Adult | 64.7 | 57.6 | -11.0 | 359.0 | 344.7 | -4.0 |
| | Juvenile | 18.3 | 16.7 | -8.7 | 62.6 | 60.9 | -2.7 |
| April | Adult | 106.2 | 57.6 | -45.8 | 404.9 | 393.1 | -2.9 |
| | Juvenile | 30.1 | 16.7 | -44.5 | 73.2 | 68.7 | -6.1 |
| May | Adult | 205.8 | 57.6 | -72.0 | 562.1 | 548.3 | -2.5 |
| | Juvenile | 91.0 | 16.7 | -81.6 | 75.0 | 56.0 | -25.3 |
| | Spawning | 1.5 | 0.1 | -93.3 | 0.0 | 0.0 | - |
| June | Adult | 202.6 | 57.6 | -71.6 | 553.2 | 548.1 | -0.9 |
| | Juvenile | 88.7 | 16.7 | -81.2 | 79.6 | 56.1 | -29.5 |
| | Spawning | 0.4 | 0.1 | -75.0 | 0.0 | 0.0 | - |
| July | Adult | 144.4 | 57.6 | -60.1 | 430.6 | 405.3 | -5.9 |
| | Juvenile | 42.7 | 16.7 | -60.9 | 71.3 | 73.4 | +2.9 |
| | Spawning | 0.9 | 0.1 | -88.9 | 0.0 | 0.0 | - |
| August | Adult | 127.4 | 57.6 | -54.8 | 413.9 | 398.7 | -3.7 |
| | Juvenile | 36.6 | 16.7 | -54.4 | 73.0 | 70.4 | -3.6 |
| | Spawning | 2.8 | 0.1 | -96.4 | 0.0 | 0.0 | - |
| | Fry | 57.3 | 28.1 | -51.0 | 65.3 | 73.1 | +11.9 |
| September | Adult | 100.2 | 57.6 | -42.5 | 397.3 | 355.4 | -10.5 |
| | Juvenile | 28.4 | 16.7 | -41.2 | 69.8 | 61.6 | -11.7 |
| | Fry | 44.5 | 28.1 | -36.9 | 73.6 | 67.1 | -8.8 |
| October | Adult | 75.4 | 57.6 | -23.6 | 362.2 | 327.4 | -9.6 |
| | Juvenile | 20.9 | 16.7 | -20.1 | 63.2 | 58.0 | -8.2 |
| November | Adult | 66.4 | 57.6 | -13.3 | 341.5 | 323.9 | -5.2 |
| | Juvenile | 18.8 | 16.7 | -11.2 | 60.0 | 57.5 | -4.2 |
| December | Adult | 64.7 | 57.6 | -11.0 | 348.5 | 330.9 | -5.1 |
| | Juvenile | 18.3 | 16.7 | -8.7 | 61.1 | 58.5 | -4.3 |

[1] The amount of WUA is expressed in 1,000 units. Average water year is defined as 1968 flows.

**Table 3-14.—Monthly Preproject and Postproject Rainbow Trout Habitat in Lower Gooseberry Creek During Average Water Year[1]**

| Month | Life Stage | Preproject | Postproject | Change (%) |
|---|---|---|---|---|
| January | Adult | 44.1 | 43.2 | -2.0 |
| | Juvenile | 21.0 | 21.0 | 0.0 |
| February | Adult | 44.5 | 43.5 | -2.2 |
| | Juvenile | 21.1 | 21.0 | -0.5 |
| March | Adult | 44.5 | 43.2 | -2.9 |
| | Juvenile | 21.1 | 21.0 | -0.5 |
| April | Adult | 65.6 | 50.0 | -23.8 |
| | Juvenile | 29.4 | 22.3 | -24.1 |
| May | Adult | 142.1 | 133.0 | -6.4 |
| | Juvenile | 49.7 | 51.9 | +4.4 |
| | Spawning | 0.0 | 0.0 | - |
| June | Adult | 141.9 | 132.9 | -6.3 |
| | Juvenile | 47.8 | 51.9 | +8.6 |
| | Spawning | 0.3 | 0.0 | -100.0 |
| July | Adult | 87.0 | 66.3 | -23.8 |
| | Juvenile | 35.1 | 29.7 | -15.4 |
| | Spawning | 0.0 | 0.0 | - |
| August | Adult | 79.4 | 56.3 | -29.1 |
| | Juvenile | 35.3 | 25.2 | -28.6 |
| | Spawning | 0.1 | 0.0 | -100.0 |
| | Fry | 62.6 | 51.8 | -17.3 |
| September | Adult | 54.4 | 44.2 | -18.8 |
| | Juvenile | 24.3 | 21.0 | -13.6 |
| | Fry | 49.7 | 48.8 | -1.8 |
| October | Adult | 44.8 | 41.7 | -6.9 |
| | Juvenile | 21.1 | 20.9 | -0.9 |
| November | Adult | 42.9 | 41.4 | -3.5 |
| | Juvenile | 21.0 | 20.9 | -0.5 |
| December | Adult | 43.5 | 42.0 | -3.4 |
| | Juvenile | 21.0 | 20.9 | -0.5 |

[1] The amount of WUA is expressed in 1,000 units.

**Table 3-15.—Monthly Preproject and Postproject Rainbow Trout Habitat in Fish Creek During Average Water Year[1]**

| Month | Life Stage | Preproject | Postproject | Change (%) |
|---|---|---|---|---|
| January | Juvenile | 170.7 | 171.0 | +0.2 |
| February | Juvenile | 173.1 | 171.5 | -0.9 |
| March | Juvenile | 187.2 | 185.0 | -1.1 |
| April | Juvenile | 203.1 | 198.4 | -2.3 |
| May | Juvenile | 239.5 | 239.6 | <0.1 |
| | Spawning | 45.9 | 44.9 | -2.2 |
| June | Juvenile | 240.2 | 238.8 | -0.6 |
| | Spawning | 48.4 | 36.9 | -23.8 |
| July | Juvenile | 224.0 | 219.5 | -2.0 |
| | Spawning | 23.6 | 18.2 | -22.9 |
| August | Juvenile | 202.6 | 197.9 | -2.3 |
| | Spawning | 11.0 | 8.2 | -25.5 |
| | Fry | 226.4 | 223.1 | -1.5 |
| September | Juvenile | 183.7 | 179.0 | -2.6 |
| | Fry | 219.0 | 214.9 | -1.9 |
| October | Juvenile | 172.7 | 170.5 | -1.3 |
| November | Juvenile | 171.1 | 170.8 | -0.2 |
| December | Juvenile | 171.0 | 171.6 | +0.4 |

[1] The amount of WUA is expressed in 1,000 units. Average water year is defined as 1968 flows.

**Table 3-16.—Monthly Preproject and Postproject Yellowstone Cutthroat Trout Habitat in Fish Creek During Average Water Year[1]**

| Month | Life Stage | Preproject | Postproject | Change (%) |
|---|---|---|---|---|
| January | Adult | 362.7 | 363.0 | +0.1 |
| | Juvenile | 85.3 | 85.5 | +0.2 |
| February | Adult | 370.4 | 365.7 | -1.3 |
| | Juvenile | 85.8 | 85.3 | -0.6 |
| March | Adult | 414.2 | 406.6 | -1.8 |
| | Juvenile | 88.3 | 88.3 | 0.0 |
| April | Adult | 476.9 | 456.1 | -4.4 |
| | Juvenile | 87.5 | 87.8 | +0.3 |
| May | Adult | 666.4 | 694.6 | +4.2 |
| | Juvenile | 226.7 | 235.4 | +3.8 |
| | Spawning | 0.8 | 6.0 | +650.0 |
| June | Adult | 680.8 | 714.1 | +5.0 |
| | Juvenile | 231.2 | 229.4 | -0.7 |
| | Spawning | 1.7 | 21.8 | +1,182.4 |
| July | Adult | 603.4 | 575.2 | -4.7 |
| | Juvenile | 91.3 | 88.3 | -3.3 |
| | Spawning | 39.8 | 27.3 | -31.4 |
| August | Adult | 489.6 | 454.1 | -7.3 |
| | Juvenile | 87.4 | 87.8 | +0.5 |
| | Spawning | 17.8 | 14.2 | -20.2 |
| | Fry | 88.6 | 84.2 | -5.0 |
| September | Adult | 415.2 | 387.8 | -6.6 |
| | Juvenile | 88.2 | 87.6 | -0.7 |
| | Fry | 82.2 | 81.3 | -1.1 |
| October | Adult | 369.2 | 362.5 | -1.8 |
| | Juvenile | 86.0 | 85.2 | -0.9 |
| November | Adult | 364.5 | 362.8 | -0.5 |
| | Juvenile | 82.1 | 85.3 | +3.9 |
| December | Adult | 363.1 | 363.9 | +0.2 |
| | Juvenile | 85.5 | 85.9 | +0.5 |

[1] The amount of WUA is expressed in 1,000 units. Average water year is defined as 1968 flows.

50 pounds of trout per acre. This level of fish biomass indicates that this segment of Fish Creek supports a good trout population. Fish population surveys conducted over 35 years have reported as few as 40 to as many as 4,000 fish per mile. Movement of spawners into the stream from Scofield Reservoir contributes to large increases in numbers and biomass in this stream segment.

#### 3.10.1.3 Gooseberry Creek Tributaries

Three headwater tributaries join to form Gooseberry Creek. Together, these three tributaries contain 7.5 stream miles. The three streams average approximately 4 feet in width. During late summer and early fall flow, major portions of the streams have little or no flow. The flowing reaches are used extensively by cutthroat trout for spawning and rearing of YOY fish. The standing crop of cutthroat trout in these tributary streams averages approximately 86 pounds per acre. Most of the trout are YOY or yearling fish, and fish numbers have averaged over 300 fish per mile. Even though the streams are small, the standing crop indicates their high value for cutthroat trout spawning and rearing habitat.

#### 3.10.1.4 Cottonwood Creek (UDWR Class 3)

At the present time, Upper Cottonwood Creek does not support a self-sustaining trout population because of low and intermittent flows during much of the year (table 3-2). During the spring runoff and irrigation season, the upper segment contains adequate water for fish, and UDWR maintains a rainbow trout fishery during that period by stocking catchable-size fish. Brown trout (*Salmo trutta*), cutthroat trout, and mottled sculpin (*Cottus bairdii*) also exist in this creek.

As shown in table 3-1, flows in the lower portion of Cottonwood Creek are considerably greater than in the upper segment. Sampling conducted by UDWR in 1988 indicated that the lower segment of Cottonwood Creek supports excellent brown and cutthroat trout populations (approximately 210 pounds per acre). The amount of WUA for rainbow, cutthroat, and brown trout in Cottonwood Creek is provided in tables 3-17 through 3-19, respectively. As indicated in the tables, the amount of spawning habitat for all three species is limited.

#### 3.10.1.5 Lower Gooseberry Reservoir

Lower Gooseberry Reservoir is an old reservoir that was created by placing a rock dam across Gooseberry Creek and is a popular fishing area. In 1990, the USDA Forest Service upgraded the dam to meet appropriate dam safety criteria.

This approximately 57-acre surface area reservoir is managed as a catchable rainbow trout fishery and also supports a resident cutthroat trout population. A creel survey conducted in 1993 determined that, of the trout harvested from the lake, 3% were cutthroat trout and 97% were rainbow trout. During that year, it was estimated that the lake received over 25,000 hours of fishing pressure from which 9,300 trout were harvested. Two gill nets set in the lake in 1991 collected 104 cutthroat trout ranging from approximately 6.5–15.5 inches long.

A large portion (30–40%) of the reservoir has a water depth of less than 3 feet. Areas with shallow water encourage the growth of phytoplankton and aquatic macrophytes, which can contribute to low DO levels. Lower Gooseberry Reservoir has a history of fishkills attributed to low DO concentration. Generally, the reported fishkills have been confined to the lower portion of the reservoir near the dam where water exchange is the least.

**Table 3-17.—Monthly Preproject and Postproject Rainbow Trout Habitat in Cottonwood Creek During Average Water Year[1]**

| Month | Life Stage | Pre Q | Preproject | Post Q | Postproject | Change (%) |
|---|---|---|---|---|---|---|
| January | Adult | 0.98 | 1,832 | 2.98 | 2,910 | +58.9 |
| | Juvenile | 0.98 | 1,456 | 2.98 | 1,928 | +32.4 |
| February | Adult | 1.12 | 1,926 | 3.12 | 2,960 | +53.7 |
| | Juvenile | 1.12 | 1,509 | 3.12 | 1,943 | +28.7 |
| March | Adult | 1.4 | 2,106 | 3.4 | 3,056 | +45.1 |
| | Juvenile | 1.4 | 1,609 | 3.4 | 1,971 | +22.5 |
| April | Adult | 2.59 | 2,728 | 2.59 | 2,728 | +0.0 |
| | Juvenile | 2.59 | 1,864 | 2.59 | 1,864 | +0.0 |
| May | Adult | 31.56 | 4,254 | 31.56 | 4,254 | +0.0 |
| | Juvenile | 31.56 | 2,093 | 31.56 | 2,093 | +0.0 |
| | Spawning | 31.56 | 204 | 31.56 | 204 | +0.0 |
| June | Adult | 33.59 | 4,202 | 33.89 | 4,195 | -0.2 |
| | Juvenile | 33.59 | 2,079 | 33.89 | 2,077 | -0.1 |
| | Spawning | 33.59 | 206 | 33.89 | 206 | +0.1 |
| July | Adult | 17.57 | 4,481 | 48.17 | 4,158 | -7.2 |
| | Juvenile | 17.57 | 2,167 | 48.17 | 1,953 | -9.9 |
| | Spawning | 17.57 | 180 | 48.17 | 210 | +16.6 |
| August | Adult | 15.12 | 4,448 | 45.25 | 4,141 | -6.9 |
| | Juvenile | 15.12 | 2,172 | 45.25 | 1,977 | -9.0 |
| | Spawning | 15.12 | 171 | 45.25 | 209 | +21.9 |
| | Fry | 15.12 | 2,822 | 45.25 | 2,034 | -27.9 |
| September | Adult | 2.79 | 2,821 | 18.56 | 4,473 | +58.5 |
| | Juvenile | 2.79 | 1,897 | 18.56 | 2,164 | +14.1 |
| | Fry | 2.79 | 2,915 | 18.56 | 2,761 | -5.3 |
| October | Adult | 0.91 | 1,774 | 2.91 | 2,877 | +62.2 |
| | Juvenile | 0.91 | 1,418 | 2.91 | 1,916 | +35.1 |
| November | Adult | 1.12 | 1,926 | 3.12 | 2,960 | +53.7 |
| | Juvenile | 1.12 | 1,509 | 3.12 | 1,943 | +28.7 |
| December | Adult | 0.98 | 1,832 | 2.98 | 2,910 | +58.9 |
| | Juvenile | 0.98 | 1,456 | 2.98 | 1,928 | +32.4 |

[1] WUA (square feet per 1,000 feet). Average water year is defined as 1968 flows.

**Table 3-18.—Monthly Preproject and Postproject Cutthroat Trout Habitat in Cottonwood Creek During Average Water Year[1]**

| Month | Life Stage | Pre Q | Preproject | Post Q | Postproject | Change (%) |
|---|---|---|---|---|---|---|
| January | Adult | 0.98 | 3,053 | 2.98 | 4,544 | +48.9 |
| | Juvenile | 0.98 | 1,392 | 2.98 | 1,504 | +8.0 |
| February | Adult | 1.12 | 3,183 | 3.12 | 4,627 | +45.3 |
| | Juvenile | 1.12 | 1,431 | 3.12 | 1,494 | +4.4 |
| March | Adult | 1.4 | 3,430 | 3.4 | 4,788 | +39.6 |
| | Juvenile | 1.4 | 1,496 | 3.4 | 1,475 | -1.4 |
| April | Adult | 2.59 | 4,289 | 2.59 | 4,289 | +0.0 |
| | Juvenile | 2.59 | 1,521 | 2.59 | 1,521 | +0.0 |
| May | Adult | 31.56 | 7,642 | 31.56 | 7,642 | +0.0 |
| | Juvenile | 31.56 | 1,236 | 31.56 | 1,236 | +0.0 |
| | Spawning | 31.56 | 218 | 31.56 | 218 | +0.0 |
| June | Adult | 33.59 | 7,579 | 33.89 | 7,570 | -0.1 |
| | Juvenile | 33.59 | 1,212 | 33.89 | 1,209 | -0.3 |
| | Spawning | 33.59 | 198 | 33.89 | 195 | -1.5 |
| July | Adult | 17.57 | 7,712 | 48.17 | 7,219 | -6.4 |
| | Juvenile | 17.57 | 1,369 | 48.17 | 1,078 | -21.2 |
| | Spawning | 17.57 | 364 | 48.17 | 133 | -63.6 |
| August | Adult | 15.12 | 7,584 | 45.25 | 7,276 | -4.1 |
| | Juvenile | 15.12 | 1,356 | 45.25 | 1,103 | -18.7 |
| | Spawning | 15.12 | 393 | 45.25 | 144 | -63.5 |
| | Fry | 15.12 | 1,827 | 45.25 | 1,345 | -26.4 |
| September | Adult | 2.79 | 4,420 | 18.56 | 7,736 | +75.0 |
| | Juvenile | 2.79 | 1,512 | 18.56 | 1,368 | -9.5 |
| | Fry | 2.79 | 1,817 | 18.56 | 1,793 | -1.3 |
| October | Adult | 0.91 | 2,965 | 2.91 | 4,498 | +51.7 |
| | Juvenile | 0.91 | 1,351 | 2.91 | 1,507 | +11.6 |
| November | Adult | 1.12 | 3,183 | 3.12 | 4,627 | +45.3 |
| | Juvenile | 1.12 | 1,431 | 3.12 | 1,494 | +4.4 |
| December | Adult | 0.98 | 3,053 | 2.98 | 4,544 | +48.9 |
| | Juvenile | 0.98 | 1,392 | 2.98 | 1,504 | +8.0 |

[1] WUA (square feet per 1,000 feet). Average water year is defined as 1968 flows.

**Table 3-19.—Monthly Preproject and Postproject Brown Trout Habitat in Cottonwood Creek During Average Water Year[1]**

| Month | Life Stage | Pre Q | Preproject | Post Q | Postproject | Change (%) |
|---|---|---|---|---|---|---|
| January | Adult | 0.98 | 835 | 2.98 | 1,448 | +73.4 |
| | Juvenile | 0.98 | 1,071 | 3.0 | 1,669 | +55.8 |
| | Spawning | 0.98 | 22 | 3.0 | 97 | +349.3 |
| | Fry | 0.98 | 263 | 3.0 | 559 | +112.5 |
| February | Adult | 1.12 | 899 | 3.1 | 1,472 | +63.8 |
| | Juvenile | 1.12 | 1,128 | 3.1 | 1,700 | +50.6 |
| | Fry | 1.12 | 291 | 3.1 | 572 | +96.6 |
| March | Adult | 1.4 | 1,021 | 3.4 | 1,518 | +48.6 |
| | Juvenile | 1.4 | 1,238 | 3.4 | 1,761 | +42.2 |
| | Fry | 1.4 | 345 | 3.4 | 597 | +73.0 |
| April | Adult | 2.59 | 1,361 | 2.6 | 1,361 | +0.0 |
| | Juvenile | 2.59 | 1,577 | 2.6 | 1,577 | +0.0 |
| | Fry | 2.59 | 514 | 2.6 | 514 | +0.0 |
| May | Adult | 31.56 | 2,324 | 31.6 | 2,324 | +0.0 |
| | Juvenile | 31.56 | 2,690 | 31.6 | 2,690 | +0.0 |
| | Spawning | 33.59 | 2,327 | 33.9 | 2,328 | +0.0 |
| June | Adult | 33.59 | 2,327 | 33.9 | 2,328 | +0.0 |
| | Juvenile | 33.59 | 2,700 | 33.9 | 2,702 | +0.1 |
| July | Adult | 17.57 | 2,232 | 48.2 | 2,280 | +2.1 |
| | Juvenile | 17.57 | 2,576 | 48.2 | 2,736 | +6.2 |
| August | Adult | 15.12 | 2,179 | 45.3 | 2,292 | +5.2 |
| | Juvenile | 15.12 | 2,539 | 45.3 | 2,736 | +7.7 |
| September | Adult | 2.79 | 1,406 | 18.6 | 2,248 | +59.9 |
| | Juvenile | 2.79 | 1,624 | 18.6 | 2,589 | +59.4 |
| October | Adult | 0.91 | 795 | 2.9 | 1,432 | +80.2 |
| | Juvenile | 0.91 | 1,035 | 2.9 | 1,652 | +59.7 |
| | Spawning | 0.91 | 19 | 2.9 | 93 | +404.4 |
| November | Adult | 31.56 | 899 | 3.1 | 1,472 | +63.8 |
| | Juvenile | 1.12 | 1,128 | 3.1 | 1,700 | +50.6 |
| | Spawning | 1.12 | 12 | 3.1 | 89 | +635.9 |
| December | Adult | 1.12 | 835 | 3.0 | 1,448 | +73.4 |
| | Juvenile | 0.98 | 1,071 | 3.0 | 1,669 | +55.8 |
| | Spawning | 0.98 | 22 | 3.0 | 97 | +349.3 |

[1] WUA (square feet per 1,000 feet). Average water year is defined as 1968 flows.

When the USDA Forest Service upgraded the dam, a new outlet structure was constructed so that water could be released from near the bottom of the reservoir. Release of water from near the bottom has improved the DO levels in the lower portions of the reservoir.

#### 3.10.1.6 Fairview Lakes

Fairview Lakes are owned and operated by the Cottonwood-Gooseberry Irrigation Company. The lakes are managed as a catchable rainbow trout put-grow-and-take fishery by UDWR with over 9,000 catchable rainbow trout stocked annually. In 2005, the average rainbow stocked was 11 inches in length and grew 3 inches in 4 months. The stocking usually occurs in early June, and approximately 8,700 of the stocked trout are harvested. Approximately 13,000 hours of fishing pressure occurs annually on Fairview Lakes. Due to the low level of the lakes during the winter period, winter survival of the stocked rainbow trout normally does not occur. Even though Fairview Lakes are located adjacent to the project, they would not be directly affected. However, they could be affected by changes in fisherman usage, changes in UDWR fishery management programs, and possible mitigation measures.

#### 3.10.1.7 Scofield Reservoir

Scofield Reservoir supports a good sport fishery consisting of cutthroat trout (natural reproduction and stocking), rainbow trout (natural reproduction and stocking), and, recently, tiger trout (stocking). Other fish species present in the reservoir include: redside shiner, Utah chub, mountain sucker, brown trout and common carp (*Cyprinus carpio*). Historically, UDWR has stocked up to 600,000 rainbow trout into Scofield Reservoir every year. Stocking quotas typically have included 450,000 rainbow trout fingerlings and 100,000 rainbow trout subcatchables. In the past, Yellowstone and Bear Lake cutthroat trout also were stocked. Hybridization of cutthroat trout with rainbow trout is common. In 2005, tiger trout were stocked for the first time; and beginning in 2008, rainbow trout fingerlings were no longer stocked. The fingerling rainbow trout were replaced with an increase in the number of subcatchable rainbow trout stocked. Based on a 1986 creel survey, an estimated 250,000 trout (both cutthroat and rainbow) were harvested from the lake, with about 347,000 hours of fishing pressure. At 4.27 hours per angler-day, this equates to 81,241 angler days or 30 angler days per surface acre. Subsequent creel surveys in 2005 and 2007 show a considerable reduction of 67% in fishing hours, which is typical of reduction in creel survey results statewide in the last 20 years. Scofield Reservoir consistently has excellent catch rates. This fishery resource represents a significant economic resource to the local area and is considered to be the third best flat water fishery in the State.

In the past, the reservoir has experienced periodic fishkills, usually late summer or fall. In 1991, a fish management program eradicated undesirable fish species.

Scofield Reservoir and the Price River between the Highway 6 Bridge and Scofield Dam are Blue Ribbon Fisheries. Under the proposed project, Scofield Reservoir would be operated within normal ranges. Peak flows may be reduced in some years. Riparian and aquatic habitats and animals dependant on these habitats, including fish, would not be significantly affected by these changes.

## 3.10.2 Methodology and Impact Indicators

A team, comprised of representatives from SWCD, Reclamation, UDWR, and the USDA Forest Service, was assembled to analyze the impact to stream fisheries and develop mitigation recommendations. Potential effects that were included in the evaluation are: stream habitat loss associated with reservoir inundation, effects of project-induced flow changes on aquatic habitat (both beneficial and adverse), and project effects on reservoir angler-days.

Available stream habitat under baseline and project alternative conditions was evaluated by instream flow incremental methodology modeling (U.S. Fish and Wildlife Service 1994). In performing this analysis, extensive field data is collected, including hydrologic data such as velocity and depth of flow over a wide range of discharge conditions, substrate conditions, and vegetation along the banks. Habitat Suitability Indices (HSI) curves then are applied for each fish species that occurs in the area. This data is used to estimate the amount of available habitat measured as WUA. WUA is the impact indicator used to determine effects on stream fisheries.

For the analysis shown in this document, data for the instream flow incremental methodology (IFIM) modeling in Cottonwood Creek was collected during low flow conditions only (Addley 1997). Additional data will be collected during the snowmelt runoff to verify the accuracy of the hydrologic model under high flow conditions. The impact indicator for stream fisheries is the percent change in weightable usable area as measured by IFIM for the various life stages.

Impacts on reservoir fisheries are based on the average reservoir surface area. The impact indicator on reservoir fisheries is the change in surface area in Scofield Reservoir.

## 3.10.3 Predicted Effects

### 3.10.3.1 No Action Alternative

Under the No Action Alternative, project-induced changes to existing conditions would not occur. The three tributaries to Gooseberry Creek in the proposed Narrows Reservoir basin would continue to provide spawning habitat for cutthroat trout to the same extent as at present. The 1.0 mile of Upper Gooseberry Creek would continue to provide habitat for all life stages of cutthroat trout, and habitat for cutthroat and rainbow trout in Gooseberry Creek and Fish Creek would remain as listed in tables 3-12 through 3-14. Habitat for cutthroat, rainbow, and brown trout in Cottonwood Creek would remain as listed in tables 3-17 through 3-19.

Fishing conditions at Lower Gooseberry Reservoir and Fairview Lakes would remain the same as at present. Lower Gooseberry Reservoir would continue to experience occasional fishkills during winter months. Fairview Lakes probably would continue to be managed as at present with annual stocking and no overwintering of fish due to low reservoir levels. Scofield Reservoir would continue to have an average of 2,375 acres of surface area.

### 3.10.3.2 Proposed Action Alternative

The State Engineer stipulates that a minimum of 1.0 cfs is to be released downstream from the proposed Narrows Dam; and, if the flow is not 1.5 cfs at the Gooseberry Campground ⅛ mile downstream from the proposed damsite, SWCD is required to release 1.25 cfs from the dam. It also is stipulated that the dam be constructed by SWCD with a

multiple-level outlet to regulate water temperature for the trout located downstream from the dam.

The proposed project would cause flow reductions in Gooseberry and Fish Creeks as shown in table 3-1. Flows in Middle Gooseberry Creek immediately downstream from the proposed dam would be expected to be reduced, on average, by 74%; whereas, flows downstream from Lower Gooseberry Reservoir would be expected to be reduced by 43%. In Fish Creek, flows would be expected to be reduced approximately 15%.

The 5,400-acre-foot diversion of project water into Cottonwood Creek would cause about a 200% increase in the base summer flow in Upper Cottonwood Creek (table 3-1). As shown, the base summer flows in Lower Cottonwood Creek would be increased by about 160%. However, the increased flows would occur only during the July-to-October period and not during the peak runoff or the low flow months (November–April). Additionally, these base summer flows would be less than the peak flows that currently shape the stream channel. Therefore, the stream channel itself would remain stable.

Providing a 2.0-cfs winter release through the Narrows Tunnel is expected to greatly increase the WUA for all fish species in Cottonwood Creek. This increased flow particularly would benefit the upper reaches of the creek and would be expected to facilitate the overwintering of fish.

The length of time required initially to fill Narrows Reservoir would, of course, depend on hydrologic conditions in the basin. During wet years, the reservoir could fill during a single spring runoff. For more normal conditions, if no diversions were made to Cottonwood Creek until the reservoir filled, it probably would fill in 2 years—almost certainly within 3 years. Under dry conditions, if diversions to Cottonwood Creek did occur during the filling period, it could take 5–15 years to fill Narrows Reservoir. Due to these hydrologic uncertainties, there is no firm filling schedule for the reservoir.

#### *3.10.3.2.1 Reservoir Inundation Effects*

At maximum storage, the proposed Narrows Reservoir would inundate about 1 mile of Upper Gooseberry Creek and approximately 4.3 miles of the three headwater tributaries with permanent flows that join to form Gooseberry Creek.

Based on the stream habitat that would be inundated by the proposed reservoir, it is expected that 1.3 and 2.1 acres of stream-based aquatic habitat would be lost in Gooseberry Creek and the tributaries, respectively. Using the standing crop estimates, approximately 230 pounds of stream-based cutthroat trout would be lost, of which 22% would occur in Gooseberry Creek and 78% would occur in the tributary streams, although the trout biomass probably would be converted into a flat water equivalent.

#### *3.10.3.2.2 Flow Alteration Effects*

**3.10.3.2.2.1 Upper Gooseberry Creek Segment.—**The upper reach of Gooseberry Creek above the proposed reservoir currently suffers from the lack of flows, particularly during the late summer and early fall. Under the proposed action, flows would be augmented during these periods to improve fish habitat.

**3.10.3.2.2.2 Middle Gooseberry Creek Segment.—**As shown in table 3-1, preproject average monthly flows in this stream segment range from 1.3–61.8 cfs and average 11.2 cfs. The expected 1-cfs postproject flow represents a 74% reduction in annual flow in this stream segment. As described above, this segment of Gooseberry Creek supports all life stages of cutthroat trout. Adult and juvenile

cutthroat trout use the aquatic habitat throughout the year, while cutthroat trout spawning habitat (including incubation) is used during May, June, July, and August, and fry are present in August and September. Table 3-13 shows the cutthroat trout habitat available on a monthly basis for the four life stages under preproject and postproject flow regime. Adult and juvenile cutthroat trout habitat is limited during the existing low flow period, which in an average year extends from October–March. Even though more habitat may occur during the high flow months, the overall trout population would be expected to be controlled by available habitat during this 6-month period. As shown in table 3-4, adult and juvenile cutthroat trout habitat is expected to be reduced by as much as 72.0 and 81.6%, respectively, in the high flow months. Conversely, during the low flow period (October–March), adult and juvenile cutthroat trout habitat in an individual month would be reduced up to 23.6 and 20.1%, respectively. On average during this period, adult habitat would be reduced 12.9%, whereas juvenile habitat would be reduced 10.8%.

Since spawning and fry life stages are in the stream segment during the spring and summer, the effect of flow reductions attributable to the project would be much greater during these seasons, with spawning habitat being reduced by almost 94% and fry habitat being reduced by almost 45%. If fry from cutthroat trout spawning upstream of the proposed dam presently are being carried into this stream reach, construction of the dam would prevent these fry from entering this reach of stream.

The project would eliminate large flows in this stream segment; therefore, it is expected that the width of the stream would be reduced. However, without the normal flushing flows, the stream could be expected to have more fine materials in the substrate, which could almost eliminate the small amount of cutthroat trout spawning habitat that is projected to remain in the stream segment. Unless the configuration of the channel of the stream is altered, the stream segment would have limited value, and 50–75% of trout biomass may be lost. If the channel configuration is altered, then the loss of trout biomass may not be as great.

**3.10.3.2.2.3 Lower Gooseberry Creek Segment.—**Operation of the proposed project would cause monthly flow reductions in this 7.1-mile stream segment that would range from 8–62% and average 43% (table 3-1). The largest flow reductions would occur during April–August. However, due to tributary inflow between the proposed dam and this stream segment, the reductions would not be as severe as they may be in the segment immediately upstream of Lower Gooseberry Dam.

As previously discussed, this stream segment supports a self-reproducing population of cutthroat trout. The amount of habitat available for the four life stages on a monthly basis with preproject and postproject flow regimes is shown in table 3-13. Similar to the upstream segment, existing habitat for adult and juvenile cutthroat trout is most restricted during the low flow period, which extends from October–March. As discussed for the previous stream segment, habitat during this period would be expected to be a major factor that would control trout biomass in the stream. As shown in table 3-13, adult and juvenile habitat would be reduced up to 10.5 and 29.5%, respectively. However, during the low flow months, adult and juvenile habitat reductions never exceed 10% in a specific month and, for the 6-month period, average 5.0 and 3.9%, respectively. With these small reductions in adult and

juvenile habitat, any change in the trout population would be expected to be negligible and difficult to detect.

Cutthroat trout spawning habitat is extremely limited with both preproject and postproject flow regimes. It appears that availability of spawning habitat is not a limiting factor, as YOY fish are normally abundant in this stream segment. Fry habitat would be expected to be only slightly affected (0.9% increase) by the proposed project.

It is expected that the proposed project would cause less than a 5% reduction in the cutthroat trout habitat in this stream segment. This is well within the range of fluctuations in the trout population that presently occurs. Little or no opportunity exists to mitigate the adverse impact within this stream segment.

As discussed above, rainbow trout (adults and juveniles) also were documented in this stream reach. The presence of these two life stages strongly suggests that rainbow trout also are using the stream for spawning and rearing habitat. The amount of rainbow trout habitat (WUA) for the four life stages in the entire stream reach was shown in table 3-14. Similar to cutthroat trout, adult and juvenile rainbow trout habitat is most restricted during the low flow period (October–March), and this would be expected to be a major factor that controls trout biomass in this stream segment. For this 6-month period, operation of the proposed project is expected to reduce rainbow trout adult and juvenile habitat by an average of 6.5 and 5.4%, respectively.

Rainbow trout spawning habitat is limited in this stream reach. Implementing the proposed project is expected to result in a slight increase (less then [<] 7%) of spawning habitat. Rainbow trout fry habitat is abundant in this stream reach, and implementing the proposed project also is expected to cause a slight increase (< 8%) in fry habitat (table 3-16). Neither increase is considered to be significant.

**3.10.3.2.2.4 Fish Creek Segment.—**The proposed project would result in a 3–24% reduction in the average monthly flow in Fish Creek. The largest reductions would occur during April–August when preproject flows are the highest. Flows during the low flow months would be reduced 10% or less, and flows during the other months would remain several times higher than those in the low flow months. Reduction in high flows would reduce the sediment transport capacity of the stream, which could increase the amount of sediment deposited within the stream channel, reducing its spawning value.

The amount of cutthroat trout habitat available for the four life stages on a monthly basis with preproject and postproject flow regimes is shown in table 3-16. Similar to the upstream segment, adult and juvenile cutthroat trout habitat is the lowest during October–March, and reduced habitat during this period would be expected to be a major factor that controls the cutthroat trout population in this stream segment. As shown in table 3-16, adult and juvenile cutthroat trout habitat in a specific month may be reduced up to 7.3 and 3.3%, respectively; while in other months, available habitat may be increased. On average for the 6-month low flow period, adult cutthroat trout habitat is expected to be reduced by less than 1%, whereas juvenile habitat would be increased by about 0.5%. Both of these changes are considered to be insignificant.

The month-to-month changes in spawning and fry cutthroat trout habitat, as shown in table 3-16, may be reduced or increased. Overall spawning habitat is expected to be increased by slightly more than 15%, while fry habitat would be reduced by about 3%.

The increase in spawning habitat is considered to be a significant beneficial impact, while the decrease in fry habitat is not significant.

The amount of juvenile, spawning, and fry habitat for rainbow trout in this segment of Fish Creek, based on preproject and postproject flow regimes, was presented earlier in table 3-15. Similar to the cutthroat trout, existing juvenile rainbow trout habitat is most limiting during October–March; and available habitat during this period would be a major factor that controls the abundance of juvenile rainbow trout in this stream segment. During this 6-month period, adult rainbow trout habitat would decrease between 0.5 and 2.7% in specific months, while juvenile rainbow trout habitat is expected to increase by up to 0.4% and decrease to 1.3% in specific months. Overall, adult and juvenile habitat reductions are expected to average about 1.3 and 0.5%, respectively. This is considered to be an insignificant impact.

Also, as shown earlier in table 3-15, impacts to rainbow trout spawning and fry habitats would be expected to decrease about 16 and 2%, respectively. If rainbow trout habitat in this stream segment was limiting, then the reduction in spawning habitat would amount to a significant impact. If so, this effect also would be carried into Scofield Reservoir, since it could affect the number of rainbow trout entering the reservoir's fishery from natural reproduction.

**3.10.3.2.2.5 Cottonwood Creek Segment.—** Flows in Cottonwood Creek would be increased during July–October (table 3-1). Increased winter flows also would be provided. This increase in summer flow would cause a slight decrease in WUA for rainbow and cutthroat trout in June, July, and August. There would be an increase in WUA for adult and juvenile rainbow and cutthroat trout in September. The higher summer flows would increase the spawning WUA for rainbow trout by 9% and decrease the spawning WUA for cutthroat trout by 41%. Overall, WUA for adult rainbow and cutthroat trout would increase by about 20%. Fry habitat would decrease by 16% for rainbow trout and by 14% for cutthroat trout. All life stages of brown trout would be benefited by the increased flows. WUA for adult brown trout would increase by 26%, WUA for juvenile brown trout would increase by 24%, spawning habitat for brown trout would increase by 410%, and habitat for fry brown trout would increase by 59%.

#### *3.10.3.2.3 Reservoir Fishery Effects*

Existing reservoir fisheries with the potential to be affected by the proposed project include Lower Gooseberry Reservoir, Fairview Lakes, and Scofield Reservoir. Each is discussed below.

**3.10.3.2.3.1 Lower Gooseberry Reservoir.—**Under the Proposed Action, flows from Gooseberry Creek into Lower Gooseberry Reservoir would be substantially reduced. As shown in table 3-1, most of the flow reduction would occur during April–August. Flow reduction during this period would reduce the exchange rate within the reservoir and may affect water quality or aquatic habitat during this period. As noted under the No Action Alternative, Lower Gooseberry Reservoir occasionally experiences fishkills due to low DO levels during the winter months. If the problem becomes more severe, it would be an adverse effect attributable to the project. If cutthroat trout spawning upstream of the proposed reservoir contributes to the abundance of cutthroat trout in Lower Gooseberry Reservoir, which appears likely, the proposed project could adversely affect the cutthroat trout population in that reservoir.

**3.10.3.2.3.2 Fairview Lakes.—**Project operation would not change the amount of water (acre-feet) that would be released from Fairview Lakes. The release would be spread over the entire year, rather than the present 18- to 20-week discharge period. This would allow higher water levels later in the year, which would increase the opportunity for overwintering of fish. This change in operation would have a beneficial effect on the overall quality of the fishery and potentially could decrease the amount of stocking of catchable size fish required.

**3.10.3.2.3.3 Scofield Reservoir.—**A primary concern regarding Scofield Reservoir as it relates to the Narrows Project has been that the decreased inflow to the reservoir resulting from the Narrows Project would further degrade the reservoir's water quality and increase the potential for fishkills. Additionally, implementing the Proposed Action would cause Scofield Reservoir to operate at a lower level and, thus, decrease the average surface area of the flat water fishery by about 245 acres (10% total reduction in surface acres for Scofield Reservoir).

**3.10.3.2.3.4 Narrows Reservoir.—**It is expected that, under the Proposed Action, UDWR would manage Narrows Reservoir as a cutthroat trout fishery. Although natural reproduction is expected in the tributary streams upstream of the reservoir, UDWR may need to augment natural reproduction with fingerling introductions to ensure that maximum reservoir production occurs. As an example, UDWR presently is managing Cleveland Reservoir, located about 6 miles southeast of the proposed Narrows Reservoir site, for rainbow trout and maintaining the population by stocking fingerling rainbow trout. Narrows Reservoir would provide an average of 436 surface acres of flat water fishery under the Proposed Action, more than under either the Mid-Sized or Small Reservoir Alternatives.

#### *3.10.3.2.4 Fishery Mitigation*

The UDWR does not recognize the creation of a reservoir fishery as adequate compensation for the loss of stream aquatic resources. Creating an additional reservoir fishery would compensate for adverse effects that may occur on Lower Gooseberry Reservoir and Scofield Reservoir. This would represent a cumulative beneficial project impact to reservoir fishery.

In summary, the Proposed Action would result in loss of cutthroat trout stream habitat attributable to reservoir inundation and flow alteration. The project also would result in more reservoir habitat for cutthroat trout. The reservoir cutthroat trout habitat that would be created by the project would compensate for any adverse impacts that may occur on Gooseberry or Scofield Reservoirs. Therefore, mitigation for reservoir habitat has not been proposed.

A total of 11 fishery improvement and mitigation measures have been proposed by SWCD to compensate for the adverse aquatic impacts that have been identified with the proposed project. To the extent possible, an attempt was made to mitigate "in place" and "in kind." These measures have been developed in coordination with various Federal and State agencies and were described in detail in chapter 2, section 2.2.2.2.1 of this document. Table 3-20 is a summary of the aquatic impacts and proposed improvement and mitigation commitments for the Proposed Action.

The intent of the aquatic mitigation measures described above is to provide full mitigation for all adverse impacts resulting in no residual cumulative or overall impacts.

**Table 3-20.—Fishery Impacts and Mitigation Measures: Proposed Action**

| Impacts | Mitigation Commitment |
|---|---|
| **Stream Fisheries** | |
| Gooseberry Creek tributaries – Loss of 4.3 miles (spawning Yellowstone cutthroat). | Restore year-round flows in 2.3 miles of tributaries and stabilize 3.0 miles of Middle Gooseberry Creek. |
| Upper Gooseberry Creek – Loss of 1.0 mile (all life stages Yellowstone cutthroat).<br>Middle Gooseberry Creek – 74% reduction in average annual flow for 3.0 miles (all life stages Yellowstone cutthroat).<br>Lower Gooseberry Creek – 43% flow reduction for 7.1 miles (decrease of 5% adult and 4% juvenile low flow habitat for Yellowstone cutthroat).<br>Fish Creek – Average 17% flow reduction of 6.0 miles (decrease of less than 1% adult and juvenile low flow habitat for Yellowstone cutthroat; overall increase of 15% spawning and 3% fry habitat for Yellowstone cutthroat; decrease of 1.3% adult and 0.5% juvenile low flow habitat for rainbow; overall decrease of 16% spawning and 2% fry habitat for rainbow). | Acquire, fence, and improve fishery habitat on the following stream segments:<br>Mud Creek 4.0 miles<br>Winterquarters Creek 2.5 miles<br>Upper Fish Creek 1.0 mile<br>Pondtown Creek 2.0 miles<br>Price River below Scofield Reservoir 2.0 miles<br><br>Provide 1.0-cfs minimum year-round release into Gooseberry Creek to provide 1.5-cfs flow at Gooseberry Campground.<br>Provide temperature control for releases to Gooseberry Creek. |
| Upper Cottonwood Creek – No summer flow increase, 2-cfs winter flow provided. | Construct Upper Cottonwood Creek Pipeline and provide 2-cfs winter release. |
| Lower Cottonwood Creek – Average 162% annual flow increase. Average 200% summer flow increase. Overall increase in habitat of 10 to 20% for rainbow trout adult, juvenile, and spawning. Increase in Yellowstone cutthroat trout adult habitat of about 20%. Little change for Yellowstone cutthroat juvenile habitat. Average of 41% decrease in Yellowstone cutthroat spawning habitat and decrease of 14% for Yellowstone cutthroat fry habitat. Increase in habitat for all life stages of brown trout. | Provide 2-cfs minimum flow during irrigation season in Lower Cottonwood Creek. |
| Price River below Scofield Dam – reduced peak flow may alter fluvial geomorphic processes | |
| The number of miles of stream affected by increase in flow is 4.9 miles. The number of miles of stream affected by decrease in flow is 16.1 miles. | The project would provide an average 300 acre-feet per year of additional water for release to Gooseberry Creek for flushing flows. |
| **Reservoir Fisheries** | |
| Scofield Reservoir – Increased potential for poor water quality resulting in fishkills; loss of some natural reproduction in rainbow trout. Reduced surface area of 274 acres, resulting in reduced standing crop of fish. | Reduce external phosphorus loading by improving riparian areas along Mud Creek, Winterquarters Creek, Upper Fish Creek, and Pondtown Creek. These measures also will improve habitat for all life stages of Yellowstone cutthroat and rainbow trout including spawning. Lost angler days would be replaced by new fishery in Narrows Reservoir. |
| Lower Gooseberry Reservoir – Increased potential for poor water quality resulting in fishkills. | |
| Fairview Lakes – Lower fishing pressure; less severe drawdown during fishing season and winter. | Beneficial impact. No mitigation required. |
| Narrows Reservoir – New reservoir fishery (average). | Would provide approximately 454 acres of flat water fishery. |

#### 3.10.3.3 Mid-Sized Reservoir Alternative

Impacts to aquatic resources under the Mid-Sized Reservoir Alternative would be similar to those generated by the Proposed Action. The exceptions would be that 4.0 miles of tributaries to Gooseberry Creek would be inundated by the reservoir instead of the 4.3 miles that would be inundated by the Proposed Action and that the Mid-Sized Reservoir Alternative would reduce the surface area of Scofield Reservoir by 231 acres (10%), while providing 331 new surface acres at Narrows Reservoir.

A summary of the 11 fishery improvement and mitigation measures proposed for the Mid-Sized Reservoir Alternative (all of which were described in greater detail in chapter 2) is presented in table 3-21.

The residual impacts to aquatic resources caused by the Mid-Sized Reservoir Alternative would be nearly equivalent to those under the Proposed Action.

#### 3.10.3.4 Small Reservoir Alternative

Impacts to aquatic resources under the Small Reservoir Alternative would be similar to those generated by the Proposed Action. The exception would be that 3.8 miles of tributaries to Gooseberry Creek would be inundated by the reservoir instead of the 4.3 miles inundated by the Proposed Action. In addition, the Small Reservoir Alternative would reduce the surface area of Scofield Reservoir by 205 acres (9%) while providing 215 new acres at Narrows Reservoir.

A summary of the nine fishery improvement and mitigation measures proposed for the Small Reservoir Alternative (all of which were described in greater detail in chapter 2) is presented in table 3-22.

The residual impacts to aquatic resources caused by the Small Reservoir Alternative would be nearly equivalent to those of the Proposed Action.

## 3.11 WILDLIFE

### 3.11.1 Affected Environment

The study, *Vegetation and Wildlife Impacts from the Narrows Project*, states that wildlife species found in the general project area are common in the Great Basin Desert valleys and Rocky Mountain Range. There are about 364 species of terrestrial vertebrates that may inhabit the project area. Approximately 88 bird species and 33 mammal species may use the habitats that would be disturbed by the proposed project (Mt. Nebo Scientific, 1992).

### 3.11.2 Methodology and Impact Indicators

The method used to evaluate the project is known as the Habitat Evaluation Procedure—a "species habitat" approach to impact assessment and habitat quality. The program uses selected species as indicators to evaluate habitat for a host of other species, assuming that these indicator (evaluation) species are functioning units of part of an ecosystem.

Impacts to a particular indicator species assume that there also would be impacts to the group of the species it represents.

HSI were ascertained for each evaluation (indicator) species. These indices range from 0.0 to 1.0 with each increment of change identical to the next. An HSI value is linearly related to the carrying capacity of the species. An HSI of "1.0" would represent the optimum habitat for the particular evaluation species, whereas "0.0" would represent habitat that is unsuitable.

**Table 3-21.—Fishery Impacts and Mitigation Measures: Mid-Sized Reservoir Alternative**

| Impacts | Mitigation Commitment |
|---|---|
| **Stream Fisheries** | |
| Gooseberry Creek tributaries – Loss of 4.0 miles (spawning Yellowstone cutthroat). | Restore year-round flows in 2.3 miles of tributaries and stabilize 3.0 miles of Middle Gooseberry Creek. |
| Upper Gooseberry Creek – Loss of 1.0 mile (all life stages Yellowstone cutthroat).<br>Middle Gooseberry Creek – 74% reduction in average annual flow for 3.0 miles (all life stages Yellowstone cutthroat).<br>Lower Gooseberry Creek – 43% flow reduction for 7.1 miles (decrease of 5% adult and 4% juvenile low flow habitat for Yellowstone cutthroat).<br>Fish Creek – Average 17% flow reduction of 6.0 miles (decrease of less than 1% adult and juvenile low flow habitat for Yellowstone cutthroat; overall increase of 15% spawning and 3% fry habitat for Yellowstone cutthroat; decrease of 1.3% adult and 0.5% juvenile low flow habitat for rainbow; overall decrease of 16% spawning and 2% fry habitat for rainbow). | Acquire, fence, and improve fishery habitat on the following stream segments:<br>Mud Creek 4.0 miles<br>Winterquarters Creek 2.5 miles<br>Upper Fish Creek 1.0 mile<br>Pondtown Creek 2.0 miles<br>Price River below Scofield Reservoir 2.0 miles<br><br>Provide 1.0-cfs minimum year-round release into Gooseberry Creek to provide 1.5-cfs flow at Gooseberry Campground.<br><br>Provide temperature control for releases to Gooseberry Creek. |
| Upper Cottonwood Creek – No summer flow increase, 2-cfs winter flow provided. | Construct Upper Cottonwood Creek Pipeline and provide 2-cfs winter release. |
| Lower Cottonwood Creek – Average 162% annual flow increase. Average 200% summer flow increase. Overall increase in habitat of 10 to 20% for rainbow trout adult, juvenile, and spawning. Increase in Yellowstone cutthroat trout adult habitat of about 20%. Little change for Yellowstone cutthroat juvenile habitat. Average of 41% decrease in Yellowstone cutthroat spawning habitat and decrease of 14% for Yellowstone cutthroat fry habitat. Increase in habitat for all life stages of brown trout. | Provide 2-cfs minimum flow during irrigation season in Lower Cottonwood Creek. |
| Price River below Scofield Dam – reduced peak flow may alter fluvial geomorphic processes | |
| The number of miles of stream affected by increase in flow is 4.9 miles. The number of miles of stream affected by decrease in flow is 16.1 miles. | The project would provide an average 300 acre-feet per year of additional water for release to Gooseberry Creek for flushing flows. |
| **Reservoir Fisheries** | |
| Scofield Reservoir – Increased potential for poor water quality resulting in fishkills; loss of some natural reproduction in rainbows. Reduced surface area of 260 acres resulting in reduced standing crop of fish. | Reduce external phosphorus loading by improving riparian areas along Mud Creek, Winterquarters Creek, Upper Fish Creek, and Pondtown Creek. These measures also will improve habitat for all life stages of Yellowstone cutthroat and rainbow trout including spawning. Lost angler days would be replaced by new fishery in Narrows Reservoir. |
| Lower Gooseberry Reservoir – Increased potential for poor water quality resulting in fishkills. | |
| Fairview Lakes – Lower fishing pressure, less severe drawdown during fishing season and winter. | Beneficial impact. No mitigation required. |
| Narrows Reservoir – New reservoir fishery (average). | Would provide approximately 277 acres of flat water fishery |

**Table 3-22.—Fishery Impacts and Mitigation Measures: Small Reservoir Alternative**

| Impacts | Mitigation Commitment |
|---|---|
| **Stream Fisheries** | |
| Gooseberry Creek tributaries – Loss of 3.8 miles (spawning Yellowstone cutthroat). | Stabilize 3.0 miles of Middle Gooseberry Creek. |
| Upper Gooseberry Creek – Loss of 1.0 mile (all life stages Yellowstone cutthroat).<br>Middle Gooseberry Creek – 67% reduction in average annual flow for 3.0 miles (all life stages Yellowstone cutthroat).<br>Lower Gooseberry Creek - 39% flow reduction for 7.1 miles (decrease of 5% adult and 4% juvenile low flow habitat for Yellowstone cutthroat).<br>Fish Creek – Average 17% flow reduction of 6.0 miles (decrease of less than 1% adult and juvenile low flow habitat for Yellowstone cutthroat; overall increase of 15% spawning and 3% fry habitat for Yellowstone cutthroat; decrease of 1.3% adult and 0.5% juvenile low flow habitat for rainbow; overall decrease of 16% spawning and 2% fry habitat for rainbow). | Acquire, fence, and improve fishery habitat on the following stream segments:<br>Mud Creek 4.0 miles<br>Winterquarters Creek 2.5 miles<br>Upper Fish Creek 1.0 mile<br>Pondtown Creek 2.0 miles<br>Price River below Scofield Reservoir 2.0 miles |
| Upper Cottonwood Creek – No summer flow increase, 2-cfs winter flow provided. | Construct Upper Cottonwood Creek Pipeline and provide 2-cfs winter release. |
| Lower Cottonwood Creek – Average 162% annual flow increase. Average 200% summer flow increase. Overall increase in habitat of 10 to 20% for rainbow trout adult, juvenile, and spawning. Increase in Yellowstone cutthroat trout adult habitat of about 20%. Little change for juvenile habitat. Average of 41% decrease in Yellowstone cutthroat spawning habitat and decrease of 14% for Yellowstone cutthroat fry habitat. Increase in habitat for all life stages of brown trout. | Provide 2-cfs minimum flow during irrigation season in Lower Cottonwood Creek. |
| Price River below Scofield Dam – Reduced peak flow may alter fluvial geomorphic processes | |
| The number of miles of stream affected by increase in flow is 4.9 miles. The number of miles of stream affected by decrease in flow is 16.1 miles. | |
| **Reservoir Fisheries** | |
| Scofield Reservoir – Increased potential for poor water quality resulting in fishkills; loss of some natural reproduction in rainbows. Reduced surface area of 234 acres resulting in reduced standing crop of fish. | Reduce external phosphorus loading by improving riparian areas along Mud Creek, Winterquarters Creek, Upper Fish Creek, and Pondtown Creek. These measures also will improve habitat for all life stages of Yellowstone cutthroat and rainbow trout including spawning. Lost angler days would be replaced by new fishery in Narrows Reservoir. |
| Lower Gooseberry Reservoir – Increased potential for poor water quality resulting in fishkills. | Stabilize 3.0 miles of Middle Gooseberry Creek to reduce external phosphorus loading. |
| Fairview Lakes – Lower fishing pressure; less severe drawdown during fishing season. | Beneficial impact. No mitigation required. |
| Narrows Reservoir – New reservoir fishery (average). | Would provide approximately 238 acres of flat water fishery. |

Evaluation species chosen to assess the impacts to habitat of the proposed project included: mule deer, beaver, Richardson vole, yellow warbler, and Brewer's sparrow. The Brewer's sparrow was used because of the vegetative community it represented, not for the species. It was determined that the Brewer's sparrow would reflect summer range needs for deer, elk, and other species as well as the sparrow. These wildlife species and the communities that they use are described below.

- **Mule Deer –** Deer are of great public interest in the area and are plentiful in the reservoir area. The project area provides excellent summer range, and areas surrounding the reservoir basin and aspen forest are critical in summer because of fawning.
- **Beaver –** The beaver is able to use a wide variety of wetlands habitat and is found at two different locations within the proposed reservoir basin.
- **Richardson Vole –** The vole uses much of the wetland habitat in the area. These voles live primarily in moist areas with high densities of grasses and sedges.
- **Yellow Warbler –** The yellow warbler also uses the wetland habitats in the area but does not use the same grassy habitat as the vole. The warbler occurs in the deciduous shrub/scrub wetlands and also is found in high abundance at the reservoir site.
- **Brewer's Sparrow –** This sparrow nests and forages in the sagebrush, which allows the evaluation to take the shrub habitat into consideration.

The impact indicator for vegetation and wildlife is the change in habitat units for the indicator species listed above. Habitat units are based on the quantity and quality of the various vegetation types used as habitat for the species.

## 3.11.3 Predicted Effects

### 3.11.3.1 No Action Alternative

The baseline conditions within the reservoir basin are summarized under the No Action Alternative in table 3-23. Wildlife habitat conditions are expected to remain the same as baseline conditions if the project were not constructed and if there were no other future developments. Because there are no impacts, no mitigation would be provided.

### 3.11.3.2 Proposed Action Alternative

Table 3-23 summarizes the impacts to wildlife habitat that would result from construction of the Proposed Action. In an assumed worst-case situation where the most habitat would be lost at one time, it would take the reservoir 2 years to fill to capacity. The *1994 Fish and Wildlife Coordination Act Report* evaluates the impacts of the proposed Narrows Project on fish and wildlife resources and recommends appropriate mitigation (see appendix D).

In addition to the 604 acres of habitat inundated by the reservoir, there would be an additional 32 acres lost due to SR-264 relocation, of associated forest development roads, and of the recreation area construction.

These areas are primarily mule deer and Brewer's sparrow habitat.

Temporary impacts would result from construction of the Upper Cottonwood Creek, Oak Creek, and East Bench Pipelines and from developing the rockfill material source area. These areas would be recontoured, covered with topsoil, and revegetated with native plant species after construction. Implementing the fishery and wildlife

**Table 3-23.—Comparison of Wildlife Habitat Losses Within Narrows Reservoir Basin (Without Mitigation)**

| Species | Cover Type(s)[1] | No Action Alternative | | | Proposed Action | | | Mid-Sized Reservoir Alternative | | | Small Reservoir Alternative | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Acres | HSI[2] | HU[3] | Acres | HSI[2] | HU[3] | Acres | HSI[2] | HU[3] | Acres | HSI[2] | HU[3] |
| Mule deer | PEM, PSS, USHE | 0 | 0.23 | 0 | 587 | 0.23 | 135 | 475 | 0.23 | 109 | 341 | 0.23 | 78 |
| Beaver | PEM, PSS | 0 | 0.13 | 0 | 100 | .013 | 13 | 81 | 0.13 | 11 | 72 | 0.13 | 9 |
| Richardson vole | PEM | 0 | 1.00 | 0 | 63 | 1.00 | 63 | 51 | 1.00 | 51 | 45 | 1.00 | 45 |
| Yellow warbler | PSS | 0 | 0.70 | 0 | 37 | 0.70 | 26 | 30 | 0.70 | 24 | 27 | 0.70 | 19 |
| Brewer's sparrow | USHE | 0 | 0.98 | 0 | 487 | 0.98 | 477 | 394 | 0.98 | 386 | 269 | 0.98 | 264 |

1 PEM = Palustrine emergent wetland cover (herbaceous wetlands); PSS = palustrine scrub/shrub cover (shrubby wetlands); and USHE = shrub cover (Vasey sagebrush; silver sagebrush).

2 A HSI of "1.0" represents the optimum habitat; whereas "0.0" represents unsuitable habitat.

3 Habitat Unit = Habitat availability.

mitigation measures would increase the amount of wildlife habitat affected by the Proposed Action to a total of about 1,931 acres of land. Species benefitting by the mitigation measures would include mule deer, beaver, Richardson vole, yellow warbler, and Brewer's sparrow.

Analyses were performed comparing the habitat units available with and without the proposed project. As mentioned previously, if the Narrows Dam were constructed, a mitigation plan would be implemented to compensate for wetlands and upland communities impacted by reservoir inundation.

Alternative wetland mitigation measures for the Proposed Action were described in chapter 2. The proposed wetland mitigation areas are in kind, and a detailed mitigation plan would be developed in conjunction with the Clean Water Act Section 404 permitting process. In determining the exact acreage to be provided, careful monitoring of the mitigation sites would be conducted to ensure that the value of the mitigation sites is at least equal to the value of the wetlands lost. This determination would be accomplished by performing HEP analyses of the sites and comparing habitat values. Because plants require time to become fully established, it is anticipated to take 6 years from the time construction is initiated to achieve the desired wildlife habitat for the wetland mitigation.

To accommodate the loss of habitat for mule deer and Brewer's sparrow if the Narrows Reservoir were constructed, additional mitigation measures would be implemented. Impacts to upland game (mule deer and Brewer's sparrow habitat and the host of species that they represent) would be mitigated in the following ways:

- Acquisition of conservation easements around Narrows Reservoir. The conservation easements would be in the name of the United States. These easements would include restrictions on land use that would benefit impacted species. This measure would serve to protect wildlife values adjacent to the reservoir and minimize impacts that would occur if the land were developed.

- Acquisition of private or State School Trust land adjacent to the Price River below Scofield Reservoir. Wildlife values would be enhanced by fencing the land to protect it from livestock grazing. The primary objective of this measure would be to protect mule deer habitat. The lower Fish Creek acquisition would protect both summer and winter range, depending on which side of the canyon is

acquired. South facing slopes provide winter range in early winter and mild winters. The area would provide riparian and fishery habitat. The wetland mitigation area near Scofield Reservoir also would provide habitat for mule deer.

A wildlife mitigation program has been designed to provide at least full mitigation for each impacted species.

A monitoring program would be implemented on a yearly basis using qualitative and quantitative sampling methods to monitor the progress of the mitigation plans. At the end of the predicted time, when it is assumed that full mitigation should be achieved, the areas would be sampled using the same techniques that were used to gather the baseline information. Statistical comparisons would be made. If full mitigation standards are not achieved, steps would be taken to ensure that the goals are eventually met.

A survey of migrating, ground nesting birds would be conducted prior to any ground disturbing activities. This survey would be conducted by a biologist to avoid, to the extent possible, any negative impacts to these birds.

Also, construction activities within 0.5 mile of any active raptor nest would not be allowed from March 15–August 31. This restriction would ensure that any nesting raptors would not be significantly affected by the project. Any effects to raptors would be short term or very limited in extent and would have no significant negative effects since these birds would be able to use very similar roost sites or other habitat elements in the vicinity of the project.

Because the wetland and upland wildlife mitigation measures are intended to provide full mitigation for project impacts, there would be no residual impacts.

#### 3.11.3.3 Mid-Sized Reservoir Alternative

Table 3-23 summarizes the impacts to wildlife habitat that would result under the Mid-Sized Reservoir Alternative. Permanent impacts caused by SR-264 relocation and construction of the recreation area would be the same as with the Proposed Action. Temporary impacts due to construction of pipelines and development of material source areas also would be the same.

Implementing the wildlife mitigation measures would increase the amount of wildlife habitat on about 1,680 acres of land. Benefited species would include mule deer, beaver, Richardson vole, yellow warbler, and Brewer's sparrow.

Under the Mid-Sized Reservoir Alternative, wetland and upland wildlife habitat mitigation measures would be similar to those described under the Proposed Action, except that the amount of acreage would be smaller, as described in chapter 2. The proposed wetland mitigation areas are in kind, and a detailed mitigation plan would be developed and designed in conjunction with the Section 404 permitting process.

Because the wetland and upland wildlife mitigation measures are intended to provide full mitigation for project impacts, there would be no residual impacts.

#### 3.11.3.4 Small Reservoir Alternative

Table 3-23 summarizes the impacts to wildlife habitat that would result under the Small Reservoir Alternative. Permanent impacts caused by SR-264 relocation and construction of the recreation area would be the same as with the Proposed Action. Temporary impacts due to construction of pipelines and development of material source areas also would be the same.

Implementing the wildlife mitigation measures would increase the amount of

wildlife habitat on about 1,510 acres of land. Benefited species would include mule deer, beaver, Richardson vole, yellow warbler, and Brewer's sparrow.

Under the Small Reservoir Alternative, wetland and upland wildlife habitat mitigation measures would be similar to those described under the Proposed Action, except that the amount of acreage would be smaller, as described in chapter 2. The proposed wetland mitigation areas are in kind, and a detailed mitigation plan would be developed and designed in conjunction with the Section 404 permitting process.

Because the wetland and upland wildlife mitigation measures are intended to provide full mitigation for project impacts, there would be no residual impacts.

## 3.12 THREATENED AND ENDANGERED SPECIES

### 3.12.1 Affected Environment

No plant species currently receiving protection under the Endangered Species Act are known to exist in the project area/action area.

A biological assessment of potential effects on endangered, threatened, and candidate wildlife and fish species was conducted in October 1991 and was amended three times, in July 1994, March 1997, and February 1999 for the Narrows Project in compliance with Section 7(c) of the Endangered Species Act of 1973 (appendix C). Federally listed or otherwise protected species addressed in the assessment included: bald eagle (*Haliaeetus luecocephalus*), greater sage grouse (*Centrocercus urophasianus*), Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*).

The bald eagle, now delisted by the Service, was listed as an endangered species in 1967. Historically, the bald eagle was a resident of Utah but currently occurs primarily as a winter visitant. Of the 10 known historic nest sites (4 sites currently occupied), none are in the vicinity of the proposed Narrows Project.

Golden eagles, which are protected under the Bald and Golden Eagle Protection Act, may use the area around the proposed dam and reservoir.

The Colorado pikeminnow evolved as the main predator in the Colorado River system. Larval pikeminnow measuring less than 40 mm subsist on diets of plankton and macroinvertebrates; pikeminnow between 40–80 mm begin to become piscivorus (fish eating); and those measuring more than 80 mm are entirely piscivorus. Fish less than 80 mm are considered larval or YOY fish. The Colorado pikeminnow is the largest cyprinid fish (minnow family) native to North America and, during the predevelopment period, may have grown as large as 6 feet in length and weighed nearly 100 pounds. The Colorado pikeminnow currently occupies about 1,000 river miles in the Colorado River system and is presently found only in the Upper Colorado River Basin above Glen Canyon Dam. Since 1995, as many as 20 adult pikeminnow, 1 in breeding condition, have been caught in the Price River and individually marked. It is currently unknown whether Colorado pikeminnow use the Price River year round. Colorado pikeminnow have been located in the Price River from April–October. Their known range in the Price River extends from the confluence with the Green River upstream almost 90 miles to the Farnham Diversion near Wellington. Further study is needed to determine the pikeminnow's seasonal use of the Price River and to identify the extent to which pikeminnow use the Price River.

Little is known about the biological requirements of the bonytail, as the species greatly declined in numbers in the Upper Colorado River Basin shortly after 1960. Bonytail are considered extremely rare or functionally extirpated from the Upper Colorado River Basin. Occasional captures of *Gila* individuals show bonytail characteristics; however, no wild populations are known to exist.

The humpback chub generally does not make migrational movements in the Upper Colorado River and tends to reside throughout the year within a limited reach of the river. The species is found in narrow, deep canyon areas and is relatively restricted in distribution, seldom leaving its canyon habitat. None have been found in the Price River.

Historically, the razorback sucker was abundant throughout the Colorado River Basin. At present, the only concentrations occur in the Green River in the Upper Colorado Basin and Lake Mojave in the Lower Colorado Basin. Catch-effort estimates suggest that adult razorback suckers are rarer than other native suckers and the endangered Colorado pikeminnow. An immediate goal for razorback sucker recovery is to prevent the species' extinction in the wild. A draft recovery plan has been developed for the razorback sucker.

The Service wrote to Reclamation, identifying the southwestern willow flycatcher (SWWF) as an additional endangered species present at a site known as Fish Creek in the proximity of the Narrows Project, and advised Reclamation that an amendment to the biological assessment would be necessary. An amended biological assessment was submitted to the Service on February 5, 1999. A final *Recovery Plan for the Southwestern Willow Flycatcher* was prepared by Region 2 of the Service and signed August 30, 2002.

Based on recent information, the Service "believes that the willow flycatcher found at the Fish Creek site is not the endangered subspecies, the southwestern willow flycatcher." No discussion was offered specifically in reference to the endangered subspecies, *E.t. extimus* from the Service. To date, the following information was used to identify the subspecies:

- The willow flycatcher subspecies inhabiting the riparian corridor in the proposed Narrows Project proximity is located at the extreme northern boundary of *E.t. extimus* but within the range of *E.t. adastus*, an unlisted species. Experts suggest that the central part of the State of Utah is probably an area of intergradation between *E.t. extimus* and *E.t. adastus* (Behle, 1985).
- Research data confirms that this willow flycatcher population is probably not the endangered *E.t. extimus* subspecies but is more likely to be *E.t. adastus* (Paxton et al., 2008).
- Vocalization analysis has determined the population to be *E.t. adastus* (personal communication, Dr. Jim Sedgwick, 1999). However, these results have yet to be published or peer reviewed.

Greater sage grouse were listed as a candidate species under the ESA in 2010. The Narrows Dam and Reservoir are proposed to be constructed within potential brood rearing and foraging habitat.

#### 3.12.1.1 Conservation and Other Special Species

A distinct population segment (DPS) of the Columbia spotted frog, *Rana luteiventris*, occurs in the San Pitch drainage and is part of what is known as the Wasatch Front population. A conservation agreement for this DPS was signed by Reclamation, the

Service, as well as others. Subsequently, on April 2, 1998, the Service removed the Wasatch Front population from the candidate species list.

The San Pitch drainage site, located near Fairview, was surveyed for spotted frog in 1991–92 and again in 1997. In 1991–92, the estimated number of breeding individuals in the population was 108; while in 1997, the estimate was 48 individuals.

Specifically within the project boundaries, two spotted frogs were found near Oak Creek at the northern terminus of the proposed water delivery pipeline. A *Conservation and Management Plan for Three Fish Species in Utah* was published September 2006. This document was developed to prevent the Federal listing of three Utah State sensitive species. These are roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*).

These species historically occupied the Price River. Roundtail chub have been extirpated from the river. Bluehead sucker and flannelmouth sucker exist in the river below the Farnham Diversion Dam, which acts as a barrier to upstream fish migration. This diversion is located approximately 3 miles southeast of Wellington, Utah, in Carbon County

Migratory birds seasonally inhabit the project area. These species are listed in table 3-24. The table indicates that three of the birds are listed under the Utah Comprehensive Wildlife Conservation Strategy as at-risk and declining species in need of conservation.

### 3.12.2 Methodology and Impact Indicators

Water depletions in the Upper Colorado River Basin have been recognized as a major source of impact to endangered fish species. Continued water withdrawal has restricted the ability of the Colorado River system to produce flow conditions required by various life stages of the fishes.

**Table 3-24.—Birds in the Project Area.**

| | |
|---|---|
| Greater sage grouse[1] | Eared grebe |
| Bald eagle | Ferruginous hawk[1] |
| Golden eagle | Peregrine falcon |
| Yellow rail | Snowy plover |
| Long-billed curlew | Marbled godwit |
| Yellow-billed cuckoo | Flammulated owl |
| White-headed woodpecker | Calliope hummingbird |
| Black-chinned sparrow | Williamson's sapsucker |
| Black swift | Willow flycatcher |
| Loggerhead shrike | Pinyon jay |
| Sage thrasher | Virginia's warbler |
| Green-tailed towhee | Brewer's sparrow |
| Lewis's woodpecker[1] | Sage sparrow |
| Tricolored blackbird | Black rosy-finch |

[1] Species of concern.

The importance of the Green River and its tributaries to endangered fish was established by the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (RIP) and recognized by many biologists as noted in the recovery plans for each of the species. The Service identified water, physical habitat, and biological environment as the primary constituent elements of critical habitat. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species.

The RIP (Chart et al., 2011) studied the proposed Narrows Project and the Price River and recommended relevant to the Proposed Action:

1. Base flows in the lower Price River of at least 30 cfs and that opportunities be investigated to increase the frequency of time when base flows exceed 30 cfs in the lower Price River.

2. Securing a pool of water (e.g., 600 acre-feet or 5 cfs for 60 days) that could be delivered in July and August to the Woodside, Utah, gauge to avoid periods of dewatering.

Based on these RIP recommendations, the volume of water in the Price River at its confluence with the Green River and at Woodside are indicators for endangered fish.

Important habitat requirements for the SWWF include space for individual and population growth; food, water, air, light, minerals, or other nutritional or physiological needs; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historic geographical or ecological distribution of the species.

The impact indicator for this issue is acre-feet of water depleted from the Colorado River system. This indicator is critical for the Colorado endangered fish species and is a key habitat requirement for the SWWF.

## 3.12.3 Predicted Effects

### 3.12.3.1 No Action Alternative

Under No Action, listed species would continue to be present in the project area, including the Colorado pikeminnow, bonytail, humpback chub, razorback sucker, and possibly the SWWF Under No Action, the willows that serve as habitat or potential habitat along Gooseberry and Fish Creeks might decline over time, and the habitat of SWWFC become reduced.

### 3.12.3.2 Proposed Action Alternative

Project impacts to threatened or endangered species were evaluated by Reclamation in a biological assessment and submitted to the Service. Subsequently, the Service issued a final biological opinion on August 24, 2000, (appendix C), finding that the proposed project would have no effect upon the bald eagle, which was subsequently delisted in 2007. The Service believes that the willow flycatcher found at the Fish Creek site is not the endangered subspecies; therefore, no discussion was offered specifically in reference to the SWWF.

The Service concluded that the project and associated depletion of water from the Colorado River system is likely to jeopardize the continued existence of the four endangered Colorado River fishes and to destroy or adversely modify designated critical habitat in the Green and Colorado Rivers from the confluence of the Price and Green Rivers downstream to Lake Powell.

The RIP for Upper Colorado River Basin Endangered Fish Species serves as the reasonable and prudent alternative (RPA) to avoid the likelihood of jeopardizing the continued existence of these listed species or the destruction or adverse modification of their critical habitat.

Reclamation suggested the following actions be developed into the RIP's Recovery Action Plan to offset the proposed Narrows Project impacts to the Price River and these endangered fish species:

1. Payment of a one-time financial contribution by SWCD to the RIP. The current depletion charge is $18.29 per acre-foot (2009 figure); and when multiplied by the project's 5,597-acre-foot average, annual depletion of flows to the Colorado River system amounts to a financial contribution of $102,369

to the RIP. The Service will notify SWCD of the current depletion charge by September 1 each year. On July 13, 1995, SWCD made a partial payment of $7,063, 10% of the total depletion charge as identified in the January 9, 1995, Biological Opinion.

2. The RIP would agree to provide funding for continuing the Price River endangered fish studies.

3. The RIP would secure water rights on the Price River that could be used to maintain instream flows during critical times of the year for Colorado pikeminnow.

These items have been incorporated into the RPA and have been identified in the fiscal year 2001 RPA.

The Service also included in the RPA the recommissioning of the discharge gauge located at Woodside in the lower Price River. The Recovery Program funded USGS to bring the Woodside, Utah, gauge back online in August 2000, and it has been functioning ever since.

Reliance on the RIP to serve as the reasonable and prudent alternative for project impacts is dependent upon the RIP making sufficient progress. In the event sufficient progress is not made by the RIP, re-initiation of consultation would be required. Payment of the depletion charge would be made by SWCD prior to beginning construction.

Initially, the Service issued a biological opinion in March 1992. Consultation was re-initiated in 1994 as a result of the Service's designation of critical habitat for the four endangered Colorado River fishes and again in 1995 after new information arose about the presence of Colorado pikeminnow in the Price River. The Service issued a biological opinion in January 1995, an amended biological opinion in October 1995, a biological opinion on December 13, 1999, and the final biological opinion on August 24, 2000 (appendix C), that addresses project impacts to designated critical habitat and the Price River. As an element of the RPA to the Narrows proposal, the Recovery Program was directed under the 2000 biological opinion to fund a study to determine seasonal endangered fish use in the Price River and develop recommendations for year-round instream flow requirements in the Price River for Colorado pikeminnow. The Recovery Program has completed field investigations to address this element of the reasonable and prudent alternative and is planning to release a summary of flow requirements for internal committee review and approval. The Recovery Program prepared a draft document titled "The Upper Colorado River Endangered Fish Recovery Program's Position on the Role of the Price River in Recovery of Endangered Fish and the Need for Flow Management." This position paper recommended that:

1. The Recovery Program should work with Utah Water Users and the State of Utah to investigate opportunities to support flows in the lower Price River and minimize periods of streamflow less than 30 cfs.

2. In support of the Three Species Conservation Agreement, the Recovery Program recommends that any future water development projects (e.g., Price-Narrows) incorporate some mechanism to secure an emergency native fish pool of water that could be delivered (most probable in July and August) to the Woodside, Utah, gauge to avoid periods of dewatering in the lower Price River. For example, a 600-acre-foot pool could support an instream flow of 5 cfs for 60 days, provided it could be delivered to the Woodside, Utah, gauge.

Because the project would result in a depletion of water to the Price River and reduced spills from Scofield Reservoir, there is, at this time, some uncertainty about what effect the project would have on the timing, duration, and magnitude of flows in the portion of the Price River used by Colorado pikeminnow. Further study of the extent to which pikeminnow use the Price River and other tributaries is needed before conclusions can be made regarding the importance of Price River flows in recovery. If flow recommendations are approved and implemented, further study may be necessary to assess response of endangered fish over a range of hydrologic conditions.

Reduced flows to Fish Creek, as a result of the Narrows Project, may affect SWWF through reduction in availability of tall, thick stands of willows and reduction of standing water and saturated soils, both typical components of their breeding habitat.

During the critical growing season, willow seedling establishment can be reduced or eliminated from a riparian system if flows are reduced to such an extent that gravel bars and other probable seed nursery sites are no longer wetted. Seedling establishment is the primary means of willow regeneration and, at the proposed project elevation and latitude, occurs in early July through late August. The average annual depletion to Fish Creek is 18%. Depletions are highest in May (18%), June (24%), July (13%), August (16%), and September (17%). Stage changes of the above levels, because they occur during the growing season, are large enough to potentially cause severe impediment of willow seedling establishment.

The Narrows Project plan includes proposed modifications to portions of the Gooseberry Creek channel. These modifications include narrowing the channel to maintain the depth of flow. In designing the stream channel modifications, the intent would be to create a stream channel that is more naturally suited to the new flow regime and that will have the same depth of flow as under baseline conditions. Therefore, the depth of ground water adjacent to the stream would not decrease, nor would there be any adverse effects on riparian and wetland vegetation adjacent to the streams.

As stated earlier, there is no Service-designated or proposed critical habitat for the SWWF in Utah; therefore, there is no adverse modification of existing or proposed critical habitat.

Prior to construction of the proposed project, greater sage grouse habitat would be surveyed for any use by these birds. If active nests are found in the area, construction would be delayed until these birds have left their nests, probably in early June.

A survey for golden eagle nest use would be conducted prior to construction. If active nests are found, construction activities within 0.5 miles of the nest would not be allowed from January 1–August 31.

With respect to the DPS of the Columbia spotted frog that occurs in the action area, Reclamation and SWCD would cooperate in implementing the measures prescribed in the *Spotted Frog Conservation Agreement and Strategy* should the loan and use of Federal land be approved.

#### 3.12.3.3 Mid-Sized Reservoir Alternative

There would be a 5,298-acre-foot-per-year depletion to the Colorado River, which could affect the Colorado pikeminnow, bonytail, humpback chub, and razorback sucker.

Incidental take of Colorado pikeminnow, humpback chub, bonytail, or razorback sucker is not anticipated under this alternative, nor would it be authorized.

It was assumed that the same criteria applied to the Proposed Action to offset project depletion impacts could be applied proportionately to the Mid-Sized Reservoir Alternative. This would result in a one-time contribution of $96,900 (5,298 acre-feet multiplied by the 2009 depletion charge of $18.29) to the Recovery Program. Other conservation measures described for the Proposed Action also would be implemented under this alternative.

Under the provisions of the Endangered Species Act, there would be no irreversible impacts to endangered species as a result of implementing the Mid-Sized Reservoir Alternative. In the event sufficient progress is not achieved under the RIP, re-initiation of consultation would be required to discuss additional conservation measures.

The impacts to the SWWF under the Mid-Sized Reservoir Alternative would be the same as those under the Proposed Action.

Prior to construction of the proposed project, greater sage grouse habitat would be surveyed for any use by these birds. If active nests are found in the area, construction would be delayed until these birds have left their nests, probably in early June.

A survey for golden eagle nest use would be conducted prior to construction. If active nests are found, construction activities within 0.5 miles of the nest would not be allowed from January 1–August 31.

#### 3.12.3.4 Small Reservoir Alternative

There would be a 4,841-acre-foot-per-year depletion to the Colorado River that could affect the Colorado pikeminnow, bonytail, humpback chub, and razorback sucker.

Incidental take of Colorado pikeminnow, humpback chub, bonytail, or razorback sucker is not anticipated under this alternative, nor would it be authorized.

It was assumed that the same criteria applied to the Proposed Action to offset project depletion impacts could appropriately be applied to the Small Reservoir Alternative. This would result in a one-time contribution of $88,542 (4,841 acre-feet multiplied by 2009 depletion charge of $18.29) to the Recovery Program. Other conservation measures described for the Proposed Action also would be implemented under this alternative.

Under provisions of the Endangered Species Act, there would be no irreversible impacts to endangered species as a result of implementing the Small Reservoir Alternative. In the event sufficient progress was not achieved under the RIP, re-initiation of consultation would be required to discuss additional conservation measures.

The impacts to the SWWF under the Small Reservoir Alternative would be the same as with the Proposed Action but proportionately reduced.

Prior to construction of the proposed project, greater sage grouse habitat would be surveyed for any use by these birds. If active nests are found in the area, construction would be delayed until these birds have left their nests, probably in early June.

A survey for golden eagle nest use would be conducted prior to construction. If active nests are found, construction activities within 0.5 miles of the nest would not be allowed from January 1–August 31.

### 3.12.4 Conservation and Other Special Status Species Impacts

The spotted frog is not a federally listed species. However, potential project impacts to the species have been considered. A survey of historic spring and wetland habitat along the San Pitch River was conducted, and

spotted frogs were found to be present within the project area. Increased flows in the San Pitch River associated with any of the construction alternatives of the project could benefit the springs and wetlands that comprise spotted frog habitat along the San Pitch River by increasing water quantity. On the other hand, if spotted frog habitat receives return flows from irrigation, habitat quality could be diminished by virtue of the conservation measures. If a construction alternative is implemented, the net effect of the project, together with the conservation measures, would probably be a slight net reduction dispersed over a large area.

Three fish species, including roundtail chub, bluehead sucker, and flannelmouth sucker, are Utah State-listed sensitive species. Although roundtail chub historically inhabited the Price River, they have been extirpated from the system. The bluehead sucker and the flannelmouth sucker exist in the Price River below the Farnham Diversion Dam, which is approximately 3 miles southeast of Wellington, Utah. This structure effectively eliminates upstream fish migration. Reaches of the Price River below this structure are a significant distance from the Proposed Narrows Dam. Effects to flows associated with this project would be attenuated to the point of insignificance as measured at the Farnham Diversion Dam. Therefore, the proposed project would have no effect on these fish species.

Migratory bird species and their habitat would be temporarily disturbed during construction activities. The long-term effects of altering flows in the various drainages described in this FEIS would be of significance. However, the FEIS proposes several mitigative measures to provide improved and additional wetland habitats that these species rely on.

# 3.13 VEGETATIVE RESOURCES

## 3.13.1 Affected Environment

Major plant communities occurring in the project area have been mapped (see figure 3-11) and include vasey sagebrush, silver sagebrush, and wetlands. Wetlands are discussed separately below.

There are also areas within the basin that have been disturbed previously by diverting water to Cottonwood Canyon through the existing Narrows Tunnel. In addition, there are those disturbed areas associated with SR-264 that cross the north end of the basin.

A summary of vegetated areas affected by the project is listed in table 3-25.

**Table 3-25.—Narrows Project Summary of Affected Vegetated Areas**

| Area | Acres |
|---|---|
| Reservoir basin | 604 |
| Wetland mitigation | 220 |
| Upland mitigation | 790 |
| Fisheries mitigation | 90 |
| Pipelines | 63 |
| SR-264 relocation | 34 |
| Recreational areas | 12 |
| Materials source | 2 |
| Total | 1,815 |

### 3.13.1.1 Vasey Sagebrush Community

This community is the driest of the three major plant communities in the basin. It exists on the more well-drained soils of the upland slopes. The vasey sagebrush community comprises 55% (331 acres) of the reservoir basin. Dominant woody plant species of the community include vasey sagebrush (*Artemisia tridentata* var. *vaseyana*), low rabbitbrush (*Chrysothamnus viscidiflorus*), and snowberry (*Symphoricarpos oreophilis*).

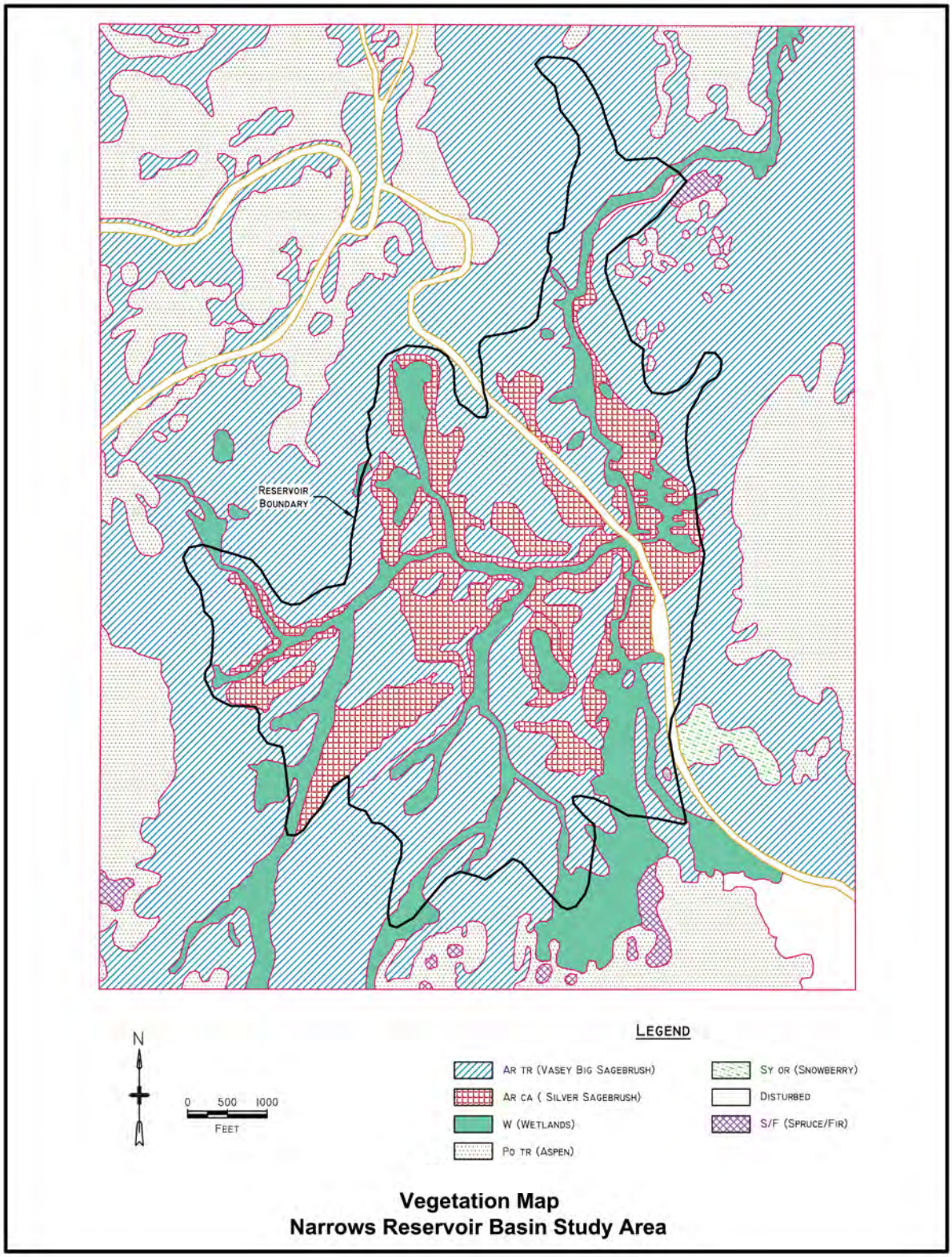



**Figure 3-11.—Narrows Reservoir Basin Study Area Vegetation Map.**

Dominant forbs are Pacific aster (*Aster chilensis*), yarrow (*Achillea millefolium*), and orange sneezeweed (*Helenium hoopsii*). The dominant grasses are represented by slender wheatgrass (*Elymus trachycaulus*), Letterman needlegrass (*Stipa lettermanii*), and mountain brome (*Bromus carinatus*).

Range analysis studies were conducted by the USDA Forest Service on federally owned land near the project area. Total annual production ranged from 682–949 dry pounds per acre.

#### 3.13.1.2 Silver Sagebrush Community

The silver sagebrush community lies immediately below (downslope) the vasey sagebrush community and comprises 26% (156 acres) of the basin. The soils of this community occur on both level and sloped terrain but generally are on the less well-drained and flatter areas. Consequently, they support more mesic shrub species—for example, silver sagebrush (*Artemisia cana*) and shrubby cinquefoil (*Potentilla fruticosa*). Forb species include penstemon (*Penstemon* spp.), varileaf phacelia (*Phacelia heteophylla*), and silver cinquefoil (*Potentilla anserina*). Grasses dominant in the area are orchardgrass (*Dactylis glomerata*), and Kentucky bluegrass (*Poa pratensis*).

#### 3.13.1.3 Previously Disturbed Areas

The total previously disturbed area within the reservoir basin was calculated to be about 17 acres or 2%. Table 3-26 is a summary of vegetation communities found in the reservoir basin.

#### 3.13.1.4 Noxious Weeds

Both the Utah Noxious Weed Act (Utah Code 4-17 et seq.) and the *Manti-LaSal Forest Plan* identify invasive species and noxious weeds. Of these species of concern, there are extensive stands of Dalmation toadflax (*Linaria dalmatica*) and some scattered musk thistle (*Carduus nutans*) that occur in the reservoir basin area, primarily on private land. These noxious weeds occur primarily in the sagebrush communities and, to a lesser extent, in the wetland areas.

**Table 3-26.—Vegetation Communities in the Reservoir Basin[1] of the Proposed Action**

| Affected Type | Acres |
|---|---|
| Vasey sagebrush | 331 |
| Silver sagebrush | 156 |
| Wetland communities | 100 |
| Previously disturbed | 17 |
| Total | 604 |

[1] An almost negligible amount (<1%; 0.18 acre) of aspen forest also could be affected within the reservoir basin.

#### 3.13.1.5 Plant Communities Adjacent to the Reservoir Basin

Major plant communities that exist within the immediate area, but are not within inundation areas, include vasey sagebrush, snowberry, aspen, and spruce/fir (see figure 3-11).

#### 3.13.1.6 Other Plant Communities

Other plant communities were studied as part of the existing environment, which could be affected by the proposed project. Foothill areas along the west side of the Wasatch Plateau would be dissected with the conveyance pipelines. Plant communities found in those areas include valley sagebrush, scrub oak, grassland, and mountain brush.

### 3.13.2 Methodology and Impact Indicators

The Narrows Reservoir basin was identified as the area that would be most significantly impacted by the proposed project. For this reason, vegetation of the basin was studied in

more detail than the other areas associated with the project. Other areas also would be directly affected by the proposed project as a result of reservoir inundation, construction disturbance, and mitigation.

Potential impacts on vegetative resources are considered significant if project implementation results in any loss of wetland acreage (extent) or function. Based on this criterion, all impacts on wetlands and riparian communities would be significant because of the loss of acreage and function prior to implementing mitigation measures.

Potential impacts on aquatic resources in streams are considered significant if project construction, implementation, or long-term operation would cause a loss of stream length due to inundation by the reservoir or stream reaches affected by the increase or decrease in flow.

Impact indicators for this issue include the number of miles of stream lost due to inundation of the reservoir or the number of miles of stream affected by flow.

## 3.13.3 Predicted Effects

### 3.13.3.1 No Action Alternative

Vegetative conditions are expected to remain the same as baseline conditions if the project were not constructed and if there were no other future developments.

Noxious weeds have the potential to spread. Control must be performed by the landowner or Sanpete County.

### 3.13.3.2 Proposed Action Alternative

A hydrologic study conducted on the potential impacts to the riparian vegetation of Gooseberry Creek by decreased flows suggested only a minor impact to the riparian vegetation. Flow measurement conducted by the State Engineer's office indicated that the stream was a "gaining stream." This means that the depth of the ground water table adjacent to the stream corresponds directly with the water surface of the stream—that is, an increase or decrease in stream water level results in the corresponding increase or decrease in the elevation of the ground water table. Moreover, the project plan includes channel modification work in the middle segment of Gooseberry Creek to keep the flow levels up. Because the depth of flow in the stream would not be reduced significantly under the project, the depth of the ground water table adjacent to the stream should not be expected to be lowered.

A lack of overbank flooding due to stream regulation can result in an absence of recruitment of younger age classes of natural riparian vegetation such as cottonwood trees and willows. Overbank flooding, particularly on larger streams and rivers, both scours the banks, providing a new seedbed, and transports and deposits seed thereon. The reduction of overbank flows appears to be the result of stream regulation—that is, placing a smaller stream into a larger channel formed by larger peak flows of the unregulated stream or river.

At the proposed project, this effect would be offset by the channel modifications on Middle Gooseberry Creek, whereby the channel actually would be sized down to match the postdam stream. Base flows would be provided from the Narrows Project, but overbank flooding also still should occur as the result of natural local events such as thunderstorms, as well as from periodic flushing flow releases from the proposed Narrows Reservoir. Given the relative size of Gooseberry Creek (i.e., as compared to larger streams), the likelihood of actual scouring would be no greater than under predam conditions, but seed spreading and propagation most probably would remain similar under postdam conditions as under

predam conditions. Therefore, the riparian vegetation should not be adversely affected by the project. (See also the discussion of "Wetland Resources" under section 3.14.3.2.)

Because the Narrows Project water would be added only to the flow (if any) of Cottonwood Creek when that creek is flowing well below its channel capacity, there would be no period of extended overbank flooding resulting from the Proposed Action. Flooding would result, both predam and postdam, only when the natural flow in the Cottonwood Creek basin is high. Project releases would not be added on top of such peak flows, nor would they be added to lower flows to produce additional floods. As a result of existing diversions, Cottonwood Creek is now dry much of the summer and fall. Project releases simply would provide a longer period of wetted channel, which should benefit riparian vegetation (see additional discussion in section 3.14).

The areas that are disturbed during construction have a high probability of being infested by noxious weed species. People using the area may spread the weeds by carrying the seeds on their person or on their vehicles. Seeds will get into the water and be spread downstream in both Gooseberry Creek and Cottonwood Creek. Control of noxious weeds as part of the Narrows Project would be the responsibility of SWCD.

Areas along the foothills of the west side of the Wasatch Plateau would be dissected with the diversion pipelines. Plant communities such as big sagebrush (*Artemisia tridentata var. tridentata*), gamble oak (*Quercus gambelii*), grasslands, and mountain brush communities, along with their associated wildlife species, would be disturbed by the conveyance pipelines. These disturbances, however, would be only temporary because the pipelines would be buried. Revegetation that reflects the existing plant community would be accomplished with a mixture of grasses, forbs, and shrubs. A total of 30 acres along a 17-mile-long alignment would be disturbed by the pipeline construction.

The reservoir basin was identified to receive the most significant impact by the proposed project. For this reason, the reservoir basin was studied in greater detail than the other areas associated with the project. The affected wetlands in this area occur in a dendritic pattern in the riparian zones along small drainages. As shown in table 3-26, plant communities that would be highly impacted by reservoir inundation include vasey sagebrush, silver sagebrush, and wetlands. All vegetation in the 604 acres listed in the table would be inundated by the reservoir. (See table 3-26 for acreage breakdown by vegetative type.)

#### 3.13.3.3 Mid-Sized Reservoir Alternative

Impacts to vegetation resulting from implementing the Mid-Sized Reservoir Alternative would be similar to those resulting from construction of the Proposed Action. The primary difference would be the smaller amount of acreage (489 acres) that would be inundated by the proposed Narrows Reservoir. This area includes 81 acres of wetlands. The affected wetlands in the reservoir basin occur in a dendritic pattern in the riparian zones along small drainages. Other impacts to vegetation would be similar to those experienced under the Proposed Action.

#### 3.13.3.4 Small Reservoir Alternative

Impacts to vegetation resulting from implementing the Small Reservoir Alternative would be similar to those resulting from construction of the Proposed Action. The primary difference would be the smaller amount of acreage (362 acres) that would be inundated by the proposed Narrows Reservoir. This area includes 72 acres of

wetlands. The affected wetlands in the reservoir basin occur in a dendritic pattern in the riparian zones along small drainages. Other impacts to vegetation would be similar to those experienced under the Proposed Action.

## 3.14 WETLAND RESOURCES

### 3.14.1 Affected Environment

The wetland community lies near the bottom of the basin and comprises 17% of the basin. The wetlands affected by the project are not unique to the area, consisting of wetland plant communities common to high elevation mountain areas. Cattle and sheep were introduced into the area in the 1800s and, subsequently, overgrazed the vegetation to the extent that rangeland restoration was necessary. In 1908, the USDA Forest Service established a controlled grazing plan for rangelands on the Manti-La Sal National Forest. Cattle and sheep grazing are still allowed in this area under USDA Forest Service control.

Within the proposed reservoir basin, water collects and forms meadows, wetlands, and, ultimately, small creeks that converge to Gooseberry Creek. Wetland communities are composed of wet meadows, riparian sedge, and willow thickets. The wet meadows are formed in topographic depressions located adjacent to some of the streamside vegetation and on higher ridges where seeps occur. They consist of plant species such as rushes (*Juncus* spp.), sedges (*Carex* spp.), and various hydric grasses, including tufted hairgrass (*Deschampsia caespitosa*). Similar in species and composition are the riparian sedge communities, which occur in a dendritic pattern along small drainages. They also consist of various rushes, sedges, and grass species, which form narrow bands (usually 3–6 feet wide) of streamside vegetation common to the area. Less common in the reservoir basin are willow thickets, occurring primarily in the upper reaches of the proposed inundation level, usually along stream channels in the basin and along Gooseberry Creek and in Cottonwood Creek. Willow species include Drummond's willow (*Salix drummondiana*), Booth willow (S. *boothii*), and Wolf willow (*S. wolfii*).

Former wetlands being considered as a mitigation alternative are located adjacent to Mud Creek near Scofield. In addition to Mud Creek, numerous springs emerge from the nearby side hill. The creek and springs should provide an ample water supply for wetland vegetation. This area, however, currently is overgrazed and often is covered by weedy plant species, but it has the potential of supporting stable, wetland plant communities. In addition, the streambanks have been severely damaged by cattle that are kept on the land.

Both USACE and EPA have jurisdiction over wetlands for the Narrows Project. USACE is responsible for issuing permits for activities in waters of the United States. The combined jurisdictional wetlands of the basin study area constitute 89 acres of the reservoir basin. Of the 89 wetland acres that exist in the reservoir basin, the riparian sedge and meadows comprise about 63%; whereas, the willow thickets comprise nearly 37%. Previous wetland losses within the reservoir basin include less than 0.5 acre associated with construction of SR-264.

For a map showing the wetland communities within the basin study area, refer to figure 3-11.

### 3.14.2 Methodology and Impact Indicators

A wetland delineation for the reservoir site was completed in 1991–92 following the procedures outlined in the USACE manual.

In 2003 at the request of the Utah Regulatory Office of the USACE, a wetland delineation verification was performed for a portion of the area within the proposed Narrows Reservoir. The 2003 delineation was verified by the USACE on January 13, 2004. The 2003–04 delineation and re-verification covered approximately 349 acres of the proposed reservoir, representing45% of the proposed reservoir area.

In 2003, it was found that the 1992 wetlands map was generally accurate; but because of methods used to create the 1992 map and possibly because of change in vegetation over time, the wetland delineation verification in 2003 was 24.53 acres out of the 349 acres examined. From this, the 2003 study extrapolated that the entire reservoir area contained 71 acres of wetlands.

Re-verification of the wetland delineation was performed in 2009. In 2009, the overall estimated wetlands were 89 acres. Because the original 1992 wetland delineation of 100 acres was generally accurate, data from that delineation were used in this FEIS for mitigation.

Because the primary function of wetlands is wildlife habitat, HEP was used to evaluate the wetland values. This is a "species habitat" approach to impact assessment of habitat quality. The program uses selected species for indicators to evaluate habitat for a host of other species, with the assumption that these indicator (evaluation) species are functioning units of part of an ecosystem. Impact to a particular indicator species assumes that there also would be impacts to the group of other species it represents.

The HSI were ascertained for each evaluation (indicator) species. These indices range from 0.0–1.0, with each increment of change identical to the next. An HSI value is linearly related to the carrying capacity of the species. An HSI of "1.0" would represent the optimum habitat for the particular evaluation species, whereas "0.0" would represent habitat that is unsuitable.

The HEP analysis is an indicator of the function and value of wetlands lost. Another important impact indicator is the total number of acres of wetlands lost as a result of the Narrows Project. Based on these criteria, all impacts on wetlands would be important because of the loss of acreage and function prior to implementing mitigation measures.

## 3.14.3 Predicted Effects

### 3.14.3.1 No Action Alternative

Wetland conditions are expected to remain the same as baseline conditions if the project were not constructed and if there were no future developments. Based on the 2009 re-verification of the wetlands in the project area, there are 89 acres of jurisdictional wetlands.

### 3.14.3.2 Proposed Action Alternative

The proposed Narrows Reservoir would inundate 89 acres of wetlands.

Hydrologic and hydraulic studies were conducted to determine the potential impacts to the riparian and wetland vegetation of Gooseberry Creek resulting from decreased flows. Flow measurements conducted by the Utah Division of Water Rights indicate that the stream is a "gaining stream." This means that the streamflow increases as it moves downstream because the stream is being fed by the adjacent ground water aquifer. Because the stream is serving as a drain for the ground water system, an increase or decrease in stream water level would result in a corresponding increase or decrease in the elevation of the ground water table adjacent to the stream.

Water surface profile studies were conducted to determine the depth of flow in Gooseberry Creek between the Narrows damsite and Lower Gooseberry Reservoir. The studies indicated that, with the reduced flows proposed by the Proposed Action and with the existing stream cross section, the depth of flow would decrease by 6–11 inches under worst-case conditions. However, the project plan includes proposed modifications to this portion of the Gooseberry Creek channel. These modifications include narrowing the channel to maintain the depth of flow. In designing the stream channel modifications, the intent would be to create a stream channel that is more naturally suited to the new flow regime and that will have the same depth of flow as under baseline conditions. Therefore, the depth of ground water adjacent to the stream would not decrease, nor would there be any adverse effects on riparian and wetland vegetation adjacent to the stream. If anything, it is entirely possible that the wetland communities would be enlarged as a result of the project impacts; the current outer bounds of those communities probably would be unchanged as a result of the shallow ground water flowing toward the stream, but the wetlands probably would be increased precisely to the degree that the stream channel itself (or at least, the open water surface of the stream) narrows.

The process of narrowing the stream, as described in the FEIS, is planned so that the configuration of the narrowed streambanks would conform to that of the original streambank with respect to slope, materials, material size, and frequency as well as the water depth. The only change would be in the width of the channel and available open water surface. The result is that the same opportunity for overbank flows and wetted perimeter would exist as in the natural configuration. The gaining nature of the stream in this reach means that ground water is flowing toward and into the stream channel and that the stream does not provide the primary supply for the riparian community. The "wetted perimeter," therefore, should continue to be supplied from this source; and the stream will continue to gain as it flows. Bank saturation will not be affected here, as it would on many streams, because the direction of the ground water flows into the stream rather than away from it. While overbank flows may be reduced in frequency, such flows, for this same reason, also are not critical to the bank saturation that supports the riparian community.

About 160 square feet (0.004 acre) of wetlands adjacent to Cottonwood Creek would be impacted by constructing the discharge structure at the end of the Upper Cottonwood Creek Pipeline. The other proposed pipelines would not affect wetlands.

#### 3.14.3.3 Mid-Sized Reservoir Alternative

Impacts to wetlands resulting from implementing the Mid-Sized Reservoir Alternative would be similar to those resulting from construction of the Proposed Action. The primary difference would be the smaller amount of acreage (81 acres of wetlands) that would be inundated by Narrows Reservoir.

#### 3.14.3.4 Small Reservoir Alternative

Impacts to wetlands resulting from implementing the Small Reservoir Alternative would be similar to those resulting from constructing the Proposed Action. The primary difference would be the smaller amount of acreage (72 acres of wetlands) that would be inundated by Narrows Reservoir.

### 3.14.4 Mitigation

Wetland mitigation measures are included in the project alternatives to compensate for impacts to wetlands. The

wetland mitigation measures would provide similar wildlife habitat values for those potentially lost due to the proposed inundation of the reservoir should the project be built.

#### 3.14.4.1 Proposed Mitigation – Mud Creek Area

The proposed mitigation would restore and create wetlands adjacent to Mud Creek near Scofield. This measure would entail purchasing about 220 acres of private land adjacent to Mud Creek, south of Scofield Reservoir. Portions of this land contain wetlands that have been severely damaged by past livestock grazing practices. The remaining portions are upland. It is anticipated that, by removing livestock, the wetland vegetation would return on its own with little or no other outside measures. Stream channel improvements on the Mud Creek channel would create additional wetlands adjacent to the stream. Some earthwork would be needed to create small berms and swales, which would create cells of new wetlands. These wetlands would be fed by the discharge from existing springs in the area (additional details can be found in section 2.2.2.2.4). Flows from Mud Creek also could be used to supply water for these wetlands. All or a portion of the required wetland mitigation could be performed at this site. The wetland area would be maintained by SWCD under a MOA with UDWR.

#### 3.14.4.2 Alternative Mitigation – Area West of Lower Gooseberry Reservoir

Water would be diverted from an existing diversion structure on Cabin Hollow and would be transported through an existing open ditch to the 120-acre mitigation site. The water would be diverted from the ditch at several locations and allowed to flow across the uplands and to the surrounding wetlands. The existing wetlands on this site appear to have been created and maintained by the existing irrigation system. Some earthwork would be needed to create small berms and swales, creating cells of wetlands. The area around the perimeter would be excavated somewhat deeper and to a 20-foot minimum width, wider in some areas so that the edge of the swale is not abrupt but serpentine. This deeper area would allow for willows and other shrubs to be planted to create a vegetation barrier to the interior wetlands. The area would still be available for grazing, and wildlife would use the area; however, sheep would be deterred from entering the wetland by the perimeter swale, unless forced to cross the deeper water. The above perimeter swale would eliminate the need to fence the area and would allow access for wildlife. At least a portion of the required wetland mitigation could be accomplished at this site.

#### 3.14.4.3 Alternative Mitigation – Area Between Fairview Lakes and Narrows Reservoir

This alternative would include enlarging existing wetland areas and creating new wetlands adjacent to Narrows Reservoir. About 100 acres of new wetlands would be created adjacent to Narrows Reservoir. This would be accomplished by releasing water from Fairview Lakes to inundate lands adjacent to existing wetlands. A new outlet from Fairview Lakes would be provided. The outlet would be designed to automatically begin releasing water once Fairview Lakes reaches a certain level. The releases would stop as the water level receded in the fall. The water would be conveyed to and distributed within the wetland area by a system of open ditches. Some recontouring would be performed to ensure that the soils become saturated. All or a portion of the required wetland mitigation could be

accomplished at this site. This wetland area would be maintained by SWCD under a MOA with UDWR.

#### 3.14.4.4 Alternative Mitigation – Manti Meadows

Under this alternative, return flows from the Narrows Project in the San Pitch River drainage would be available for UDWR to use at the Manti Meadows Waterfowl Management Area located southwest of Manti. Sixmile Creek water, which belongs to the Gunnison Irrigation Company and now flows into Gunnison Reservoir, would be diverted and delivered to the Manti Meadows area through existing facilities belonging to the Manti Irrigation and Reservoir Company. Narrows Project return flows arising in the San Pitch River would be delivered to Gunnison Reservoir in exchange for the water delivered to Manti Meadows. The water could be used to create at least 100 acres of new wetlands and to improve wetland habitat values of existing wetlands in the area. Some excavation and ground recontouring of existing uplands would be required to control drainage and encourage wetland development.

SWCD would have primary responsibility for implementing the wetland measures described above. SWCD would be responsible for funding and acquiring all lands and rights-of-way. SWCD would provide and transplant any native plantings needed. The wetland area would be maintained by SWCD under a MOA with UDWR.

### 3.14.5 Monitoring

Careful monitoring of the mitigation sites would be conducted to ensure that the value of the mitigation sites is at least equal to the value of the wetlands lost. This determination would be accomplished by performing HEP analysis of the sites prior to construction. Baseline information would be collected and compared to existing habitat values for 4 years after construction was completed to determine whether objectives were met. Monitoring would continue for a longer period of time if the wetland mitigation was not completed satisfactorily, or as otherwise deemed appropriate by USACE. If the mitigation goal is not met, additional mitigation would be provided at other alternative mitigation sites.

### 3.14.6 Maintenance

SWCD would be responsible to ensure that all fences are in good repair and are maintained properly. SWCD also would be responsible to install and maintain any diversion and/or irrigation facilities. The initial work would be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way would be acquired, and initial construction of wetland measures would be completed prior to initial filling of the reservoir. SWCD would be responsible to fund the monitoring of the wetland mitigation. SWCD would be responsible to enter into a MOA with UDWR, USACE, and other appropriate agencies for wetland measures. The MOA clearly would define the roles and responsibilities of SWCD, UDWR, USACE, and other parties for implementing and maintaining the wetland measures.

### 3.14.7 Secondary Benefits

#### 3.14.7.1 Upper Cottonwood Creek from the Left Hand Fork to the Mouth of the Canyon and Irrigation Diversion Works

During winter months, a 2.0-cfs release flow would be made from Narrows Reservoir to Cottonwood Creek to increase the available fish habitat and provide hydrology for

wetlands along the creek. Although primarily intended as a measure to facilitate winter survival of fish, this measure also would have some beneficial effects on the riparian and wetland areas adjacent to the creek.

#### 3.14.7.2 Lower Cottonwood Creek from the Irrigation Diversion to the San Pitch River

A 2.0-cfs minimum diversion would be provided in lower Cottonwood Creek from the canyon mouth. This measure would provide year-round flows in the stream, which would enhance the riparian corridor. This segment of stream historically has been dewatered during the irrigation season. Although primarily intended as a measure to facilitate winter survival of fish, this measure also would have some beneficial effects on the riparian and wetland areas adjacent to the creek. Cottonwood Creek has essentially no riparian zone, due to existing irrigation diversions, from the mouth of the creek to the San Pitch River confluence. Providing flows in summer months would stimulate the growth of riparian and wetland vegetation.

#### 3.14.7.3 Streamflows from Fairview Lakes to the Proposed Reservoir

Presently, during the spring runoff period, water is stored in Fairview Lakes and released for irrigation use in the Fairview area. This release is a transbasin diversion of water to the San Pitch River drainage. With the historic operational pattern, the small tributaries to Gooseberry Creek located downstream from Fairview Lakes are dry several months each year. This mitigation measure involves providing year-round releases, averaging about 2.6 cfs from Fairview Lakes, into two of these tributaries to Gooseberry Creek. This amounts to an average 1.3-cfs flow per channel. The total annual amount of water that is released from Fairview Lakes would not be changed. The flow, however, would be dispersed during the entire year, rather than the present 18- to 20-week discharge period.

Water released from Fairview Lakes during the year would be captured and stored in Narrows Reservoir. Upon call by CGIC, their water would be released through the Narrows Tunnel to the San Pitch River drainage. This would provide aquatic benefits to the Narrows Project and aesthetic and recreational benefits to Fairview Lakes. These benefits would result from maintaining the lakes at a higher water level during the prime summer recreational season. This measure also would result in creating approximately 2.3 stream miles of spawning and rearing habitat for cutthroat trout and creating and enhancing wetlands and riparian areas along the stream.

SWCD would be responsible for entering into operating agreements necessary to implement these year-round releases. SWCD would ensure that the releases are made according to environmental commitments.

#### 3.14.7.4 Middle Gooseberry Creek

As part of the fishery mitigation, the channel of Gooseberry Creek would be narrowed between Lower Gooseberry Reservoir and Narrows Dam to provide better habitat with reduced flows. It is expected that the channel eventually would narrow by itself due to the decreased flow. However, to expedite the process, certain manmade improvements would be made, reducing the vertical cut and eroded banks and providing wetland and riparian areas.

# 3.15 RECREATION AND VISUALS

## 3.15.1 Recreation

### 3.15.1.1 Affected Environment

According to the Utah Division of Parks and Recreation's *2009 State Comprehensive Recreation Plan*, the most popular outdoor individual recreational activity in Utah is walking for pleasure or exercise, followed by picnicking. The third most popular activity in most districts was swimming, though camping was the third in the six-county and southeastern planning districts. As with other major reservoirs along the Wasatch Front, Lower Gooseberry Reservoir, Beaver Dam Reservoir, and Fairview Lakes are heavily fished and overcrowded. Boating also ranks as a popular outdoor recreation activity in Utah.

High priority needs for new facilities are mostly new parks, new facilities at existing parks, new ballfields, new motorized trails, and facilities.

Beaver Dam is a heavily used day-use area for anglers near the proposed project, and there are several developed USDA Forest Service campground facilities in close proximity to the project area. The Lower Gooseberry Reservoir (16 units), Gooseberry (10 units), Flat Canyon (13 units), and Lake Campground (51 units) are all fee areas, with a 92-day season of use from June 15–September 15. Water, sanitation facilities, tables, and fire grills are provided. Also in the area is Boulger Reservoir, a nondeveloped, dispersed camping area equipped with vault toilet facilities. These campgrounds (with the exception of Boulger) are typically full on weekends and one-third full on weekdays throughout their season of use.

The proposed reservoir area is known as a very popular location for snowmobile enthusiasts. The USDA Forest Service and UDOT maintain unloading, parking, and sanitation facilities along SR-31, immediately west of the proposed reservoir area, from which snowmobiles embark for travel along groomed trails following Skyline Drive and SR-31, as well as in the proposed reservoir area itself.

Whitewater boating is limited mostly to a relatively short season when flows are peaking, coinciding with the high flows from the White River, when the gates at Scofield Reservoir are closed. In wet years, spills from Scofield may contribute to the peak. When Scofield releases again are started up to supply irrigation demands downstream, the level of boating falls off significantly. The segment of the river between Scofield Reservoir and the picnic area above Price Canyon Dam (approximately 15 river miles) contains Class I–III rapids. The segment of the river between the picnic area above Price Canyon to Castle Gate (approximately 8.5 river miles) contains Class III–V rapids. This segment of the river is more challenging and requires skill and careful maneuvering to avoid the hazards of the narrow canyon. The segment of the river between Woodside to the confluence with Green River receives the greatest use due to the flow regime and the wilderness setting of the river segment. This segment of the river also contains Class III–V rapids.

### 3.15.1.2 U.S. Bureau of Labor and the U.S. Census Methodology and Impact Indicators

Recreation use rates at Narrows Reservoir would be expected to be approximately the same use rates as at Scofield, Huntington North, Millsite, Piute, and Otter Creek Reservoirs, based on the current recreation use, number of campsites, and other such facilities per surface acre at each of these reservoirs. The proposed number of

campground units and picnic sites for the Proposed Action, the Mid-Sized Reservoir Alternative, and the Small Reservoir Alternative are intended only as reasonable estimates. The actual number, including restroom type and quantity, boat ramp capacity, group site accommodations, and other facilities, would be determined in detail during the recreation facility design process for the proposed project.

Scofield and Huntington North Reservoirs, both constructed by Reclamation, are in the same vicinity as the proposed Narrows Reservoir. Both reservoirs are heavily used for recreation. Table 3-27 shows the recreation use at Scofield, Huntington North, Millsite, Piute, and Otter Creek Reservoirs as well as the annual visitation and revenues.

**Table 3-27.—Narrows Project Nearby Reservoirs Present Recreation Use and Revenues**

| Reservoir | Recreation Days | Revenues |
|---|---|---|
| Scofield | 79,076 | $68,912 |
| Huntington North | 56,451 | $41,627 |
| Millsite | 32, 556 | $32,499 |
| Piute | 22,230 | $ 7,410 |
| Ottercreek | 64,752 | $77,666 |

Recreation use of the reservoirs includes fishing, boating, camping, picnicking, snowmobiling, and hunting. Although total recreation days (any or all of a 24-hour period) are available for these areas, there is no breakdown of data for the number of visitor days spent on each specific activity.

Lower Gooseberry Reservoir, Beaver Dam Reservoir, and Fairview Lakes are heavily fished. In the immediate project area, Gooseberry Creek is used to a lesser degree by fishermen.

Dispersed recreation occurs outside of areas where existing recreation facilities are built. It occurs mostly along or adjacent to roads and includes activities such as driving for pleasure, camping, hiking or mechanized trail use, hunting, fishing, and wilderness travel. Based on the Recreation Opportunity Spectrum (ROS) system for classifying recreation opportunities, as described in the 1986 *Manti-La Sal National Forest Land and Resource Management Plan (LRMP)*, the dispersed recreation opportunity within the proposed reservoir area would be classified as "Roaded Natural." There are nearly 413,672 acres of land with this classification within the Manti-La Sal National Forest. As indicated in table 3-28, the 1980 recreation use of these lands was about 524,036 visitor days or an average of 1.3 visitor days per acre per year. By the year 2030, the demand for this type of recreation use is expected to increase to about 1,587,912 visitor days per year or 3.8 visitor days per acre per year.

Other areas within the Gooseberry Creek and Fish Creek drainage, but outside the reservoir basin, provide dispersed recreation opportunities classified as "Roaded Natural," "Semiprimitive Motorized," "Semiprimitive Nonmotorized," and "Primitive." The 1980 use and estimated 2030 project demands for these types of recreation opportunities are summarized in table 3-28.

### 3.15.1.3 Predicted Effects

#### *3.15.1.3.1 No Action Alternative*

The existing recreational facilities in and around the project area are overcrowded. Under this alternative, the overcrowding would continue.

#### *3.15.1.3.2 Proposed Action Alternative*

Under this alternative, recreation facilities, including a 24-unit campground, boat ramp, boat ramp parking area for 26 vehicles with trailers, 14 picnic sites, and a corresponding

**Table 3-28.—Manti-La Sal National Forest Dispersed Recreation 1980 Use and Estimated 2030 Demand**

| ROS Class | 1980 Base | | 2030 Demand | |
|---|---|---|---|---|
| | RVDs[1] | Gross Acres | RVDs | Gross Acres |
| Primitive | 2,806 | 48,082 | 20,800 | 48,082 |
| Semiprimitive nonmotorized | 18,162 | 117,891 | 58,256 | 117,891 |
| Semiprimitive motorized | 158,194 | 831,807 | 473,287 | 831,807 |
| Roaded natural appearing | 524,036 | 413,672 | 1,587,912 | 413,672 |
| Total | 703,198 | 1,411,452 | 2,140,255 | 1,411,452 |

[1] RVD = recreation visitor day.

number of restroom facilities, would be provided at the proposed Narrows Reservoir. The recreation facilities would draw heavy use from not only Sanpete, Carbon, and Emery Counties but also from the Provo/Orem and metropolitan Salt Lake City areas. The proposed Narrows Project would help meet the demand for additional boating facilities in the area. In addition, it is expected that the reservoir would develop into an excellent flat-water fishery. A conservation pool would be provided to ensure successful overwintering of fish.

The proposed Narrows Reservoir would increase the State and regional inventory for fishing, boating, and water play. At the top of the active capacity water level for the Proposed Action, the proposed project's facilities are expected to attract a total of 46,930.8 additional recreation days per year of total developed recreation use. These use rates are based on use rates of Scofield, Huntington North, Millsite, Piute, and Otter Creek Reservoirs. Construction of the proposed Narrows Project and its associated recreation facilities would cause the loss of 237 acres of "Roaded Natural" dispersed recreation on Reclamation withdrawn lands and 466 acres on private lands. It is estimated that these 703 acres would provide approximately 910 visitor days at 1980 levels of use and would provide about 2,670 visitor days of use in 2030. This reduction in dispersed use would be offset by the new facilities that would act as an attraction to local communities and individuals from the Wasatch Front who already contribute above 60% of the use on the Manti-La Sal National Forest. It is anticipated that the 46,930.8 recreation days of newly developed recreation use would be paralleled by an equal amount of dispersed recreation in the reservoir vicinity within the first 5 years of operation. This growth in recreation use would be a direct effect of the project and would require more intensive management in the area surrounding it (approximately, the area 8–10 miles in each direction).

At times when this newly developed recreation site and others in the area are at capacity (most of the summer season and particularly holiday weekends), users would move into nearby nondeveloped or dispersed areas. Some reservoir users actually would prefer dispersed sites regardless of developed site availability, and others would use dispersed sites to avoid associated fees.

The amount of dispersed use within 8–10 miles of the proposed reservoir is already at a level considered to be crowded during holidays and big game hunting seasons. The additional attraction of the new flat-water fishery in this area is expected to increase dispersed use to a point that the USDA Forest Service would need to place restrictions on areas available for this type of use. Such restrictions may include special measures for sensitive areas such as wetlands.

In addition to increased resource protection and rehabilitation costs, conflicts among such activities as ice fishing and snowmobile use, hiking, and ATV users could be expected.

Along with increased, dispersed use in the area, nearby developed recreation facilities would be impacted. Gooseberry Campground and the Lower Gooseberry Reservoir units are immediately adjacent to the proposed reservoir, as is the Scenic Byway and snowmobile parking area. Skyline Drive, Flat Canyon Campground, and the limited facilities at Beaver Dam and Boulger Reservoirs are also within reasonably close proximity.

Implementing the Proposed Action would cause Scofield Reservoir to operate at a slightly lower level, thus reducing the surface area. Based on current recreation use at varying water levels, it is anticipated that there would be no impact to the recreation visits annually. Reclamation data is referenced in table 3-27. Based on use rates obtained in 2005 and 2007 creel surveys by UDWR, there would be a loss of 3,239 angler days of fisherman use. The aquatic mitigation measures of restoring year-round flows in two small tributaries to Gooseberry Creek and maintaining Fairview Lakes at a higher elevation during the prime summer recreational season also would provide angler benefits to the area.

Under the Proposed Action, more frequent fishkills and accelerated eutrophication also could degrade the park. However, water quality mitigation has been provided. Whereas the total inventory of water-based recreation may be increased, some of it would be offset by a downgraded State park at Scofield. The higher elevation of the proposed Narrows Reservoir would have a shorter season of use at an elevation of more than 8,600 feet than would the Scofield Reservoir at about 7,600 feet. Greater snow cover probably would occur at elevation 8,600 feet, causing less access because of deep snow and later snowmelt.

Depending on the type of hydrologic year, water levels in Narrows Reservoir would fluctuate between 25–75% of the full pool area during the recreation period—25% on average and up to 75% in an extended drought cycle. Recreation action may be affected, particularly for those using the boat dock at maximum drawdown.

#### *3.15.1.3.3 Mid-Sized Reservoir Alternative*

Under this alternative, recreation facilities would include a 20-unit campground, a boat ramp, 11 picnic sites, and a corresponding number of restroom facilities. At the top of the active capacity for the Mid-Sized Reservoir Alternative, the facilities are expected to attract 37,995.3 additional recreation days per year of developed recreation use (see tables 3-29 and 3-30).

**Table 3-29.—Proposed Recreation Use at the Narrows Project**

| Alternative | Surface Area Acres | Visitor Days per Acre | Visitor Days |
|---|---|---|---|
| Proposed Action | 604 | X 77.7 = | 46,930.8 |
| Mid-Sized Reservoir | 489 | X 77.7 = | 37,995.3 |
| Small Reservoir | 362 | X 77.7 = | 28,127.4 |

Source: Reclamation comparable reservoir analysis, Liljegren, Sterzer, Brown; August 2011.

**Table 3-30.—Proposed Recreation Use at the Narrows Project Including Impacts to Scofield**

| Alternative | Visitor Days for Narrows | Visitor Days for Scofield | Overall Visitor Days for Alternatives |
|---|---|---|---|
| Proposed Action | 46,930.8 | 3,239 | 43,691.8 |
| Mid-Sized Reservoir | 37,995.3 | 3,073 | 34,922.3 |
| Small Reservoir | 28,127.4 | 2,766 | 25,361.4 |

Source: Reclamation comparable reservoir analysis, Liljegren, Sterzer, Brown; August 2011.

## 3.15.2 Visual Resource

### 3.15.2.1 Affected Environment

The project features would be located within the Manti-La Sal National Forest on the Wasatch Plateau. The dam and diversion works would be located in the Gooseberry Valley, a tributary to the Price River, at about elevation 9,000 feet.

The characteristic landscape is consistent with typical high elevation mountain areas. The topography on top of this plateau is rolling and contains shallow basins covered with sage/grass communities bordered by spruce/fir, interspersed with aspen.

The Narrows damsite is within 2 miles of the intersection of two State highways, SR-31 and SR-264. Both highways have been designated as National and State Scenic Byways. SR-31 connects Fairview in the Sanpete Valley with Huntington in Emery County. SR-264 connects Scofield with SR-31 at Skyline Drive. These are major commuter routes for miners from the Sanpete Valley working in the coal mines on the east side of the Wasatch Plateau. In addition to commuting and recreation traffic, SR-31 serves as a route for hauling livestock from the Sanpete Valley to summer ranges.

It should be emphasized that scenery is an important natural resource and recreational element in this part of the forest. It is primarily through the visual sense that most visitors perceive the forest and its interrelated components. There is additional visual sensitivity here due to the adjacent Scenic Byway, which serves as a forest gateway/ viewing corridor for many recreationists.

### 3.15.2.2 Methodology and Impact Indicators

General direction for visual resource management located on page III-17 of the *Manti-La Sal National Forest Land and Resource Management Plan* states, "Forest resource uses or activities should meet the adopted Visual Quality Objective as displayed on the Planned Visual Quality Objective Map."

The Manti-La Sal LRMP has assigned a VQO to each area of the forest, reflecting the desired management emphasis of the specific area. Some of those objectives assigned by the LRMP allow a noticeable degree of change from the existing condition, as determined during the visual assessment conducted in 1986, to facilitate subsequent use in reaching comprehensive forest management goals.

The term, visual quality objective, refers to the degree of acceptable visual alteration of the landscape and is defined as follows: a desired level of scenic excellence based on physical and sociological characteristics of an area. Typically, more stringent VQOs are incorporated to protect the most highly visible and most frequently seen areas that have the greatest amount of variety in vegetation and other features that occur naturally. These long-term VQOs or goals are based on a large-scale visual inventory and management process called the Visual Management System (VMS), which has been used by the national forests for the past two decades. Although inherently subjective, the VMS framework facilitates the attainment of aesthetic goals while balancing other important resource needs.

Much of the reservoir itself, and particularly the anticipated area of mud flat to become exposed when the reservoir is drawn down, is located on private land, which, consequently, has no assigned VQO. A portion of the project near the proposed dam and rerouted section of SR-264 is located in an area designated with a VQO of "Partial Retention."

The objective of the classification of Partial Retention is to ensure that management activities do not visually dominate the characteristic landscape. Management activities should repeat form, line, color, or texture commonly observed in the area. Management activities may introduce form, line, color, or texture, which are found infrequently or not at all in the surrounding scenery, but any changes should remain visually subordinate to the characteristic landscape. Reduction in form, line, color, or texture to meet partial retention should be accomplished as soon after project completion or, at a minimum, within the first year. Any activity must be blended into the landscape so as to attract little uncharacteristic attention.

#### 3.15.2.3 Predicted Effects

##### *3.15.2.3.1 No Action Alternative*

The scenic character of the area would remain undisturbed. Neither positive nor negative visual impacts on the landscape would occur under this alternative.

##### *3.15.2.3.2 Proposed Action Alternative*

Temporary and permanent landscape disturbances would be apparent from the placement of project features such as the rerouting of SR-264 and construction of the Narrows Dam structure. These more permanent features would be acceptable in this area of partial retention, especially in the long term. The dam would be within the setting of other dams in the area, and the rerouted portion of the Scenic Byway would serve as a viewing corridor and not a dominant element. Maintaining views within the parameters of partial retention would be contingent upon successful restoration/ revegetation of the old highway alignment and any scarred areas associated with the dam. Care would need to be taken in developing any associated recreation facilities to ensure that their design is subordinate to the surrounding landscape.

The Narrows Reservoir would be the most noticeable feature. The reservoir would have a surface area of 604 acres when full; however, during the recreation season, the surface area would average 454 acres. A body of water generally is considered to be aesthetically pleasing; however, as the reservoir is drawn down, exposed mud flats around the more shallow parts of the reservoir may be visually detractive but should remain naturally appearing as they follow the natural line of the reservoir's shore. Although viewed from the Scenic Byway and the reservoir itself, these mud flats primarily would be located on private lands that have no VQO designation. However, it is anticipated that these areas would appear more natural over time; and the additional variety provided by the new water body would well offset any negative effect. In the short term, it is anticipated that the visual impact of exposed mud flat or shoreline would be negligible due to steeper topography and the duration and angle of view.

The aquatic mitigation measures of restoring year-round flows in two small tributaries to Gooseberry Creek and maintaining Fairview Lakes at a higher elevation during the prime summer recreational season also would provide aesthetic benefits to the area.

During project construction, increased human activity, heavy machinery, and surface excavation would temporarily detract from the scenery. Such detractions would be visible in localized areas where construction would occur. Minor disruption of traffic on SR-264 would be expected since the existing road would not be inundated until dam construction was completed and the relocated road is serviceable. Temporary disruption on SR-31 is expected.

#### *3.15.2.3.3 Mid-Sized Reservoir Alternative*

Under the Mid-Sized Reservoir Alternative, temporary and permanent landscape disturbances would be the same as those described for the Proposed Action but at a somewhat reduced scale. The proposed Narrows Reservoir would have a surface area of 489 acres when full. During the recreation season, the surface area would average 277 acres. Detractions associated with project construction would be the same as those described for the Proposed Action.

The net effect to visual quality in comparison with the Proposed Action would be largely unnoticeable to the casual forest visitor. A dam still would be built, and a portion of highway would be rerouted. Possibly, there would be less than a proportionate impact relative to exposed mud flats because the Mid-Sized Reservoir Alternative would fill steeper topography near the dam.

#### *3.15.2.3.4 Small Reservoir Alternative*

Under the Small Reservoir Alternative, temporary and permanent landscape disturbances would be the same as those described for the Proposed Action but at a somewhat reduced scale. The proposed Narrows Reservoir would have a surface area of 362 acres when full. During the recreation season, the surface area would average 238 acres. Detractions associated with project construction would be the same as those described for the Proposed Action.

The net effect to visual quality in comparison with the Proposed Action would be largely unnoticeable to the casual forest visitor. A dam still would be built, and a portion of highway would be rerouted. Possibly, there would be less than a proportionate impact relative to exposed mud flats because the smaller reservoir would fill steeper topography near the dam.

# 3.16 CULTURAL RESOURCES

Cultural resources are defined as places, natural features, structures, buildings, landscapes, districts, and objects that are significant in history, architecture, archeology, engineering, community, or culture. Cultural resources are protected by a number of statutes, regulations, and policies that must be taken into consideration during the NEPA process. Of particular importance is Section 106 of the National Historic Preservation Act, which mandates that Federal agencies take into account the potential effects of a proposed Federal undertaking (the Proposed Action) on historic properties and afford the Advisory Council on Historic Preservation the opportunity to comment. In compliance with the NHPA, historic properties are defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the *National Register of Historic Places*.

## 3.16.1 Affected Environment

The affected environment for cultural resources corresponds to the APE as defined in the regulations implementing Section 106 of the NHPA (36 CFR Part 800).

> "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."
> (36 CFR 800.16(d))

The APE for the Proposed Action includes the areas impacted by construction activities associated with the construction of the dam and the land areas eventually inundated by the reservoir pool area. Also included would be any disturbed areas associated with the construction of a proposed pipeline to Cottonwood Creek as well as additional

pipelines to deliver water to existing water distribution systems. Finally, impacts from the proposed rehabilitation of an existing tunnel to Cottonwood Creek, the development of recreation facilities, staging areas, access roads, borrow areas, and any other ancillary facilities linked to the Proposed Action would be included in the APE.

## 3.16.2 Methodology

Should Reclamation approve the loan application and use of Federal lands, then a Federal undertaking would be initiated in compliance with Section 106 of the NHPA, and Reclamation would work with the SWCD, the State Historic Preservation Officer, the Forest Service, Indian tribes and other interested parties to fulfill Section 106 of the NHPA.

To review potential effects to historic properties, the APE was reviewed for prior inventories and documentation of sites or historic properties. Some 1,514 acres were inventoried (Singer, 1979). The 1979 inventory identified three sites: two prehistoric archaeological and one historic site. The prehistoric sites were open lithic scatters with few formal tools.

One historic site, a stone structure foundation, was also located during the 1979 inventory. The three cultural resource sites were not evaluated for their NRHP eligibility. As a result, the sites would have to be revisited and evaluated for their current NRHP eligibility should the undertaking proceed.

The 1979 inventory did not include the Upper Cottonwood Creek, Oak Creek, and East Bench Pipeline alignments, new road alignments, borrow areas, staging areas, recreation facilities, marinas, wetland mitigation areas, haul roads, and other potential ancillary facilities associated with the Proposed Action. These additional portions of the APE would have to be intensively inventoried should the undertaking proceed.

## 3.16.3 Predicted Effects

Predicted effects are based on the 1979 inventory results.

### 3.16.3.1 No Action Alternative

Under the No Action Alternative, there likely would be no effects to the three cultural resources that are known to be present, except for the ongoing effects from grazing and natural processes like erosion.

### 3.16.3.2 Proposed Action Alternative

Under the Proposed Action, should the project be built, then the responsible Federal agency would have to work with the SWCD and other consulting parties to comply with the procedures outlined at 36 CFR 800. The regulatory requirements would be as follows:

- Determine whether the project constitutes a Federal undertaking.
- Identify the State Historic Preservation Officer and other consulting parties, including Indian tribes.
- Define the APE.
- Identify any historic properties within the APE.
- Apply the criteria of adverse effect to any historic properties.
- Assusming adverse effects, resolve adverse effects to historic properties as a result of the Federal undertaking per 36 CFR 800.6.

Based on the three sites (1,514 acres) inventoried, there is a low density of sites in the APE; and historic properties eligible to the *National Register of Historic Places* are

expected to be few in number. Furthermore, consultation with Indian tribes that might attach religious or cultural significance to these sites or that might have sacred sites (as defined in Executive Order 13007) in this area indicates that such sites are not present.

Reclamation and the other consulting parties could either enter into a programmatic agreement to stipulate how these or alternative procedures would be carried out for the undertaking, or the parties could elect to follow the regulatory process at 36 CFR 800 and enter into a memorandum of agreement to resolve effects.

#### 3.16.3.3 Mid-Sized Reservoir Alternative

Cultural resource impacts under this alternative would be the same as those described above in the Proposed Action, except the APE would be reduced in size. Presumably, the number of historic properties and potential adverse effects would decrease proportionately. Given the density of resources in the previously inventoried area, we would not expect to find more historic properties.

#### 3.16.3.4 Small Reservoir Alternative

Cultural resource impacts under this alternative would be the same as those described above in the Proposed Action. The APE would be reduced even further in size, and the number of historic properties would decrease as well.

## 3.17 Economic and Social Resources

### 3.17.1 Affected Environment

Sanpete and Carbon Counties are considered the affected environment for this analysis.

In 2009,[2] population in Carbon County was 19,989 and Sanpete County was 25,946 (i.e., the total county region contained 45,935 persons.) From 1990–2009, Carbon County has the smallest population change, (-0.8%), while Sanpete had an increase of 58.9%. Ethnically, both counties are unusual by United States standards with 91.1% of Carbon County identifying themselves as white and 92.4% of Sanpete County; the median family income in Carbon County was $40,900 in the year 2000, while Sanpete was $37,796.[3] In 2000, Carbon County has 13.4% of its population below the poverty threshold, while Sanpete has a larger share of individuals living below the poverty threshold at 15.9%. In 2000, the United States percentage was 12.4.

For both counties combined, 49.6% of the land is owned by the Federal Government. This high percentage of Federal land is important to socioeconomic analysis because these lands play a role in local employment by providing for commodity extraction, as well as opportunities for travel and tourism. In 2009, mining accounted for 13.8% of the jobs in Carbon County and 0.2% in Sanpete County; agriculture accounted for 2.3% of the jobs in Carbon County and 9.1% in Sanpete. The travel and tourism industry accounted for 13.4% of the jobs in Carbon County and 11.4% in Sanpete. In 1998, travel and tourism accounted for 15.99% of the total employment, and in 2009, 12.63%.

From 1970–2009, farm employment in both counties shrank from 1,641 to 1,332 jobs, an 18.8% decrease.[4] During this same period, nonfarm employment grew by 144.7%. By

[2] U.S. Department of Commerce, 2011. Bureau of Economic Analysis, Regional Economic Information System.

[3] U.S. Department of Commerce, 2011. Census Bureau, American Community Survey Office.

[4] U.S. Department of Commerce, 2011. Bureau of Economic Analysis, Regional Economic Information System, tables CA25 and CA25N.

farms, we include all forms of agricultural production, including livestock operations. In 2007, Carbon County had 294 farms with 215,557 acres devoted to agriculture; while Sanpete had 879 farms with 311,551 acres in agriculture. Some 22.8% of the land area in Carbon County was used for farms and 30.7% in Carbon County.[5] Table 3-31 shows that both counties have the greatest amount of land devoted to raising beef cattle.

Under existing conditions in Sanpete County, two crops of alfalfa are harvested each year; and in some years (less than 25% of the time) when weather conditions are favorable, a small third crop is harvested. One crop of meadow hay normally is harvested, and the aftermath is used as late summer and fall pasture. Small grains are used as rotation crops for hay and pasture. Small grains also sometimes are used as a "nurse" or companion crop for alfalfa. The most common small grain crop is barley. Corn silage, which makes up less than 1% of the irrigated area, is raised primarily by dairymen and livestock feeding operations. Present and projected project crop distribution and yields in Sanpete County are summarized in table 3-32.

## 3.17.2 Methodology

There are two main methods of analysis for the economics of the Narrows Project. The first method is the modeling of regional economic effects; the second is the application of six indicators by Reclamation's loan engineer who will make the decision to approve or deny the loan application from SWCD.

### 3.17.2.1 IMPLAN Modeling

The modeling package used in this study to assess the regional economic effects of construction of each alternative is IMpact Analysis for PLANning (IMPLAN). IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in an economic region.

IMPLAN data files are compiled for the study area from a variety of sources, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau. This analysis used 2004 IMPLAN data for Utah's Sanpete County, where most of the construction activity would occur for the regional impact analysis.

The expenditures associated with construction were placed into categories that represent different sectors of production in the economy. The expenditures that are made inside the study region were considered in the regional impact analysis. Expenditures made outside the study area were considered "leakages" and would have no impact on the local economy. Some construction items (specialized equipment and skilled labor) more likely are to be purchased outside the region and brought to the construction site because of their high cost and lack of availability in the region.

Because of the scale of the construction project, it was assumed that local suppliers and contractors would be able to supply only a portion of the necessary construction, equipment, supplies, and expertise. The regional impact analysis assumed that approximately 50% of the labor wages would be spent locally, and approximately 45% of the construction equipment and supplies would be purchased locally.

[5] U.S. Department of Agriculture, 2009, National Agricultural Statistics Service, Census of Agriculture, table 8.

**Table 3-31.—Types of Farms by County and Production, 2007**

| Number of Farms by Type, 2007 | Carbon | Sanpete |
|---|---|---|
| All farms | 294 | 879 |
| Oilseed and grain farming | 7 | 15 |
| Vegetable and melon farming | 2 | 13 |
| Fruit and nut tree farming | 5 | 6 |
| Greenhouse, nursery, etc. | 8 | 7 |
| Other crop farming | 89 | 272 |
| Beef cattle ranch and farm | 96 | 261 |
| Cattle feedlots | 9 | 21 |
| Dairy cattle and milk production | 0 | 20 |
| Hog and pig farming | 1 | 11 |
| Poultry and egg production | 8 | 68 |
| Sheet and goat farming | 14 | 67 |
| Animal aquaculture and other animal production | 55 | 118 |
| **Percent of Total** | **%** | **%** |
| Oilseed and grain farming | 2.4 | 1.7 |
| Vegetable and melon farming | 0.7 | 1.5 |
| Fruit and nut tree farming | 1.7 | 0.7 |
| Greenhouse, nursery, etc. | 2.7 | 0.8 |
| Other crop farming | 30 | 30.9 |
| Beef cattle ranch and farm | 33 | 29.7 |
| Cattle feedlots | 3.1 | 2.4 |
| Dairy cattle and milk production | 0 | 2.3 |
| Hog and pig farming | 0.3 | 1.3 |
| Poultry and egg production | 2.7 | 7.7 |
| Sheet and goat farming | 4.8 | 7.6 |
| Animal aquaculture and other animal production | 19 | 13.4 |

Source: U.S. Department of Agriculture, 2009. National Agricultural Statistics Service, Census of Agriculture, Washington DC, table 45.

**Table 3-32.—Summary Crop Distribution and Yield for Sanpete County**

| Crop/Unit | Distribution of Total Crop Production (%)[1] | 1990 Yields[2] | Project Yields: With Full Water Supply[3] |
|---|---|---|---|
| Pasture (per animal unit month) | 39 | 5.0 AUM per acre | 8.0 |
| Alfalfa hay (per ton) | 31 | 3.5 tons per acre | 5.2 |
| Small grains (per bushel) | 12 | 80.0 bushels per acre | 85.0 |
| Meadow hay (per ton) | 8 | 2.0 tons per acre | 2.5 |
| Other crops | 2 | NA[4] | NA |
| Fallow and idle | 8 | NA | NA |

[1] Distribution would be essentially the same for present and project conditions; source is *1999 Utah State Water Plan*, Sevier River Basin, table 10-2.

[2] Estimates were generated by SWCD for this study.

[3] Estimates for irrigators purchasing enough project water to obtain a full water supply.

[4] NA = Not applicable.

This analysis also assumed that the majority of the construction expenditures will be funded from sources outside the study area. Money from outside the region that is spent on goods and services within the region would contribute to regional economic impacts, while money that originates from within the study region is much less likely to generate regional economic impacts. Spending from sources within the region represents a redistribution of income and output, resulting in a negligible increase in economic activity.

For the purpose of this study, the construction costs allocated to labor and construction materials spent in the region were used to measure the overall regional impacts. These overall impacts would be spread over the construction period and would vary year by year proportionate to actual expenditures.

#### 3.17.2.2 Indicators for the Loan Application

Reclamation has not had an active small loan program since the 1990s. However, as mentioned previously, the Narrows Project was "grandfathered in" with the understanding that the factors that would be used to analyze the loan are those in effect in 1991. At that time, the Credit Reform Act of 1990 had been passed by Congress; this, coupled with the Office of Management and Budget's Circular A-11, modified how loans were to be made under the SRPA. In accordance with the Credit Reform Act and OMB requirements, Reclamation was directed to compute loan risks tied to computing loan subsidy and to adjust cash inflows from scheduled principal and interest payments for estimating defaults or deferrals. The six indicators that were established in 1991 to determine the overall loan risk and category assignment were:

- Debt/revenue ratio
- Debt/repayment ratio
- Interest/debt ratio
- Expenditures/cash and securities
- Quality of investments
- Bond rating (Moody's)

For the Narrows Project (and other SRPA loan applications), the results of these six financial indicators will be compared

against national averages (standards) to determine the loan's overall classification assignment. In gleaning out this financing and accounting information, the SWCD's audit reports and balance sheets may need to be supplemented and revised to fully evaluate and measure the indicators. The audit report formation and content now required in all loan application reports generally will not cover the entities' bonding status or authority, and this additional information will need to be provided. It is believed that at least four of the six proposed indicators would need to be presented and weighted in determining an overall risk profile and assignment for each loan.

## 3.17.3 Predicted Effects

### 3.17.3.1 No Action Alternative

Under the No Action Alternative, there would be no economic effects of the Narrows Project. The economic profile of the forest was described under the Affected Environment section. The Forest Plan, as amended in 2003, updated and projected the economics for Sanpete County. Comparable projections are not available for Carbon County.

### 3.17.3.2 Regional Impact Analysis of Proposal

The number of jobs created in Sanpete and Carbon Counties during construction of the Narrows Project would not be significant based on a regional impact analysis conducted for this study's action alternatives. At the regional level, the project would cause positive economic output to the study area. Potentially, the most significant short-term impact would occur from construction activities.

It was estimated that the regional impacts on employment, regional output, and income would be less than 1% of the study area's base employment, output, and income (see table 3-33).

**Table 3-33.—Regional Impacts**

| | Regional Base Data | Regional Impacts | % Change |
|---|---|---|---|
| Employment (Full-time jobs) | 9,443 | 50 | <1 |
| Output (millions of dollars) | $802 | $5.8 | <1 |
| Income (millions of dollars) | $234 | $0.9 | <1 |

The regional impacts from the construction costs for all the alternatives would be similar in that the impacts would be less than 1% of the regional employment, output, and income.

These regional construction impacts would be lost after construction was completed. A small amount of regional impacts related to O&M activities would be expected but would not significantly impact the overall regional economy in the study area. The additional water amount provided by each of the alternatives would support the existing community lifestyles and social structure in the study area.

# 3.18 LAND RESOURCES

## 3.18.1 Affected Environment

The proposed non-Federal Narrows Project is located within the exterior boundaries of the Manti-La Sal National Forest. The proposed Federal action is that Reclamation will: 1) approve or deny the SRPA loan application and 2) determine whether to allow the SWCD to use 304.5 acres of Reclamation withdrawn land. SWCD has acquired 366 acres of private lands for project uses from owners by perpetual easement or in fee. SWCD would need to purchase 1,340 additional acres of private and State School Trust lands

for project needs (table 2-4). It is important to note that there may be no SRPA loan, but construction may proceed on Reclamation land with other sources of funding.

While there are some private in-holdings, the majority of the lands located within the Manti-La Sal National Forest boundary is federally owned and is administered by the USDA Forest Service pursuant to specific authorities granted by Congress to the Secretary of Agriculture and pursuant to the public land laws.

Lands within forest reserves may, however, be withdrawn and used for irrigation works constructed under authority of Section 3 of the Reclamation Act of 1902 (32 Statute 388). Therefore, by Secretarial Order dated April 1, 1941, Reclamation withdrew certain forest lands from public entry under the first form of withdrawal (as provided in Section 3 of the 1902 Act). These lands were withdrawn for the Federal Gooseberry Project, which, as originally planned, was never constructed. However, a portion of the original project was constructed as the Scofield Project. The Narrows Project is presently proposed as a private project by SWCD. Their proposal is to use 304.5 acres of the 6,728 acres of the lands originally withdrawn by Reclamation for the Gooseberry Project.

The 1941 Reclamation withdrawal of lands within the Manti-La Sal National Forest created the potential for two Federal agencies—Reclamation and the USDA Forest Service—to have overlapping jurisdiction on the same lands. However, the authority of the Secretary of the Interior under the 1902 Act to withdraw and administer lands for Reclamation purposes is limited to the specific water projects provided for in that Act—that is, Reclamation projects.

At present, both Reclamation and the USDA Forest Service have administrative authority over the withdrawn lands—but each for activities related only to its own mission. Thus, Reclamation has jurisdiction over the withdrawn lands for uses associated with water resources, while the USDA Forest Service has jurisdiction over the withdrawn lands for uses related to their mission. If the non-Federal Narrows Project were constructed, the Reclamation withdrawal would be revoked for all but the 304.5 acres that would be licensed to SWCD under the authority of Section 10 of the 1939 Act for the proposed non-Federal Narrows water project.

Land ownership and use characteristics of Sanpete and Carbon Counties are summarized in tables 3-34 and 3-35, respectively. An inventory of prime and unique farmland (Public Law 95-87) did not reveal any prime or unique farmland in the project area, but as described under the Economic and Social Resources section, in 2007, Carbon County had 215,557 acres devoted to agriculture, while Sanpete had 311,551 acres.

Lands approximately 3 miles east of the project area are under a Federal coal lease and currently are being mined. Additional mineable coal reserves are believed to exist beneath lands east of the East Gooseberry Fault approximately 1 mile east of the project area. A nearby landowner with both land and mineral rights to the east of the proposed reservoir, between the proposed dam and the currently operating Skyline mine, expressed to Reclamation in April 2009 his intent to mine his coal, but exact plans and timing are unknown at this time. Lands immediately adjacent to the project area (within the Gooseberry Graben) are not believed to have mineable coal reserves due to an offset of several hundred feet within the Gooseberry Graben area.

**Table 3-34.—Land Ownership – Sanpete and Carbon Counties, 2011 (acres)**

| | Carbon | Sanpete |
|---|---|---|
| Total Acres | 949,893.75 | 1,024,678.25 |
| Private Lands | 370,605.24 | 436,369.54 |
| Federal Lands | 451,296.62 | 527,429.09 |
| Forest Service | 30,269.52 | 391,554.45 |
| Bureau of Land Management (BLM) | 421,027.10 | 135,118.43 |
| Department of Defense (DOD) | 0.00 | 756.21 |
| State Lands | 127,991.89 | 60,879.62 |
| State Trust Lands | 105,073.04 | 31,770.16 |
| Other State | 22,794.19 | 29,109.46 |
| Tribal Lands | 124.66 | 0.00 |
| **Percent of Total** | | |
| Private Lands | 39.015 | 42.586 |
| Federal Lands | 47.511 | 51.472 |
| Forest Service | 3.187 | 38.212 |
| BLM | 44.324 | 13.186 |
| DOD | 0.000 | 0.074 |
| State Lands | 13.461 | 5.941 |
| State Trust Lands | 11.062 | 3.101 |
| Other State | 2.399 | 2.840 |
| Tribal Lands | 0.013 | 0.000 |

Source: Utah GIS Portal, 2011.
http://gis.utah.gov/utah-gis-portal/utah-land

**Table 3-35.—Land Use Characteristics, Sanpete and Carbon Counties**

| Item | County[1] | |
|---|---|---|
| | Sanpete | Carbon |
| Total acres | 1,022,609 | 947,632 |
| Urban | 1,664 | 9,200 |
| Percent of total | .16 | .98 |
| Agricultural (acres) | 311,551 | 215557 |
| Percent of total acres | 30 | 23 |
| Cropland (acres) | 98,230 | 22,781 |
| Percent of agriculture acres | 32 | 11 |
| Rangeland (acres) | 199,272 | 179,210 |
| Percent of agriculture acres | 64 | 83 |

[1] U.S. Department of Agriculture National Agricultural Statistics Service, 2007.

Agricultural land use within the project area is based on the livestock economy of the area—principally, cattle and sheep operations and a number of Grade A dairies. Other land uses include the turkey industry, large garden spots, potatoes, raspberries, and conifer or deciduous trees.

The majority of the land area that would be inundated by the reservoir is privately owned; the dam, however, would be on Federal land. Some of the private land near the proposed dam and reservoir within the national forest boundary has been subdivided for summer homes and recreation development. Such development must comply with the zoning and building codes of the Sanpete County Commission and the sanitation requirements of the Utah Department of Environmental Quality. The area adjacent to the proposed Narrows Reservoir is county-owned and is zoned as Forest Watershed 1–10 (one dwelling per 10 acres). The primary areas now under development include the area approximately 2 miles east of Lower Gooseberry Reservoir and the area on the north side of privately owned Fairview Lakes.

The Fairview Lakes development contains approximately 150–200 memberships in the privately owned Fairview Lakes Association. The memberships include the right to use a specific lot in the area north and east of Fairview Lakes and south of the project area to park a trailer or construct a cabin. This area has been rezoned, and the one dwelling per 10 acres development ratio does not apply to this area. As a result, it has been developed with lots every 1+ acre each. About 50 cabins have been constructed within the past 5 years. The cabins are used during the winter as well as the summer, since the general area is a popular cross-country skiing and snowmobiling area. Many of the other lots have one to three trailers parked on them for the summer season (June–September). The private landowners allow

their members to use some of the area southwest of Fairview Lakes for recreation use.

Portions of three grazing allotments occur within the project area. They include Swen's Canyon allotment, the Gooseberry-Cottonwood allotment, and the Beaver Dams-Boulger allotment.

Additional allotments that may be impacted by the mitigation measures include the Fairview, Cabin Hollow, and Pondtown allotments.

Swen's Canyon allotment is located in two watershed drainages. That portion, which is located in the same drainage as the proposed Narrows Dam and Reservoir, consists of 583 acres, of which all is suitable for grazing land in fair range condition. Grazing capacity of that portion is about 115 AUMs.

The Beaver Dams-Boulger allotment is a combination of two allotments. Grazing use includes 1,200 head of sheep with a season of July 6–October 5. It is grazed with a rest rotation grazing system where part of the allotment is rested each year.

The Cottonwood-Gooseberry allotment is grazed by 900 head of sheep with a season of July 6–September 30 using a rest rotation grazing system. Suitable grazing land was determined during a range analysis conducted during 1976.

A summary of information concerning the three grazing allotments and four grazing permits is presented in table 3-36. Range conditions and grazing were discussed earlier in the vegetation section of this chapter.

## 3.18.2 Methodology and Impact Indicators

Information on numbers of livestock and grazing seasons was obtained from USDA Forest Service grazing permits. Grazing capacity is derived from range analysis data and other studies to determine grazing capacity.

Impact indicators are the change in AUM available for livestock use. The changes are caused by direct and indirect effects such as increased recreational use and mitigation.

Additional areas will be impacted as additional homes are built.

## 3.18.3 Predicted Effects

If an action alternative were selected and a non-Federal Narrows Project were constructed (see action alternatives below), the Reclamation withdrawal would be revoked for all but the 304.5 acres, which would be licensed to SWCD under the authority of Section 10 of the 1939 Act for the proposed non-Federal water project. Direct effects of this license on withdrawn lands within the area of the dam and reservoir are described in chapter 3 of the FEIS. Reclamation may license the 304.5 acres to SWCD regardless of SWCD's source of financing for the non-Federal water project. Consequently, these effects remain the same whether the construction of the dam is financed under a SRPA loan or some other mix of public and private financing.

### 3.18.3.1 No Action Alternative

Construction of summer homes on private land outside of platted subdivisions is expected to continue at the current rate until development reaches the zoning restrictions of one dwelling per 10 acres. Development of the Fairview Lakes complex would continue as presently planned. Sheep and cattle grazing would continue as described for the existing environment. Mining of Federal and private coal reserves would continue at current levels consistent with market demands and as coal leases are available.

**Table 3-36.—Grazing Allotments Within the Narrows Project Vicinity[1]**

| Allotment | Swen's Canyon | Gooseberry-Cottonwood | Beaver Dams-Boulger |
|---|---|---|---|
| Permits | 1 | 1 | 1 |
| Acreage | | | |
| Federal[2] | 2,277 | 4,229 | 3,014 |
| Private | 1,473 | 384 | 940 |
| Total | 3,750 | 4,613 | 3,954 |
| Suitable grazing | 3,000 | 3,096 | 2,631 |
| Number of Sheep Allowed | | | |
| Federal | 559 | 1,200 | 900 |
| Private | 400 | 0 | 0 |
| Period of use | July 1–September 30 (3.0 months) | July 6–September 30 (2.90 months) | July 6–October 5 (3.06 months) |
| Animal Unit Months[3] | | | |
| Federal | 335 | 696 | 551 |
| Private | 240 | 0 | 0 |
| Condition of Suitable Grazing Land | | | |
| GOOD | | | |
| Number of acres | 326 | 542 | 360 |
| Percent | 11 | 18 | 14 |
| FAIR | | | |
| Number of acres | 2,057 | 2,088 | 1,551 |
| Percent | 69 | 67 | 59 |
| POOR | | | |
| Number of acres | 617 | 466 | 720 |
| Percent | 20 | 15 | 27 |

[1] Source: USDA Forest Service, 1992; Personal communication, USDA Forest Service Supervisory Range Conservationist. Reverified by personal communication in 2003.

[2] Includes Reclamation withdrawn and USDA Forest Service lands.

[3] 1 AUM = 5 sheep.

#### 3.18.3.2 Proposed Action Alternative

Major changes in land use in the area surrounding the dam and reservoir are not anticipated under the Proposed Action. Construction of summer homes outside of platted subdivisions might be accelerated but would be limited by zoning restrictions of one dwelling per 10 acres. Development of the Fairview Lakes complex would continue as previously planned although build-out may occur earlier. Narrows Reservoir, SR-264 and forest development roads relocation, the recreation area, and the conservation easements adjacent to the reservoir would reduce the available grazing area by 856 acres. This area is about 10% of the suitable grazing acreage in the area. The Proposed Action may result in the direct loss of 114 AUM grazing use (856 project acres per 1.5 acres per sheep month = 571 sheep months per 5 sheep months per AUM = 114 AUM); however, indirect loss of grazing (estimated to be about 1,014 acres) may occur on adjacent areas around the reservoir, between the highway and the reservoir, and around camping and residence areas. The total grazing impact is estimated to be 249 AUM (1,870 acres per 1.5 acres per sheep month = 1,247 sheep months per 5 sheep per AUM = 249 AUM). This impact of grazing includes both private and Federal lands. Restrictions on the number of sheep and cattle allowed and/or realignment of grazing allotments may be required due to implementing the Proposed Action.

As the recreation use increased and summer home development proceeded, there could be additional areas in the upper Gooseberry drainage that would not be available for livestock grazing due to anticipated or existing livestock-people conflicts. For every 7 to 10 acres of additional land that cannot be grazed due to conflicts with traffic and/or people, there may be a loss of 1 AUM (5 sheep months) grazing use. Grazing permits and allotment boundaries may need to be adjusted. Land use in the *Manti-La Sal National Forest Land and Resource Management Plan* would change to reflect project implementation.

No reduction of acres of mineable coal reserves is anticipated under the Proposed Action.

#### 3.18.3.3 Mid-Sized Reservoir Alternative

As with the Proposed Action, major changes in land use in the area surrounding the dam and reservoir are not anticipated under this alternative. Narrows Reservoir, SR-264 relocation, the recreation area, and the conservation easements adjacent to the reservoir would reduce the available grazing area by 736 acres. This area is about 7% of the suitable grazing acreage in the area. The Mid-Sized Reservoir Alternative may result in the direct loss of 98 AUM (736 project acres per 1.5 acres per sheep month = 491 sheep months per 5 sheep months per AUM = 98 AUM); however, indirect loss of grazing (estimated to be about 811 additional acres) may occur on adjacent areas around the reservoir, between the highway and the reservoir, and around camping and residence areas. The total grazing impact is estimated to be 206 AUM (1,547 acres per 1.5 acres per sheep month = 1,031 sheep months per 5 sheep month per AUM = 206 AUM). This impact to grazing includes both private and Federal lands. For every 7–10 acres of additional land that cannot be grazed due to conflicts with traffic and/or people, there may be a loss of 1 AUM (5 sheep months) grazing use. Grazing permits and allotment boundaries may need to be adjusted. Land use in the *Manti-La Sal National Forest Land and Resource Management Plan* would change to reflect project implementation.

No reduction of acres of mineable coal reserves are anticipated under the Mid-Sized Reservoir Alternative.

As the recreation use increased and summer home development proceeded, there could be additional areas in the upper Gooseberry drainage that would not be available for livestock grazing due to livestock-people conflicts. Livestock grazing is generally not compatible in, or immediately adjacent to, dwellings and high recreation use areas.

#### 3.18.3.4 Small Reservoir Alternative

As with the Proposed Action, major changes in land use in the area surrounding the dam and reservoir are not anticipated under this alternative. Narrows Reservoir, SR-264 relocation, the recreation area, and the conservation easements adjacent to the reservoir would reduce the available grazing area by 610 acres. This area is about 7% of the suitable grazing acreage in the area. The Small Reservoir Alternative may result in the direct loss of 81 AUM (610 project acres per 1.5 acres per sheep month = 407 sheep months per 5 sheep months per AUM = 81 AUM); however, indirect loss of grazing (estimated to be about 705 additional acres) may occur on adjacent areas around the reservoir, between the highway and the reservoir, and around camping and residence areas. The total grazing impact is estimated to be 175 AUM (1,315 acres per 1.5 acres per sheep month = 877 sheep months per 5 sheep month per AUM = 175 AUM). This impact to grazing includes both private and Federal lands. For every 7–10 acres of additional land that cannot be grazed due to conflicts with traffic and/or people, there may be a loss of 1 AUM (5 sheep months) grazing use. Grazing permits and allotment boundaries may need to be adjusted. Land use in the *Manti-La Sal National Forest Land and Resource Management Plan* would change to reflect project implementation.

No reduction of acres of mineable coal reserves would be anticipated under the Small Reservoir Alternative.

As the recreation use increased and summer home development proceeded, there could be additional areas in the upper Gooseberry drainage that would not be available for livestock grazing due to livestock-people conflicts. Livestock grazing is generally not compatible in or immediately adjacent to dwellings and high recreation use areas.

## 3.19 PUBLIC HEALTH AND SAFETY

### 3.19.1 Affected Environment

Two public health and safety issues were raised related to development of the Narrows Project. The first issue deals with increases in recreational traffic, while the second is the public's concern with drinking water quality from Scofield Reservoir. The latter issue is covered in detail in the Water Quality section, but the following is a summary of effects by alternatives.

As to the traffic issue, the area adjacent to the proposed Narrows Reservoir is served by two State highways, SR-31 and SR-264. These two-lane roads are narrow and winding. Both highways are maintained for year-round use by the Utah Department of Transportation. Average daily traffic (ADT) numbers for these roads are listed in table 3-37.

ADT values shown in the table are based on UDOT traffic counts taken in 2000.

### 3.19.2 Methodology and Impact Indicators

Narrows Project impacts on public safety were quantified by comparing projected ADT values under each of the action alternative conditions with the ADT under the No Action Alternative. Increased ADT was estimated based on projected recreation visitor days created by each of the alternatives and using an average of two persons

**Table 3-37.—Projected Average Daily Traffic in Vicinity of Narrows Reservoir During Recreation Season (Vehicles Per Day)**

| | No Action[1] | Proposed Action[2] | Mid-Sized Reservoir Alternative[2] | Small Reservoir Alternative[2] |
|---|---|---|---|---|
| SR-31 in Fairview Canyon | 1,540 | 1,792 | 1,744 | 1,691 |
| SR-264 adjacent to Narrows Reservoir site | 820 | 1,072 | 1,024 | 971 |

[1] Based on 2000 UDOT traffic surveys.
[2] Based on two persons per vehicle and 92-day recreation season.

per vehicle. All of the increase in traffic was assumed to occur within a 92-day recreation season from June 15–September 15.

The impact indicator for public safety is the percent increase in ADT.

## 3.19.3 Predicted Effects

### 3.19.3.1 No Action Alternative

There would be no increase in ADT under the No Action Alternative. ADT values for SR-31 and SR-264 would be expected to remain as shown in table 3-37.

As for drinking water effects under the No Action Alternative, the drinking water standards would continue to be met. Because drought years or low flow years are not correlated with changes in drinking water conditions, even if there were climate change or an unusual run of drought years, there should be no changes in public health.

### 3.19.3.2 Proposed Action Alternative

As shown in table 3-37, ADT on SR-31 would increase by 252 or 16% under the Proposed Action. ADT on SR-264 would increase by 31%. However, even with these increases, both roads still would be well within their design capacity. To increase safety, additional turning lanes with adequate sight distance would be provided at recreation area entrances and exits.

With respect to public health and drinking water quality, as mentioned in the Water Quality section, in 1992 and subsequently, the State of Utah investigated alleged correlations between drought, gastrointestinal illnesses, and chlorination at the city of Price water treatment plant. No correlations were found. Therefore, due to the lack of correlation, the reduction in water availability in Scofield Reservoir should not lead to any public health effects in Price or homes served by the local water treatment plant. Public health should be unaffected by the proposal.

### 3.19.3.3 Mid-Sized Reservoir Alternative

ADT on SR-31 would increase by 204 or 13% under the Mid-Sized Reservoir Alternative. ADT on SR-264 would increase by 25%. As with the Proposed Action, additional turning lanes with adequate sight distance would be provided at recreation area entrances and exits to enhance public safety.

As with the Proposed Action, there should be no effects on drinking water due to the lack of correlation with water levels in Scofield Reservoir or downstream.

### 3.19.3.4 Small Reservoir Alternative

ADT on SR-31 would increase by 151 or 10% under the Small Reservoir Alternative. ADT on SR-264 would increase by 18%. As with the Proposed Action, additional turning

lanes with adequate sight distance would be provided at recreation area entrances and exits to enhance public safety.

As with the Proposed Action, there should be no effects on drinking water due to the lack of correlation with water levels in Scofield Reservoir or downstream.

## 3.20 INDIAN TRUST ASSETS

The United States has a trust responsibility to protect and maintain rights reserved by, or granted to, American Indian tribes or individuals by various treaties, statutes, and Executive orders. These rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires that agencies, such as Reclamation, take actions reasonably necessary to protect these trust assets.

Reclamation policy is to reasonably protect ITAs from adverse impacts of its programs and activities. ITAs are property interests held in trust by the United States for the benefit of Indian tribes or individuals.

No Indian trust assets have been identified in or near the affected area; therefore, implementation of the Proposed Action would have no foreseeable negative impacts on ITAs.

## 3.21 ENVIRONMENTAL JUSTICE

On February 11, 1994, the President issued Executive Order 12898 on Environmental Justice in Minority Populations and Low Income Populations. As a result of that Executive order, each Federal agency is required to analyze the environmental effects, including human health, economic, and social effects, of Federal actions, including effects on minority communities and low-income communities.

In the project area, there are no minority or low-income populations; and, therefore, there are no environmental justice effects.

## 3.22 RELATED LAWS, RULES, REGULATIONS, AND EXECUTIVE ORDERS

The Council of Environmental Quality regulations (40 CFR 1500.2 and 1502.25) encourage related environmental laws, rules, regulations, and Executive orders to be integrated concurrently to the fullest extent possible in an EIS.

The following environmental laws, rules, regulations, and Executive orders have been considered during preparation of this FEIS. It has been determined that the Narrows Project would have no adverse effect upon them.

- Executive Order 11988 (Flood Plain Management)
- Wild and Scenic Rivers Act, Public Law 90-542. In 2007, the USDA Forest Service and Bureau of Land Management evaluated thousands of river miles for potential inclusion in the National Wild and Scenic Rivers System. In determining suitability, a key question was, does the river segment have Outstanding Remarkable Values (ORV).

The USDA Forest Service conducted an environmental impact statement to evaluate the suitability of 86 eligible river segments (840 miles) including 21 miles of Fish Creek and Gooseberry Creek. The Record of Decision, signed November 2008, determined that Fish Creek and Gooseberry Creek were not suitable to be designated by Congress as components of the National Wild and Scenic Rivers System. All the nonsuitable river segments are no longer afforded agency interim protection under the Wild and Scenic

Rivers Act and continue to be managed under the direction of the respective agencies.

## 3.23 CUMULATIVE IMPACTS

### 3.23.1 Cumulative Resource Issues

Cumulative impacts are the effects on the environment that result from the impact of implementing the Proposed Action in combination with other actions. The CEQ regulations for implementing NEPA define cumulative impacts as: "…the impact on the environment, which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1500-1508)

### 3.23.2 Cumulative Impact Area and Reasonably Foreseeable Actions

After a careful review of the resources or components of the environment analyzed in chapter 3 of the FEIS, Sanpete and Carbon Counties are considered the affected environment for this cumulative impact analysis. The cumulative impacts area is Sanpete and Carbon Counties or within the watershed potentially affected by the Narrows Project.

Following U.S. Department of the Interior regulations at 43 CFR 46.30, reasonably foreseeable future actions include all Federal and non-Federal activities not yet undertaken, but sufficiently likely to occur, within the cumulative impact area. These activities include activities for which there are existing decisions, funding, or proposals identified by bureaus or local governments. Plans and environmental decisions of BLM's Richfield Field Office, the Price Field Office, and the Manti-LaSal National Forest were reviewed to identify any existing decisions, funded projects, or proposals that should be analyzed for their cumulative impacts. For the BLM, all documents posted to their online environmental notification bulletin board were checked to see if actions approved in findings of no significant impact or records of decision would add cumulative impacts to the resources in chapter 3. No decisions were found that would affect any of the resources affected by the Narrows Project.

For the USDA Forest Service, the Manti-LaSal Forest Plan and related social and economic assessment were the main reasonably foreseeable actions that are considered here. The Narrows Project was planned in conformance with the Forest Plan. Multiple environmental assessments of the USDA Forest Service were checked, but no specific action was identified that meets the definition of a reasonably foreseeable future action for the Narrows Project.

Nor were reasonably foreseeable actions identified by Sanpete or Carbon Counties. Thus, there are no single or specific actions to be analyzed for cumulative effects. Instead, the direct and indirect impacts of the Narrows Project that might contribute to a cumulative impact on identified resources in chapter 3 are summarized below. The action alternatives are grouped for this analysis.

Resource issues have been affected by past Reclamation developments and would be affected by the proposed project; thus, they have the potential to contribute to cumulative (additive) impacts within Sanpete and Carbon Counties. These issues involve stream depletions that can impact fisheries, endangered native fishes, and change salt loading within the Colorado River. These issues are treated below under the headings of water resources, use, and quality; water rights; paleontological resources; fisheries;

wildlife; threatened and endangered species; wetlands; recreation and visual; and cultural resources.

#### 3.23.2.1 Water Resources

As described in chapter 3, a long-term diversion of water by the Narrows Project to the Cottonwood Creek and San Pitch River watersheds would permanently reduce flows downstream from the project. The lowered reservoir storage would increase the potential of reaching dead storage in Scofield Reservoir by 20%. Decreased reservoir storage in Scofield Reservoir also would result in reduced spills from the reservoir, which would, in turn, impact the Price, Green, and, ultimately, the Colorado Rivers.

Approximately 5 miles of small streams or creeks, including 1 mile of Upper Gooseberry Creek, would be inundated by Narrows Reservoir. Middle Gooseberry Creek, between the proposed Narrows Reservoir and Lower Gooseberry Reservoir, would see a 74% reduction in annual flows; but the minimum flow requirements from the Narrows Project would eliminate historic periods of dry stream channels. Mitigation measures could include 300 acre-feet of water to be managed for water quality and aquatic biological resources.

Another water resources effect would be that a transbasin diversion through the Narrows Tunnel to Cottonwood Creek would result in lower peak flows during the spring runoff period, offset by higher flows during the irrigation season.

#### 3.23.2.2 Water Quality

Carbon County has identified water quality in the Price River and watershed as a major concern, largely because the county's ground water is unusable due to high salinity. The county has formed a Carbon Water Committee that has and will continue to investigate uses to which the Price River are applied. County planning will continue to attempt to provide a land use and water quality scheme that is viable and in conformance with USDA Forest Service and BLM plans.

If one of the action alternatives is selected, timing of flows, temperature, turbidity, and ecological composition of the rivers and streams would be affected; and water quality downstream from the project would be more sensitive to future activities that degrade or improve water quality. These include phosphorus load increases and reduction efforts in the Scofield Reservoir drainage and salinity control efforts in the Price River watershed.

Proposed mitigation measures to reduce phosphorus loading in Scofield Reservoir as part of the Narrows Project may impact the ability to meet the target phosphorus load reduction through stream restoration identified in the Scofield Reservoir TMDL. Mitigation measures implemented as part of the Narrows Project may be the most cost effective, most easily implemented, and maintained. This may result in less effective load reduction measures available for implementation as part of the Scofield Reservoir TMDL. A great deal of uncertainty exists surrounding this potential impact though, as specific mitigation measures through stream restoration have not been identified for either the Scofield Reservoir TMDL or the Narrows Project. It is possible that measures are available to satisfy the reduction target of both efforts or that the mitigation from both efforts will not overlap. SWCD is required to mitigate impacts to water quality in Scofield Reservoir and to ensure that it does not deteriorate due to the Narrows Project. Mitigation measures are designed to maintain Scofield Reservoir at its existing condition.

Under a water quality protection program, water quality at the proposed Narrows Reservoir would be protected by meeting State and Federal requirements and establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.

#### 3.23.2.3 Water Rights

If the Narrows Project is built, Water Right Nos. 91-130, 91-131, and 91-132 would be developed and would increase the water depletions in the Gooseberry Creek basin up to 5,400 acre-feet per year. The Narrows water right represents about 6.6% of the average annual yield of the Price River above the city of Price. Although these are valid water rights, their development would incrementally decrease the water available in the Gooseberry, Price, Green, and Colorado River systems. The 1948 Colorado River Compact gives Utah 23% of the Colorado River (and all tributaries) water allocated to the Upper Basin States, which is estimated at approximately 1.3 million acre-feet (maf) of depletion annually. Utah is currently depleting 1.0 maf per year of Colorado River water, and this project would bring Utah closer to using its entire allocation. Once Utah reaches full allocation, there would be a greater likelihood that some water rights would need to be curtailed to ensure that Utah does not exceed its allotment.

#### 3.23.2.4 Paleontological Resources

Under the No Action Alternative, the existing conditions in the APE would remain intact, and paleontological resources likely would not be impacted. No past, present, or reasonably foreseeable actions are expected to result in cumulative effects to fossil resources. Thus, there would be no cumulative effects to paleontological resources from the No Action Alternative.

Under the action alternatives, should paleontological resources located directly within or adjacent to the Narrows Reservoir pool area be present, the lowered reservoir pool could result in damage to or theft of fossil resources due to increased public visitation. This increased visitation, in the form of recreation and residential development, for example, has the potential to cause cumulative impacts to paleontological resources. Therefore, cumulative effects to cultural resources are likely under the action alternatives.

#### 3.23.2.5 Fisheries

Past and future water diversions and depletions have affected and will continue to affect the sport fishery and native species. The analysis in chapter 3 shows that the Narrows Project will have minor impacts on flows below Scofield Reservoir. Mitigation measures are designed to help reduce impacts.

#### 3.23.2.6 Wildlife

If one of the action alternatives is selected, and the reservoir is built, then there will be a future loss of vegetation and wildlife habitat; and the quality of the habitat could be degraded from development around the reservoir. This could increase forage competition among grazing animals. Habitats may be unavailable to wildlife because of human disturbance factors (e.g., traffic or noise during sensitive time periods such as winter, birthing, nesting, and early rearing of young). Impacts on wildlife could result if increased development and surface disturbance altered existing migration corridors where access to important habitat areas would be greatly reduced. Mitigative

efforts have reduced these effects or they have improved habitat conditions for these species in various areas.

The additive effects of the Proposed Action, in conjunction with the past action have resulted in irreversible and irretrievable impacts to wildlife. Mitigation measures have been designed to mitigate these impacts to the extent possible.

Conservation species, such as the Columbia spotted frog, roundtail chub, bluehead sucker, flannelmouth sucker, as well as other sensitive species identified in the FEIS, have experienced cumulative effects from loss of habitat from development and construction projects over the years. These species rely on natural water systems for their habitat. The proposed project identifies reasonable actions to reduce or eliminate impacts to these species.

#### 3.23.2.7 Threatened, Endangered, Conservation, and Other Special Species

Under past and ongoing actions, the Colorado pikeminnow, bonytail, razorback sucker, and humpback chub are endangered in the Colorado River Basin, including the Green, Yampa, Gunnison, and San Juan Rivers. These species evolved in the Colorado River and its larger tributaries under conditions of warm water, large seasonal flow fluctuations, heavy sediment loads, extreme turbulence, and a wide range of dissolved solids concentrations. These conditions have been altered by human activities, and all four species have experienced population declines. The Upper Colorado River Endangered Fish Recovery Program was established as the major offset for the impacts of historic and future water development projects in the basin.

To minimize the possible adverse effects of the Narrows Project on the Colorado pikeminnow, bonytail, humpback chub, and razorback sucker, SWCD would participate in the Recovery Program as described in the FEIS, which includes a one-time depletion fee payment.

#### 3.23.2.8 Wetlands and Riparian

The proposed Narrows Reservoir would permanently inundate approximately 89 acres of wetlands. Proposed modifications to portions of the Gooseberry Creek include narrowing the channel to maintain the depth of flow. Flows in the middle portion of Gooseberry Creek between the proposed dam and Lower Gooseberry Reservoir would decrease the average current flow by about 73.1%. The reduced magnitude and duration of flood flows would have the potential to impact the riparian area along Gooseberry and Fish Creeks. The riparian vegetation communities of sedges, rushes, and hydric grasses found as bands and small pockets along the banks of the stream may be reduced in quantity and quality by the proposed action. Willow thickets along Gooseberry and Fish Creeks could be reduced in quantity and quality. This reduction of the quantity and quality of riparian and wetland systems is likely to continue. Implementation of recommended flows by the Utah Division of Wildlife Resources and the gaining stream status of Gooseberry Creek could result in positive changes for riparian and wetland vegetation.

#### 3.23.2.9 Recreation and Visual

##### *3.23.1.9.1 Recreation*

As discussed in chapter 3, travel and tourism employment has decreased from 1998 to 2009 in Sanpete and Carbon Counties by 5.8%. Over the same time period, nontravel and tourism employment has grown from 8,299 to 10,298 jobs, a 24.1% increase. This trend is likely to continue into the future, although

there could be some increase in visitor use due to the Narrows Project.

ATVs are popular within the project area for agricultural and recreational use. The Arisen Trail System, a joint effort of Federal, State, and local agencies and communities, is an extensive trail system south of the project area that links Federal- and State-managed public lands with communities. There are areas of intensive ATV use throughout the project area, particularly around some of the communities, where soils, vegetation, and scenic values are being affected. Should the project be implemented, dispersed recreational activity would not change. There would be some changes in recreational use; however, these are disclosed in section 3.15.

## 3.24 Other NEPA Considerations

### 3.24.1 Irreversible and Irretrievable Commitments of Resources

Renewable and nonrenewable resources would be irreversibly or irretrievably committed by construction and operation of the Narrows Project. Although it would be theoretically possible to reverse commitments of some of these resources, the Council on Environmental Quality has stated that ". . . construction and facility uses are basically irreversible since a large commitment of resources makes removal or nonuse thereafter unlikely." This section briefly describes these commitments for all alternatives, with the exception of the No Action Alternative. Under that plan, there would be no commitment of resources other than moneys already spent.

#### 3.24.1.1 Water Resources

The Narrows Project would commit up to 5,400 acre-feet of water from Upper Gooseberry Creek and its tributaries, which are located in the Price River drainage, to project purposes. Initially, about 4,900 acre-feet would be used for irrigation, and 500 acre-feet would be designated for municipal use in the northern Sanpete County area. As the need arises, the balance between M&I and irrigation water will change. As the demand for M&I use increases, M&I use will increase, and irrigation use will decrease. The conversion of water from irrigation to M&I use will occur in stages.

Under present Utah water law and the 1984 Compromise Agreement, commitments of water resources essentially would remain permanent, provided that they are beneficially used. Although the area's water resources would not be irretrievably or irreversibly committed, use of the project water would be long term in nature.

#### 3.24.1.2 Fish, Wildlife, and Grazing Habitat

The inundation by the reservoir of about 1 mile of UDWR Class 3B-Unique stream fishery in Upper Gooseberry Creek and 4.3 miles of cutthroat trout spawning and rearing habitat in the Gooseberry Creek tributaries would be essentially irreversible.

The commitment of land in the reservoir pool for water storage and around the reservoir to recreation uses would be essentially irreversible, since to do otherwise could jeopardize the water quality of the reservoir as well as the proposed wildlife mitigation plan. Streamflow patterns resulting from project operation would be subject to change should water needs in service areas change, but current trends indicate that the proposed operational criteria would be long term and would constitute a basically irreversible commitment. The loss of grazing AUMs also would be considered an irreversible commitment of resources.

#### 3.24.1.3 Land

Narrows Reservoir and other project features (damsite, recreation facilities, and road relocations) would permanently alter use on about 786 acres of the 1,931 acres needed for the project. The land currently functions primarily as recreation, rangeland, and wildlife habitat. The remaining 1,145 acres for the project will, over time, be restored to original functions as rangeland and wildlife habitat. Geologic studies of the reservoir and damsite have not identified any critical mineral resources within the reservoir basin or damsite.

#### 3.24.1.4 Construction Materials

About 375,000 cubic yards of permeable and impermeable earth material, gravel, cobble, and riprap would be irretrievably committed to use in the dam embankments and associated features. Much smaller amounts of concrete aggregate would be used in the dam and project features. Imported cement and manufactured materials would be irretrievably committed to the project features. Fuels, explosives, and electrical power would be consumed during project construction.

#### 3.24.1.5 Aesthetics

Narrows Project would irreversibly alter the scenery of the feature sites by the building of structures, excavation of landscape, and inundation of the reservoir. The construction scars would be revegetated where practical; but the visual impact, which would be unattractive to some people, would be permanent.

### 3.24.2 Short-Term Uses and Long-Term Productivity

The CEQ regulations for implementing NEPA at 40 CFR 1502.16 require analysis of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity.

### 3.24.3 Action Alternatives

Short-term losses from the action alternatives, as described in sections 3.23 and 3.24.1, would include construction impacts such as increased noise, traffic delays, or detours. Air quality would be worse during construction. These temporary environmental impacts would be balanced through mitigation and avoidance as much as is reasonably possible.

Short-term benefits would include increased jobs from construction and revenue generated during construction.

Long-term losses from the action alternatives would include the permanent loss of approximately 1,145 acres of rangeland and wildlife habitat, displacement of wildlife and fish, loss of grazing habitat, reduction of water flows below the dam, visual impacts, possible loss of paleontological resources, and recreational impacts such as access inconveniences.

Long-term benefits would include that the reservoir would make it possible to store water from spring runoff for use during the drier summer months. This would allow local farmers the opportunity to have a longer, more productive growing season. The reservoir also would provide a habitat for sport fish and provide water for the nearby wildlife. Below the dam, a minimum flows requirement would provide year-round flows in Gooseberry Creek and Cottonwood Creek. These stream segments historically have been dewatered at times of the year. Although primarily intended as a measure to facilitate winter survival of fish, this requirement also would have some beneficial effects on the riparian and wetland areas adjacent to the creeks. Providing flows in

summer months also would stimulate the growth of riparian and wetland vegetation.

### 3.24.4 No Action Alternative

This alternative would offer none of the benefits or have any of the losses listed above. It would not meet SWCD's proposal or need for additional water for irrigated agriculture.

CHAPTER 4

# Consultation and Coordination

## 4.0 INTRODUCTION

This chapter details the consultation and coordination between Reclamation and other State, Federal, and local agencies; Native American tribes; and the public in preparation of this FEIS, the SDEIS, and the DEIS published in 1998, which this FEIS updates and supplements. Throughout the EIS process dating back to 1990, input has been actively solicited from a broad range of public constituencies as part of the ongoing public involvement process. Comments and involvement in the planning for, and preparing of, the Narrows Project generally were sought through two broad efforts: communication and consultation with a variety of Federal, State, and local agencies; Native American tribes; and interest groups and the formal SDEIS scoping process and comment process, both of which invited input from the general public.

## 4.1 SUMMARY OF INTERAGENCY COORDINATION 1996–2003

In 1996, Reclamation invited a number of State and Federal agencies to become cooperating agencies in preparation of the DEIS. The two agencies that agreed to become cooperating agencies for the EIS process, including this FEIS, are the U.S. Department of Agriculture Forest Service and the U.S. Army Corps of Engineers. In addition to these two agencies, the following agencies had representation on the interdisciplinary team led by Reclamation that prepared the DEIS published in 1998:

- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- Utah Division of Wildlife Resources
- Utah Division of Water Quality
- U.S. Department of the Interior, Office of the Solicitor
- Sanpete Water Conservancy District

Reclamation hosted periodic cooperating agency meetings and interdisciplinary team meetings throughout preparation of the DEIS and the SDEIS to ensure that all of the agencies were informed of, and involved in, the issues and analyses related to this FEIS.

## 4.2 CONSULTATION

Consultation was conducted as needed with agencies or experts that provided information for preparation of the DEIS published in 1998, the SDEIS, and this FEIS.

### 4.2.1 Fish and Wildlife Coordination Act

Reclamation consulted with the Service on fish and wildlife resources and habitats that would be affected by the Narrows Project. A Fish and Wildlife Coordination Act Report was prepared by the Service. As a result of continued consultation regarding project impacts to fish and wildlife, Reclamation requested an updated Fish and Wildlife Coordination Act Report from the Service (appendix D). In 2006,

the Service verified that this report was still current and did not require updating.

### 4.2.2 Endangered Species Act of 1973

Reclamation consulted with the Service regarding potential project impacts to threatened and endangered species. A list of species that could occur in the project area was received from the Service. Reclamation submitted a biological assessment to the Service. The Service then issued a biological opinion. Consultation was re-initiated by Reclamation as a result of critical habitat designation. The Service then issued an amended biological opinion for the Narrows Project. Consultation was again re-initiated by Reclamation after the discovery of Colorado pikeminnow in the lower Price River. Subsequently, Reclamation submitted an amended biological assessment to the Service analyzing this new information. Reclamation received a biological opinion from the Service August 24, 2000.

### 4.2.3 National Historic Preservation Act of 1966

In a letter dated September 10, 1997, Reclamation consulted with the SHPO regarding cultural resources potentially affected by the Proposed Action (appendix E). In the letter, Reclamation requested a review of the cultural resource-related environmental commitments in the 1998 DEIS to determine their adequacy in complying with Reclamation's Section 106 responsibilities. SHPO concurred with the adequacy of Reclamation's environmental commitments in a letter dated September 16, 1997 (appendix E).

On January 25, 2007, Reclamation consulted again with the SHPO by phone regarding the same cultural resource-related environmental commitments in appendix G. The SHPO again concurred with the cultural resource commitments and agreed that they were adequate in complying with Reclamation's responsibilities under Section 106 of the NHPA.

Due to both the age of the previous SHPO consultations and the fact that the entire APE was not included in the previous consultations for the Proposed Action (as discussed in section 3.16.1), Reclamation will be required to conduct consultations with the SHPO in findings and determinations made throughout the Section 106 process. This requirement is stated in the environmental commitments in appendix G.

In addition to the SHPO, 36 CFR 800 requires consultation with other consulting parties, such as representatives of local governments, for example, in findings and determinations made throughout the Section 106 process. The Advisory Council on Historic Preservation also must be consulted if historic properties are adversely affected by the Proposed Action. The environmental commitments (see appendix G) require Reclamation to conduct consultation with all consulting parties as mandated under 36 CFR 800.

### 4.2.4 Tribal Consultations

In 1997, Reclamation initiated consultation with the Ute Indian Tribe of the Uintah and Ouray Reservation in accordance with 36 CFR Part 800, Section 106 of the NHPA, and all other cultural resource-related laws, regulations, and directives pertinent to the Proposed Action. Members of the tribe toured the proposed location of the Narrows Dam and Reservoir and were briefed on the scope of the Proposed Action. Reclamation consulted again with the Ute Indian Tribe of the Uintah and Ouray Reservation, in a letter dated September 28, 2001, regarding potential traditional cultural properties

(TCPs) or sacred sites within the APE. Reclamation also consulted with the Paiute Indian Tribe of Utah, in a letter dated September 28, 2001, concerning the same inquiry. Neither tribe expressed concerns regarding either TCPs or sacred sites within the APE.

Due to the age of the previous tribal consultations, Reclamation will be required to conduct consultations with tribes prior to initiation of final design and construction associated with the Proposed Action. This requirement is stated in the environmental commitments in appendix G. In accordance with 36 CFR 800.2(ii), consultation will be required with any tribe that may attach religious and cultural significance to historic properties potentially affected by the Proposed Action. The consultation process shall provide each tribe a "reasonable opportunity" to identify concerns about historic properties, advise Reclamation on the identification and evaluation of historic properties, including those of traditional religious and cultural importance, express views on the Proposed Action's effects on such properties, and participate in the resolution of any adverse effects.

### 4.2.5 Indian Trust Assets

In a letter dated January 7, 1997, Reclamation consulted with the Bureau of Indian Affairs (BIA), Uintah and Ouray Agency, regarding possible impacts upon ITAs resulting from the Proposed Action. In a response letter, dated January 18, 1997, BIA concluded that the Proposed Action would not impact any ITAs under the jurisdiction of the Uintah and Ouray Agency of BIA.

## 4.3 PUBLIC INVOLVEMENT AND SCOPING

The scoping process for this FEIS was conducted by Reclamation beginning in November 2003 to provide the general public, organizations, State and local governments, and affected Federal agencies an opportunity to identify issues and concerns they believe should be studied early in preparation of the SDEIS. "Scoping" is the public involvement process required by the Council on Environmental Quality regulations to help Federal agencies determine issues and alternatives analyzed in the SDEIS. Results of the scoping meetings and comments received during the scoping process were used to establish the scope of the SDEIS and to focus the environmental analysis on the important issues and concerns.

The original scoping process for the Narrows Project began with scoping meetings held at Fairview and Price, Utah, on October 3 and 4, 1990, respectively. Notice of the scoping meetings was given through a *Federal Register* Notice dated September 7, 1990, and through a news release dated September 24, 1990. In addition, 32 letters were sent to State and Federal agencies and environmental groups giving notice of the meetings. Three newspapers—the Salt Lake Tribune, the Mt. Pleasant Pyramid, and the Sun Advocate—published articles regarding the project and the upcoming scoping meetings. Concerned citizens were encouraged to attend the scoping meetings or express their concerns in writing.

After the 1995 Record of Decision was rescinded, a new DEIS was prepared, beginning in 1996, and was published in 1998. Comments were received on that DEIS (and public hearings were held to receive comments); those comments were analyzed

and responded to, and the 1998 DEIS was revised based on input from those comments. Since a decision was made in 2003 to prepare this SDEIS in lieu of publishing a FEIS based on the 1998 DEIS, it should be noted that the SDEIS does capture revisions made earlier based on public comments and input.

After the decision was made to prepare the SDEIS, public meetings to inform the public and to share information were held in Price and Manti, Utah, in September 2003. On November 25, 2003, a *Federal Register* Notice was published to serve as an official notice that Reclamation intended to prepare a supplemental draft environmental impact statement for the Narrows Project. Public hearings were held again in Price and Manti, Utah, in April 2010 during a 63-day comment period ending June 2010. Reclamation received 696 comment documents, and formal responses to substantive comments were published in appendix H of this FEIS. Comments received in response to the *Federal Register* Notice also were taken into consideration, along with all prior public comments in preparing this FEIS.

Section 1.4 provides further information on the scoping process for this FEIS.

## 4.4 DOCUMENT AVAILABILITY

Those who were on the mailing list for the 1998 DEIS, or who asked to be added to the mailing list in response to the SDEIS in 2010, were provided notification of document availability along with other environmental groups; Federal, State, and local government agencies; and other interested parties. Over 400 notifications of the FEIS have been mailed to interested agencies, organizations, and individuals. The FEIS is available online at www.usbr.gov/uc/envdocs/index.html.

CHAPTER 5

# List of Preparers

This Narrows Project, Utah, Final Environmental Impact Statement was prepared by the Bureau of Reclamation, Upper Colorado Region, Provo Area Office. The names of persons who prepared various sections, provided extensive background information, or participated to a significant degree in preparing the present document are listed below. Immediately following is a listing of members of the former interdisciplinary team who produced the 1998 *Draft Environmental Impact Statement, Narrows Project*.

**Preparers of Final Environmental Impact Statement**

**U.S. Department of the Interior**
**Bureau of Reclamation**
**Provo Area Office**
**Provo, Utah**

| Name and Title | Education and Professional Experience | EIS Responsibility |
|---|---|---|
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| Rafael Lopez<br>General Biologist | BA General Biology<br>BA Recreation<br>Federal Service: 14 Years | Wetlands, Riparian |
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**Preparers of Final Environmental Impact Statement (continued)**

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**Preparers of Final Environmental Impact Statement (continued)**

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**Bureau of Reclamation**
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|---|---|---|
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**Preparers of Final Environmental Impact Statement (continued)**

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CHAPTER 6

# Bibliography, Glossary of Terms, and List of Acronyms and Abbreviations

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http://www.water.utah.gov/waterplan.

## 6.1 GLOSSARY OF TERMS

### A

| | |
|---|---|
| Acre-foot | A measure of water volume—1 foot of water covering an acre in area. |
| Active storage | That portion of a reservoir capacity from which releases are made. |
| Activity occasion | Any activity by an individual at a recreation area for any length of time. |
| Alluvium | A deposit of sand and gravel formed by flowing water. |
| Angler day | Any visit by an individual to a fishing area during any part or all of a 24-hour day. |
| Animal unit month (AUM) | The amount of feed necessary to support one cow and her unweaned calf or five sheep for 1 month. |
| Autotrophic | Organisms that are capable of producing organic substances from inorganic materials by means of energy received from outside the organism. |

### B

| | |
|---|---|
| Bedrock | The solid rock that underlies soil, sand, clay, or other loose surface material. |
| Benthos | Organisms living in or on the bottom of a lake or stream. |
| Biomass | The amount of living matter in the form of one or more kinds of organisms present in a particular habitat. |
| Browse | Twigs, leaves, and young shoots of trees and shrubs on which animals feed—in particular, those shrubs that are used by big game animals for food. |

### C

| | |
|---|---|
| Carrying capacity | The number of animals that can be maintained in a given habitat through the pinch period—usually winter. |
| Celsius (Centigrade) | ºC = (ºF-32)5/9. |
| Coldwater fishery | Generally, water or a water system that has an environment suitable for salmonoid fishes such as trout. |

| | |
|---|---|
| Cubic foot | A measure of a moving volume of water per second (measured in cubic feet per second). |
| Cultural resource | Physical or other expressions of human activity or occupation. Such resources include culturally significant landscapes, prehistoric and historic archaeological sites as well as isolated artifacts or features, traditional cultural properties (TCPs), Native American and other sacred places, artifacts, and documents of cultural and historic significance. |

## D

| | |
|---|---|
| Dead storage | That portion of a reservoir capacity that constitutes the minimum pool. Because this portion of a reservoir is below the outlet works, it cannot be released. It is used for the benefit of recreation, fishery habitat, and silt deposition. |
| Degradation | The geologic process wherein streambeds and flood plains are lowered in elevation by removing material. The opposite of aggradation. |

## E

| | |
|---|---|
| Ecosystem | A complex system composed of a community of fauna and flora, taking into account the chemical and physical environment with which the system is interrelated. |
| Endangered species | A species that is in danger of extinction throughout all or a significant portion of its range. |

## F

| | |
|---|---|
| Fahrenheit | ºF = (9/5 ºC) + 32. |
| Fault | A break in the rocks in which there has been unequal movement of the two sides relative to each other. |
| Fish stream improvement | Improving a stream channel to make a new fish habitat or to enhance an existing habitat. |
| Fisherman day | An aggregate of 12 hours of fishing use by one or more individuals. |
| Forb | An herb other than grass. |
| Fry | Fish between the egg and fingerling stage. |

## G

| | |
|---|---|
| Game fish | Those species of fish classified and managed by the State for sport fishing or angling. |
| Gauging station | A location on a water channel where streamflows are recorded. |

## H

| | |
|---|---|
| Habitat evaluation procedure (HEP) | "HEP" is a "species habitat" approach to impact assessment and habitat quality. |
| Head | The difference in elevation between two bodies of water. |
| Hectare | An area of land or water equal to 2.471 acres. |
| Hunting day | A visit by an individual to an area for the purpose of hunting during any portion or all of a 24-hour day. |

## I

| | |
|---|---|
| Inactive storage | That portion of a reservoir's capacity that is neither dead storage nor active storage. It normally is not released because of the benefits to fish, recreation, and other uses; but it can be since it is above the outlet works in the reservoir's profile. |
| Indian trust assets | Legal interests in property held in trust by the United States for Indian tribes or individuals. |
| Invader plants | Species, often annuals, which are not part of the climax vegetation that invade land when there is little or no competition from other plant species. |
| Irrigation water management | The art of timing and regulating irrigation water applications in a way that will satisfy the water requirement of the crop with minimum waste of water, soil, or plant nutrients. |

## L

| | |
|---|---|
| Lateral | A small ditch used to deliver water from a canal to irrigation lands. |
| Limnology | The scientific study of physical and chemical conditions in fresh waters. |

## M

| | |
|---|---|
| Macroinvertebrates | Animals lacking a backbone and internal skeleton (i.e., insects, worms, and crayfish). |
| Mesophyte | A plant growing under medium condition of moisture. |
| Metabolism | The sum total of the chemical transformations occurring in the body of a living organism. |
| Minimum pool | The amount of inactive and dead storage in a reservoir. |
| Mitigation | Actions to avoid, minimize, reduce, eliminate, or rectify the impact of a management practice. |

## N

| | |
|---|---|
| *National Register of Historic Places* (NRHP) | The federally maintained register of significant districts, sites, buildings, structures, and objects associated with American history, architecture, archeology, engineering, and culture. |
| Nongame fish | Those species of fish not classified as sport fish by the State. |

## P

| | |
|---|---|
| Palustrine | Living or thriving in a marshy environment. |
| Paleontological resource | Any fossilized remains, traces, or imprints of organisms, preserved in or on the Earth's crust, that are of paleontological interest and that provide information about the history of life on Earth. |
| Periphyton | Organisms that live attached to underwater surfaces. |
| Persons-at-one-time | A recreation capacity measurement term indicating the number of people who can use a facility or area at one time. |
| Phreatophyte | A deep-rooted plant that grows in riparian zones and obtains water from the water table or the soil just above it. |
| Phytoplankton | Passively floating plant life, primarily algae. |
| Pipelines | A means of conveying water from a water source to a farm or group of farms. They also are used to convey water between fields or to sprinkler laterals. |

## R

| | |
|---|---|
| Reach | A finite length of a stream, river, or canal. |
| Recreation day | Twelve visitor hours, which may be aggregated continuously, intermittently, or simultaneously by one or more persons. |
| Recruitment | The increase in population caused by natural reproduction or immigration. |
| Redd | The spawning ground or nest of various fishes. |
| Riffle | A shallow water area across a streambed causing broken water. |
| Riparian (vegetation) | Living on the banks of a river or stream. |
| Riprap | Stones placed on the face of a dam or on streambanks or other land surfaces to protect them from erosion. |

## S

| | |
|---|---|
| Salinity | A term referring to the quantity of dissolved mineral salts in solution. |
| Salmonid | Of or related to the Salmonidae, the family of fishes including trout. |
| Salt loading | Term used to express the amount of salt added to streams from any natural or manmade source. |
| Scoping | The public involvement process required by the Council on Environmental Quality regulations to help Federal agencies determine issues and alternatives analyzed in the final supplemental environmental impact statement. |
| Sediment | Any usually finely divided organic and/or mineral matter deposited by water in nonturbulent areas. |
| Seismicity | The phenomenon of Earth movement that usually results in an earthquake. |
| Sere | A series of ecological (vegetative) communities. |
| Sheep month | Use of forage by one mature ewe with lamb at side for 1 month. A sheep month equals 1/5 animal unit month. |

| | |
|---|---|
| Sprinkler irrigation | Application of water to the land surface by aboveground sprinkler nozzles attached to either stationary, moving, or movable laterals. |
| Supplemental service land | Irrigated land that receives project water in addition to a previous allotment from another source. |
| Surface irrigation | Application of water to the land surface through the use of corrugations, furrows, graded borders, or level borders. |

## T

| | |
|---|---|
| Taxon (plural taxa) | A group of genetically similar organisms. |
| Thermal stratification | A temperature gradient within a body of water caused by warmer water occupying the upper level of the water and colder, denser water occupying the lower level. |
| Threatened species | A species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. |
| Trophic | Related to nutrition, particularly the types of food an organism requires. |
| Trophic level | Place of an organism in the food chain. |
| Trophy fish | In terms of trout, a fish that exceeds 14 inches. |

## V

| | |
|---|---|
| Visitor day | An aggregate of 12 hours of recreation use by one or more individuals. |

## W

| | |
|---|---|
| Water right | A legal permit issued by the State government that allows the holder to divert a specific amount of water for beneficial use. |
| Weighted usable area | An expression of the quantity of fish habitat in feet squared per 1,000 feet of river channel. |
| Wetland | An area characterized by periodic inundation or saturation, hydric soils, and vegetation adapted for life in saturated soil conditions. |
| Wildlife wetland habitat management | Retaining, creating, or managing wetland habitat for wildlife. |

| | |
|---|---|
| Winter range (big game) | An area of land that has suitable vegetation and topographic conditions to support big game animals during the winter months when snow depth restricts use in other areas. |

## 6.2 LIST OF ACRONYMS AND ABBREVIATIONS

### A

| | |
|---|---|
| ADT | average daily traffic |
| APE | area of potential effects |
| ATV | all terrain vehicle |
| AUM | animal unit months |

### B

| | |
|---|---|
| BIA | Bureau of Indian Affairs |
| BLM | Bureau of Land Management |
| BMP | best management practice |

### C

| | |
|---|---|
| $CaCO^3$ | calcium carbonate |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CGIC | Cottonwood-Gooseberry Irrigation Company |
| CMP | corrugated metal pipe |
| CRSP | Colorado River Storage Project |
| CRWQIP | Colorado River Water Quality Improvement Program |
| CUP | Central Utah Project |
| CUPCA | Central Utah Project Completion Act |
| CUWCD | Central Utah Water Conservancy District |
| CWCD | Carbon Water Conservancy District |

### D

| | |
|---|---|
| DEIS | draft environmental impact statement |
| DO | dissolved oxygen |
| DOD | Department of Defense |
| DPS | Distinct population segment |

## E

| | |
|---|---|
| ECC | Environmental Chemical Corporation |
| EIS | environmental impact statement |
| EPA | U.S. Environmental Protection Agency |
| ESA | Endangered Species Act |

## F

| | |
|---|---|
| FDR | Forest Development Road |
| FEIS | final environmental impact statement |
| Forest Plan | 1986 Forest Land and Resource Management Plan for the Manti-La Sal National Forest |
| $ft^2$/day | square feet per day |
| FY | fiscal year |

## G

| | |
|---|---|
| GPCD | gallons per capita per day |

## H

| | |
|---|---|
| HEP | habitat evaluation procedures |
| HSI | Habitat Suitability Index |
| HU | habitat unit |

## I

| | |
|---|---|
| IDC | interest during construction |
| IFIM | instream flow incremental methodology |
| IMPLAN | IMpact Analysis for PLANning |
| Interior | U.S. Department of the Interior |
| ITA | Indian trust asset |

## K

| | |
|---|---|
| kg | kilogram |
| kg/yr | kilogram per year |

## L

| | |
|---|---|
| lb/day | pound per day |
| LEDPA | Least Environmentally Damaging Practicable Alternative |
| LRMP | Land and Resource Management Plan |

## M

| | |
|---|---|
| maf | million acre-feet |
| M&I | municipal and industrial |
| Master Plan | Sanpete County Water Resources Master Plan |
| MCE | maximum credible earthquake |
| meq/L | milliquivalent per liter |
| mg/L | milligram per liter |
| mm | millimeter |
| MOA | memorandum of agreement |
| MOU | memorandum of understanding |
| msl | mean sea level |

## N

| | |
|---|---|
| NAAQS | National Ambient Air Quality Standards |
| Narrows Project | Narrows Project, Utah |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act of 1966 |
| NOI | notice of intent |
| No. | number |
| NRHP | *National Register of Historic Places* |

## O

| | |
|---|---|
| O&M | operation and maintenance |
| ORV | Outstanding Remarkable Values |

## P

| | |
|---|---|
| PEM | palustrine emergent wetland cover (herbaceous wetlands) |
| $PM_{10}$ | Particulate matter of 10 microns in diameter or smaller |
| ppm | parts per million |
| PRPA | Paleontological Resources Preservation Act of 2009 |
| PRWUA | Price River Water Users Association |
| PSS | palustrine scrub/shrub cover (shrubby wetlands) |
| PVC | polyvinyl chloride |

## R

| | |
|---|---|
| RAP | Recovery Action Plan |
| Reclamation | Bureau of Reclamation |
| Recovery Program | Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin |
| *Research Report 145* | *Consumptive Use of Irrigated Crops in Utah*, October 1994 |
| RIP | Recovery Implementation Program |
| ROD | Record of Decision |
| ROS | Recreation Opportunity Spectrum |
| ROW | rights-of-way |
| RPA | reasonable and prudent alternatives |
| RVD | recreation visitor day |

## S

| | |
|---|---|
| SAR | Specific absorption rate |
| SCORP | 1992 Utah State Comprehensive Recreation Plan |
| SDEIS | supplemental draft environmental impact statement |
| Service | U.S. Fish and Wildlife Service |
| SHPO | State Historic Preservation Officer |
| SR | State Route |
| SRPA | Small Reclamation Projects Act of 1956 |

| | |
|---|---|
| Stat. | Statute |
| SWCD | Sanpete Water Conservancy District |
| SWWF | southwestern willow flycatcher |

## T

| | |
|---|---|
| TCP | traditional cultural property |
| TDS | total dissolved solids |
| TMDL | total maximum daily load |
| TOC | total organic carbon |
| Tripartite Agreement | The October 11, 1943, reconstruction and repayment contract on Scofield Reservoir between the Federal Government and local sponsors |
| TSI | Trophic State Index |

## U

| | |
|---|---|
| UDEQ | Utah Department of Environmental Quality |
| UDOT | Utah Department of Transportation |
| UDWR | Utah Division of Wildlife Resources |
| UGS | Utah Geological Survey |
| USACE | U.S. Army Corps of Engineers |
| U.S.C. | United States Code |
| USDA Forest Service | U.S. Department of Agriculture Forest Service |
| USGS | U.S. Geological Survey |
| USHE | shrub cover |

## V

| | |
|---|---|
| VMS | Visual Management System |
| VQO | Visual Quality Objective |

## W

| | |
|---|---|
| WUA | weighted usable area |

## Y

| | |
|---|---|
| YOY | young-of-the-year |

## Miscellaneous

| | |
|---|---|
| 1995 FEIS | January 1995 final environmental impact statement |
| 1998 DEIS | *Draft Environmental Impact Statement, Narrows Project* (DES-98-10), published in March 1998 |
| °C | degree Celsius |
| °F | degree Fahrenheit |
| < | less than |
| µg/L | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |
| µmhos/cm | microhos per centimeter |
| % | percent |
| § | section |

CHAPTER 7

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# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX A

# 1984 COMPROMISE AGREEMENT

## AGREEMENT

THIS AGREEMENT, made and entered into the 8th day of June, 1984, by and between the SANPETE COUNTY WATER CONSERVANCY DISTRICT, a Utah Water Conservancy District, herein referred to as "Sanpete" and the CARBON WATER CONSERVANCY DISTRICT, a Utah Water Conservancy District, and the PRICE RIVER WATER USERS ASSOCIATION, a Utah non-profit corporation, collectively herein referred to as "Carbon".

W I T N E S S E T H :

WHEREAS, there has been a long standing controversy concerning the building of storage and diversion works on the Price River System for transmountain diversion of Gooseberry Creek water to the San Pitch River System; and

WHEREAS, the parties hereto desire to compromise and settle the controversy and their respective claims to such water.

NOW, THEREFORE, in consideration of the mutual covenants herein contained, IT IS AGREED:

I

## DEFINITIONS

A. "Scofield" means the Scofield Reservoir near Scofield, Utah.

B. "Tripartite Contract" means that contract dated October 11, 1943 among the Carbon Water Conservancy District, the Price River Water Conservation District, and the United States of

America, relating to the reconstruction of Scofield Dam and describing the Gooseberry Plan. The Price River Water Users Association is successor to the Price River Water Conservation District.

C. The expression "prior water rights" as used in this Agreement means the right to the use of the water of the Price River System having priorities earlier than September 6, 1941.

D. "Narrows Site" means the approximate location for a proposed dam to be constructed on Gooseberry Creek, the center of which is located:

North 625 feet and East 1200 feet from the West Quarter corner of Section 19, Township 13 South, Range 6 East, SLB&M.

E. "Narrows Project" means a successor project to the Gooseberry Plan and constitutes a substitute for the allocation of water for the Gooseberry Plan as mentioned in the Tripartite Contract. The Narrows Project is the project proposed by this Agreement and contemplates the building of storage and diversion works at or above the location of the Narrows Site, to store Gooseberry Creek water for transmountain diversion to the San Pitch River System.

F. "Tunnel" means that transmountain diversion tunnel located in Section 24, Township 13 South, Range 5 East, SLB&M which diverts water from the Price River System to the San Pitch River System.

II

WATER RIGHT FILINGS

A. Price River Water Users Association covenants and represents that it is the owner of the following water applications on file in the office of the Utah State Engineer for the diversion, storage, and use of Price River System water:

| APPLICATION NO. | CLAIMED DATE OF PRIORITY | NATURE AND AMOUNT OF CLAIMED RIGHT |
|---|---|---|
| 1035 (91-2) | Aug. 30, 1906 | Storage 12,020 acre-feet |
| 2989a (91-78) | Oct. 11, 1937 | Storage 17,950 acre-feet |
| 13334 (91-126) | Feb. 13, 1940 | Direct Flow 50 second-feet |

B. Sanpete covenants and represents that it is the owner of record of the following water applications on file in the office of the Utah State Engineer for the diversion, storage and use of Price River System water, subject to the Assignment Agreement dated July 22, 1975, between Sanpete and the United States of America:

| APPLICATION NO. | CLAIMED DATE OF PRIORITY | NATURE AND AMOUNT OF CLAIMED RIGHT |
|---|---|---|
| 14025 (91-130) | Jan. 16, 1941 | Storage 30 second feet |
| Change Application a-9237 | | |
| 14026 (91-131) | Jan. 16, 1941 | Storage 17,000 acre-feet |
| Change Application a-9236 | | |
| 14477 (91-132) | Sept. 6, 1941 | Storage 130 second feet |
| Change Application a-9238 | | |

C. Sanpete covenants and represents that it is the owner of the following application on file in the office of the Utah State Engineer for the diversion, storage, and use of Price River System water:

| APPLICATION NO. | CLAIMED DATE OF PRIORITY | NATURE AND AMOUNT OF CLAIMED RIGHT |
|---|---|---|
| 9593 (91-87) | Oct. 12, 1937 | Storage 15,000 acre-feet |

III

SUBORDINATION OF WATER RIGHTS

The Price River Water Users Association water rights, evidenced by Application Numbers 1035 (91-2), 8989a (91-78), and 13334 (91-126), shall be subordinated, to the extent hereinafter provided, to the Sanpete water rights evidenced by Application Number 14025 (91-130), Change Application a-9237; Application Number 14026 (91-131), Change Application a-9236; and Application Number 14477 (91-132), Change Application a-9238, to divert and store on a first priority basis in each year all water of Gooseberry Creek and its tributaries arising above the Narrows Site, and to the extent provided in Article IV, paragraph A (3) the waters from Brooks and Cabin Hollow Creeks, and to convey by transmountain diversion up to 5,400 acre-feet of water from storage at the Narrows Site each year for use in the San Pitch River System, subject to the rights of the Cottonwood Gooseberry Irrigation Company for Fairview Lakes.

IV

## DISTRIBUTION OF WATER

### A. NARROWS PROJECT

1. The active capacity of the reservoir for the Narrows Project shall not exceed 10,000 acre-feet to provide for the transmountain diversion to the San Pitch River System. If requirements are made of Sanpete to release or bypass water for minimum streamflow purposes in Gooseberry Creek below the Narrows Site the active storage capacity of the reservoir for such purposes may be increased as necessary, but shall not exceed 4,500 acre-feet of additional storage capacity. The total active storage capacity shall not exceed 14,500 acre-feet.

2. The 5,400 acre-feet of water to be diverted to the San Pitch River System as provided in Article III shall be measured at the outlet of the tunnel, without deduction for reservoir evaporation, seepage, or storage losses, provided however, that any seepage that would have been intercepted by the tunnel before construction of the Narrows Project shall not be charged against the 5,400 acre-feet. Any additional seepage water resulting from the construction of the Narrows Project shall be charged against the said 5,400 acre-feet.

3. Water from Brooks Canyon and Cabin Hollow Creeks may be diverted, stored and used to provide minimum streamflows in Gooseberry Creek below the Narrows Site.

### B. SCOFIELD

1. Application Number 14683 (91-135) in the name of the United States of America, Bureau of Reclamation shall be approved to permit Carbon to use the additional storage capacity of 35,000 acre-feet of water in Scofield Reservoir in addition to the

present storage rights evidenced by Application Numbers 1035 (91-2), and 8989a (91-78).

2. Carbon shall release from storage in Scofield Reservoir water sufficient to satisfy prior water rights, which otherwise would be impaired by the diversion and storage by the Narrows Project. Any and all water stored in the active capacity of Scofield Reservoir shall be subject to such release. The total active capacity of Scofield Reservoir would have to be depleted, and all direct flow water passed through the reservoir to satisfy prior water rights, before any call could be made upon Sanpete to pass through the direct flow waters originating above the Narrows Site. Such releases shall be in such quantity and at such times as may be required to satisfy prior water rights as determined by the Utah State Engineer.

3. Storage releases from Scofield shall be limited to 30,000 acre-feet annually for use by Carbon, exclusive of replacement waters needed to supply prior water rights interfered with by Sanpete's diversion and use of water for the Narrows Project.

V.

APPROVALS, WITHDRAWALS, AND REJECTION OF APPLICATIONS

A. The United States of America shall withdraw Application Number 9594 (91-88).

B. The State Engineer shall approve Application Number 14683 (91-135).

C. Within thirty (30) days of approval of this Agreement by the United States of America, the State Engineer may reject the Price River Water Improvement District's Application Number 38882 (91-3557).

D. Sanpete shall within thirty (30) days of approval of this Agreement by the United States of America, withdraw Application Number 9593 (91-87).

E. The parties agree that no protest shall be filed to any of the foregoing approvals, withdrawals, rejections, dismissals or assignments or to any further change applications or permits from any state or federal agencies necessary to carry out the purpose and intent of this Agreement.

VI

DISMISSAL OF PENDING SUIT

Carbon shall file a Motion for Voluntary Dismissal, with prejudice, within thirty (30) days of approval of this Agreement by the United States of America, of the lawsuit entitled Price River Water Users Association, et al, vs United States, et al, Civil No. C-83-0407W, now pending in the United States District Court for the District of Utah, Central Division, upon the grounds that the issues have been settled by this Agreement, and to seek joinder in the motion by other plaintiffs to said case.

VII

MEASURING DEVICES AND OUTLET STRUCTURES

The parties hereto shall install and maintain outlet structures and measuring devices to measure and deliver water in accordance with this Agreement. The expense of such installation and maintenance, as part of the Narrows Project, shall be borne by Sanpete. Such devices shall be approved as to location, type, size and quality by the Utah State Engineer. Each party reserves the right to inspect and test at their own expense, at any reasonable time, any and all facilities for the measurement and delivery of water.

VIII

AGREEMENTS NOT SUPERSEDED OR AMENDED

This Agreement shall not supersede, amend or otherwise modify the rights of the United States of America under the Tripartite Contract, except the Narrows Project shall be substituted for the Gooseberry Plan as mentioned therein; nor shall it amend the repayment contract dated February 28, 1944, between the United States of America and the Carbon Water Conservancy District involving Scofield Reservoir and the Assignment Agreement dated July 22, 1975, between Sanpete and the United States of America.

IX

ADMINISTRATION

All waters stored and diverted pursuant to this Agreement shall be administered by the Utah State Engineer.

X

SUCCESSORS BOUND

This agreement shall be binding upon the parties hereto and upon the successors and assigns of the parties.

XI

INCORPORATION BY REFERENCE

The parties agree that the terms and conditions of this Agreement may be incorporated, by reference, in and made a specific part of the State Engineer's Memorandum Decisions on Sanpete's Application Numbers 14025 (91-130), 14026 (91-131) and

14477 (91-132), as amended, and the Application of the United States of America, Number 14683 (91-135).

XII

APPROVAL OF THE UNITED STATES

This Agreement is subject to the approval of the United States of America.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement the day and year first above written.

SANPETE COUNTY WATER
CONSERVANCY DISTRICT

By: _____
Its: Chairman

ATTEST:

_____
Secretary

CARBON WATER CONSERVANCY DISTRICT

By: _____
Its: President

ATTEST:

_____
Secretary

PRICE RIVER WATER USERS ASSOCIATION

By: Lyle B Gayner

Its: President

ATTEST:

Secretary

The foregoing Agreement is approved this 28 day of June, 1984.

UNITED STATES OF AMERICA

By:

Title

## R E S O L U T I O N

BE IT AND IT IS HEREBY RESOLVED by the Board of Directors of the SANPETE WATER CONSERVANCY DISTRICT, at a meeting held on the 7th day of June, 1984, that the President and Secretary of said District be, and they are hereby authorized and empowered to execute on behalf of the District an Agreement with the CARBON WATER CONSERVANCY DISTRICT and the PRICE RIVER WATER USERS ASSOCIATION bearing the above date settling controversies between Carbon County water users and Sanpete County water users on the terms and conditions set out in said agreement presented and considered at this meeting.

## C E R T I F I C A T I O N

I, Janice Petersen, Secretary of SANPETE WATER CONSERVANCY DISTRICT, hereby certify that the foregoing is a true and correct copy of a resolution adopted by the directors of the said District at a regular meeting of the SANPETE WATER CONSERVANCY DISTRICT held on the 7th day of June, 1984.

Janice Petersen, Secretary
SANPETE WATER CONSERVANCY DISTRICT

EXHIBIT "D"

JUL 11 1984
WATER RIGHTS

# R E S O L U T I O N

BE IT AND IT IS HEREBY RESOLVED by the Board of Directors of the PRICE RIVER WATER USERS ASSOCIATION, at a meeting held on the 8th day of June, 1984, that the President and Secretary of said association be, and they are hereby authorized and empowered to execute on behalf of the Association an Agreement with the SANPETE COUNTY WATER CONSERVANCY DISTRICT bearing the above date settling controversies between Carbon County water users and Sanpete County water users on the terms and conditions set out in said agreement presented and considered at this meeting.

## CERTIFICATION

I, ANN B. O'BRIEN, Secretary of PRICE RIVER WATER USERS ASSOCIATION, hereby certify that the foregoing is a true and correct copy of a resolution adopted by the directors of the said District at a special meeting of the PRICE RIVER WATER USERS ASSOCIATION held on the 8th day of June, 1984.

Ann B. O'Brien
ANN B. O'BRIEN, Secretary
PRICE RIVER WATER USERS ASSOCIATION

EXHIBIT "C"

JUL 11 1984

WATER RIGHTS

# R E S O L U T I O N

BE IT AND IT IS HEREBY RESOLVED by the Board of Directors of the CARBON WATER CONSERVANCY DISTRICT, at a meeting held on the 8th day of June, 1984, that the President and Secretary of said District be, and they are hereby authorized and empowered to execute on behalf of the District an Agreement with the SANPETE COUNTY WATER CONSERVANCY DISTRICT bearing the above date settling controversies between Carbon County water users and Sanpete County water users on the terms and conditions set out in said agreement presented and considered at this meeting.

## CERTIFICATION

I, the undersigned Secretary of the CARBON WATER CONSERVANCY DISTRICT, hereby certify that the foregoing is a true and correct copy of a resolution adopted by the directors of the said District at a special meeting of the CARBON WATER CONSERVANCY DISTRICT held on the 8th day of June, 1984.

Secretary

EXHIBIT "D"

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX B

# IDENTIFICATION AND EVALUATION OF POTENTIAL DAMSITES

FRANSON-
NOBLE & ASSOCIATES, INC. CONSULTING ENGINEERS

July 25, 1996

To: Files

From: Richard Noble

Subject: Identification and Evaluation of Potential Dam Sites in Sanpete Valley

This document describes a process that was used to identify and evaluate potentially practicable dam sites in north Sanpete Valley. USGS 7.5 minute quadrangle maps were used to identify potentially suitable sites. The goal of this initial search was to find sites that would serve as alternatives to the Narrows Reservoir site and that could create reservoirs with a minimum storage capacity of 5,400 acre-feet, either individually or collectively. Attached is a map showing the location of the 10 sites identified and considered. Following is a tabulation of data related to the sites:

| Site | Area (sq. ft.) | Average Depth (ft.) | Max Volume (AF) | Dam Ht (ft.) | Length (ft.) | Max Elevation (ft.) |
|---|---|---|---|---|---|---|
| 1 | 9,728,000 | 40 | 8,933 | 120 | 2900 | 6600 |
| 2 | 11,392,000 | 120 | 31,383 | 240 | 4800 | 6600 |
| 3 | 40,601,600 | 20 | 18,642 | 50 | 3000 | 6280 |
| 4 | 2,560,000 | 100 | 5,877 | 300 | 1400 | 7200 |
| 5 | 7,680,000 | 300 | 52,893 | 450 | 2000 | 7200 |
| 6 | 1,177,600 | 40 | 1,081 | 90 | 800 | 6520 |
| 7 | 5,939,200 | 40 | 5,454 | 120 | 2800 | 6400 |
| 8 | 3,840,000 | 60 | 5,289 | 140 | 1500 | 6200 |
| 9 | 4,275,200 | 120 | 11,777 | 240 | 2200 | 6600 |
| 10 | 2,432,000 | 120 | 6,700 | 240 | 1200 | 7200 |

Site 8 would require pumping from the reservoir to service much of the project area. Those reservoirs with elevations greater than 7000 would need to have a diversion structure and pipeline constructed approximately 2 miles up Cottonwood Canyon to be supplied by gravity flow. This may be infeasible because of the geologic instability of the canyon. Sites 1,2 and 9 would require a diversion approximately 3/4 miles up Cottonwood Canyon.

Initial screening of the above sites resulted in two sites being investigated further. Screening criteria was based on location, dam height and length, and ability of the site

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to delivery project water with minimal or no pumping. Based on initial screening, sites 1,2,4,6,7,8,9 and 10 were eliminated from further consideration. Preliminary dam height versus capacity curves were developed for sites 3 and 5 to determine the dam height necessary to develop 5,400 acre-feet of storage. Four feet of freeboard is assumed for this more detailed analysis.

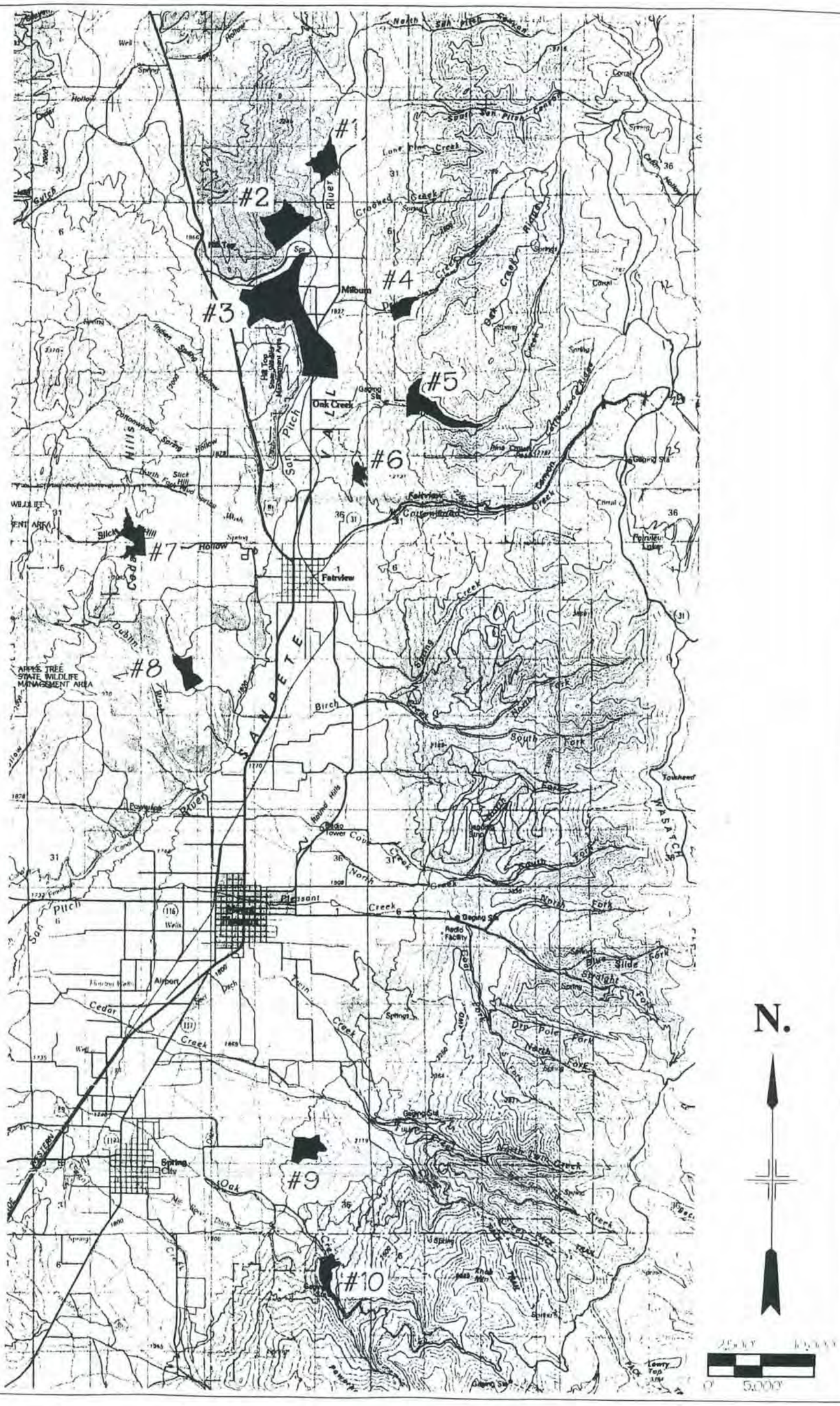
Site 3 would require a dam height of 64 feet and a length of 2,185 feet to develop 5,400 acre-feet. Reconnaissance level cost estimate for constructing a dam at Site 3 is $9.5 million. It would also require annual pumping costs of $95,000 to service project lands and approximately 6,000 feet of additional pipeline to connect the reservoir to the Oak Creek Pipeline at an estimated cost of $1.3 million. The county road would also need to be rerouted around the reservoir. It is estimated that this cost would be comparable to relocation of the highway for Narrows Dam, which is $1 million.

Site 5 would require a dam height of 185 feet and a length of 1,190 feet and would cost approximately $91 million. Site 5 would have the additional cost of one mile of additional pipeline in Cottonwood Canyon and an another mile of pipeline from the Oak Creek Pipeline to the proposed site. The cost for these additional pipelines is estimated to be $2.2 million.

The Oak Creek Pipeline would need to be enlarged from 10 inch PVC to 27 inch concrete pipe to carry the East Bench water with both Site 3 and Site 5. This additional cost is estimated to be $2,5 million. Computations for these estimates are on file.

The total cost of the Site 3 alternative is $14.3 million with annual pumping costs of $95,000 compared to Narrows Dam costs of $7.2 million with no pumping costs. The total cost for Site 5 is $95 million. Clearly, these most reasonable two sites of the ten identified in Sanpete Valley are much more costly than the proposed Narrows Dam.

Richard M Noble




# Sanpete Valley Dam Site Alternatives

## Narrows Project

July 1993

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX C

# BIOLOGICAL OPINION FOR THE PROPOSED NARROWS PROJECT – A SMALL RECLAMATION PROJECT ACT (SRPA) LOAN

ORIGINAL

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:

FWS/R6
ES

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228-1807

AUG 24 2000

PRO OFFICIAL FILE COPY
RECEIVED
AUG 28 '00

| Reply Date | | |
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Action:
Classification: ENV-7.00
Project: NAR
Control No.: 3895
Folder I.D.: 38348

Memorandum

To: Area Manager, Upper Colorado Region
Bureau of Reclamation
Provo, Utah

From: Regional Director, Region 6
U.S. Fish and Wildlife Service
Denver, Colorado.

Subject: Draft Biological Opinion for the Proposed Narrows Project - A Small Reclamation Project Act (SRPA) Loan

In accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR Part 402), this transmits the Fish and Wildlife Service's draft biological opinion on the proposed Narrows Project and its effects on the endangered Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*Gila elegans*).

This Opinion is the result of reinitiation of an extended consultation including two biological opinions (March 1992, January 1995), one amended biological opinion (October 1995), the original biological assessment (October 1991), and three amended biological assessments (July 1994, March 1997, February 1999), the Draft Environmental Impact Statement (DEIS, March 1998), and the Price River Cumulative Hydrology Study (November 1998). We also considered other materials on file such as technical memoranda, project plans, various reports, and other relevant information. A complete administrative record of this consultation is on file in our Salt Lake City field office.

The reinitiation of consultation and resultant issuance of this Opinion was prompted by the most recent two amended biological assessments. The first of these was received on March 7, 1997, based on new information on the status of Colorado pikeminnow in the lower Price River. The second amended biological assessment dated February 5, 1999, was based on the presence of willow flycatcher (*Empidonax traillii* sp.) preliminarily identified as the endangered subspecies

**This is your future. Don't leave it blank. - *Support the 2000 Census.***

of southwestern willow flycatcher (*E. t. extimus*) (Service memorandum dated October 13, 1998) in the proximity of the proposed Project.

We concur that the project as proposed is not likely to adversely affect the bald eagle for reasons described by the Bureau of Reclamation in the biological assessments and EIS for the proposed Project, and is likely to adversely affect the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail.

Based on more recent information which has become available on the subspecies of willow flycatcher found within the affected project area, at this time we do not believe this willow flycatcher to be the endangered subspecies, the southwestern willow flycatcher. Therefore no discussion is offered specifically in reference to the endangered subspecies, *E. t. extimus* in this Opinion. The basis for this finding follows.

In an October 13, 1998, memorandum, we notified Reclamation that State of Utah surveys had discovered the endangered southwestern willow flycatcher present in the proximity of the Narrows Project, and that an amendment to the biological assessment would be necessary. The memorandum further stated that genetic and vocal sampling was being conducted to verify the willow flycatcher subspecies. To date, we have the following preliminary information of subspecies identification.

- The willow flycatcher subspecies inhabiting the riparian corridor in the Project proximity is located at the extreme northern boundary of *E. t. extimus* but within the range of *E. t. adastus, an unlisted subspecies*. Experts suggest that the central part of the State of Utah is more likely an area of intergradation between *E. t. adastus* and *E. t. extimus* (Behle 1985).

- Genetic analysis to date has shown that the willow flycatcher population does not have the genetic markers of *E. t. extimus* and is more closely related to *E. t. adastus* (Memorandum from Evan Paxton and Dr. Mark Sogge, Biological Resources Division, October 1, 1999). A final report is expected on this analysis.

- Vocalization analysis has determined the population to be *E. t. adastus* (Dr. Jim Sedgwick, USGS, Midcontinent Ecological Science Center, Ft. Collins, pers. comm; Spring 1999). However, these results have yet to be published or peer-reviewed.

Therefore, the following Opinion only addresses the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. If further analysis determines that the willow flycatcher subspecies population is the *E. t. extimus* subspecies or some significant intercross gradation between *E. t. adastus* and *E. t. extimus,* reinitiation of formal consultation will be required and a new biological opinion which includes the southwestern willow flycatcher will be issued. This opinion does, however, include recommendations to protect the willow flycatcher subspecies population in the Project proximity because of our interest in neo-tropical migratory birds as a

trust resource and because of the potential for identifying a biologically significant intercross gradation between *E. t. extimus* and *E. t. adastus* in the Project proximity. Protection of the riparian habitats within the project area could also be important to assist in recovery of *E. t. extimus*.

## CONSULTATION HISTORY

We have been involved with Reclamation in an extended consultation on the proposed Project. The following documents the consultation history.

- October 1991 - We receive the first biological assessment on the proposed Narrows Project from Reclamation.

- March 25, 1992 - We issue the initial biological opinion.

- July 7, 1994 - Reclamation requests reinitiation of consultation based on an anticipated increase in average annual depletion and based on newly designated critical habitat for the four endangered Colorado River fish species.

- January 9, 1995 - We issue a second biological opinion on the proposed Project.

- July 18, 1995 - Reclamation provides information to us on capture of one juvenile Colorado pikeminnow in the Price River but indicates that reinitiation of formal consultation may not be necessary.

- October 5, 1995 - We concur that formal consultation is not necessary but amend the January 1995 biological opinion with an additional reasonable and prudent alternative to avoid jeopardy to the Colorado pikeminnow. This reasonable and prudent alternative calls for a 2-year study of fish composition and water quality in the Price River to assess the recovery potential of the Price River.

- We also recommend the Price River be prioritized within the Recovery Implementation Program for Upper Colorado River basin endangered fish species (RIP) Recovery Action Plan (RIPRAP).

- March 7, 1997 - Reclamation issues an amendment to the biological assessment for the proposed Narrows Project which describes new-found information on the status of Colorado pikeminnow and suggests specific items to be included into the RIPRAP. These items include: 1) the RIP depletion charge be applied to the Narrows Project, 2) additional years of study to identify year-round use of the Price River by Colorado pikeminnow, and 3) legal protection of instream flows. This letter also requested reinitiation of consultation.

- October 13, 1998 - We identify southwestern willow flycatcher as an additional endangered species present in the proximity of the proposed Project and advise Reclamation to provide an amendment to the biological assessment addressing southwestern willow flycatcher.

- February 5, 1999 - Reclamation provides an amended biological assessment that includes southwestern willow flycatcher.

## BIOLOGICAL OPINION

### I. DESCRIPTION OF PROPOSED ACTION

The Sanpete Water Conservancy District has applied to Reclamation for a Small Reclamation Project Act loan to help finance construction of the proposed Narrows Project. Such loans are made available by Reclamation to assist with construction of non-Federal projects. The Sanpete Water Conservancy District has also applied to use lands for the Narrows Project that were withdrawn from the public domain by Reclamation. The proposed Narrows Project would include a 120-foot high dam and 7,900 acre-foot total storage capacity reservoir to be constructed on Gooseberry Creek, a tributary to Fish Creek in the Price River drainage (there are no threatened or endangered species in this drainage). This proposed Project would also include a trans-basin diversion of water through an existing tunnel that would be rehabilitated (3,100 feet in length; 36 inch diameter; 60 cfs capacity) into Cottonwood Creek in the San Pitch/Sevier River drainage. The proposed Narrows Project will result in an average annual depletion of 5,717 acre-feet of water in the Price River. The Narrows Dam and Reservoir site are located approximately 9 miles northeast of the town of Fairview, Utah. Affected downstream water storage projects include the existing Lower Gooseberry Reservoir (small pass-through reservoir) approximately 5 miles downstream and the existing Scofield Dam and Reservoir (approximately 45,000 acre-foot total storage capacity) approximately 20 miles downstream of the proposed Narrows Project site.

The proposed Narrows Project would involve construction of features and facilities to develop a supplemental water supply to be used on presently irrigated lands and by municipal water users in the north part of Sanpete County, Utah. The proposed Project would divert water from Gooseberry Creek in the upper Price River drainage through an existing tunnel to Cottonwood Creek in the San Pitch/Sevier River drainage for delivery to lands and water users in the Sanpete Valley area surrounding Fairview, Utah. Water stored in the Narrows Reservoir would be diverted and delivered trans-basin through the existing Narrows Tunnel to Cottonwood Creek. The Narrows Tunnel would be rehabilitated as part of the proposed Project. Proposed Project water would then be diverted from Cottonwood Creek to a pipeline delivery system constructed as part of the project. This pipeline would then deliver the proposed Project water to existing water distribution systems in northern Sanpete County where it would be used by agricultural and municipal water users. Recreation facilities would be developed at Narrows Reservoir and a 2,500 acre-foot minimum pool for a reservoir fishery would be established. Specific mitigation measures would be implemented to offset wetland, terrestrial wildlife and stream fishery impacts.

Water conservation measures would be implemented as part of the proposed Project (BOR 1998).

Operation of the Narrows Project would affect stream flows in Gooseberry Creek, Fish Creek, Price River, and that portion of the Green River downstream of its confluence with the Price River within the Colorado River Basin, and would also affect stream flow in Cottonwood Creek within the San Pitch/Sevier River Basin. The proposed Project water supply would come from upper Gooseberry Creek and its tributaries. Impacts to lower Gooseberry Creek and Fish Creek would occur primarily during the spring snow melt period as water is stored in the Narrows Reservoir for release later in the summer. Impacts to Scofield Reservoir would be reduced inflows, resulting in lowering of reservoir storage. Impacts downstream of Scofield Dam would include reduced spring peak flows and overall water depletions affecting approximately 130 to 150 miles of the Price River as it flows between Scofield Dam and the Price/Green River confluence and an overall depletion from the Green River. Scofield Dam would spill less frequently and for shorter durations, lowering the volume of peak flows in the Price River below the dam and in the Green River below the mouth of the Price River (138 miles upstream of the Green/Colorado rivers confluence). Depletions to the Price River drainage would average 5,717 acre-feet per year. This amount consists of 5,324 acre-feet of trans-basin diverted water and 393 acre-feet of increased evaporation.

## II. BASIS FOR BIOLOGICAL OPINION

The biological opinion addresses an average annual depletion of approximately 5,717 acre-feet from the Upper Colorado River basin. Water depletions in the Upper Basin have been recognized as a major source of impact to endangered fish species. Continued water withdrawal has restricted the ability of the Colorado River system to produce flow conditions required by various life stages of the fishes.

Critical habitat has been designated for the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker within the 100-year flood plain in portions of their historic range (59 FR 13374). Destruction or adverse modification of critical habitat is defined in 50 CFR 402.02 as a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. In considering the biological basis for designating critical habitat, we focused on the primary constituent elements that are essential to the conservation of the species without consideration of land or water ownership or management. We have identified water, physical habitat, and biological environment as the primary constituent elements. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species. Water depletions reduce the ability of the river system to provide the required water quantity and hydrologic regime necessary for survival and recovery of the fishes. The physical habitat includes areas of the Colorado River system that are inhabited or potentially inhabitable for use in spawning and feeding, as a nursery, or serve as corridors between these

areas. In addition, oxbows, backwaters, and other areas in the 100-year flood plain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats.

## III. STATUS OF THE SPECIES/CRITICAL HABITAT

Information on Colorado pikeminnow, razorback sucker, humpback chub, and bonytail presented in this Opinion are considered the best scientific and commercial biological information available on these species. Sources of information include previous biological opinions concerning these species, technical reports, published scientific manuscripts, unpublished data, and working knowledge of the species. The most comprehensive compilation of information on these species to date was conducted by the Flaming Gorge Technical Team in their efforts to develop Green River and Flaming Gorge flow recommendations to benefit endangered fishes. The team consists of Reclamation and Service personnel and technical experts from Argonne National Laboratory (contracted through Western Area Power Administration) and Colorado State University Larval Fish Laboratory. Although the report from which this information was taken is in draft form and not approved for citation, the biological information is considered the most recently compiled and accurate comprehensive review of the status and biology of the endangered Colorado River fish species and is therefore used in this Opinion.

### COLORADO PIKEMINNOW

#### A. Species description

The Colorado pikeminnow evolved as the dominant predator in the Colorado River system. Historically, adult Colorado pikeminnow attained lengths in excess of one meter and individuals in excess of 20 kg were common (Minckley 1973; Tyus 1991a). Individuals in excess of 0.8 meter in length and 10 kg in weight are now very uncommon and are likely older than 40 years (Tyus 1991a; Osmundson et al. 1997). Habitat of adult Colorado pikeminnow consists of deep, low-velocity eddies, pools, and runs, or seasonally flooded lowlands (Tyus 1990; Tyus 1991a). Adults mature at total lengths exceeding 400 mm and at 5 to 7 years of age (Vanicek and Kramer 1969; Hamman 1981; Tyus 1991a).

Based on early fish collection records, on archaeological finds, and on other observations, the Colorado pikeminnow was once found throughout warm water reaches of the entire Colorado River Basin, including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, and the Gila River system in Arizona (Seethaler 1978). Colorado pikeminnow apparently were never found in colder, headwater areas. Seethaler (1978) indicates that the species was abundant in suitable habitat throughout the entire Colorado River Basin prior to the 1850's. Historically, Colorado pikeminnow have been collected in the upper Colorado River as far upstream as Parachute Creek, Colorado (Kidd 1977).

A marked decline in Colorado pikeminnow populations can be closely correlated with the construction of dams and reservoirs between the 1930's and the 1960's, with introduction of nonnative fishes, with overwhelming water pollution, and with removal of water from the

Colorado River system. Behnke and Benson (1983) summarized the decline of the natural ecosystem. They pointed out that dams, impoundments, and water use practices are probably the major reasons for drastically modified natural river flows and channel characteristics in the Colorado River Basin. Dams on the mainstream essentially have segmented the Colorado River system, blocking Colorado pikeminnow spawning migrations and drastically changing river characteristics, especially flows and temperatures.

In addition, major changes in species composition were caused by introduction of nonnative fishes, many of which have thrived as a result of changes in the natural riverine system (i.e., flow and temperature regimes). The decline of endemic Colorado River fishes seems to be at least partially related to competition or other behavioral interactions with nonnative species, which have perhaps been exacerbated by alterations in the natural fluvial environment. In addition, water pollution, which went virtually unchecked until passing of environmental legislation in the 1960's and 1970's, could in extreme cases cause fish kills. The extent to which pollution affected the status of Colorado River fish is unknown but one example of water pollution noted in a 1953 Utah Fish and Game Bulletin which cited 'heavy losses of fish, particularly Colorado River salmon (*Ptychocheilus lucius*)' suggests impacts may have been spatially and temporally devastating to Colorado pikeminnow populations.

Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow utilize relatively deep, low-velocity habitats that occur in nearshore areas of main river channels (Tyus 1991a). In spring, however, when discharge is high due to snow-melt runoff, Colorado pikeminnow adults utilize flood plain wetlands, flooded tributary mouths, flooded side canyons, and eddy habitats that are accessible only during high flows (Tyus 1990). Such environments may be particularly beneficial for Colorado pikeminnow because other riverine fishes gather in flood plain habitat to exploit food and temperature resources, and may serve as prey for all life stages. Such low-velocity environments may also serve as resting areas for Colorado pikeminnow.

**B. Life history**

Adults undergo spawning migrations that may involve long-distance movements. Round-trip distances of over 500 miles (Irving and Modde in press) have been reported and individuals may migrate to natal areas using cues that were imprinted during the larval stage (Tyus 1985; Tyus 1990; Irving and Modde in press). As an integral part of the natural flow regime, peak spring flows aid formation of habitat for all life stages of Colorado pikeminnow and may also provide an important cue to prepare adults for migration. Other factors such as water temperature, photoperiod, and conspecific odors may also be important to cue reproduction (Nesler et al. 1988; Tyus and Karp 1989; Tyus and Karp 1991; Bestgen et al. 1998). Environmental cues used by the fish to complete their life cycle are needed in all areas occupied by adults including tributaries and the mainstem Green River.

Colorado pikeminnow reproduce during late spring and summer after discharge from snow-melt runoff peaks and when water temperatures are increasing and generally greater than 16° C

(Haynes et al. 1984; Tyus 1990; Tyus 1991a; Bestgen et al. 1998). Following spawning, most adults return by late August or September to home ranges occupied the previous spring (Tyus 1990; Irving and Modde in press).

Although direct observation of Colorado pikeminnow spawning is not possible in the Green and Yampa rivers because of high turbidity, radiotelemetry indicates spawning occurs over cobble-bottomed riffles (Tyus 1990). If adhesive eggs are deposited in interstitial spaces of spawning substrate they likely require clean cobble surfaces for secure attachment (Hamman 1981; Tyus and Karp 1989).

Laboratory studies suggested that wild embryos may incubate in the spawning substrate for 4–7 days, with duration inversely related to water temperature (Hamman 1981; Marsh 1985; Bestgen and Williams 1994). Temperatures from 18° to 26° C produced similar and relatively high rates of hatching (54–79 percent) and survival to 7 days posthatch (52–88 percent). Survival was only 13 percent at 30° C, which may be near the upper lethal limit for embryos. Hatching success at 16° C, the lowest temperature at which Colorado pikeminnow were known to spawn in the wild (Bestgen et al. 1998), is unknown. Hatching success averaged about 10 percent higher in fluctuating (5° C diel range) than in constant temperatures (18° to 26° C).

Eggs deposited in spawning gravel hatch within 5–7 days, and larvae swimup 5–7 days later. At swimup, larvae are 6–9 mm (implied total length) and are immediately swept downstream, sometimes long distances, from spawning areas (Hamman 1981; Haynes et al. 1984; Nesler et al. 1988; Bestgen and Williams 1994; Bestgen et al. 1998). Larvae drift to relatively low-gradient river reaches where low-velocity, shallow, channel-margin habitats (e.g., backwaters) are common, and they remain there throughout the summer (Vanicek and Kramer 1969; Tyus and Haines 1991; Muth and Snyder 1995).

The exact mechanism by which Colorado pikeminnow larvae drift downstream and inhabit backwater habitat is not completely understood. Larvae are probably carried near shorelines by prevailing river currents and eventually encounter backwaters with a probability that depends on availability of such habitat. Because swimming in relatively swift main-river currents is energetically costly and mortality risks are high, larvae that quickly encounter a suitable backwater are more likely to survive. Based on tests of swimming performance in a velocity tube, larvae of a size typically captured in drift nets (8–10 mm) were often capable of maintaining position for nearly 30 seconds in water flowing 15 cm/s (K. Bestgen, unpublished data). Thus, active locomotion may play an important role when Colorado pikeminnow larvae move from the main channel into backwaters.

Early life stages of Colorado pikeminnow in backwaters feed on a variety of small invertebrates, of which chironomids are particularly important (Muth and Snyder 1995). As in other fishes, the growth rate of Colorado pikeminnow is dependent on food abundance and water temperature (Bestgen 1996). Seasonal food abundance in Green River backwaters is most likely a function of backwater stability, nutrient levels, primary production, and "maturity", which affects the time

invertebrates have to colonize and build populations. Benthic assemblages may be an even more important food source for early life stages of fishes in the Green River (Muth and Snyder 1995).

Nighttime temperature fluctuations may cool backwaters to well below 22° C and create sub-optimal growth conditions. In a laboratory study, growth of Colorado pikeminnow larvae was optimal at 31° C and high at all temperature treatments that were 22° C or warmer (Bestgen 1996). At the highest food abundance, growth of Colorado pikeminnow larvae was 36 percent less at 18° C compared to that observed at 22° C (Bestgen 1996). In the wild, Colorado pikeminnow may move to acquire more optimal habitat. For example, Tyus (1991b) found that early life stages of Colorado pikeminnow moved out of backwaters at night, presumably in response to water temperatures that were colder than the main channel, and moved back in as temperatures warmed during the day. Such a strategy would allow Colorado pikeminnow to maximize degree-day accumulation and growth in a diel period.

The abundant nonnative fishes that co-occur with Colorado pikeminnow in backwaters are potential predators on fish larvae. Of particular concern is the most abundant species, red shiner, a known predator on fish larvae in the wild (Ruppert et al. 1993). In laboratory tests, red shiners averaging about 60 mm were able to capture and consume Colorado pikeminnow as large as 22 mm (Bestgen et al. 1997). Larger Colorado pikeminnow were not vulnerable to red shiners because they could not be physically ingested.

Energy reserves, particularly lipids, are thought to influence overwinter survival of age-0 fish (Thompson et al. 1991). Because lipid stores are generally positively correlated with body size and condition of fish, biotic and abiotic conditions in summer and autumn that affect growth may influence overwinter survival. Thompson et al. (1991) found that smaller Colorado pikeminnow with lower amounts of lipid were in poorer condition and survived at lower rates than larger fish over a simulated winter period in the laboratory, and they concluded that overwinter survival of wild fish may be size-dependent.

Comparison of catch-effort data collected in fall and then again in spring from 1979 to 1988 showed negligible overwinter mortality of age-0 Colorado pikeminnow relative to other seasons (Tyus and Haines 1991). However, other studies in other years (Converse et al. 1998b) or those using capture-recapture estimation techniques (Haines et al. 1998) have demonstrated substantial overwinter mortality, especially for small-bodied Colorado pikeminnow. Converse et al. (1998b) suggested that size-dependent overwinter mortality was important in some years, but in others, abundance of Colorado pikeminnow in spring was mostly a function of autumn abundance. Haines et al. (1998) reported overwinter survival of 56 to 62 percent in three estimates but only 6 percent overwinter survival of a cohort in the Green River that had small body size. They suggested that low overwinter survival in that high flow year was partially due to lack of energy reserves.

Juveniles also occupy backwaters and other low-velocity nearshore areas; older and larger subadults tend to use habitat similar to that of adults. Subadults then disperse and recruit to upstream reaches where they establish home ranges (Osmundson et al. 1998).

The ability to feed in turbid waters of the Colorado River system and lack of teeth in jaws are unusual features of piscivorous Colorado pikeminnow. Colorado pikeminnow less than 50 mm eat primarily invertebrates, the diet of those between 50 and 200 mm is a combination of invertebrates and fish, and those greater than 200 mm are mainly piscivorous (Vanicek and Kramer 1969; Muth and Snyder 1995). Large adults also occasionally consume other vertebrates including birds and mammals (Tyus 1991a).

**C. Population Dynamics**

All life stages of Colorado pikeminnow in the Green River demonstrate wide variations in abundance at seasonal, annual, or longer time scales, but reasons for shifts in abundance are poorly understood. The population structure of the Colorado pikeminnow is thought to resemble a metapopulation in that several somewhat spatially distinct populations are centered around specific spawning locations; however some interchange of individuals between populations occurs (Gilpin 1993). Colorado pikeminnow occupy life-stage specific habitats that are distributed over a broad spatial scale in the Green River system. Adults migrate to canyon-bound spawning areas distant from home ranges, embryos incubate and hatch in spawning gravel, newly emerged larvae drift downstream and into low-velocity nursery habitats, and subadults move back upstream.

In alluvial valley reaches of the Green River where most nursery habitat occurs, age-0 and age-1 Colorado pikeminnow occupy shallow, channel-margin backwaters. Juveniles and adults eventually disperse from nursery-habitat areas and into tributaries or the mainstem Green River up- or downstream of spawning localities. Because factors that affect survival of various Colorado pikeminnow life stages are imposed over a spatially extensive area, a variety of biological and physical factors may interact to influence recruitment success of individual year classes.

**A. Status and distribution**

The endangered Colorado pikeminnow is endemic to the Colorado River basin and was formerly widespread and abundant in warmwater streams and rivers (Jordan and Evermann 1896). Historic accounts suggest that Colorado pikeminnow were especially abundant in the lower Colorado River basin downstream of Lee's Ferry, Arizona (Minckley 1973; Tyus 1991a; Maddux et al. 1993). Lower basin populations remained abundant until the 1930's (Miller 1961) but declined soon thereafter presumably due to the combined effects of river regulation by dams and introduced fishes (Minckley and Deacon 1968; Minckley 1973). The last Colorado pikeminnow collected in the Gila River system was in 1950; scattered individuals were captured in the lower mainstem Colorado River and reservoirs in the 1960's (Minckley 1973), but by the early 1970's the species was extirpated from the lower Colorado River basin (Tyus 1991a).

In the upper Colorado River basin, historic accounts also report the presence of large populations of Colorado pikeminnow (Tyus 1991a; Quarterone 1993). Populations persist in all three major river and tributary systems of the upper Colorado River basin (i.e., San Juan, Colorado, and Green river systems), but they are severely reduced in all but the latter (Platania et al. 1991; Tyus 1991a; Osmundson and Burnham 1996). There may be less than 100 wild adult Colorado pikeminnow remaining in the San Juan River system based on the few recent captures and relatively high recapture rates (D. Propst, New Mexico Department of Game and Fish, personal communication). Osmundson and Burnham (1996) recently estimated that about 600 to 650 adult Colorado pikeminnow occur in the Colorado River upstream of the Green River confluence. Although no abundance estimates have been calculated, populations in the Green River system are thought to be substantially larger than those in the Colorado River based on relative capture-rate data collected annually in the Interagency Standardized Monitoring Program (ISMP) and capture rates of marked fish (Tyus 1991a; McAda et al. 1994a, 1994b, 1995, 1996, 1997).

Although historic accounts are sketchy, most described Colorado pikeminnow as widespread and abundant in the Green River system (Tyus 1991a; Quarterone 1993). Based on those accounts and habitat tolerances described in more recent studies, it is reasonable to assume that Colorado pikeminnow were found throughout lower reaches of most tributary streams in warm and cool water, and extended far upstream in the mainstem Green River to near Green River, Wyoming (Ellis 1914; Baxter and Simon 1970). In the vicinity of the Flaming Gorge Dam site, an aggregation of ripe male Colorado pikeminnow was discovered in early August 1961 (Vanicek et al. 1970), suggesting that this area once supported a reproducing population.

By the time the first comprehensive surveys were conducted during 1967–1973 (Holden and Stalnaker 1975a, 1975b), the Colorado pikeminnow was considered rare and endangered throughout the upper Colorado River basin, including the Green River system. Holden and Stalnaker (1975a) identified the lower Yampa River in Yampa Canyon and the middle and lower Green River as potential spawning areas based on aggregations of ripe adults and presence of early life stages. These inferences later proved mostly correct as spawning areas have been found in the lower Yampa River and Green River in Gray Canyon (Haynes et al. 1984; Tyus 1990; Tyus and Haines 1991; Bestgen et al. 1998).

The Colorado pikeminnow currently occupies approximately 1,100 river miles in the Colorado River system (25 percent of its original range) and is presently found only in the upper Colorado River basin above Glen Canyon Dam. The Colorado pikeminnow inhabits about 390 miles of the mainstem Green River from its confluence with the Colorado River upstream to the Gates of Ladore (Kevin Bestgen pers.comm.). Colorado pikeminnow have also been observed in the lower 49 miles of the Duchesne River and the lower 88.5 miles of the Price River. The Colorado pikeminnow's range also extends 160 miles up the Yampa River and 104 miles up the White River, the two largest tributaries of the Green River. In the mainstem Colorado River, it is currently found from Lake Powell extending about 201 miles upstream to Palisade, Colorado

(Tyus et al. 1982), and in the lower 60 miles of the Gunnison River, a tributary to the mainstem Colorado River (Burdick 1995).

During most of the year, distribution patterns of adults in the Green River system are stable, and from late summer to the following spring, adults are widely distributed and thought to occupy distinct home ranges (Tyus 1990; Tyus 1991a; Irving and Modde in press). Distribution of adults changes in late spring and early summer when most mature fish migrate to spawning areas in the lower Yampa River in Yampa Canyon and the lower Green River in Gray Canyon (Tyus and McAda 1984; Tyus 1985; Tyus 1990; Tyus 1991a; Irving and Modde in press). Those fish remain in spawning areas for 3–8 weeks before returning to their individual home ranges. Some radio-tagged fish did not migrate to spawning areas each year. These may have been immature or non-spawning individuals, or fish that moved to other areas for spawning (Tyus 1990). Although additional spawning sites may exist (Tyus 1990), recent movement patterns of adults (Irving and Modde in press) and capture rates of larvae at drift-net sites downstream of principal spawning areas (Bestgen et al. 1998) suggest that other sites are rarely used.

Historically, Echo and Island parks in the upper Green River supported nursery habitat for Colorado pikeminnow (Vanicek et al. 1970; Holden and Stalnaker 1975a; Holden and Crist 1981). Early life stages of Colorado pikeminnow in that area remain rare (Holden and Crist 1981; Tyus and Haines 1991; Bestgen and Crist 1998). No larvae or juveniles of Colorado pikeminnow have been collected from the Green River upstream of the Yampa River confluence since initial post-impoundment studies of Flaming Gorge Dam ended in 1966 (Vanicek and Kramer 1969; Vanicek et al. 1970; Holden and Crist 1981; Bestgen and Crist 1998; Bestgen et al. 1998).

Presently, there are two primary reaches of Colorado pikeminnow nursery habitat in the Green River system. One occurs in the middle Green River from near Jensen, Utah, downstream to the Duchesne River confluence. The other is in the lower Green River from near Green River, Utah, downstream to the Colorado River confluence (Tyus and Haines 1991; McAda et al. 1994a; McAda et al. 1994b-1997). The reach of the Green River defined mostly by Desolation and Gray canyons also provides nursery habitat for Colorado pikeminnow (Tyus and Haines 1991; Day et al. 1999).

Juvenile Colorado pikeminnow 80–400 mm have the most restricted distribution of any life stage in the Green River system. Juveniles are most common in the lower portion of the Green River, downstream of Green River, Utah, with fewer in the middle Green River (McAda et al. 1994a). Juveniles are found in the White River and other tributaries (McAda et al. 1994b, 1995, 1996, 1997; Cavalli 1998), but few have ever been caught in the Yampa River upstream of Yampa Canyon. A few age-0 and juvenile Colorado pikeminnow were captured in recent years from the lower Yampa River and the Green River in the Island-Rainbow Park reach (Bestgen and Crist 1998; K. R. Bestgen, unpublished data).

The Colorado pikeminnow was listed as endangered on March 11, 1967. Full protection under the Endangered Species Act of 1973, as amended, occurred on January 4, 1974.

**Critical Habitat Description for Colorado pikeminnow**

Critical habitat, as defined in section 3(5)(A) of ESA, means: "(i) the specific areas within the geographical area occupied by the species at the time it is listed in accordance with section 4 of the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed in accordance with section 4 of the Act, upon a determination by the Secretary that such areas are essential for the conservation of the species."

Critical habitat was designated for four endangered Colorado River fishes on March 21, 1994, including the Colorado pikeminnow. Designated critical habitat for the endangered Colorado River fishes includes those portions of the 100-year flood plain that contain constituent elements. The constituent elements are those physical and biological features that the Service considers essential for the conservation of the species and include, but are not limited to, the following items: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of the species.

The primary constituent elements determined necessary for the survival and recovery of four endangered Colorado River fishes include (59 FR 13374), but are not limited to:

(1) Water

A quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species;

(2) Physical Habitat

Areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursing, feeding, and rearing, or corridors between these areas. In addition to river channels, these areas also include bottom lands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year flood plain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats;

(3) Biological Environment

Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition,

although considered normal components of this environment, are out of balance due to introduced nonnative fish species in many areas.

Destruction or adverse modification of critical habitat is defined at 50 CFR 402.02 as a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. In evaluating actions, we consider the action's impact on factors used to determine critical habitat of the Colorado River endangered fishes. These factors include the primary constituent elements of water, physical habitat, and biological environment. The ability of an area to provide these constituent elements into the future and the reaches' capability to contribute to the recovery of the species will also be considered.

Activities which may disturb or remove the primary constituent elements within designated critical habitat include, among others, actions that would reduce the volume and timing of water, destroy or block off spawning and nursery habitat, prevent recruitment, adversely impact food sources, contaminate the river, or increase predation by and competition with nonnative fish. Examples of activities that may destroy or adversely modify critical habitat are listed at 59 FR 13387, and include construction and operation of hydroelectric facilities, irrigation, flood control, bank stabilization, oil and gas drilling, mining, grazing, stocking or introduction of nonnative fishes, municipal water supplies, and resort facilities.

Critical habitat has been designated within the 100-year flood plain of the Colorado pikeminnow's historical range in the following sections of the Upper Basin and the San Juan River (59 FR 13374).

Colorado, Moffat County. The Yampa River and its 100-year flood plain from the State Highway 394 bridge in T. 6 N., R. 91 W., section 1 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).

Utah, Uintah, Carbon, Grand, Emery, Wayne, and San Juan Counties; and Colorado, Moffat County. The Green River and its 100-year flood plain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (Salt Lake Meridian).

Colorado, Rio Blanco County; and Utah, Uintah County. The White River and its 100-year flood plain from Rio Blanco Lake Dam in T. 1 N., R. 96 W., section 6 (6th Principal Meridian) to the confluence with the Green River in T. 9 S., R. 20 E., section 4 (Salt Lake Meridian).

Colorado, Delta and Mesa Counties. The Gunnison River and its 100-year flood plain from the confluence with the Uncompahgre River in T. 15 S., R. 96 W., section 11 (6th Principal Meridian) to the confluence with the Colorado River in T. 1 S., R. 1 W., section 22 (Ute Meridian).

Colorado, Mesa and Garfield Counties; and Utah, Grand, San Juan, Wayne, and Garfield Counties. The Colorado River and its 100-year flood plain from the Colorado River Bridge at exit 90 north off Interstate 70 in T. 6 S., R. 93 W., section 16 (6th Principal Meridian) to North Wash, including the Dirty Devil arm of Lake Powell up to the full pool elevation, in T. 33 S., R. 14 E., section 29 (Salt Lake Meridian).

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. 41 S., R. 11 E., section 26 (Salt Lake Meridian) up to the full pool elevation.

## RAZORBACK SUCKER

### A. Species description

The razorback sucker is a member of the sucker family, *Catostomidae,* and is endemic and unique to the Colorado River system. Females are larger than males of the same age. The moderate sized ventral mouth has a cleft lower lip, with lateral margins continuous and rounded. Razorback sucker coloration ranges from dark brown to olive dorsally and yellow to white ventrally, but color and morphology differ due to a sexual dimorphism that is especially obvious during reproductive seasons.

Adults are distinguished by a pronounced bony dorsal keel ("razor") arising immediately posterior to the occiput and may attain maximum total length of about one meter (commonly 400 -700 mm), weigh 5-6 kg (commonly less than 3 kg), and exceed 40 years of age (Minckley 1983; McCarthy and Minckley 1987). Larvae are generally 7-9 mm at hatching, 9-11 mm at swimup, and consume most of their yolk and begin exogenous feeding by 10-11 mm (Minckley and Gustafson 1982; Marsh and Langhorst 1988; Papoulias and Minckley 1990; Snyder and Muth 1990). Transition to the juvenile period (sensu Snyder 1976) occurs at 27-30 mm (Snyder and Muth 1990), and, generally, fish greater than 350 mm are sexually mature (Minckley 1983; Hamman 1985).

### B. Life History and population dynamics

The razorback sucker is adapted to the various habitats and greatly fluctuating, unpredictable hydrologic conditions of the pristine Colorado River system (Minckley 1973, 1983; Holden and Stalnaker 1975a; Behnke and Benson 1983; Carlson and Muth 1989; Lanigan and Tyus 1989; Bestgen 1990; Minckley et al. 1991a) and apparently has a life strategy that includes use of inundated flood plain habitats as growth and conditioning areas (Tyus 1987; Tyus and Karp 1989, 1990, 1991; Modde 1996, 1997; Modde et al. 1995, 1996; Wydoski and Wick 1998). The razorback sucker has a multi-phase life cycle, with larvae and early juveniles representing several life-intervals that are morphologically and ecologically distinct from each other and from later juvenile and adult stages (Snyder and Muth 1990).

Habitats used by adult razorback suckers in rivers of the upper Colorado River basin include deeper runs, eddies, backwaters, and, at higher discharges, flooded off-channel environments in spring (the latter apparently including movements from the colder main channel into warmer habitats, a behavior called "staging", before spawning); runs and pools often in shallow water associated with submerged sandbars in summer; and low-velocity runs, pools, and eddies in winter (Tyus 1987; Osmundson and Kaeding 1989a; Valdez and Masslich 1989; Tyus and Karp 1990; Modde 1997; Modde and Wick 1997; Modde and Irving 1998). Young razorback suckers require nursery environments with quiet, warm, shallow water such as tributary mouths, backwaters, or inundated flood plain habitats in rivers (Smith 1959; Taba et al. 1965; Gutermuth et al. 1994; Modde 1996, 1997; Muth et al. 1998) and coves or shorelines in reservoirs (Minckley et al. 1991a). The diet of all life stages is varied and includes insects, zooplankton, phytoplankton, algae, and detritus (Taba et al. 1965; Vanicek 1967; Hamman 1987; Marsh 1987; Marsh and Langhorst 1988; Muth et al. 1998). Growth to adult size is rapid in warm, food-rich environments (Osmundson and Kaeding 1989b; Minckley et al. 1991a; Mueller 1995).

Minckley (1973) stated that razorback suckers in riverine environments make annual spawning runs to specific river areas. Razorback suckers in the Green River system spawn over bars of cobble, gravel, and sand substrates during spring-runoff flows at widely ranging discharges and water temperatures (McAda and Wydoski 1980; Tyus 1987; Tyus and Karp 1989, 1990; Muth et al. 1998). Reproduction in the lower Colorado River basin generally occurs during January through April (Medel-Ulmer 1983; Minckley 1983; Langhorst and Marsh 1986; Mueller 1989) but may extend from November into May (Bozek et al. 1991). Estimates of the total fecundity of wild females ranged up to 144,000 ova/fish (Minckley 1983). Presumably, long life and high fecundity allow the species to persist through several consecutive seasons of no or low reproduction and recruitment (Bestgen 1990).

Direct observation of spawning behavior and release of gametes in the Green River is prevented by high water turbidity (Tyus 1987; Tyus and Karp 1990). However, Mueller (1989) observed razorback suckers spawning in the clear Colorado River downstream of Hoover Dam, Arizona-Nevada, and reported behavior similar to that reported for populations in lower Colorado River basin reservoirs. In Lake Mohave, spawning groups of one female and several male razorback suckers congregate over coarse cobble in water 0.5-5 m deep. The males press against the female, and spawning convulsions (a few seconds in duration) sweep the substrate clear of fine materials and create depressions 20 cm or more deep. Individual females have been observed spawning hourly and daily on successive days within a week. The number of eggs released by a female with each spawning act is apparently only a small fraction of her total complement (Minckley et al. 1991a). McAda and Wydoski (1980) estimated the total fecundity of 10 razorback suckers (446-534 mm) caught in the Green River during autumn at 27,614 to 76,576 ova/fish, whereas estimates of total fecundity for five razorback suckers (391-570 mm standard length) collected from Lake Mohave during spring ranged from 74,600 to 144,000 ova/fish (Minckley 1983).

Incubation time and hatching success of razorback sucker embryos are temperature dependent. Marsh (1985) evaluated the effects of temperatures ranging from 5° to 30° C on incubation and hatch of captive razorback sucker embryos acclimated at 18° C. Among his treatments, total mortality of embryos occurred at 5°, 10°, and 30° C. Of those treatments with surviving embryos, hatch duration was longest (204 h) and percent hatch was highest (35 percent) at 20° C, hatch duration was shortest (96 h) at 25° C, and percent hatch was lowest (19 percent) at 15° C. Bozek et al. (1990) reported that hatching success of captive razorback sucker embryos acclimated to experimental temperatures ranged from 22 to 57 percent at 10° C, 32 to 65 percent at 15° C, and 34 to 65 percent at 20° C; total mortality occurred at 8° C. They concluded that optimal hatching temperatures were 12°-20° C. Hatching time for 50 percent of the eggs was 420-556 h at 10° C, 256-298 h at 15° C, and 15-168 h at 20° C.

Haines (1995) evaluated the effects of temperature (12°, 16°, and 20° C) on the developmental rate and hatching success of captive embryos of razorback and flannelmouth suckers. Mean number of days between fertilization and peak hatch decreased as temperature increased for both species and ranged from 6.5 to 12.5 days for razorback sucker and 6.0 to 16.5 days for flannelmouth sucker. The period from first to last hatch averaged 2.0 days longer for razorback sucker than for flannelmouth sucker over all temperatures. Percent hatch of flannelmouth embryos was independent of temperature and, at each temperature, was greater (83-91 percent) than for razorback sucker embryos (48-67 percent); hatching success of razorback sucker embryos increased as temperature increased.

Several factors may limit the survival of razorback sucker embryos in the Green River system. These factors include reduced water temperatures caused by operation of Flaming Gorge Dam (Tyus and Karp 1991), sedimentation of cobble and gravel spawning substrates associated with high releases from Flaming Gorge Dam occurring too early in the spring-runoff period (Wick 1997), predation on eggs by nonnative fishes (Hawkins and Nesler 1991; Lentsch et al. 1996c; Tyus and Saunders 1996), and selenium contamination of adults and embryos (Hamilton and Waddell 1994).

Before 1992 (Muth et al. 1998), direct evidence of reproduction by razorback suckers in the Upper Colorado River basin or information on the species' natural early life history in riverine environments were limited to those larvae collected by Tyus (1987) and captures of a few early juveniles from backwaters (e.g., Smith 1959; Taba et al. 1965; Gutermuth et al. 1994). However, diagnostic characters for distinguishing larval razorback suckers from larvae of sympatric suckers were only recently developed (Snyder and Muth 1990) and previous sampling for riverine razorback suckers did not target early life stages. Razorback sucker larvae are generally 7-9 mm at hatching and 9-11 mm at swimup; at 15° C, larvae swimup 13 days after hatching (Minckley and Gustafson 1982; Marsh 1985; Snyder and Muth 1990; R. T. Muth, personal observation). In rivers, larval razorback suckers presumably enter the drift after emerging from spawning substrates (Mueller 1989; Paulin et al. 1989) and are transported downstream into off-channel nursery environments with quiet, warm, shallow water (e.g., tributary mouths, backwaters, and inundated flood plain habitats).

Food-limited growth and survival of razorback sucker larvae has been postulated as contributing to the low or nonexistent recruitment (Minckley 1983; Marsh and Langhorst 1988; Papoulias and Minckley 1990, 1992; Modde 1997). Muth et al. (1998) reported that mean and maximum total length of larval razorback suckers in collections from the middle or lower Green River generally increased as sampling progressed each year, and approximately 20 percent of all larvae captured were larger than 12 mm; the two largest specimens were 20 and 24 mm. They estimated that mean daily growth (posthatching) of larvae less than 35 days old collected from either river section during 1993-1996 was lowest in 1994 (0.31 and 0.27 mm TL/d for the middle and lower Green River, respectively) and greatest in 1996 (0.35 and 0.33 mm TL/d). Over all years, specimens from the middle Green River grew 6-21 percent faster than those from the lower Green River.

Muth et al. (1998) noted that, although food abundance in existing Green River nursery habitats appeared adequate to meet the minimum nutritional requirements for larval survival, growth of razorback sucker larvae was not optimal. Relatively minor differences in growth rates can be biologically significant if size-dependent processes, such as predation by small, gape-limited predators, are important regulators of larval survival. Predation by adult red shiners on larvae of native catostomids in flooded and backwater habitats of the Yampa, Green, or Colorado rivers was documented by Ruppert et al. (1993) and Muth and Wick (1997). Horn (1996) concluded that although nutritional limitations in Lake Mohave may directly contribute to the high mortality of larval razorback suckers, a greater problem is reduced growth, which keeps larvae at a size vulnerable to predation for a longer period of time. He further stated that apparently all razorback sucker larvae in Lake Mohave, starving or not, are consumed by nonnative fish predators.

Predation by nonnative fishes on young razorback suckers is considered a serious threat to populations (Bestgen 1990; Minckley et al. 1991a; Horn 1996; USFWS 1998). Ruppert et al. (1993) and Wydoski and Wick (1998) reported that because razorback suckers in the Green River system spawn on the ascending limb of the hydrograph and their larvae disperse into low-velocity habitats during May and June when invertebrate numbers are low in riverine nursery habitats, razorback sucker larvae would be highly susceptible to predation by nonnative fishes at that time because other food organisms are scarce. Extremely low survival of larval razorback suckers in the Green River during 1992-1996 was suggested by Muth et al. (1998) based on the apparent disappearance of larvae from nursery habitats by early or mid-July each year. Thus it appears that low survival of early life stages is responsible for the low or nonexistent recruitment in wild populations.

Historically, flood plain habitats inundated and connected to the main channel by overbank flooding during spring-runoff discharges would have been available as nursery areas for young razorback suckers in the Green River. Tyus and Karp (1990) associated low recruitment with reductions in flood plain inundation since 1962, and Modde et al. (1996) associated years of high spring discharge and flood plain inundation in the middle Green River (1983, 1984, and 1986) with subsequent suspected recruitment of young adult razorback suckers. Flood plain habitats are typically warmer and substantially more productive than the adjacent river and have abundant

vegetative cover (Mabey and Shiozawa 1993; Wolz and Shiozawa 1995; Modde 1997; Wydoski and Wick 1998). Spawning at increasing and highest runoff flows provides drifting razorback sucker larvae maximum access to flooded habitats, and enhanced growth of larvae in those habitats may increase overall survival by shortening the period of vulnerability to predation (Lentsch et al. 1996b).

Little is known about the biology of juvenile razorback suckers, but the few collected from rivers were found in quiet-water habitats. In 1950, about 6,600 larval or early juvenile razorback suckers were seined along warm, shallow margins of the Colorado River at Cottonwood Landing, Nevada (Sigler and Miller 1963). Smith (1959) caught two juveniles (both about 38 mm long) in the Glen Canyon area of the Colorado River before inundation by Lake Powell, one from a backwater and one from a flooded tributary mouth. Taba et al. (1965) collected eight razorback sucker juveniles (90–115 mm long) from backwaters on the Colorado River near Moab, Utah, 1962–1964. The digestive tracts of those fish contained "algae and bottom ooze." Juvenile razorback suckers have been caught in lateral canals off the lower Colorado River (Marsh and Minckley 1989; Maddux et al. 1993), and stocked, hatchery-produced young have been observed along shorelines, in embayments, along sandbars, or in tributary mouths, eventually moving into river channels or larger backwaters (Minckley et al. 1991a).

Outside the breeding season, adult razorback suckers tend to utilize deeper eddies, backwaters, and pool-type habitats (Minckley et al. 1991a), and their movements are generally reduced (Tyus 1987; Tyus and Karp 1990). Summer or autumn habitat use in rivers of the upper Colorado River basin includes submerged mid-channel sandbars, pools, eddies, and runs (Tyus 1987; Osmundson and Kaeding 1989a; Modde and Wick 1997). Tyus (1987) reported that Green River fish during summer occupied uneven mid-channel sandbars in water less than 2 m deep with an mean velocity of 0.5 m/s. Habitat use in the middle Green River during spring and summer 1993 included runs, eddies, or run-eddy interfaces in water 1–3 m deep over sand, cobble, and gravel substrates (Modde and Wick 1997; Modde and Irving 1998). Although turbulent canyon reaches are not considered preferred habitat for razorback suckers (Tyus 1987; Lanigan and Tyus 1989; Minckley et al. 1991a), Modde and Wick (1997) and Modde and Irving (1998) reported that six radio-tagged adults moved into or near the vicinity of Split Mountain Canyon (Reach 2) during summer or autumn in 1993 and 1994, and possibly remained there over winter. Ryden and Pfeifer (1998) reported that large juvenile and adult razorback suckers stocked in the San Juan River, New Mexico-Utah, preferred fast, mid-channel habitats during the summer–autumn base-flow period.

### C. Status and distribution

The endangered razorback sucker is an endemic catostomid of the Colorado River basin (Miller 1959; Minckley et al. 1986) and was once widely distributed in warmwater reaches of larger rivers from Mexico to Wyoming (Jordan and Evermann 1896; Minckley 1973; Behnke and Benson 1983; Bestgen 1990; USFWS 1994). Historic records indicate that the lower Colorado River basin supported the largest numbers of razorback sucker; the species was most abundant in the mainstem Colorado River downstream of present-day Lake Mead, the Salton Sea area, and the lower Gila River drainage in Arizona (Kirsch 1888; Gilbert and Scofield 1898; Minckley

1973, 1983; Bestgen 1990; Minckley et al. 1991a). In the upper Colorado River basin, razorback suckers historically occurred in the Colorado, Green, and San Juan river drainages but apparently were common only in calm, flat-water reaches of the mainstem Colorado and Green rivers and lower sections of their major tributaries (Jordan 1891; Evermann and Rutter 1895; Ellis 1914; Simon 1946; Hubbs and Miller 1953; Koster 1960; Sigler and Miller 1963; Baxter and Simon 1970; Vanicek et al. 1970; Holden and Stalnaker 1975a, 1975b; Wiltzius 1978).

Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and, further, that commercially marketable quantities were caught in Arizona as recently as 1949. In the Upper Basin, razorback suckers were reported in the Green River to be very abundant near Green River, Utah, in the late 1800's (Jordan 1891). An account in Osmundson and Kaeding (1989) reported that residents living along the Colorado River near Clifton, Colorado, observed several thousand razorback suckers during spring runoff in the 1930's and early 1940's. In the San Juan River drainage, Platania and Young (1989) relayed historical accounts of razorback suckers ascending the Animas River to Durango, Colorado, around the turn of the century.

Declines in the abundance and distribution of razorback suckers were first noted in the early 1940's (Dill 1944; Wiltzius 1978). Today, the species is one of the most imperiled fishes in the Colorado River basin and exists naturally as only a few disjunct, aging populations or scattered individuals (Minckley et al. 1991a). Although there is evidence of reproduction in the two largest extant populations, natural survival of fish beyond the larval period appears low or nonexistent. Wild stocks are primarily composed of older fish and continue to decline in abundance (Lanigan and Tyus 1989; Marsh and Minckley 1989). Lack of recruitment sufficient to sustain populations has been mainly attributed to the cumulative effects of habitat loss and modification (including reductions in river-flood plain connectivity) caused by water and land development, and predation on early life stages by nonnative fishes (Tyus and Karp 1990; Hawkins and Nesler 1991; Modde et al. 1995; Horn 1996; Lentsch et al. 1996c; Tyus and Saunders 1996; Hamilton 1998; USFWS 1998a).

Remaining wild populations of razorback sucker are in serious jeopardy. The largest extant population is found above Davis Dam in Lake Mohave on the lower mainstem Colorado River, Arizona-Nevada, but little or no natural recruitment has occurred since completion of the dam in 1954 (McCarthy and Minckley 1987; Minckley et al. 1991a). Estimated numbers of adult razorback suckers in Lake Mohave declined 68 percent (from 73,500 to 23,000) during 1980–1993 (Marsh 1994), and further steep declines in the population are expected within the next decade (Minckley et al. 1991a; Mueller 1995). Most razorback suckers occupying exclusively riverine habitat are now limited to the upper Colorado River basin and populations are small. Lanigan and Tyus (1989) estimated that from 758 to 1,138 razorback suckers inhabit the upper Green River. More recent studies of this Green River population of razorback suckers indicate that this population consists of a precariously small but dynamic population that appears to be stable or declining slowly and may consist only of about 500 individuals (Modde et al. 1996). In the Colorado River, most razorback suckers occur in the Grand Valley area near Grand

Junction, Colorado; however, they are increasingly rare. Osmundson and Kaeding (1991) report that the number of razorback sucker captures in the Grand Junction area has declined dramatically since 1974. Modde et al. (1996) characterized the middle Green River population as "precariously" small but dynamic, with at least some recruitment.

In the San Juan River subbasin, small concentrations of razorback suckers have been reported at the inflow area in the San Juan arm of Lake Powell, Utah and one specimen was captured in the San Juan River near Bluff, Utah in 1988 (Platania 1990, Platania et al. 1991). In Bestgen (1990) additional captures of small numbers of razorback suckers were reported from the Dirty Devil and Colorado River arms of Lake Powell.

The razorback sucker was listed as endangered, pursuant to the Act, on October 23, 1991.

**Critical habitat description for Razorback sucker**

Critical habitat has been designated within the 100-year flood plain of the razorback sucker's historical range in the following sections of the Upper and Lower Basin and the San Juan River (59 FR 13374). The critical elements are the same as those listed above under Colorado pikeminnow.

Colorado, Moffat County. The Yampa River and its 100-year flood plain from the mouth of Cross Mountain Canyon in T. 6 N., R. 98 W., section 23 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).

Utah, Uintah County; and Colorado, Moffat County. The Green River and its 100-year flood plain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to Sand Wash in T. 11 S., R. 18 E., section 20 (6th Principal Meridian).

Utah, Uintah, Carbon, Grand, Emery, Wayne, and San Juan Counties. The Green River and its 100-year flood plain from Sand Wash at river mile 96 at T. 11 S., R. 18 E., section 20 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (6th Principal Meridian).

Utah, Uintah County. The White River and its 100-year flood plain from the boundary of the Uintah and Ouray Indian Reservation at river mile 18 in T. 9 S., R. 22 E., section 21 (Salt Lake Meridian) to the confluence with the Green River in T. 9 S., R 20 E., section 4 (Salt Lake Meridian).

Utah, Uintah County. The Duchesne River and its 100-year flood plain from river mile 2.5 in T. 4 S., R. 3 E., section 30 (Salt Lake Meridian) to the confluence with the Green River in T. 5 S., R. 3 E., section 5 (Uintah Meridian).

Colorado, Delta and Mesa Counties. The Gunnison River and its 100-year flood plain from the confluence with the Uncompahgre River in T. 15 S., R. 96 W., section 11 (6th Principal Meridian) to Redlands Diversion Dam in T. 1 S., R. 1 W., section 27 (Ute Meridian).

Colorado, Mesa and Garfield Counties. The Colorado River and its 100-year flood plain from Colorado River Bridge at exit 90 north off Interstate 70 in T. 6 S., R. 93 W., section 16 (6th Principal Meridian) to Westwater Canyon in T. 20 S., R. 25 E., section 12 (Salt Lake Meridian) including the Gunnison River and its 100-year flood plain from the Redlands Diversion Dam in T. 1 S., R. 1 W., section 27 (Ute Meridian) to the confluence with the Colorado River in T. 1 S., R. 1 W., section 22 (Ute Meridian).

Utah, Grand, San Juan, Wayne, and Garfield Counties. The Colorado River and its 100-year flood plain from Westwater Canyon in T. 20 S., R. 25 E., section 12 (Salt Lake Meridian) to full pool elevation, upstream of North Wash, and including the Dirty Devil arm of Lake Powell in T. 33 S., R. 14 E., section 29 (Salt Lake Meridian).

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. 29 N., R. 13 W., section 17 (New Mexico Meridian) to Neskahai Canyon in the San Juan Arm of Lake Powell in T. 41 S., R. 11 E., section 26 (Salt Lake Meridian) up to the full pool elevation.

Arizona, Cococini and Mohave Counties; and Nevada, Clark County. The Colorado River and its 100-year flood plain from the confluence with the Paria River in T. 40 N., R. 7 E., section 24 (Gila and Salt River Meridian) to Hoover Dam in T. 30 N., R. 23 W., section 3 (Gila and Salt River Meridian) including Lake Mead to full pool elevation.

## HUMPBACK CHUB

### A. Species description

The humpback chub is endemic to the Colorado River Basin and is part of a native fish fauna traced to the Miocene epoch in fossil records (Miller 1955, Minckley et al. 1986). Humpback chub remains have been dated to about 4000 B.C., but the fish was not described as a species until the 1940's (Miller 1946), presumably because of its restricted distribution in remote white water canyons (USFWS 1990a). Because of this, its original distribution is not known.

The humpback chub is a relatively large North American minnow reaching a maximum length of 480 mm and a weight of 1,165 g (Valdez and Ryel, 1995). Humpback chub have a laterally-compressed and tapering fusiform body, short narrow caudal peduncle with deeply forked tail fin, and large falcate paired fins. Adults have a narrow flattened head, with small eyes and a long fleshy snout and inferior subterminal mouth. Subadults are olivaceous above with silvery sides fading to a creamy-white belly, while adults are light olivaceous and slate-gray dorsally and laterally, with a white belly tinged with light orange and yellow (Valdez and Ryel, 1995).

Although historic data are limited, the apparent range-wide decline in humpback chubs is likely due to a combination of factors including alteration of river habitats by reservoir inundation, changes in stream discharge and temperature, competition with and predation by introduced fish species, and other factors such as changes in food resources resulting from stream alterations (USFWS 1990a).

**B. Life history**

The humpback chub evolved in seasonally warm and turbid water and is highly adapted to the unpredictable hydrologic conditions that occurred in the pristine Colorado River system. It is extraordinarily specialized for life in torrential water, with an enlarged stabilizing nuchal hump and large falcate fins (Minckley 1991). Although not strong swimmers (Bulkley et al. 1982), humpback chubs are apparently so well adapted to canyon environments that populations appear to have always occupied a specialized niche in canyon-bound segments of the river system (Carlson and Muth 1989) where individual adults exhibit high fidelity to particular locales (Valdez and Clemmer 1982; Valdez and Ryel 1995).

Little is known about the specific spawning requirements of the humpback chub. The fish is known to spawn soon after the highest spring flows when water temperatures approach 20° C (Kaeding et al. 1990, Karp and Tyus 1990a, USFWS 1990b). The collection of ripe and spent fish indicated that spawning occurred in Black Rocks during June 2-15, 1980, at water temperatures of 10° to 15° C; in 1981, spawning occurred on May 15-25 at water temperatures of approximately 15° C (Valdez et al. 1982b). Humpback chub spawned in Black Rocks on the Colorado River in 1983 when maximum daily water temperatures were between 12° and 17° C (Archer et al. 1986).

The humpback chub is an obligate warmwater fish that requires relatively warm temperatures for spawning, egg incubation, and survival of larvae. Optimum growth temperatures range from 16° to 22° C (Hamman 1982; Lechleitner 1992). Little else is known about reproduction except that spawning occurs on the descending limb of annual spring hydrographs, most likely over gravel substrates (Valdez and Clemmer 1982; Valdez et al. 1982; Kaeding and Zimmerman 1983; Tyus and Karp 1989; Valdez and Ryel 1995).

Unlike larvae of Colorado pikeminnow and razorback sucker, emerging larval humpback chubs do not appear to drift extensively and remain in the general vicinity of spawning areas. Extensive sampling for larvae and young-of-year immediately downstream of Black Rocks and Westwater Canyon yielded very low numbers of young humpback chubs (Valdez et al. 1982; Chart and Lentsch 1999a). Robinson et al. (1998) documented drift of larval humpback chubs from the Little Colorado River and into the mainstem Colorado River in Grand Canyon; they noted lower abundance at more downstream stations, which suggested that humpback chub larvae may drift shorter distances than speckled dace, bluehead sucker, and flannelmouth sucker. Young-of-year fish in the Little Colorado River were noted to distribute themselves downstream in the main Colorado River within several months of hatching, however it is not known if this emigration is passive or active (Valdez and Ryel 1995).

Backwaters, eddies, and runs have been reported as common capture locations for young-of-year humpback chub (Valdez and Clemmer 1982). These data indicate that in Black Rocks and Westwater Canyon, young utilize shallow areas. Habitat suitability index curves developed by Valdez et al. (1990) indicate young-of-year prefer average depths of 2.1 feet with a maximum of 5.1 feet. Average velocities were reported at 0.2 feet per second. Subadult humpback chub (under 200 mm) occupied shoreline habitats within two meters of the shore and were specifically more abundant in talus and vegetated shorelines which provided more cover compared to sand or cobble bars in the Grand Canyon (Converse et al. 1998a). Humpback chubs mature in 2-3 years at approximately 200 mm and may live 20-30 years (Valdez et al. 1992; Hendrickson 1993).

Adults are thought to be negatively phototactic and are more active in turbid water or at night (Valdez et al. 1992; Valdez and Ryel 1995, 1997). Valdez et al. (1982b) and Wick et al. (1981) found adult humpback chub in Black Rocks and Westwater Canyons in water averaging 50 feet in depth with a maximum depth of 92 feet. In these localities, humpback chub were associated with large boulders and steep cliffs. In Grand Canyon, adult humpback chub were specifically associated with geomorphic reaches of the river characterized by large eddy hydraulic habitat. Humpback chub appear to have a high fidelity for particular eddies in some reaches of the river (Valdez and Ryel 1995).

Generally, humpback chub show fidelity for canyon reaches and move very little (Miller et al. 1982c, Archer et al. 1985; Burdick and Kaeding 1985, Kaeding et al. 1990). Movements of adult humpback chub in Black Rocks on the Colorado River were essentially restricted to a 1-mile reach. These results were based on the recapture of Carlin-tagged fish and radiotelemetry studies conducted from 1979 to 1981 (Valdez et al. 1982) and 1983 to 1985 (Archer et al. 1986; Kaeding et al. 1990).

Diet of humpback chubs in the upper Colorado River basin has not been described. In Grand Canyon, humpback chubs primarily consumed aquatic invertebrates (e.g., midges, blackflies, and amphipods), green algae, terrestrial invertebrates, and occasionally fish and reptiles (Kaeding and Zimmerman 1983; Kubly 1990; Valdez and Ryel 1997). Tyus and Minckley (1988) reported that migrating Mormon crickets (*Anabrus simplex*) were an important food source for humpback chubs in the Green and Yampa rivers.

Two species of non-indigenous parasites infect humpback chubs; the external parasitic copepod (*Lernaea cyprinacea*) has been reported from all populations (Valdez et al. 1982) and the internal Asian tapeworm (*Bothriocephalus acheilognathi*) is found in humpback chubs of Grand Canyon (Brouder and Hoffnagle 1997; Clarkson et al. 1997). Infection by the Asian tapeworm may cause stress or death to the host and widespread infestation during periods of stress. This parasite can complete its life cycle only where water temperatures are greater than 20° C but is apparently able to survive in a fish host at colder temperatures.

**C. Status and distribution**

The humpback chub is endemic to the Colorado River basin, with ancestral fossil evidence of a *Gila* complex dating back to the Miocene epoch (Miller 1955). *Gila cypha* is believed to be a more recent, specialized derivative that evolved in response to conditions in large, erosive Colorado River habitats during the mid-Pliocene and early Pleistocene epochs, 3–5 million years ago (Minckley et al. 1986). Skeletal remains of humpback chubs were found in 4,000-year-old flood deposits in Stanton's Cave in Marble Canyon, Arizona, as well as at an archeological site in Catclaw Cave, now inundated by Lake Mead (Miller 1955).

Records documenting distribution and abundance of the species in modern time are incomplete, and factors associated with its decline are scarce or poorly understood (Tyus 1998). The lack of early information on humpback chub is due to several factors. Humpback chubs occur primarily in remote canyon areas and apparently were rare in most early collections because of inaccessibility and difficulty in sampling these areas (Tyus 1998). In addition, there has been some uncertainty over nomenclature and taxonomy of species in the genus *Gila*. For example, during the 1950's, two forms of bonytail (a common name for morphotypes of the Colorado River *Gila* complex) were taxonomically recognized as subspecies, roundtail chub *Gila robusta robusta* and bonytail chub *Gila robusta elegans*.

A third form, the humpback chub *Gila cypha*, was described by Miller (1946) and was not universally recognized as a valid taxon (Holden and Stalnaker 1970; Holden 1991). Although many researchers recognized the presence of morphological variants, a common nomenclature has not been accepted. As a result, many early fish surveys of the Colorado River system assigned the vernacular "bonytail" to all three closely-related *Gila* species (*G. cypha*, *G. elegans*, and *G. robusta*), thereby confounding confirmation of humpback chub localities prior to approximately 1970 (Banks 1964; Vanicek and Kramer 1969; Holden and Stalnaker 1970; Valdez and Clemmer 1982; Douglas et al. 1989; Rosenfeld and Wilkinson 1989; Minckley 1991; Dowling and DeMarais 1993; Quartarone 1993).

Despite sparse historic records and taxonomic confusion, strong evidence exists that the historic range of the humpback chub included most canyon-bound reaches of the Colorado River system. Known historic distribution of humpback chubs includes portions of the mainstem Colorado River and four of its tributaries: the Green, Yampa, White, and Little Colorado rivers (USFWS 1990a). However, the species may have been extirpated from some river reaches, in both the lower and upper Colorado River basins, as a result of water development and other human-related alterations prior to complete documentation of its range.

Description of the present distribution of humpback chubs in the Colorado River basin is based on collection records from widely separated locations since approximately 1980. The Humpback Chub Recovery Plan (USFWS 1990a) described the present distribution of the species as:

1. Little Colorado River, Arizona, from its mouth to 13 km upstream;
2. Colorado River in Marble and Grand canyons, Arizona;
3. Colorado River in Cataract Canyon, Utah;

4. Colorado River in Black Rocks, Colorado, and Westwater Canyon, Utah;
5. Green River in Desolation and Gray canyons, Utah;
6. Green River in Whirlpool and Split Mountain canyons, Dinosaur National Monument, Colorado and Utah; and
7. Yampa River in Yampa Canyon, Dinosaur National Monument, Colorado.

The largest and most stable humpback chub population is presently thought to reside in the Little Colorado River and Colorado River near their confluence in Marble and Grand canyons, Arizona (1 and 2 from list above). Valdez and Ryel (1995) estimated that 3,750 adult humpback chubs larger than 200 mm occurred in the mainstem river during 1990–1993, and Douglas and Marsh (1996) reported 4,346 humpback chubs larger than 150 mm in the Little Colorado River in 1992. In addition, several other aggregations of humpback chub are found in the Grand Canyon, always in association with reaches characterized by large eddy complexes. In one aggregation at approximately river mile 30 in Grand Canyon, larval humpback chub were identified in association with springs expressed from local limestone geology; however it is not believed that any recruitment occurs as a result of this spawning activity. Rather the aggregation appears to be a relict group from the pre-dam era, that are prompted to spawn by relatively warmer spring water compared to the cold hypolimnetic river water (Valdez and Ryel 1995).

Of the five locations in the upper Colorado River basin (3–7 from list above), self-sustaining populations occur in Cataract Canyon (Valdez 1990; Valdez and Williams 1993), Black Rocks (Kaeding et al. 1990), Westwater Canyon (Chart and Lentsch 1999a), Desolation and Gray canyons (Chart and Lentsch 1999b), and Yampa Canyon (Karp and Tyus 1990b). A few humpback chubs also have been reported from the Green River in Dinosaur National Monument, primarily in Whirlpool Canyon (Holden and Stalnaker 1975a; Karp and Tyus 1990b) and Split Mountain Canyon (Vanicek 1967; Holden and Stalnaker 1975). Estimates of humpback chub population size in the Green and Colorado rivers have been difficult to obtain because of low numbers of fish and low recapture rates. Chart and Lentsch (1999a) sampled for humpback chubs at three locations in Westwater Canyon and derived abundance estimates ranging from 572 to 5,880 individuals larger than 175 mm; however, confidence intervals about the estimates were typically greater than the estimate means due to low recapture rates. Catch rates of humpback chubs in Black Rocks indicate a relatively large concentration (Maddux et al. 1993), but no abundance estimates have been attempted.

The humpback chub was included in the first List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001). The humpback chub was classified as endangered because of declines in distribution and abundance throughout its range. It was afforded full protection under ESA of 1973, as amended.

**Critical Habitat for humpback chub**

Critical habitat has been designated within the humpback chub's historical range in the following sections of the Upper Basin (59 FR 13374):

Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).

Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the southern boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).

Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumners Amphitheater in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).

Utah, Grand County; and Colorado, Mesa County. The Colorado River from Black Rocks in T. 10 S., R. 104 W., section 25 (6th Principal Meridian) to Fish Ford in T. 21 S., R. 24 E., section 35 (Salt Lake Meridian).

Utah, Garfield and San Juan Counties. The Colorado River from Brown Betty Rapid in T. 30 S., R. 18 E., section 34 (Salt Lake Meridian) to Imperial Canyon in T. 31 S., R. 17 E., section 28 (Salt Lake Meridian).

**Bonytail**

**A. Species description, life history and distribution**

Bonytail have an elongated fusiform body, small flattened head with small eyes, subterminal mouth, long slender caudal peduncle, and large deeply forked tail fin. Subadults are olivaceous above with silvery sides fading to creamy-white belly, while adults are greenish to gray dorsally and laterally, with a white belly and irregular black lateral spots (Valdez and Ryel 1995).

Formerly reported as widespread and abundant in mainstem rivers (Jordan and Evermann 1896), bonytail populations have been greatly reduced. The fish is presently represented in the wild by a low number of old adult fish in Lake Mohave and perhaps other lower Colorado River basin reservoirs (USFWS 1990a). The last known riverine area where bonytail were common was the Green River in Dinosaur National Monument, where Vanicek (1967) and Holden and Stalnaker (1970) collected 91 specimens during 1962-1966.

From 1977 to 1983, no bonytail were collected from the Colorado or Gunnison rivers in Colorado or Utah (Wick et al.1981; Valdez et al. 1982). However, in 1984, a single bonytail was collected from Black Rocks on the Colorado River (Kaeding et al. 1986). Several suspected bonytail were captured in Cataract Canyon in 1985-1987 (Valdez 1990). Researchers continue to capture suspected bonytail individuals or potential hybrid combinations of bonytail, roundtail chub and humpback chub; however it is difficult to determine the extent of hybridization in the

field or if certain individuals represent the bonytail species because of the complexity of *Gila* morphometric

The bonytail is considered a species that is adapted to mainstem rivers, where it has been observed in pools and eddies (Vanicek 1967, Minckley 1973). Spawning of bonytail has never been observed in a river, but ripe fish were collected in Dinosaur National Monument during late June and early July suggesting that spawning occurred at water temperatures of about 17° C (Vanicek and Kramer 1969).

Early stocking efforts which placed hatchery-raised adult bonytail into the Green River at Split Mountain and near the Jensen, Utah area proved unsuccessful. Currently, the State of Utah has an experimental stocking program in place through which thousands of subadult bonytail have been stocked into the Colorado River in the Moab area in the past 5 years. This experimental stocking also includes investigations into muscle fitness of stocked fish (Lentsch et al. 1996a).

The bonytail is the rarest native fish in the Colorado River. Fewer than 10 individuals have been caught in the upper Colorado River basin in the last decade and small numbers of adults persist in Lake Mohave, Nevada-Arizona (Kaeding et al. 1986). Bonytail was listed as an endangered species in 1980.

**Critical Habitat for Bonytail**

Critical habitat has been designated within the bonytail's historical range in the following sections of the Upper Basin (59 FR 13374):

Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).

Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).

Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumner's Amphitheater (river mile 85) in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid (river mile 12) in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).

Utah, Grand County; and Colorado, Mesa County. The Colorado River from Black Rocks in T. 10 S., R. 104 W., section 25 (6th Principal Meridian) to Fish Ford in T. 21 S., R. 24 E., section 35 (Salt Lake Meridian).

Utah, Garfield and San Juan Counties. The Colorado River from Brown Betty Rapid in T. 30 S., R. 18 E., section 34 (Salt Lake Meridian) to Imperial Canyon in T. 31 S., R. 17 E., section 28 (Salt Lake Meridian).

**E. Analysis of the species/critical habitat likely to be affected**

It is anticipated that the Colorado pikeminnow that occupy 88.5 miles of the Price River will be directly affected, as will their habitat, by flow depletions and instream habitat modifications. In addition, flow depletions in the Price River will deplete flows in the Green and Colorado rivers and affect critical habitat for the four endangered fish species from the confluence of the Price and Green rivers downstream to Lake Powell. Depletions on Green and Colorado rivers within the affected area are herein considered in accumulation with other small tributary depletions as a net change to the sediment and flow regimes and lost potential for creation and maintenance of habitat characteristics crucial to various life-stages of these fish. For example, lower peak flows prevent interconnection of the 100-year flood plain and flood plain inundation and also decreases capacity for creation of backwaters in downstream reaches. Lower peak flows may also affect Colorado pikeminnow spawning habitat in Gray Canyon and other species spawning habitat as yet unidentified.

## IV. ENVIRONMENTAL BASELINE

**A. Status of the species within the action area**

Colorado pikeminnow are found in the Price River from Farnham Diversion near Wellington at river mile 88.5 down to the confluence of the Price and Green rivers. Wellington is located approximately 50 to 70 miles downstream of the proposed Narrows Dam.

The collection of 21 Colorado pikeminnow in the Price River and seven additional individuals positively identified but not captured during a 2-year seasonal study indicates that some suitable habitat for juvenile and adult Colorado pikeminnow is available during April through September although the quality or quantity is unknown. No data has been collected during late fall or winter, so it is not known whether the Price River is used by Colorado pikeminnow during those seasons.

Although spawning of the Colorado pikeminnow has not been documented in the Price River, the potential for Colorado pikeminnow spawning in the Price River is unknown. The Price River warms earlier than the Green River which may attract Colorado pikeminnow from the Green River that are searching for suitable spawning and/or feeding areas in the spring. A ripe male Colorado pikeminnow was captured at river mile 10.5, which suggests that the fish may attempt to spawn in the Price River, however one ripe male may also be anomalous. The availability and quality of spawning habitat is unknown other than observation of some riffle habitat in the canyon reaches. Minimal quality and quantity of nursery habitat (defined as low-velocity shoreline pockets or backwaters) has been noted within the Price River. The nursery habitat present within the Price River is suspected to be completely dewatered during low water periods. It is not clear if the year-round flow and sediment regimes are adequate to maintain spawning or nursery habitat.

Despite anecdotal accounts of abundant Colorado pikeminnow in the early part of the century (Hardy 1964 in reference to early 1900s), most biologists including biologists from the State of Utah Division of Wildlife Resources (UDWR) did not believe Colorado pikeminnow occupied the Price River at any appreciable level before recent findings from surveys in 1996 and 1997. In fact, McAda et al. (1977) reported that no endangered species were identified at any of three locations within the Price River; however this survey represented minimal effort during 1 year, which happened to be a severe drought year.

It is possible that Colorado pikeminnow have been present in the Price River at varying or low densities but only recently detected, or Colorado pikeminnow may have only recently recolonized the Price River. In either case, juvenile and adult Colorado pikeminnow appear to use as much of the Price River that is available (88.5 miles from the confluence of the Price and Green rivers to the Farnham Diversion, an upstream barrier to fish movement) at least from April through September. In contrast, if Colorado pikeminnow were in fact, locally extirpated, recent note of more than twenty juveniles and adults in the Price River may indicate that Colorado pikeminnow are recolonizing the Price River after years of absence. Recolonization of tributaries may exemplify an increasing trend for Colorado pikeminnow in the Green River system.

The Price River may play an important role to the overall Green River system both biologically and physically. The proportion of native species is much higher in the Price River than in the Green River, and the number of nonnative predators and competitors, such as channel catfish and green sunfish, in the Price River is relatively low. The dominant native fish community in the Price River may be one reason why Colorado pikeminnow are found there. Water temperatures within the Price River warm earlier than the Green River, which may attract the endangered fish from the Green River searching for suitable spawning and/or feeding areas (Cavalli 1999). The Price River may also provide better growing conditions, food supply, and nutrients needed by the endangered fishes; however, further studies are needed to determine the importance of these relationships to the overall recovery of the species in the upper Colorado River basin.

Outside of the Price River basin, Colorado pikeminnow, humpback chub, razorback sucker and to some extent, bonytail, are present and utilize the Green River from the confluence of the Price and Green rivers downstream to Lake Powell; this area will be affected by depleted flows in the Price River. Various life-stages of these species occur within this area including: 1) spawning adult Colorado pikeminnow, humpback chub and most likely razorback sucker; 2) young-of-year Colorado pikeminnow, humpback chub and razorback sucker; 3) juvenile Colorado pikeminnow, humpback chub and razorback sucker; and 4) migrating and feeding adults of all four species. In addition, the critical habitat that is affected by the proposed Project is within several areas of focus for recovery efforts for these species. Any factor detrimentally affecting these species is expected to hinder recovery efforts to some unknown extent.

**B. Factors affecting species environment within the action area**

The Colorado pikeminnow, razorback sucker, humpback chub, and bonytail are adversely affected by the following project activities or consequences:

1. Depletions to instream flows and resultant degradation of instream habitat as well as direct influences on various life-stages and the food-base of Colorado pikeminnow within 88.5 miles of occupied habitat in the Price River.

2. Depletions to the Green River and Colorado River basin including direct impacts on all four endangered fish species and their critical habitat, cumulative depletion impacts on the sediment and flow regimes, and adverse modification of habitat downstream from the confluence of the Price and Green rivers to Lake Powell.

## V. EFFECTS OF THE ACTION

### A. Factors to be considered

Water depletions in the upper Colorado River basin have been long recognized as a major source of impact to the endangered fish species native to this basin. Continued water withdrawal has restricted the ability of the Colorado River system to produce flow conditions required to create and maintain habitat for various life stages of these species. Impoundments and diversions, like the proposed Narrows Project, have substantially reduced peak discharges in the Colorado River basin while increasing base flows in some reaches. These depletions along with a number of other factors have resulted in such drastic reductions in the populations of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker that the Service has listed these species as endangered and has implemented programs to prevent extinction and recover the species. Both direct and indirect effects of depletions that will occur as a result of the proposed Narrows Project as well as cumulative effects within the Price River drainage were considered in the formulation of this Opinion.

The fact that the project depletes flows during peak runoff period is of concern to us because this hydrologic characteristic is geomorphically and ecologically significant to the endangered fish species. Spring runoff is the most extreme parameter of the hydrologic cycle, and it precedes and influences the very critical spawning period of the endangered fishes. Observations clearly demonstrate that migration and spawning activities of these fishes are synchronized with and undoubtedly influenced by the runoff period (Archer et al. 1986; Archer and Tyus 1984). The Service further believes that peak spring flows are crucial for creating and maintaining in-channel habitats, such as spawning habitat and backwaters, and for providing access to off-channel habitats, such as inundated floodplains.

Also, we are generally concerned about the base-flow condition. Minimum instream flows have not been identified or secured for the Price River. It is not clear what minimum flows and what time of year such flows would be required to protect and maintain habitat for endangered fish species. Further depletions from the system could affect the base-flow condition which would impact instream habitat quality and quantity.

**B. Analysis for effects of the action**

The Price River is a tributary to the Green River that drains approximately 1,892 square miles of southeastern Utah. Past and ongoing impacts to the Price River include water development projects for irrigation, industrial, and culinary purposes. Two existing Federal projects impact the Price River Basin. The Price-San Rafael River Salinity Control Project results in an annual depletion of 25,310 acre-feet, and diversions associated with Scofield Reservoir were reported to have an annual depletion of approximately 55,345 acre-feet (based on 63 percent consumptive use) for an average water year (19,161 acre-feet for a dry year and 55,703 acre-feet for a wet year) (Bureau of Reclamation 1998). Appendix A (Tables 1.1 to 1.4) summarizes the cumulative hydrology study.

The historical volume of water available in the Price River was estimated to be approximately 157,249 acre-feet (Bureau of Reclamation 1998). Depletions resulting from the two existing Federal projects have been estimated to be approximately 82,412 AF, resulting in a flow volume that is approximately 47.6 percent of historical flows. Much of the Price River has been channelized for highway and railroad construction. As a result of instream flow and physical channel modifications, instream habitat has shifted from a pool, riffle, run complex to extensive reaches of homogeneous habitat (riffles with large substrates or runs with fine substrates depending on gradient), although some reaches of the lower Price River retain elements of the natural physical habitat.

Subtracting the annual depletion of the Price-San Rafael River Salinity Control Project and Scofield Reservoir Project (82,412 AF) from historic flows (157,249 AF), results in the existing condition or average monthly flows without the Narrows Project of 74,837 AF (Table 1.4). Subtracting the depletion for the Narrows Project (5,717 AF) results in 69,120 AF of water remaining in the Price River. The overall depletion of all Federal projects including the proposed Narrows project will be 88,129 AF. This is a depletion of 56% of historic flows.

**C. Species' response to the proposed action**

It is expected that the proposed action would detrimentally impact Colorado pikeminnow and result in a decline in the number of individuals using the Price River or possibly inhibiting use altogether. Also, the unknown importance of the Price River as winter or spawning habitat prevents protection of these important life-history elements, if, in fact, they are present. Furthermore, adverse modification of critical habitat for all four endangered fish species from the confluence of the Price and Green rivers downstream to Lake Powell is expected to result in detriment and overall harm to the populations, thereby offsetting recovery efforts elsewhere in the basin.

## VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions

that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

We are not aware of any known cumulative effects at this time.

## VII. CONCLUSION

The Narrows Project, in association with existing Federal projects, will further reduce peak discharge within the Price River. Annual depletions of the Narrows Project is 5,717 AF. Total depletion within the Price River Basin is 88,129 AF. It is our biological opinion that the effects of the Narrows Project, as proposed, are likely to jeopardize the continued existence of the Colorado pikeminnow, humpback chub, razorback sucker, and bonytail through water depletions from the Green and Colorado rivers and is likely to destroy or adversely modify designated critical habitat in the Green and Colorado rivers from the confluence of the Price and Green rivers downstream to Lake Powell. In addition, the proposed Narrows Project is likely to jeopardize Colorado pikeminnow currently occupying the Price River and detrimentally impact instream habitat conditions of the Price River.

## VIII. REASONABLE AND PRUDENT ALTERNATIVES

Regulations (50 CFR 402.02) implementing section 7 of ESA define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, we believe, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

On January 21-22, 1988, the Secretary of the Interior; Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration were cosigners of a Cooperative Agreement to implement the RIP (USFWS, 1987). An objective of the RIP was to recover the listed species while providing for new water development in the Upper Colorado River Basin.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the RIP, a section 7 agreement and a RIPRAP was developed (USFWS 1993). The agreement establishes a framework for conducting all future section 7 consultations on depletion impacts related to new projects and all impacts associated with historic projects in the Upper Basin. Procedures outlined in the agreement will be used to determine if sufficient progress is being accomplished in the recovery of endangered fishes to enable the RIP to serve as a reasonable and prudent alternative to avoid jeopardy. The RIPRAP was finalized on October 15, 1993, and has been reviewed and updated annually.

In accordance with the agreement, the Service assesses the impacts of projects that require section 7 consultation and determines if progress toward recovery has been sufficient for the RIP to serve as a reasonable and prudent alternative. If sufficient progress is being achieved, biological opinions are written to identify activities and accomplishments of the RIP that support it as a reasonable and prudent alternative. If sufficient progress towards the recovery of the endangered fishes has not been achieved by the RIP, actions from the RIPRAP are identified which must be completed to avoid jeopardy to the fishes. For historic projects, these actions serve as the reasonable and prudent alternative as long as they are completed according to the schedule identified in the RIPRAP. For new projects, these actions serve as the reasonable and prudent alternative as long as they are completed before the impact of the project occurs.

In determining if sufficient progress has been achieved, the Service considers: (a) actions which result in a measurable 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; (b) status of fish populations; (c) adequacy of flows; and (d) magnitude of the project impact. In addition, we consider support activities (funding, research, information, and education, etc.) of the RIP if they help achieve a measurable 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. We evaluate progress separately for the Colorado River and the Green River sub-basins; however, we gives due consideration to progress throughout the Upper Basin in evaluating progress towards recovery.

In the amended Biological Assessment from Reclamation to the Service (March 7, 1997), Reclamation suggested the following actions be developed into RIPRAP items to offset the proposed Narrows Project impacts to the Price River and endangered fish species:

1) 'Project sponsors . . . pay the depletion charge for the entire depletion caused by the Narrows Project.'

2) 'The Recovery Program would agree to provide funding for the continuance of the [Price River endangered fish] study for . . . additional . . . year(s) . . . this study could include . . . data . . . to provide a better understanding of the year-round utilization of the Price River by Colorado squawfish (sic); . . . identifying flow needs and potential sources of water . . . for in stream flows needed by endangered fish [in the Price River].'

3) 'The Recovery Program would secure water rights on the Price River that could be used to maintain instream flows during critical times of the year for squawfish (sic) in the Price River.'

The Service agrees that these activities will assist in providing the necessary protection and conservation of listed fishes in the Price River. These items have been incorporated into the following reasonable and prudent alternative and have been identified in the FY2001 RIPRAP finalized March 8, 2000.

The purpose of the following reasonable and prudent alternative is to avoid the likelihood of jeopardy to listed species and destruction or adverse modification of their critical habitats while also allowing the proposed Narrows Project to be constructed and operated for its purposes including water development.

The Service has determined, based on the analysis of the hydrological and biological information that currently exists, that if Reclamation and the Sanpete Water Conservancy District, in cooperation with RIP participants and responsible Federal agencies, agree to carry out all the following elements then these actions will avoid the likelihood of jeopardizing the continued existence of endangered fishes and avoid the likelihood of destruction or adverse modification of critical habitats for the proposed Project.

The following items, numbers 1, 2 and 3 combined, will serve as the reasonable and prudent alternative for the proposed Narrows Project:

1) The following excerpts are pertinent to the consultation because they summarize portions of the RIP that address depletion impacts, section 7 consultation, and project proponent responsibilities:

> "All future section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to the Service by water project proponents in the amount of $10.00 per acre-foot based on the average annual depletion of the project . . . . This figure will be adjusted annually for inflation [the current figure is $14.36 per acre-foot] . . . . Concurrently with the completion of the Federal action which initiated the consultation, e.g., . . . issuance of a 404 permit, 10 percent of the total contribution will be provided. The balance . . . will be . . . due at the time the construction commences . . . ." (Specific figures are listed below)

It is important to note that these provisions of the RIP were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. The RIP further states:

> ". . . it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to

> ensure instream flows . . . . Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, the Service will consider these elements under section 7 consultation as offsetting project depletion impacts."

The Sanpete Water Conservancy District has applied to Reclamation for a Small Reclamation Project Act loan to help finance construction of the proposed Narrows Project. Such loans are made available by Reclamation to assist with construction of non-federal projects. The Sanpete Water Conservancy District has also applied to use lands for the Narrows Project that were withdrawn from the public domain by Reclamation. Reclamation has a regulatory responsibility to comply with the National Environmental Policy Act and requirements of the Small Reclamation Project Act. A repayment contract and a Management Agreement between Reclamation and the Sanpete Water Conservancy District will include any stipulations to meet environmental commitments of the project including those contained in this biological opinion.

Thus, we have determined that project depletion impacts, which the Service has consistently maintained are likely to jeopardize the listed fishes, can be offset by (a) the water project proponent's one-time contribution to the RIP in the amount of $14.13 per acre-foot of the project's average annual depletion, (b) appropriate legal protection of instream flows pursuant to State law, and (c) accomplishment of activities necessary to recover the endangered fishes as specified under the RIP RAP. We believe it is essential that protection of instream flows proceed expeditiously, before significant additional water depletions occur.

With respect to (a) above (i.e., depletion charge), the Sanpete Water Conservancy District will make a one-time payment which has been calculated by multiplying the project's average annual depletion of 5,717 acre-feet by the depletion charge in effect at the time payment is made. For Fiscal Year 2000 (October 1, 1999, to September 30, 2000), the depletion charge is $14.36 per acre-foot for the average annual depletion which equals a total payment of $82,096.12 for this project. We will notify the Sanpete Water Conservancy District of any change in the depletion charge by September 1 of each year. Ten percent of the total contribution, $8,210, or total payment, will be provided to our designated agent, the National Fish and Wildlife Foundation (Foundation), at the time of issuance of any funding or authorization from Reclamation. The balance will be due at the time the construction commences. The payment will be included by Reclamation as a stipulation in any agreement or authorization provided by Reclamation to the District. All payments should be made to the Foundation at the following address:

> National Fish and Wildlife Foundation
> 1120 Connecticut Avenue, N.W.
> Suite 900
> Washington, D.C. 20036

In a letter dated November 11, 1999, the Sanpete Water Conservancy District agreed to this payment (Appendix B). They also noted that on July 13, 1995, the Sanpete Water Conservancy District sent a check for $7,063 to the National Fish and Wildlife Foundation to cover what was then 10 percent of the depletion charge. As soon as Reclamation approves the loan for the proposed Project, the Sanpete Water Conservancy District will send an additional $1147.00 to bring the contribution up to 10 percent of the current depletion charge (Appendix B).

Payment is to be accompanied by a cover letter that identifies the project and biological opinion that requires the payment, the amount of payment enclosed, check number, and any special conditions identified in the biological opinion relative to disbursement or use of the funds (there are none in this instance). The cover letter also shall identify the name and address of the payor, the name and address of the Federal agency responsible for authorizing the project, and the address of our office issuing the biological opinion. This information will be used by the Foundation to notify the payor, the lead Federal agency, and us that payment has been received. The Foundation is to send notices of receipt to these entities within 5 working days of its receipt of payment.

2) An objective of the RIP is to quantify and provide a process for the legal protection of instream flows pursuant to State law, and accomplish activities necessary to recover the endangered fishes as specified under the RIPRAP. To date, flow requirements have not been determined although a RIPRAP item has been developed specifically for the Price. Currently the RIP is evaluating tributary importance and overall contribution to the Green River and Colorado River system and the recovery of its endangered fish species. As part of the RPA to offset impacts from the proposed narrows project, the RIP will fund a study to determine the following:

- Seasonal endangered fish use in the Price River, particularly winter.

- Recommendation of year-round, instream flows requirements for Colorado pikeminnow.

The following background information provides a rationale for this element of the RPA. Historically, the Price River was inhabited by large numbers of native fish including Colorado pikeminnow, flannelmouth suckers, bluehead suckers, speckled dace, roundtail chubs, and possibly razorback suckers (Cavalli, 1999). However, due to impacts resulting from development (i.e., dams, water diversions, highways, railroads, etc.), habitat for the endangered Colorado River fishes now appears to be limited. The channel has been altered and instream habitat is structurally less complex; in addition, flows are substantially lower than historical flows with some periods of complete dewatering in parts of the system. The extent of these instream habitat and flow alterations are not well understood, nor is the effect on fish populations.

Fish surveys from the late 1970's indicated that no endangered fish occupied the Price River. Overall, most biologists familiar with the system believed that endangered fish had been

completely extirpated from this river. In 1995, Trout Unlimited sponsored a single, 5-day sampling trip which resulted in the capture of one juvenile Colorado pikeminnow 2.2 miles above the confluence of the Green River. With pending water development projects, it became important to determine the extent of endangered fish use of the Price River. The single capture in 1995 was enough to prompt an additional 2 year study directed at determining endangered fish use of the Price River and examining potential habitat conditions in the lower 50 miles.

The 2-year study, conducted from April through October in 1996 and 1997, unexpectedly showed that the Price River is utilized by juvenile and adult Colorado pikeminnow. Over 20 Colorado pikeminnow were captured ranging in size from under 200 mm to nearly 600 mm. One large adult was captured (and several others were reported to be caught by anglers) at the most upstream possible point for fish movement, at the base of a diversion structure 88.5 miles above the confluence of the Price and Green rivers. These findings suggest the Price River may be hydrologically and biologically important to the Green River and the overall recovery and persistence of Colorado pikeminnow populations in the Upper Colorado River Basin.

The Price River system appears to be important not only in providing an additional 88.5 miles of occupied habitat to Colorado pikeminnow but also in its abundance and high percentage of natives in the fish community. The plentiful forage available in flannelmouth and bluehead suckers may attract the predaceous Colorado pikeminnow. It is unclear whether Colorado pikeminnow have been present in the Price River since the late 1970's but simply elusive to capture. Alternatively, recolonization of the Price River in the recent decade may represent a response to a recovering and increasing metapopulation in the main Green River system.

In the most dire case, the Price River may only provide seasonal, sub-optimal habitat for foraging adults. However, it may not be entirely serendipitous that the presence of Colorado pikeminnow in the Price River represent a recent range expansion in light of the extensive recovery efforts and environmental protection occurring throughout the last three decades. If newly located tributary occupation of Colorado pikeminnow is a response to recovery efforts, it is crucial to document and understand the role of tributaries to overall system recovery and persistence. In either case, 88.5 miles of river occupation by this endangered species should be better understood before it is dismissed and possibly lost during this time of great recovery strides.

In particular, it is important to know if Colorado pikeminnow use the Price River year-round and potentially spawn, thereby comprising a possibly new, contributing population. Instream flow requirements should be identified that will protect this enclave through upcoming water development. Although the 2-year Price River study provided a wealth of new and important information, it was not sufficient to determine year-round or accurate seasonal instream flow requirements. Some cursory data are available from the 2-year study; however, this information contains crucial gaps and does not sufficiently describe the potential for spawning activity and habitat use or year-round use of the river by Colorado pikeminnow (Cavalli 1999).

3) The discharge gage station located at Woodside in the lower Price River will be recommissioned so that flows in the lower river can be evaluated and instream flows can be identified and monitored.

Based on newly acquired and past information, we and Reclamation should determine the flows needed to maintain or improve the biological requirements of the Colorado pikeminnow in the Price River by the year 2003. This field effort should be closely monitored by the Utah Field Office to ensure that study objectives and data collected allow development of flow recommendations and understand year-round use. Funding for these actions should be the responsibility of the RIP and not Reclamation or the Sanpete Water Conservancy District.

## INCIDENTAL TAKE STATEMENT

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

We do not anticipate the proposed action will incidentally take any endangered Colorado River fishes by construction of the proposed Project and water depletion from the Price, Green or Colorado rivers. As such, no incidental take is authorized.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

### A. Conservation Recommendations for Willow Flycatcher subspecies.

As previously stated the Service has not included the endangered subspecies southwestern willow flycatcher (*Empidonax traillii extimus*) in this Opinion. However, further analysis may

determine that the willow flycatcher population affected by the proposed Narrows Project is *E. t. extimus* or some significant intercross gradation between *E. t. extimus* and *E. t. adastus* (a non-endangered subspecies of willow flycatcher) in which case Reclamation may need to reinitiate formal consultation. Because proposed Project impacts on riparian vegetation cannot be anticipated, and considering the unknown information regarding the status of the flycatcher population in the project area, the following conservation actions are recommended to provide a basis for determining impacts of the project and developing mitigation strategies for riparian vegetation and willow flycatcher subspecies.

1) Develop and implement, in coordination with us and the UDWR: a) a monitoring plan for willow flycatcher subspecies in the proposed Project area, surrounding drainages and mitigation sites; and b) a habitat analysis plan of current and potential willow habitat for the project area, surrounding drainages and mitigation sites.

    A) Develop and implement, in coordination with us and UDWR, a monitoring plan that estimates willow flycatcher subspecies populations and habitat availability.

        A qualified biologist with appropriate training and permits should conduct willow flycatcher surveys following the most recent protocol within the project area, surrounding drainages, and mitigation sites for breeding flycatchers, territories, nest locations, and habitat availability.

        Establish a database for the Narrows Project area and surrounding area and update the database annually.

        Determine pre-project willow flycatcher population levels that will help to detect any post-project changes in populations and willow habitat.

        Maintain records for each nest site or territory habitat patch, the location, size, structure, vegetative species composition, hydrology, and vulnerability to erosion.

        Record the use of newly established willow habitats developed as a result of the proposed Project for nesting and report this information to us and UDWR.

    B) Develop and implement, in coordination with us and UDWR, a habitat analysis plan of riparian habitats that includes specific monitoring of suitable nesting habitat. In general, the habitat analysis plan should be designed to detect changes in suitable nesting habitat quantity and quality. The level of detail of suitable nesting habitat monitoring should be commensurate with the population of willow flycatchers determined by initial surveys.

The habitat analysis plan should include an initial inventory of pre-project suitable nesting habitat patches and post-construction monitoring of suitable nesting habitat patches, both pre-project and newly established.

Information that should be collected includes location, size, structure, vegetative species composition, and hydrology of pre-project and established habitat patches. Changes in these characteristics should also be monitored.

Hydrology analysis should determine the importance of spring run-off, inundation frequency, inundation intervals, groundwater influences, beaver activity, and standing water to the willow regeneration process and willow habitat.

2) Develop and implement, in coordination with us and the UDWR, a contingency plan for full replacement of willow habitat suitable for nesting if monitoring reveals that habitat is being impacted or full replacement of this habitat is not occurring at mitigation sites.

    A) Develop and implement, in coordination with us and the UDWR, a technically and economically feasible contingency plan to replace willow habitat and reduce delays in establishing lost habitat later if it becomes necessary to do so.

3) Project mitigation measures for lost sport fish included 300 AF of water that could be used for stream flow maintenance. Develop and implement, in coordination with us and the UDWR, a hydrology plan that includes the 300 AF of sport fish mitigation water to be used in conjunction with natural spring flows to support riparian habitat suitable for willow flycatcher subspecies.

    A) Develop and implement, in coordination with us and the UDWR, a hydrology plan that includes the 300 AF of sport fish mitigation water to be used in conjunction with natural spring flows to support potential riparian or willow habitat. The plan should include measures to store and use this water approximately every four or five years or in conjunction with wet year flows to increase the spring peak flows to inundate more riparian habitat to help regeneration of willows.

4) Coordinate on a regular basis with us on willow flycatcher subspecies plans, monitoring, and study results.

    A) Annual reports for Terms and Conditions 1 - 3 listed above should be submitted to the Service detailing monitoring and study results. Impacts of the project and future measures that would be needed to avoid or reduce impacts to the willow flycatcher should be determined and monitored.

5) A qualified biologist with southwestern willow flycatcher survey certification should conduct nest monitoring to determine nest success and presence of cowbird parasitism.

6) If Reclamation documents cowbird parasitism higher than 50 percent on willow flycatchers, it will initiate a cowbird trapping program within the immediate nesting area. Cowbird trapping will be conducted until the larger issues of cowbird presence (i.e., local foraging sites and concentration areas) are identified and addressed.

7) Reclamation should evaluate livestock concentration sites within and adjacent to the project area that may act as likely foraging sources of cowbirds. Once these sources have been identified, Reclamation should work to eliminate or manage these sites administratively to limit their benefits to cowbirds.

## REINITIATION NOTICE

This concludes formal consultation of the action outlined in the Draft Environmental Impact Statement, biological assessment, three amended biological assessments, Price River Cumulative Hydrology Study, and the accompanying request for formal consultation. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action specifically if new information indicates that the subspecies of willow flycatcher present near the proposed Project site is the endangered southwestern willow flycatcher subspecies. In instances where the amount or extent of incidental take is exceeded, any operations causing such take use cease pending reinitiation.

We appreciate the assistance and cooperation of your staff throughout this consultation process and your interest in conserving threatened and endangered species. If you have any questions regarding this biological opinion or would like to discuss it in more detail, please call Reed Harris, Field Supervisor, Utah Ecological Services Field Office, at 801-524-5001.

Sincerely,

Ralph O. Morgenweck

Regional Director

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Table 1.1
Theoretical Virgin Flows
Price River at Woodside

| | Average Year 1968 | | Wet Year 1984 | | Dry Year 1977 | |
|---|---|---|---|---|---|---|
| Month | (cfs) | (ac-ft) | (cfs) | (ac-ft) | (cfs) | (ac-ft) |
| October | 14.4 | 886 | 368.0 | 22,622 | 28.7 | 1,765 |
| November | 6.8 | 404 | 77.5 | 4,761 | 20.0 | 1,227 |
| December | 15.0 | 924 | 65.4 | 4,017 | 23.5 | 1,443 |
| January | 2.0 | 126 | 38.2 | 2,350 | 9.3 | 571 |
| February | 13.2 | 735 | 33.7 | 2,069 | 7.4 | 452 |
| March | 40.9 | 2,514 | 3.9 | 238 | 16.1 | 987 |
| April | 301.5 | 17,934 | 570.5 | 35,070 | 80.6 | 4,952 |
| May | 514.6 | 31,632 | 1,842.6 | 113,267 | 85.9 | 5,282 |
| June | 655.0 | 38,969 | 1,211.6 | 74,482 | 68.0 | 4,183 |
| July | 481.1 | 29,573 | 458.3 | 28,175 | 184.6 | 11,346 |
| August | 291.1 | 17,896 | 463.5 | 28,492 | 93.9 | 5,774 |
| September | 263.2 | 15,657 | 372.9 | 22,921 | 72.5 | 4,455 |
| Annual Total (ac-ft) | | 157,249 | | 338,467 | | 42,437 |

Table 1.2
Environmental Baseline Flows
Price River at Woodside

| | Average Year 1968 | | Wet Year 1984 | | Dry Year 1977 | |
|---|---|---|---|---|---|---|
| Month | (cfs) | (ac-ft) | (cfs) | (ac-ft) | (cfs) | (ac-ft) |
| October | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| November | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| December | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| January | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| February | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| March | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| April | 160.0 | 9,517 | 155.8 | 9,579 | 56.3 | 3,295 |
| May | 154.8 | 9,517 | 155.8 | 9,579 | 53.6 | 3,295 |
| June | 266.3 | 15,844 | 258.7 | 15,906 | 156.5 | 9,622 |
| July | 257.7 | 15,844 | 258.7 | 15,906 | 156.5 | 9,622 |
| August | 257.7 | 15,844 | 258.7 | 15,906 | 156.5 | 9,622 |
| September | 266.3 | 15,844 | 258.7 | 15,906 | 156.5 | 9,622 |
| Annual Total (ac-ft) | | 82,412 | | 82,782 | | 45,080 |

Table 1.3*

Average Monthly Flows with Narrows Project
Price River at Woodside

| | Average Year 1968 | | Wet Year 1984 | | Dry Year 1977 | |
|---|---|---|---|---|---|---|
| Month | (cfs) | (ac-ft) | (cfs) | (ac-ft) | (cfs) | (ac-ft) |
| October | 6.7 | 410 | 360.3 | 22,147 | 21.0 | 1,289 |
| November | -1.2 | -72 | 69.7 | 4,286 | 12.2 | 751 |
| December | 7.3 | 448 | 57.6 | 3,542 | 15.7 | 967 |
| January | -5.7 | -350 | 30.5 | 1,875 | 1.5 | 95 |
| February | 4.7 | 259 | 25.9 | 1,594 | -0.4 | -2.4 |
| March | 33.2 | 2,038 | -3.9 | -237 | 8.3 | 511 |
| April | 133.5 | 7,942 | 406.9 | 25,016 | 19.2 | 1,181 |
| May | 352.0 | 21,639 | 1,679.0 | 103,213 | 24.6 | 1,511 |
| June | 380.7 | 22,649 | 945.1 | 58,100 | -96.2 | -5,915 |
| July | 215.6 | 13,253 | 191.8 | 11,793 | 20.3 | 1,248 |
| August | 25.6 | 1,576 | 197.0 | 12,110 | -70.3 | -4,324 |
| September | -11.1 | -663 | 106.4 | 6,539 | -91.8 | -5,643 |
| Annual Total (ac-ft) | | 69,128 | | 249,976 | | -8,352 |

Table 1.4
Average Monthly Flows without Narrows Project
Price River at Woodside

| | Average Year 1968 | | Wet Year 1984 | | Dry Year 1977 | |
|---|---|---|---|---|---|---|
| Month | (cfs) | (ac-ft) | (cfs) | (ac-ft) | (cfs) | (ac-ft) |
| October | 14.4 | 886 | 368.0 | 22,622 | 28.7 | 1,765 |
| November | 6.8 | 404 | 77.5 | 4,761 | 20.0 | 1,227 |
| December | 15.0 | 924 | 65.4 | 4,017 | 23.5 | 1,443 |
| January | 2.0 | 126 | 38.2 | 2,350 | 9.3 | 571 |
| February | 13.2 | 735 | 33.7 | 2,069 | 7.4 | 452 |
| March | 40.9 | 2,514 | 3.9 | 238 | 16.1 | 987 |
| April | 141.5 | 8,417 | 414.7 | 25,492 | 27.0 | 1,657 |
| May | 359.7 | 22,115 | 1,686.7 | 103,689 | 32.3 | 1,987 |
| June | 388.7 | 23,124 | 952.9 | 58,576 | -88.5 | -5,440 |
| July | 223.3 | 13,729 | 199.6 | 12,269 | 28.0 | 1,723 |
| August | 33.4 | 2,052 | 204.7 | 12,586 | -62.6 | -3,849 |
| September | -3.1 | -187 | 114.1 | 7,015 | -84.1 | -5,168 |
| Annual Total (ac-ft) | | 74,837 | | 255,685 | | 2,643 |

*It is important to note that the depletion for the Narrows Project used in table 1.3 of the Bureau of Reclamation Price River Hydrology Report is 5,709 AF. This depletion was corrected in November 1999 to be 5,717 AF, therefore numbers in the table does not accurately reflect this new depletion estimate. (K. Schwarz, Bureau of Reclamation; personal communication)

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EDWIN SUNDERLAND

# SANPETE WATER CONSERVANCY DISTRICT

November 11, 1999

Mr. Reed Harris
Field Supervisor, U.S. Fish
and Wildlife Service
Lincoln Plaza
145 East 1300 South, Suite 404
Salt Lake City, Utah 84115

Subject: Draft Amended Biological Opinion – Narrows Project

Dear Mr. Harris:

The Sanpete Water Conservancy District (District) has reviewed the draft, Amended Biological Opinion on the Narrows Project, as transmitted to the Bureau of Reclamation in October 1999.

The District hereby agrees to pay the $14.13 per acre-foot depletion charge (current fiscal year value) which will be used in accomplishment of the Recovery Implementation Program Recovery Action Plan for the endangered fishes of the Colorado River System. Based on the estimated 5,717 acre-foot depletion, the total depletion charge would be $80,781,21.

On July 13, 1995, the District sent a check for $7,063 to the National Fish and Wildlife Foundation to cover what was then 10 percent of the depletion charge. As soon as Reclamation approves the loan for the project, the District will send an additional $1,015.12 to bring the contribution up to 10 percent of the current depletion charge.

Sincerely,

David L. Peterson
President

cc: Mr. Bruce Barrett
Bureau of Reclamation
Attn: PRO-405
302 East 1860 South
Provo, UT 84606

Mr. Richard Noble
Franson-Noble & Associates, Inc.
776 East Utah Valley Drive
American Fork, UT 84003

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX D

# FISH AND WILDLIFE
# COORDINATION ACT REPORT

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
LINCOLN PLAZA
145 EAST 1300 SOUTH, SUITE 404
SALT LAKE CITY, UTAH 84115



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August 21, 1997

MEMORANDUM

TO: Manager, Resource Management Division, Bureau of Reclamation, UPPR, Colorado Region, Provo Area Office, 302 East 1860 South, Provo, Utah 84606-7317

FROM: Field Supervisor, Ecological Services, Fish and Wildlife Service, Utah Field Office, 145 East 1300 South, Ste. 404, Salt Lake City, Utah 84115

SUBJECT: Formal Section 7 Consultation for the Proposed Narrows Project and Request for Updated Fish and Wildlife Coordination Act Report

On March 10, 1997, the Fish and Wildlife Service reinitiated and entered into formal Section 7 consultation on the proposed Narrows Project, a small reclamation project act loan. The 135-day consultation period expired on July 24, 1997. Due to personnel shortages and the complexities involved with this consultation, we are requesting a 60-day extension of the consultation period in accordance with 50 CFR Part 402.14(e).

The Service is currently in consultation with the Bureau of Reclamation on two projects involving water depletions in the Price River drainage. New information has revealed the presence of the endangered Colorado squawfish in the Price River. The significance of the Price River to the conservation and recovery of the Colorado squawfish has not been addressed as yet. However, it is the Services intention to evaluate the significance of the Price River and to develop a RIPRAP item for Recovery of Colorado squawfish in the Price River. This will be done as expeditiously as possible, however, a new RIPRAP item must be coordinated with the Management Committee of the Colorado River Fishes Recovery Program and will delay the Service's completion of formal Section 7 consultation on the Narrows Project.

In addition, the Service was requested to complete an updated Coordination Act Report by the 1st of June, 1997. At this time we are attempting to update this Report, however, we do not anticipate that an updated Coordination Act Report will be finalized until the issues involved with Section 7 consultation have been resolved.

# United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Provo Area Office
302 East 1860 South
Provo, Utah 84606-7317


IN REPLY REFER TO:

PRO-751
ENV-6.00

MAY 0 9 1997

Mr. Reed Harris
Ecological Services
U.S. Fish and Wildlife Service
145 East 1300 South, Suite 404
Salt Lake City UT 84115

Subject: Request for Completion of Updated Fish and Wildlife Coordination Act Report for the Narrows Project

Dear Mr. Harris:

The Bureau of Reclamation completed an Environmental Impact Statement for the proposed Narrows Project in January 1995. A Record of Decision (ROD) was signed by Reclamations' Upper Colorado Regional Director. However, the ROD was later rescinded and a notice of intent to prepare a new draft EIS was published in the Federal Register in February 1996.

A Coordination Act Report (dated October 1994) was prepared by your office, with assistance from Utah Division of Wildlife Resources, for the original EIS. The report evaluates the impacts of the proposed Narrows Project on fish and wildlife resources, and recommends appropriate mitigation in accord with the Fish and Wildlife Coordination Act and the U.S. Fish and Wildlife Service's mitigation policy.

Because it has been almost three years since the Coordination Act Report was prepared, Reclamation believes it is necessary for the Service to review and update, if needed, the 1994 report for inclusion with the revised EIS being prepared. We request that the Coordination Act Report review and update, if needed, be completed by June 1, 1997, so that it can be included with the Draft EIS. Kerry Schwartz of my staff discussed this issue with Janet Mizzi of your staff on April 30, 1997.

If you have any further questions regarding this matter, please contact Kerry Schwartz at (801) 379-1167.

Sincerely,

LEE G. BAXTER

ACTING FOR
Larry Fluharty
Manager, Resource Management Division

cc: Mr. Richard Noble
6 South 100 West
American Fork UT 84003

Mr. John Anderson
Pruitt, Gushee, and Bachtell
Suite 1850, Beneficial Life Tower
36 South State Street
Salt Lake City UT 84111

Mr. David Peterson
President, Sanpete Water Conservancy District
1484 South 70 West
Mount Pleasant UT 84647

Mr. Leland Matheson
Manti-LaSal National Forest
599 West Price River Drive
Price UT 84501

Mr. Bill Bates
Habitat Manager, Utah Division of Wildlife Resources
Southeastern Regional Office
455 West Railroad Avenue
Price UT 84501

bc: Manager, Resources Management Division, Salt Lake City UT, Attention: UC-320
Field Solicitor, Salt Lake City UT, Attention: Scott Loveless

bcc: PRO-750, PRO-751, and PRO-752

# GOOSEBERRY NARROWS DAM PROJECT
# SANPETE COUNTY, UTAH

A FISH AND WILDLIFE COORDINATION ACT REPORT

PREPARED BY

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
SALT LAKE CITY, UTAH

WITH ASSISTANCE FROM

UTAH DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE RESOURCES
SALT LAKE CITY, UTAH
SPRINGVILLE, UTAH
PRICE, UTAH

OCTOBER, 1994

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## INTRODUCTION

This Coordination Act Report has been developed in concert with the Environmental Impact Statement being prepared by the Bureau of Reclamation (Reclamation) for the proposed Narrows Dam Project (Narrows). The report evaluates the impacts of the proposed Narrows Project on fish and wildlife resources, and recommends appropriate mitigation in concert with The Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) and the U.S. Fish and Wildlife Service Mitigation Policy (Federal Register, Vol. 46, No. 15, January 23, 1981 (as modified February 4, 1981)). Endangered Species Act (16 U.S.C. 1531 as amended) requirements have been addressed in a separate Biological Opinion from the U.S. Fish and Wildlife Service (Service) to Reclamation, dated March 25, 1992. National Environmental Policy Act (NEPA) documentation is being prepared by the Sanpete Water Conservancy District (District) for Reclamation.

The Narrows project is proposed by the District. It would develop a supplemental irrigation water supply for presently irrigated lands and provide municipal water to project communities in northern Sanpete County, Utah. The project would include a transbasin diversion of $6.7 \times 10^6$ cubic meters ($m^3$) (5,400 acre-feet {af}) per year from the Price River (Colorado River drainage) to the San Pitch River drainage (Great Basin). The District plans to apply to Reclamation for a Small Reclamation Project Act Loan. The District also needs a 404 permit for the project from the U.S. Army Corps of Engineers (Corps).

In January of 1991 two teams of specialists from various State and Federal agencies were formed to review plans for the Narrows and assist in the identification of impacts and the development of mitigation plans. A fisheries team was formed to look at aquatic impacts and fisheries issues. This team consisted of a consultant for the District and members from the Service, Reclamation, Corps, U.S. Forest Service (USFS), and Utah Division of Wildlife Resources (UDWR). A wetlands/wildlife team was formed to evaluate impacts to wetlands and wildlife habitat. The team consisted of a consultant for the District and members from the Service, Reclamation, Corps, USFS, and UDWR. Agency representatives on both teams were not necessarily the same.

Information in this report is based on preliminary documents prepared for the District in coordination with the two teams. These include draft reports on Aquatic Ecology (Woodward - Clyde Consultants, December 1991), Vegetation and Wildlife Impacts (Mt. Nebo Scientific, February 1992), the Preliminary Draft Environmental Impact Statement (Reclamation, August 1993), and other information in Service files.

## DESCRIPTION OF THE STUDY AREA

The basin which would be inundated by the proposed reservoir lies in a high elevation, shallow valley in the Wasatch Plateau. The basin, isolated by several ridges, is 2,646 meters (m) (8,680 feet {ft}) above sea level. Vegetation consists of plant communities common to high elevation mountain meadow areas, including Vasey sagebrush, Silver sagebrush, and

various wetland community types. The majority of the reservoir basin is privately owned, although the actual dam site is in the Manti-LaSal National Forest.

Historically the area has been used for livestock grazing. Cattle and sheep were introduced into the area in the late 1800's and subsequently overgrazed the area so that rangeland restoration became necessary. The USFS established a controlled grazing plan for the Manti National Forest in 1908. Sheep still graze in the area.

The Sanpete Valley, which will receive water from the proposed project, lies at an elevation of 1,676-1,890 m (5,500-6,200 ft). It is bordered on the east by the Wasatch Plateau and on the west by the San Pitch Mountains. U.S. Highway 89 extends through the project area, connecting Fairview, Mt. Pleasant, Ephraim, and Manti (the county seat) with Salt Lake City, approximately 209 kilometers (km) (130 miles {mi}) to the north (Figure 1). The estimated population of Sanpete County in 1990 was 16,259. Government, agriculture, services, manufacturing and retail trade are the leading economic sectors. Approximately 44 percent of the land in Sanpete County is in agricultural use, with 36 percent of the total agricultural land developed for crops.

## DESCRIPTION OF THE PROJECT

The Narrows project is designed to bring supplemental irrigation water to the Sanpete Valley and to provide supplemental municipal water for irrigation of lawns and gardens. The District also cites the need for honoring long-standing water rights contracts and agreements, for improving water conveyance facilities, and improving recreation and fishery opportunities. The project area consists of the Sanpete Valley and the headwaters area of the Price River (Figure 2). Sanpete Valley contains approximately 68,800 hectares (ha) (170,000 acres {ac}) of land, of which 24,280 ha (60,000 ac) are currently irrigated. About 6,230 ha (15,400 ac) of currently irrigated land would be eligible to receive project water. Currently these lands experience moderate to severe late season irrigation water shortages, averaging $2.3 \times 10^7$ $m^3$ (19,000 af) per year. The project would provide $6.7 \times 10^6$ $m^3$ (5,400 af) of water per year, of which $6.07 \times 10^6$ $m^3$ (4,920 af) would go to irrigation and $5.9 \times 10^5$ $m^3$ (480 af) to municipal supplies.

The proposed action includes construction of a dam on Gooseberry Creek, a tributary of the Price River, approximately 14.5 km (9 mi) east of Fairview, Utah. The proposed dam would be a zoned earthfill embankment, 37 m (120 ft) high, with a crest length of 168 m (550 ft) and a crest width of 9 m (30 ft). The dam would have 3:1 horizontal to vertical slopes upstream and downstream. The dam would impound a reservoir with a capacity of $2.1 \times 10^7$ $m^3$ (17,000 af), with $1.8 \times 10^7$ $m^3$ (14,500 af) of active storage and $3.1 \times 10^6$ $m^3$ (2,500 af) of dead storage. The maximum reservoir surface area is approximately 244 ha (604 ac). At an average water surface during the recreation season (June through September) the reservoir would cover 184 ha (454 ac). The water surface will fluctuate an average of about 3.7 m (12 ft) vertically each year, with a maximum fluctuation of 5.5 m (18 ft) per year.

An alternative, smaller reservoir, would consist of a dam at the same location that would be 30.5 m (100 ft) high, with a crest length of 129.5 m (425 ft) and a crest width of 9 m (30 ft). The impounded smaller reservoir would have a capacity of $9.7 \times 10^6$ $m^3$ (7,900 af), with $6.7 \times 10^6$ $m^3$ (5,400 af) of active storage and $3.1 \times 10^6$ $m^3$ (2,500 af) of dead storage. The maximum reservoir surface area would be 146 ha (362 ac), with an average of 96.3 ha (238 ac) during the recreation season. The water surface would fluctuate an average of 4.9 m (16 ft) vertically per year, with a maximum fluctuation of 6.7 m (22 ft) per year.

An existing tunnel, which currently conveys water from Fairview Lakes into Cottonwood Creek, would be rehabilitated to carry releases from Narrows Reservoir into Cottonwood Creek. The water would be carried in a pipeline for the upper 1.3 km (0.8 mi) of Cottonwood Creek to prevent degradation of the stream channel. At the mouth of Fairview Canyon some of the flow would be diverted into two pipelines, which would convey project water north to Oak Creek and south to Spring City (Figure 2). Project water would also be diverted into Cottonwood-Gooseberry Irrigation Company's existing pressurized irrigation system for use in the Fairview area. The remainder of the project water would flow into the San Pitch River where it could be diverted into existing canals and ditches. A stream-level emergency outlet would also be constructed through the dam to provide downstream releases into Gooseberry Creek for fisheries and emergency evacuation of the reservoir.

The Narrows Reservoir would inundate about 1.3 km (0.8 mi) of the Skyline Coal Mine Road, which provides access between Fairview and Scofield. Under the project, 4.2 km (2.6 mi) of new road would be constructed across the Narrows Dam. Asphalt surfacing would also occur on 0.5 km (0.3 mi) of existing gravel road to Lower Gooseberry Reservoir.

The District studied several other alternatives to meet project needs, but found them to be nonviable. These included using an alternative dam site, providing year-round releases from the new reservoir, additional groundwater development within Sanpete County, using Central Utah Project water, and direct diversion without a reservoir. The District was hampered by the fact that a 1984 water rights settlement agreement dictates the dam location and storage capacity and because the State Engineer has closed the Sanpete Valley to further ground water development due to downstream water rights interests. Other alternatives were eliminated because of economics, including construction of a storage reservoir in the Sanpete Valley and developing a conveyance system to deliver Central Utah Project water to the area.

On-farm conservation measures, including improved irrigation methods such as canal lining, sprinklers, and gated pipe will be required for participants to be eligible for project water. For the most part, due to existing irrigation water shortages, these measures have already been implemented. Without these conservation measures, the supplemental irrigation demand would be $2.8 \times 10^7$ $m^3$ (23,000 af) per year, versus the $1.5 \times 10^7$ $m^3$ (12,300 af) per year that the project is based on.

## EVALUATION METHODOLOGY

Terrestrial Resources

Evaluation of terrestrial resources included baseline vegetation mapping and identification of plant and animal species occurring in the potentially affected area. A "Habitat Evaluation Procedures" (HEP) analysis was then used to assess pre-project conditions and impacts to wildlife and their habitats from project development.

Vegetation mapping was achieved by using aerial photography and contour maps on the ground. Plant species lists were compiled from previous reports and verified by District employees on the ground. Wildlife species lists were generated by UDWR, then verified by the District through field observation and animal live-trapping studies.

Use of HEP analysis was chosen by the Wetlands and Wildlife Team biologists as the best tool to quantify project impacts to wetlands, wildlife and their habitats. This is a process developed by the Service and is based on the assumption that habitat quality and quantity can be numerically described on a nonmonetary basis (USFWS, 1980). This species-habitat approach to impact assessment uses selected species as indicators to evaluate habitat for a representative group of species. It is assumed that impacts to indicator species represent impacts to the broader groups as functioning ecosystem units. The HEP process evaluates habitat quality for the selected species and allows for the development of Habitat Suitability Indices (HSI). These indices range from 0.0 to 1.0, with the values being related linearly to the habitat carrying capacity for the species. An HSI value of 1.0 represents optimum habitat for the species, while 0.0 represents unsuitable habitat. Comparison of pre- and post-project HSI values allows for a quantitative determination of impacts to the evaluation species and the groups they represent.

The Wetlands and Wildlife Team determined the species to be evaluated based on the habitat types and wildlife species lists prepared by the District. An attempt was made to identify species which were important or common to the impacted areas. These species were then put into feeding and reproductive guilds, and representative species for which HSI models were available were chosen from these guilds for evaluation. The guilds used are shown in Tables 1 and 2, with chosen indicator species bolded. Indicator species chosen were the montane vole (Microtus montanus)(to represent the closely related Richardson's vole, Microtus richardsoni), yellow warbler (Dendroica petechia), beaver (Castor canadensis), mule deer (Odocoileus hemionus), and Brewer's sparrow (Spizella breweri). It should be noted that, while the mule deer was considered an important species, application of the mule deer model in this situation was not totally appropriate since it is primarily based on winter habitat variables, whereas the reservoir basin is primarily used as summer habitat. Therefore the Brewer's sparrow model was used to evaluate habitat used by mule deer.

District personnel collected data, including quantitative and qualitative habitat variables, and analyzed the HSI models to determine HSI indices. All field parameters were obtained by multiple samplings. Means and standard deviations were calculated for each parameter and an attempt was made to obtain statistically adequate samples for each parameter. Average

Annual Habitat Units were determined for each species by multiplying the determined HSI by the acreage of the cover type(s) used in the evaluation area. The models used and raw data collected are available from the Service.

Aquatic Resources

Analysis of impacts to aquatic resources included evaluating the effects of reservoir inundation, flow alterations on streams, and the effects of the project on reservoir fisheries.

Effects of reservoir inundation were evaluated by assessing the number of stream kilometers (miles) and trout biomass (kilograms {pounds}) and numbers that would be lost to direct inundation by the Narrows project. Standing crop estimates prepared by UDWR provided biomass estimates.

Flow alteration effects will include flow reductions in Middle and Lower Gooseberry and Fish Creeks and a flow increase in Cottonwood Creek. The Instream Flow Incremental Methodology (IFIM) (Bovee, 1982) was chosen by the Fisheries Team to determine the effects flow alterations would have on weighted usable area (WUA) of aquatic habitats. WUA is a measure of usable microhabitat present in a stream reach. It is determined for each life stage of each species evaluated in an analysis and is defined as the microhabitat area per unit length of stream, most often expressed as $ft^2$ WUA/1,000 ft stream. This procedure uses computer models which combine stream hydraulic characteristics and habitat utilization characteristics for various life stages of a species (Physical Habitat Simulation System (PHABSIM)) (Milhous et al., 1984) to predict changes in WUA with changes in flow. The UDWR used the Habitat Quality Index method to compare project impacts and project-induced mitigation improvements and to provide recommendations for mitigation for stream impacts. The number of Habitat Units present in stream segments which would be impacted by the Narrows project and those which could be used as potential mitigation sites were estimated and compared (Appendix B).

Data on stream channel characteristics was collected in the field by District representatives and Fisheries Team members and the analysis was performed by the District. Five to nine transects were taken across the stream channel at several locations in five different stream reaches (stations) which could be affected. Field measurements were compared with model predictions for calibration. Good calibration was achieved for all stations. The models used and raw data collected are available from the Service.

Reservoir fishery effects were determined by evaluating the number of angler days per year that could be affected by the Narrows project on reservoirs in the Gooseberry and Fish Creek watersheds, including the proposed reservoir.

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

Terrestrial Resources

Vegetation in the reservoir basin area consists mainly of Vasey sagebrush (Artemisia tridentata v. vaseyana) and silver sagebrush (Artemisia cana) communities. The Vasey sagebrush is the driest plant community in the basin, existing on well-drained soils on upland slopes. Other dominant species include low rabbitbrush (Chrysothamnus viscidiflorus), snowberry (Symphoricarpos oreophilis), Pacific aster (Aster chilensis), slender wheatgrass (Elymus trachycaulus), and Letterman needlegrass (Stipa lettermanii). It encompasses approximately 134 ha (331 ac) of the basin.

The silver sagebrush community type lies downslope of the Vasey sagebrush community and comprises approximately 63.1 ha (156 ac) of the basin. The topography is generally flatter and the soils less well drained than with the Vasey sagebrush type. More mesic species, including shrubby cinquefoil (Potentilla fruticosa), Penstemon spp., orchardgrass (Dactylis glomerata), and Kentucky bluegrass (Poa pratensis) are found in this community.

The majority of the rest of the basin (40.5 ha {100 ac}) is in wetland vegetation types. These include wet meadows, riparian sedge wetlands, and willow thickets. Wet meadows are formed in topographic depressions adjacent to some of the streamside vegetation and seeps. Plant species include rushes (Juncus spp.) and sedges (Carex spp.) and grass species. Riparian sedge wetlands are similar in species and composition, including various rush, sedge, and grass species. They usually form 0.9-1.8 m-wide (3-6 ft-wide) bands of vegetation adjacent to streams. Willow thickets are less common, along stream channels in the basin and along Gooseberry and Cottonwood Creeks. Species include Drummond's (Salix drummondiana), Booth (Salix boothii) and Wolf (Salix wolfii) willows.

Approximately 6.9 ha (17 ac) in the reservoir basin have been previously disturbed by the water diversion tunnel to Cottonwood Creek, and the State road that crosses the north end of the basin.

Plant communities in the Sanpete Valley area which could be temporarily disturbed by pipeline construction include Valley sagebrush, Scrub oak, Grassland and Mountain Brush types.

Approximately 88 bird and 33 mammal species were found to utilize habitats that could be disturbed by the proposed project and adjacent areas. The reservoir basin provides summer habitat for mule deer and elk (Cervus canadensis). Elk use the aspen forests surrounding the reservoir basin for calving. The aspen forest also provides nesting habitat for a variety of passerine and raptorial birds. The linear riparian corridors are important wildlife habitats, providing nesting habitat for a variety of nongame birds, hiding cover for larger animals, and movement corridors for many species. UDWR estimates that up to 70 percent of species in Utah utilize riparian habitats, with some species being dependent on them.

The species picked for HEP analysis were chosen because they were known to use the different vegetation communities in the reservoir basin which will be affected if the project is constructed. Richardson's (meadow) vole uses wet meadow and sedge habitats, which

comprise many of the wetlands in the basin. Beaver also use this type of habitat, damming natural streams and creating additional wetlands. The yellow warbler utilizes the deciduous shrub/scrub wetland habitat. Mule deer range throughout the reservoir basin in summer using a variety of habitat types. The Brewer's sparrow which nests and forages in the sagebrush habitats was chosen as a HEP representative species for the habitat types found in the basin, including summer range for mule deer, that are not wetlands habitat. Table 3 gives acreages of the various vegetation and habitat types in the basin to be disturbed and details the habitat units (HUs) of each of the indicator species which were found to occur in the reservoir basin.

Because the land use of the reservoir basin consists primarily of some sheep grazing activities and light recreation, little change is expected to occur in the existing habitat and wildlife resources in the future without the project.

Aquatic Resources

**Stream Fisheries**

Stream segments in the area of the project which could be impacted include Gooseberry Creek along with its upper tributaries, Fish Creek and Cottonwood Creek (Figure 3). All three of these provide important recreational fisheries use and contain naturally reproducing game fish populations. Gooseberry and Fish Creeks have characteristics which are unique in the State. Fishery values must be maintained.

*Gooseberry Creek* and its tributaries are categorized by UDWR as a Class 3B-Unique stream. Class 3 streams are important from the standpoint of supporting fishing pressure, and fisheries should be considered a primary use. The B indicates that the stream provides important spawning and nursery habitat. Unique identifies streams that provide unique physical, chemical and biological values to the fishery. Gooseberry Creek has been divided into three segments (Upper, Middle, and Lower), which are 1.6, 4.8 and 11.4 km (1.0, 3.0, and 7.1 mi) in length, respectively. Three unnamed tributaries combine to form the Upper Gooseberry segment.

*Upper Gooseberry Creek* supports a naturally reproducing cutthroat trout (Oncorhynchus clarki) population, comprised of adult, juvenile, and young-of-the-year (YOY) fish. Numerous riffle areas provide cutthroat trout spawning habitat. UDWR estimates indicate that the standing crop of cutthroat trout in this segment averages about 42.5 kilograms (kg) per ha (38 pounds {lbs} per ac). This stream segment provides important rearing habitat for cutthroat, with over 720 fish per km (450 fish per mi) (mostly YOY) counted by UDWR. This segment provides only marginal overwinter habitat for cutthroat trout due to low winter flows and limited pool habitat.

The *Middle Gooseberry Creek* segment receives inflow from numerous springs and seeps, as well as several tributary streams. Average flows are consequently higher than in the Upper segment. This segment also supports a reproducing population of cutthroat trout.

The *Lower Gooseberry Creek* segment is downstream from the existing Lower Gooseberry Reservoir. Flow in this segment is double the flow of the Upper and Middle segments. Both cutthroat and rainbow (Oncorhynchus mykiss) trout use this segment. Rainbow trout apparently use this section for spawning a few weeks each year, while cutthroats are year-round residents. Spawning habitat for both species is not abundant in this segment, although YOY have been found to be plentiful, so this does not appear to be a limiting factor. More habitat is available for adult and juvenile trout from April through August than during the rest of the year. UDWR has found that the cutthroat standing crop averages 45- 57.5 kg per ha (40-50 lbs per ac). No estimate of standing crop for rainbows has been made, but both adults and juveniles have been collected in this stream segment.

The three *Gooseberry headwater tributaries* contain 12 stream km (7.5 stream mi). During late summer and early fall major portions of these streams have low flow or are dry. The flowing reaches have high value as cutthroat trout spawning and rearing of YOY habitat. Standing crop in these tributaries averages approximately 97.5 kg per ha (86 lbs per ac), with most being YOY or yearling fish.

*Fish Creek* is rated by UDWR as Class 2-Unique. Class 2 waters are of great importance to the state fishery, indicating productive streams with high aesthetic value. This segment of Fish Creek extends from the confluence with Gooseberry Creek to Scofield Reservoir. In addition to a self-reproducing cutthroat trout population, this segment also provides spawning and rearing habitat for rainbow trout that migrate upstream from Scofield Reservoir. Thus this stream segment provides habitat for adult, juvenile, spawning, and fry life stages of both species. The UDWR surveys have shown a wide range of standing crop values, with an average of almost 57.5 kg of trout per ha (50 lbs per ac).

The 16 km (10 mi) segment of *Lower Fish Creek* (sometimes considered the upper segment of the Price River) between Scofield Dam and its confluence with the White River forming the Price River, is heavily used as a fishery. It is stocked mainly with brown trout (Salmo trutta), but also contains rainbow and cutthroat trout. UDWR is working to make this stretch a blue ribbon brown trout fishery. At present, the standing crop of all trout species in this segment averages 278 kg per ha (244 lbs per ac).

*Cottonwood Creek* is rated Class 3B by UDWR, indicating that this segment supports natural reproduction. This segment extends from the Narrows tunnel outlet to the mouth of the canyon. Presently the upper part of the segment doesn't support a self-sustaining trout population due to low or intermittent flows during much of the year. A rainbow trout fishery is maintained by stocking catchable-sized fish during the period in which there is adequate water. Flows in the lower portion of this segment are higher year-round and support a standing crop of approximately 237 kg per ha (210 lbs per ac) of rainbow and brown trout.

Nongame fish in the upper sections of Gooseberry Creek include redside shiner (Richardsonius balteatus) and mountain sucker (Catostomus platyrhynchus). Lower Gooseberry Creek below Gooseberry Reservoir and portions of Fish Creek were poisoned in 1991 to kill nongame fish which were causing problems with the fishery in Scofield Reservoir.

**Reservoir Fisheries**

Reservoirs in the project vicinity are shown on Figure 3. *Lower Gooseberry Reservoir* has a surface area of approximately 109 ha (270 ac) and is managed as a catchable rainbow trout fishery. It also supports a resident cutthroat trout population. It is estimated that 25,000 trout were harvested in 1982, with 31 percent being cutthroat and the remainder rainbows. A large portion of the reservoir is shallow, which has led to problems with low dissolved oxygen (DO) concentrations and resultant fish kills. Recent steps have been taken by the USFS to improve water quality by releasing water from the bottom of the reservoir.

*Fairview Lakes* are owned and operated by the Cottonwood-Gooseberry Irrigation Company, with water being delivered via the Narrows Tunnel to Cottonwood Creek. The lakes are managed as a catchable rainbow trout fishery, with approximately 12,000 fish stocked every year, and 8,700 harvested. Stocked trout do not generally survive the winter due to the low level of the lakes during this period.

*Scofield Reservoir* has a storage capacity of $8.1 \times 10^7$ $m^3$ (65,800 af) and an annual surface area averaging 923 ha (2,282 ac). Approximately $9.9 \times 10^6$ $m^3$ (8,000 af) of the reservoir is available as a conservation pool as the reservoir cannot be further drawn down. It provides water for irrigation, culinary and industrial uses to the Price River Valley. The reservoir supports naturally reproducing cutthroat trout and natural and stocked rainbow trout. UDWR stocks approximately 600,000 3-inch rainbows into the reservoir each year. Approximately 250,000 rainbow and cutthroats were caught in 1986. The reservoir has experienced periodic fish kills resulting from low DO levels. The occurrence of fish kills is increasing due to declining water quality.

No changes in stream segment or reservoir management are predicted in the future without the project.

## FISH AND WILDLIFE RESOURCES WITH THE PROJECT

### Terrestrial Resources

Approximately 244 ha (604 ac) of wildlife habitat, including 40.5 wetland ha (100 ac), in the reservoir basin will be inundated by dam construction under the proposed project. Under the smaller alternative, 147 ha (363 ac) would be inundated. Also inundated will be 6.9 km (4.3 mi) (6.1 km {3.8 mi} under the smaller reservoir alternative) of linear stream channel riparian corridors. This habitat will be lost over a 2-5 year period after dam closure while

the reservoir fills. All HUs for indicator species in the reservoir basin will eventually be lost. In addition to habitat inundated by the reservoir, an additional 13 ha (32 ac) would be lost to highway relocation and recreational construction, including campground, boat ramp, picnic site, and restroom facilities.

Riparian vegetation in affected downstream segments will be impacted by the change in water regime. It could be killed by the lowering of the water table and narrowing of stream channels, or flooded by large increases in flow. Hydraulic analyses were performed on Gooseberry and Cottonwood Creeks by the District (Barnes, September 12 and 27, 1991). The maximum reduction in depth of flow for Gooseberry Creek was projected to be 0.15-0.27 m (0.5-0.9 ft), which would occur in May, during normal spring runoff. Since Gooseberry Creek is a gaining stream, the depth of the ground water table adjacent to the stream is directly linked with the water surface of the stream. In Cottonwood Creek 0.6 ha (1.5 ac) of riparian habitat, mostly willows, throughout the affected stream segments will be lost to channel widening due to higher flows. The linear riparian corridors lost to reservoir development may be replaced by wetland vegetation surrounding the reservoir which will not provide the same critical wildlife values. Due to fluctuating reservoir levels it will be hard to reestablish trees around the reservoir.

Wildlife in the area will be directly impacted by loss of habitat to the reservoir and associated activities such as roadbuilding, or indirectly impacted through increased human activities, including recreational uses such as fishing, boating and off-road vehicle use, constructing cabins and increasing traffic throughout the area. A small area of aspen (Populus tremuloides) forest will be disturbed when the road is rerouted over the new dam. Bisection of the aspen grove by the rerouted road and increased traffic through the area may cause elk to desert their calving areas. Although less than 0.4 ha (one ac) of actual disturbance to the aspen habitat is proposed, the road will divide and fragment the existing unbroken block of forest, which could create passage problems for big game and will give interior forest-nesting birds smaller areas of suitable nesting habitat. Nesting raptors may be subject to harassment in addition to loss of prey base from the flooded meadows. Loss of hiding cover may cause many medium- and large-sized animals to discontinue traveling through the basin.

Construction of a water distribution system in the Sanpete Valley will temporarily disturb plant communities including Valley sagebrush/grass, scrub oak, grassland and mountain brush. These disturbances will be temporary as the pipelines will be buried underground and the linear nature of the disturbance will cause relatively small areas to be disturbed per unit area. A total of 12.1 ha (30 ac) along the 27.4 km (17 mi) pipeline alignment would be disturbed. These disturbed areas will be reseeded following completion of construction and wildlife impacts should be minimal.

UDWR has identified a potential impact of the project on an existing crop depredation program in northern Sanpete County. They have determined that increasing alfalfa production through use of project water will encourage mule deer to remain at low elevations

during summer to feed on agricultural fields, exacerbating an existing problem. Crop depredations could increase, requiring UDWR to spend additional time removing problem deer and to pay additional damages for crop depredations. UDWR will also have to pay for fencing for any new haystacks developed due to greater alfalfa production. It estimates that additional depredation expenses could increase by as much as $2,000 over the existing program costs of approximately $20,000. No mitigation for this project impact has been identified by UDWR at this time.

Aquatic Resources

**Stream Fisheries**

Operation of the dam will affect flows in Gooseberry, Fish and Cottonwood Creeks. The Upper Gooseberry Creek segment (1.6 km {one mi}) and 6.9 km (4.3 mi) of the tributary streams will be inundated. Under the smaller reservoir alternative 6.1 km (3.8 mi) of the Gooseberry Creek tributaries would be inundated. All other aquatic impacts should be the same under both alternatives.

Flows in the Middle Gooseberry Creek segment will be reduced by an average of 91 percent. The State Engineer has stipulated that a minimum of 0.03 cubic meters per second (cms) (one cubic foot per second {cfs}) be released from the Narrows Dam so that the segment will not be totally dewatered. If the flow at the Gooseberry Campground (approximately one mile below the dam site) is not 0.04 cms (1.5 cfs), then 0.035 cms (1.25 cfs) must be released from the dam. Flows in Lower Gooseberry Creek are expected to be reduced by as much as 62 percent, with an average flow reduction of 51 percent. Fish Creek flows will be reduced by an average of 18 percent, and up to 24 percent. Flows in the upper part of Cottonwood Creek would be increased by up to 1000 percent through the diversion of project water. Flows in the lower section would increase by up to 550 percent.

Table 4 shows the pre- and post-project flows for Gooseberry Creek, Fish Creek, the Price River, and Cottonwood Creek. Tables 5-9 show changes in WUA for cutthroat and rainbow trout in Gooseberry and Fish Creeks with the implementation of the project. Changes range from a monthly decrease of less than one percent to 100 percent.

In general, the decrease in flow in the *Middle Gooseberry segment* will have the greatest impacts during the spring and summer when flow is normally the highest. This is the time when cutthroat spawning occurs. Flow will be reduced to 0.03 cms (one cfs) from average flows of 1.27 and 1.76 cms (45 and 62 cfs) in May and June, respectively. Spawning and fry habitat will be seriously reduced (by 94 and 45 percent, respectively). Fry will also be prevented from being carried downstream by the dam. Adult (-72 percent) and juvenile (-81.6 percent) habitat will also be reduced during this period. Without flushing flows the width of the stream will reduce and more fine materials will accumulate in the substrate, which could eliminate any remaining spawning habitat. Fifty to 75 percent of trout biomass could be lost from this segment.

*Lower Gooseberry Creek* will also suffer the largest flow reduction from April to August. However, due to tributary inflow, reductions will not be as severe. Flows will be reduced from approximately 2.29 to 1.05 cms (81 to 37 cfs) in May and from 2.78 to 1.05 cms (98 to 37 cfs) in June. The low flow period, from October through March, is considered to be the most restrictive for providing trout habitat. Flows would be reduced from 8-32 percent at this time. During this period adult and juvenile cutthroat trout habitat would be reduced by 10.5 and 29.5 percent respectively. Reductions of adult and juvenile habitat of less than 10 percent will occur during other times of the year. Rainbow trout adult and juvenile habitat is projected to be reduced by 6.5 and 5.4 percent, respectively, during the low flow period. Implementation of the proposed project is expected to slightly increase rainbow spawning and fry habitat.

During the low flow period average flow will be reduced between 5 and 8 percent in *Fish Creek*. Habitat is expected to be reduced by up to 7.3 and 3.3 percent,respectively, for adult and juvenile cutthroat trout. For rainbow trout habitat may be reduced by up to 2.7 and 1.3 percent, for adults and juveniles, respectively. Spawning habitat could decrease by 16 percent for rainbows and increase by approximately the same amount for cutthroats. Fry habitat would change by less than 3 percent for both species.

Flows in *Lower Fish Creek* will not be directly affected by construction of the Narrows, but will be indirectly affected by changes in operation of Scofield Reservoir. Because the Narrows will capture runoff during spring high flows that would otherwise have gone to Scofield Reservoir, Scofield will spill less frequently and for shorter durations, lowering the volume of peak flows in Lower Fish Creek, and consequently in the Price and Green Rivers downstream. Controlled releases from Scofield Reservoir would remain unaltered during most years. However, under prolonged drought conditions, irrigation releases would be reduced due to lack of water in the reservoir. In simulations using data for the years 1960-1992, reductions would have occurred in 5 of the 33 years if the Narrows Project had been in place.

Flows in *Cottonwood Creek* will increase dramatically during water delivery, from July to October (Table 4). Because flows will not be increased during the low flow period the upper portion will still support a catch and release fishery. However, fishing will be more difficult due to higher flows. The self-sustaining fishery in the lower portion of the creek could be affected by impacts to riparian vegetation or streambank sloughing due to high flows. An engineering stability report (Barnes, September 12, 1991) was prepared for the District, which showed that the increased flows will degrade the channel by up to 0.1 m (0.36 ft) in certain segments. The District has committed to place a pipe in the upper 1.3 km (0.8 mi) of the stream to convey irrigation releases during the summer season. Thus, project impacts in this segment will be avoided. Change in flows could affect the lower 7.9 km (4.9 mi) of Cottonwood Creek. An IFIM analysis has not been done on Cottonwood Creek, so exact reductions in habitat for fish life stages, due to the project are unknown.

**Reservoir Fisheries**

Flow of Gooseberry Creek into *Lower Gooseberry Reservoir* will be substantially reduced, particularly during spring and summer months. Flow reduction during this period may reduce the exchange rate in the reservoir, affecting water quality and leading to more severe fish kill problems. The project could also affect the cutthroat trout population in the reservoir by decreasing recruitment from upstream.

*Fairview Lakes* will not be directly affected by the project, but changes in management and fishing pressure may occur due to coordination of operation with the Narrows. Effects on the fishery could be beneficial due to reduced fishing pressure and greater availability of water due to operational changes.

A study prepared for the District (Cloward, Madden & Associates, November 1991) has shown that probability of eutrophication of *Scofield Reservoir* is slightly lower with the project conditions (from 79.3 to 78.0 percent). This is due to reduced sediment entering Scofield. However, sediments currently existing in the reservoir will continue to act as a nutrient sink, and reduction of incoming sediments due to the project will not improve the situation. After project construction, sediments would be intercepted in the Narrows Reservoir or build up in the contributing stream channels as discussed above.

Another concern is that decreased inflow may degrade water quality and increase the number of periodic fish kills. A comparison of Scofield Reservoir flushing rates under future without-project and project conditions showed an increase in projected fish kills from four in 30 years to five in 30 years. This is based on the assumption that fish kills occur 80 percent of the time when the annual flushing rate is less than 0.85 (Stephens, 1985). Decreased inflow will also result in a lower average surface area for the reservoir which will reduce the standing crop of fish in the reservoir. This loss of fish biomass would result in the loss of approximately 4,500 angler days per year.

The loss of spawning habitat for rainbow trout in Fish Creek could affect the fishery in Scofield Reservoir by reducing the number of rainbows entering the Scofield population from natural reproduction. It is not known what proportion of the rainbow trout existing in Scofield Reservoir come from natural production.

The *Narrows Reservoir* will be operated so that it will be at its highest level following spring runoff and water would be released so that most of the $6.7 \times 10^6$ $m^3$ (5,400 af) would be delivered by the end of September. It is expected that UDWR will manage the reservoir for a cutthroat trout fishery, though sterile rainbows may also be stocked. Natural cutthroat reproduction is expected under the proposed project alternative in the remaining segments of the three tributary streams, but this may need to be supplemented by stocking of fingerling cutthroats and rainbows. UDWR has expressed concern that, due to existing demand, there may not be enough hatchery stock available to meet demand in the new reservoir. The reservoir may support approximately 13,700 angler days of fishing annually (7,200 days

under the smaller reservoir alternative), if managed similarly to other reservoirs in the area.

Endangered Species

The Service determined that the endangered bald eagle (Haliaeetus leucocephalus) and the endangered Colorado squawfish (Ptychocheilus lucius), razorback sucker (Xyrauchen texanus), humpback chub (Gila cypha) and bonytail chub (Gila elegans) could occur in the area of the project. Reclamation prepared a Biological Assessment (BA) with a determination that the project "may affect" the four endangered Colorado River fish through the $6.7 \times 10^6$ $m^3$ (5,400 af) depletion. The Service prepared a Biological Opinion (March 25, 1992) based on the BA which concluded that the Narrows project would not jeopardize the continued existence of the fish species with the implementation of a designated Conservation Measure. The Conservation Measure requires the payment of a depletion charge into the Recovery Implementation Program (RIP) established by the Service to recover the endangered Colorado River fish. If sufficient progress is not made in the RIP through the ongoing reoperation of Flaming Gorge Dam, additional steps may need to be taken by the District to offset the Narrows depletion. Since the Biological Opinion was prepared the District has changed its estimate of average annual water depletion to $6.85 \times 10^6$ $m^3$ (5,557 af). The Service is preparing a revised Biological Opinion at this time. Additional mitigation measures may be required under the RIP in the amended Biological Opinion. These measures are not included in this document, but would need to be added to the District's final mitigation plan.

A category 2 candidate species, the spotted frog (Rana pretiosa) could also occur in the project vicinity. The District conducted a survey for this species in historic habit in the Sanpete Valley. Two frogs were found near Oak Creek at the northern terminus of the proposed water delivery pipeline. It is not expected that the project will have an adverse effect on this species (Hovingh, 1992).

Since the Biological Assessment was prepared the roundtail chub (Gila robusta), a fish which occurs in the lower Price River, has been added to the list of species which are candidates for threatened or endangered species listing. It is not known how this species could be impacted by lowered flows in the Price River.

DISCUSSION/PROPOSED MITIGATION

The main impacts of the Narrows project will occur on fish and wildlife resources in the reservoir basin and adjacent downstream segments of Gooseberry Creek and Cottonwood Creek. Proposed fish and wildlife mitigation measures as detailed in the Draft Environmental Impact Statement are described below. These measures were developed through coordination of the two technical teams and adopted by the District. They are referenced in the following text as the District's proposed mitigation, but it should be understood that these measures were developed with input from all interested agencies. Where there are differences between the project proposal and the small reservoir alternative,

information pertaining to the small reservoir alternative is shown in parentheses. The District's intention is to totally mitigate all impacts, where possible. To the extent possible, the District attempted to find mitigation measures which could be implemented "in place" and "in kind".

Flooding of the reservoir basin will destroy all HUs of indicator species present, as shown in Table 3. Wetland areas to be destroyed, including 6.9 km (4.3 mi) of the Gooseberry Creek tributaries (6.1 km {3.8 mi}) and the 1.6 km (one mi) Upper Gooseberry Creek segment, provide habitat units for the Richardson's vole, yellow warbler, mule deer and beaver. The District has proposed two alternatives to mitigate for wetlands losses. One alternative would involve enlarging existing wetlands and creating new wetlands adjacent to the Narrows Reservoir. Under this proposal approximately 44.5 ha (110 ac) of new wetlands will replace the hectares (acres) lost, including riparian habitat lost to flooding along Cottonwood Creek. Habitat units lost for all wetland habitat types will be replaced onsite adjacent to the reservoir according to the District's plan. However, the Corps has not accepted this plan as mitigation for wetland losses at this time. The District has proposed another alternative for full or partial mitigation that consists of purchase and restoration of wetlands adjacent to Mud Creek, a tributary to Scofield Reservoir. Approximately 89 ha (220 ac) of private lands containing degraded wetlands would be purchased. Most of the degradation has been caused by cattle which would be removed to facilitate enhancement of the wetlands. Figure 4 shows the location of the alternative wetland mitigation sites.

Conversion of upland habitat adjacent to the reservoir for wetland replacement would remove additional HUs for mule deer and Brewer's sparrow. This is reflected in the acreage of impacted HUs shown in Table 3 and will need to be mitigated if this alternative is chosen for wetlands mitigation. If the Mud Creek alternative wetland mitigation is chosen, these additional HUs would not be required.

The District has proposed mitigation measures to replace lost upland shrub HUs for mule deer and Brewer's sparrow. Proposed measures include acquiring 60.7 ha (150 ac) of conservation easements with land use restrictions adjacent to the reservoir basin, which would avoid future adverse impacts, but would not mitigate for project impacts. Offsite mitigation through participating in other projects in the Manti-LaSal National Forest such as reclaiming areas infested with tarweed (Media glomerata) to native shrub/grass habitats is also proposed. It is not known if these rehabilitated areas would meet the specific habitat needs of mule deer and Brewer's sparrow lost due to the project. Specific projects have not been committed to as yet. The District has also committed to acquire 259 ha (640 ac) of private land adjacent to Lower Fish Creek (Price River) below Scofield Reservoir. The sections also contain some upland sagebrush habitats whose protection could compensate somewhat for upland habitats including elk calving and mule deer fawning areas lost to the project. Wildlife values would be enhanced by fencing.

Other project impacts include impacts to stream fisheries, stream channels and riparian habitat corridors in downstream segments of Gooseberry and Cottonwood Creeks.

The 4.8 km (3 mi) Middle Gooseberry segment will be largely dewatered. The channel will become narrower and shallower. Sediments will also accumulate due to low flow conditions. The District proposes to mitigate riparian habitat losses onsite by placing constrictions in the channel to prevent the water surface from dropping and modifying stream banks so that overbank flooding will still be possible. Riparian plantings will be used in areas where vegetation has been damaged or destroyed. Buildup of fine sediments in the stream channel will be minimized by providing flushing flow releases from the Narrows Dam when necessary. The District has proposed to acquire a 16.2 ha (40 ac) parcel of private land that this segment of the creek runs through.

Impacts to stream fisheries in the inundated segments in Upper Gooseberry will be total, and they will be severe in the Middle Gooseberry segment. Other impacted stream segments will not be as directly affected. To mitigate onsite for lost fisheries the District will restore year-round flows in two of the Gooseberry Creek tributaries through releases from Fairview Lakes. This will result in the creation of approximately 3.7 km (2.3 mi) of spawning and rearing habitat for cutthroat trout, which will partially mitigate for the 8.5 km (5.3 mi) lost in the Upper Gooseberry segments. Under the smaller reservoir alternative, this mitigation measure will not be available and the District will need to provide an additional stream segments for cutthroat spawning habitat elsewhere.

The District has proposed to release water from the Narrows Dam for flushing sediments and for fish habitat during critical periods to avoid some fishery losses in the Middle Gooseberry segment. An average of $3.7 \times 10^5$ $m^3$ (300 af) would be available for release each year. UDWR has also suggested that the water might be used as an instream flow supplement during the winter period to help prevent fish kills in Lower Gooseberry Reservoir. The District and UDWR would determine the timing and amount of water to be released.

Through these measures, spawning and rearing habitat for cutthroat trout will be able to be maintained in the Middle Gooseberry segment. However, habitat for adult and juvenile trout will be lost throughout 6.4 km (4 mi) of stream in the Upper and Middle segments. The District has proposed to acquire stream segments in a 1:1 ratio with the mileage of impacted streams. The District proposed to acquire approximately 20.2 ha (50 ac) of private land containing live fishery streams. A corridor, approximately 61 m (200 ft) wide, would be acquired along a total of 6.4 km (4 mi) of stream. The project might include parcels from several different streams. In the DEIS, the District identified five stream segments that may be available for purchase. The acquired stream corridors would be fenced with a pole top fence to exclude grazing. These stream segments would provide habitat for all life stages of cutthroat trout.

The purchase of the State section in the Lower Fish Creek area could also contribute to mitigation of fishery impacts associated with the project, particularly to stream segments suitable for adult and juvenile occupancy. This section of Fish Creek currently provides habitat for adult and juvenile cutthroat, rainbow and brown trout.

The District has proposed to prevent stream degradation from increased flows in Upper Cottonwood Creek by construction of a 1.3 km (0.8 mi) pipeline to convey reservoir releases. A winter release of 0.056 cms (2 cfs) would also be made from the Narrows Reservoir to Cottonwood Creek during the winter months (October through March) to increase fish habitat during that period and to provide mitigation for stream channel widening that would occur due to high summer flows. No mitigation was proposed for loss of fishery habitat in Lower Cottonwood Creek.

Lower stream flows and their impacts on fisheries in Gooseberry and Fish Creeks may affect reproduction and recruitment into the Lower Gooseberry and Scofield Reservoir populations. This could impact recreational use of the two reservoirs. The District calculates that 4,500 angler days per year will be lost at Scofield Reservoir but does not calculate potential losses at Lower Gooseberry Reservoir. Creation of a new fishery on the Narrows Reservoir would provide approximately 13,700 angler days of use, according to the District, offsetting losses at other reservoirs. The smaller reservoir alternative would provide approximately 7,200 days of angler user.

The District has committed to a monitoring program to evaluate the progress of wildlife and wetlands mitigation plans, both qualitatively and quantitatively to ensure that lost HUs and wetland acreages are replaced. Statistical comparisons will be made and additional mitigation measures would be required if full mitigation standards are not achieved. A similar monitoring program for aquatic mitigation measures was not included in the Draft EIS.

The Service and UDWR believe that the types of mitigation proposed in the DEIS are appropriate. However, the two agencies were concerned about inadequacies in the amount of mitigation proposed, as not all impacts were proposed to be totally mitigated. The Corps will determine whether the amount of mitigation proposed for wetland resource losses is appropriate. Mitigation for upland wildlife species will be total replacement of lost HUs. The main concern of the Service and UDWR was the adequacy of proposed aquatic mitigation measures, particularly for losses of stream segments that support fisheries. In a letter dated September 21, 1994 (see Appendix B), the UDWR has recommended measures, including some already committed to by the District, to be taken to totally mitigate for these losses in both the Price River Basin and the Sanpitch River Basin. The Service concurs with the recommendations of UDWR. The District voted on September 7, 1994 to incorporate those additional measures not contained in the DEIS into their mitigation plan in the Final EIS. Therefore the cost estimate (Appendix A) and the Aquatic Impacts and Mitigation Measures (Table 10) include these additional measures, as described below.

Affected streams in the **Price River Basin** (Gooseberry Creek, and Fish Creek) will suffer losses to fishery values; in some segments the losses will be complete. The UDWR recommended the following measures to offset project impacts. Acquisition and fencing of 4.0 miles of Mud Creek would complement the proposed wetland mitigation project in this area. These projects together would mitigate for both wetlands and stream impacts, as well as potentially benefitting water quality in Scofield Reservoir by reducing nutrients entering

the reservoir from the Mud Creek drainage. UDWR recommended that two miles of Lower Fish Creek be acquired, fenced and enhanced. This would be done in conjunction with the acquisition of a section of State School trust lands which is proposed as mitigation for upland impacts. It is also recommended that 2.5 miles of Winterquarters Creek, and one mile of Pondtown Creek within the USFS boundary, be acquired, fenced, and/or enhanced for improvement of stream and riparian habitat conditions.

Recommendations for the **Sanpitch River Basin** include piping the irrigation flows in the upper 0.8 miles of Cottonwood Creek and providing a minimum 2 cfs instream flow for this stretch during the winter season. For enhancement of the segment of Cottonwood Creek from the canyon mouth to the confluence with the Sanpitch River, UDWR recommended a 2 cfs minimum instream flow during the irrigation season. This will provide year-round flows for fish habitat and enhance the riparian corridor. Currently, this stream segment is dewatered during the irrigation season. UDWR also recommended enhancement of 4 miles of Starvation Creek, from the confluence of Bennion Creek to the confluence with Soldier Creek in Spanish Fork Canyon to improve water quality and riparian habitat. Enhancement may include bank stabilization, revegetation, or other measures.

RECOMMENDATIONS

Properties acquired for mitigation, whether for upland wildlife, wetlands, or aquatic wildlife, could be managed under the following strategies: acquisition for protection, acquisition for enhancement, conservation easements for protection, conservation easements for enhancement, enhancement of USFS property and enhancement of UDWR property. Mitigation for this project will probably includes a combination of several or all of these strategies.

The following recommendations also need to be addressed in the Final EIS to complete the mitigation plan:

1. The above recommendations apply to the preferred (large reservoir) alternative. If the small reservoir alternative is chosen, additional mitigation will be required for the loss of cutthroat trout spawning habitat which could not be replaced by restoration of headwater streams from Fairview Lakes. At the time this alternative is chosen, additional mitigation measures will be developed in coordination with the Service and UDWR.

2. Acquisition of private lands should preferably be made by fee title. In areas adjacent to the reservoir basin easements would be appropriate. In the Final EIS the District should identify the appropriate management entities for specific properties being considered for acquisition. Conditions of easements should also be specified in the Final EIS.

3. As part of the mitigation plan the District must develop a comprehensive monitoring and maintenance program to ensure that aquatic and wildlife habitat replacement values are being met. This program will address monitoring procedures, responsible parties, and steps to be taken if mitigation efforts do not prove successful. It should also include an Operation and Maintenance account with adequate funding to ensure that mitigation requirements are met. This plan should be included as part of the Final EIS.

4. Reclamation will ensure that language in the Small Reclamation Project Loan repayment contract stipulates that mitigation will be concurrent with project construction.

5. Any additional measures for wetland mitigation required by the Corps should be included in the Final mitigation plan.

6. Any additional measures for impacts to listed fish species required by the Amended Biological Opinion should be included in the Final mitigation plan.

7. The Final EIS should list detailed mitigation commitments for all project impacts. Specifics such as management entities for the various stream segments, and specific enhancement measures to be taken in each area should be listed. If there are any areas where a specific final mitigation strategy has yet to be determined a timetable for development should be included, along with a list of agencies to be consulted for concurrence.

Appendix A includes a preliminary cost analysis of the mitigation plan including costs for mitigation as proposed by the District in the DEIS as well as costs for additional mitigation measures approved by the District as discussed above. Costs are estimated since property acquisition costs may vary.

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## APPENDIX A

## MITIGATION COST ESTIMATE (PREFERRED ALTERNATIVE)

| Mitigation Item | Quantity | Unit | Unit Price | Cost |
|---|---|---|---|---|
| Wetland Mitigation Area (adjacent to reservoir) | 110 | acre | 500 | 55,000 |
| Plantings for Wetland Mitigation Area | lump sum | lump sum | 10,000 | 10,000 |
| or | | | | |
| Wetland Mitigation Area *(Mud Creek) | 220 | acre | 500 | 110,000 |
| Fencing on Mud Creek | 2 | mile | 13,000 | 26,000 |
| Wildlife Conservation Easement Adjacent to Reservoir | 150 | acre | 400 | 60,000 |
| Acquire State Section on Price River below Scofield Reservoir | 640 | acre | 350 | 224,000 |
| Fencing for State Section | 4 | mile | 13,000 | 52,000 |
| Acquire Middle Gooseberry land | 40 | acre | 350 | 14,000 |
| Fencing on Middle Gooseberry | 0.25 | mile | 13,000 | 3,250 |
| Middle Gooseberry Channel rehab | 3 | mile | 10,000 | 30,000 |
| Upper Gooseberry Tributaries Planting & Channel Improvements | lump sum | lump sum | 10,000 | 10,000 |
| Reseeding on Forest Service lands | 900 | acre | 30 | 27,000 |
| Monitoring Aquatic and Wildlife Mitigation | lump sum | lump sum | 50,000 | 50,000 |
| Endangered Fish Depletion Fee (1995 Cost) | 5,557 | acre-feet | 12.71 | 70,629.47 |

| | | | | |
|---|---|---|---|---|
| Acquire Stream Segments (2 mi *Mud Creek, 1 mi Lower Fish Creek, 1 mi Upper Fish Creek, 2.5 mi Winterquarters Creek, 2 mi Pondtown Creek, 4 mi Starvation Creek) | 303 | acre | 500 | 151,500 |
| Fence Fishery Segments | 25 | mile | 13,000 | 325,000 |
| Enhance Stream Segments | 13.5 | mile | 15,000 | 202,500 |

| | |
|---|---|
| TOTAL (Wetlands Alternative Adjacent to Reservoir) | 1,284,879.47 |
| TOTAL (Mud Creek Wetland Alternative) | 1,355,879.47 |

*2 miles of Mud Creek will be purchased for mitigation of aquatic impacts. If the Mud Creek wetlands mitigation alternative is chosen, an additional 2 miles of stream will be purchased and fenced.

APPENDIX B

UTAH NATURAL
RESOURCES
Wildlife Resources
1596 West North Temple • Salt Lake City, UT 84116-3195 • 801-533-9333

# memorandum

SEP 28 1994

September 21, 1994

Mr. Reed Harris
U.S. Fish and Wildlife Service
Lincoln Plaza
145 East 1300 South, Suite 404
Salt Lake City, Utah 84115

Subject: Final Comments, Fish and Wildlife Coordination Act Report, Narrows Project

Dear Reed:

We have reviewed the subject draft Fish and Wildlife Coordination Act Report dated June 1994 for the proposed Narrows Project in Utah. Contained herein are the Division of Wildlife Resources' (Division) final comments regarding the document. We have provided additional information and mitigation recommendations which have been derived since the draft report was issued.

Through previous consultation among our agencies, the Division had recommended that mitigation for stream impacts occur on a 3:1 or 2:1 linear basis whenever the project sponsor proposed improvement of existing stream segments as a mitigation method, by either fencing to protect riparian and stream bank areas, or through other unidentified methods. Since that time, Division staff have refined the recommendation to account for project impacts and project-induced mitigation improvements using the Habitat Quality Index method. For this analysis, Division staff used existing file data, published reports, and professional judgement to estimate the number of Habitat Units present in stream segments which would or could be affected by the Narrows project, either as impacted streams or as potential mitigation sites. Both pre- and post-project Habitat Units were estimated using those methods.

Table 1 presents the Division's recommended mitigation for impacts to stream fishery resources of the Proposed Large Dam Alternative of the Narrows Project which had previously been recommended in concept at 3:1 or 2:1 linear ratios. All other proposed mitigation recommendations in the draft report would

remain unchanged, unless specifically modified herein. Also shown is the analysis of Habitat Units for each stream segment under existing and Post-Project conditions. Specific recommendations regarding the types of improvements which should be implemented follow.

Price River Basin

The recommendation to acquire and fence 4.0 miles of Mud Creek is intended to complement the proposed wetland mitigation project also along Mud Creek. Together these two projects would not only mitigate wetland and stream impacts, but could potentially benefit water quality in Scofield Reservoir by trapping and reducing nutrients entering Scofield Reservoir from the Mud Creek drainage. The recommendation regarding Lower Fish Creek is to acquire, fence and enhance two miles. Much of this would be accomplished in concert with the proposed mitigation for upland impacts of acquiring a section of State School Trust lands. Acquiring and fencing 2.5 miles of Winterquarters Creek would allow for improvement of stream and riparian conditions. One mile of Pondtown Creek within the U.S. Forest Service boundary is also recommended for acquisition and fencing or enhancement.

Sanpitch River Basin

Piping most of the irrigation flows from the tunnel outlet downstream 0.8 miles to discharge into Cottonwood Creek will avoid an impact from high project releases, and will allow for enhancement of summer flows in the upper 0.8 mile reach of Cottonwood Creek. Providing a 2 cfs minimum instream flow in the winter season to this same reach of stream will provide for establishment of year-round flows and a naturally reproducing complement of fish species. The enhancement measure proposed for the lower Cottonwood Creek, from the canyon mouth to the confluence of the San Pitch River, is to provide a 2 cfs minimum instream flow during the irrigation season. This will provide year-round flows in the stream, which will provide some fish habitat, will create a fishery for local residents, and enhance the riparian corridor. Presently this reach of stream is de-watered during the irrigation season.

Enhancement along the 4 miles of Starvation Creek, from the confluence of Bennion Creek down to the confluence with Soldier Creek (Utah County, Spanish Fork Canyon) will improve water quality and riparian habitat of the stream. Enhancement can

include, but is not limited to, bank stabilization, especially where the road confines the stream channel and causes bank erosion, and revegetation in appropriate locations.

Mitigation recommendations for the Small Dam Alternative would be similar to the recommendations provided for the Large Dam Alternative, with the exception that additional mitigation for loss of cutthroat trout spawning habitat would need to be provided in lieu of the restoration of headwater streams from Fairview Lakes. The Division proposes that a final mitigation plan for that impact would be developed in consultation with the project sponsor at that time, if the Smaller Dam Alternative is selected.

The only other comment we have on the report is that the 2 cfs minimum streamflow release from the Narrows Tunnel to the headwaters of Cottonwood Creek during the "winter" should actually be a commitment to maintain the 2 cfs minimum flow in the stream from the end of one irrigation season to the beginning of the next. This should be noted in the report, rather than beginning and ending on a fixed date regardless of when irrigation deliveries equal to or greater than the 2cfs minimum begin and end.

We appreciate the efforts of your staff in working closely with Division staff during the past several years on this project. Please contact Mark Holden or Catherine Quinn at 538-4700 if you have any questions regarding these comments.

Sincerely,

Robert G. Valentine
Director

RGV/MH/kj

cc: Richard Noble, Franson-Noble Associates
Manti-LaSal National Forest Supervisor

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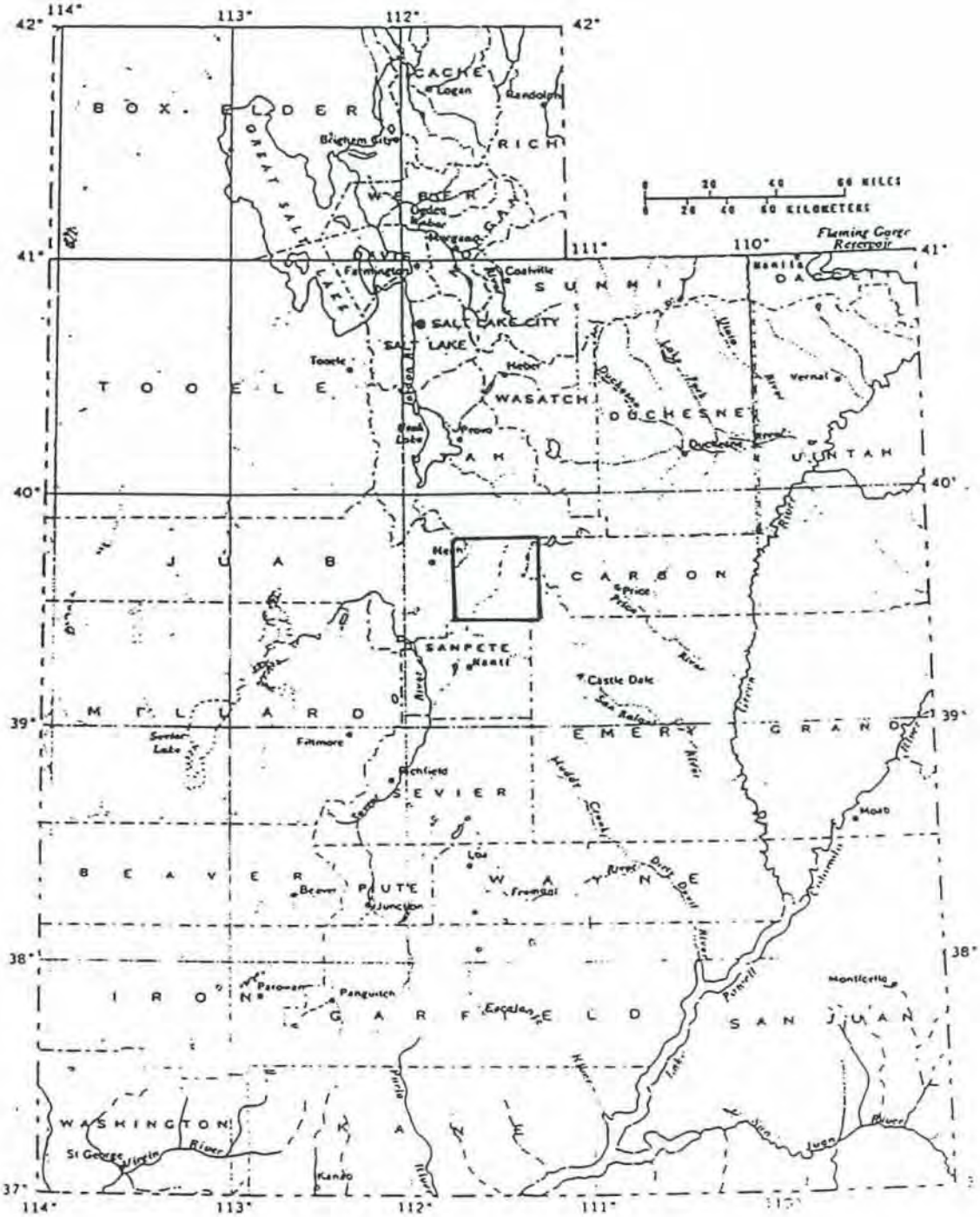
TABLE 1
ESTIMATION OF HABITAT QUALITY INDEX UNITS ON AFFECTED AND POTENTIAL MITIGATION REACHES, PREFERRED ALTERNATIVE

| Stream | Miles Affected | Existing HUs/mi | HUs Post Project | Change in HUs/mi | HUs to Replace | Replacement HUs Gained |
|---|---|---|---|---|---|---|
| **Price River Basin** | | | | | | |
| Middle Gooseberry C. | 4 | 139 | 0 | -139 | 556 | ----- |
| Lower Gooseberry Cr. | 2 | 203 | 132 | -71 | 142 | ----- |
| **Total HUs Lost** | | | | | **698** | |
| Mud Creek | 4 | 79 | 160 | 81 | ---- | 324 |
| Lower Fish Creek | 2 | 312 | 350 | 38 | ---- | 76 |
| Upper Fish Creek | 1 | 432 | 517 | 85 | ---- | 85 |
| Winterquarters Creek | 2.5 | 35 | 77 | 42 | ---- | 105 |
| Pondtown Creek | 2 | 50 | 103 | 53 | ---- | 106 |
| **Total HUs Replaced** | | | | | | **696** |
| **Sanpitch River Basin** | | | | | | |
| Cottonwood Creek | 4.9 | 79 | 13 | -66 | 322 | ---- |
| **Total HUs Lost** | | | | | **322** | |
| Upper Cottonwood Cr. | 0.8 | 4 | 202 | 198 | ---- | 158 |
| Lower Cottonwood Cr. | 1.2 | 0 | 40 | 40 | ---- | 48 |
| Starvation Creek | 4 | 82 | 111 | 29 | ---- | 116 |
| **Total HUs Replaced** | | | | | | **322** |

Figure 1 - General Project Location Map




PROJECT AREA

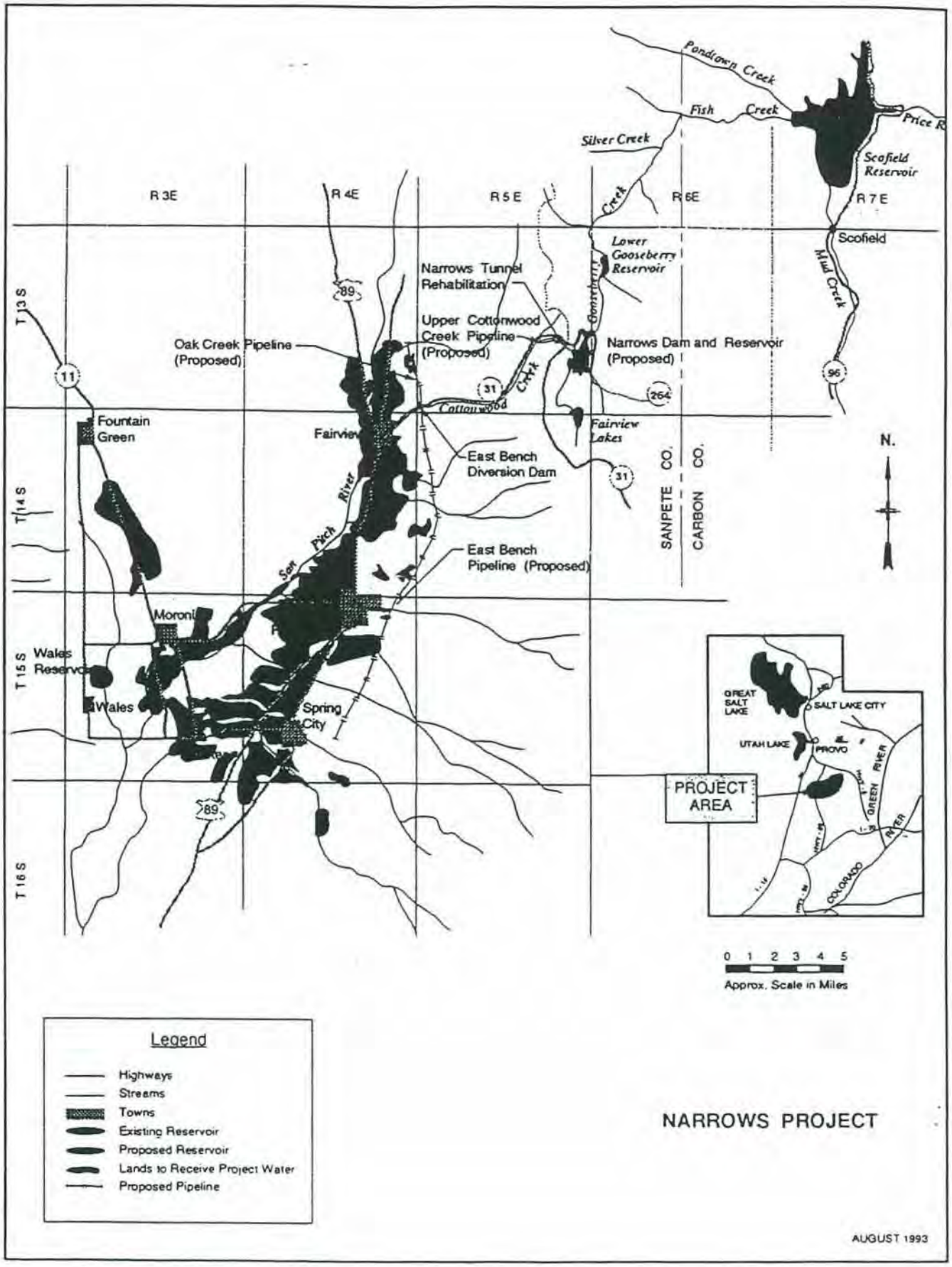



Figure 2. Narrows Project Area and Water Distribution System

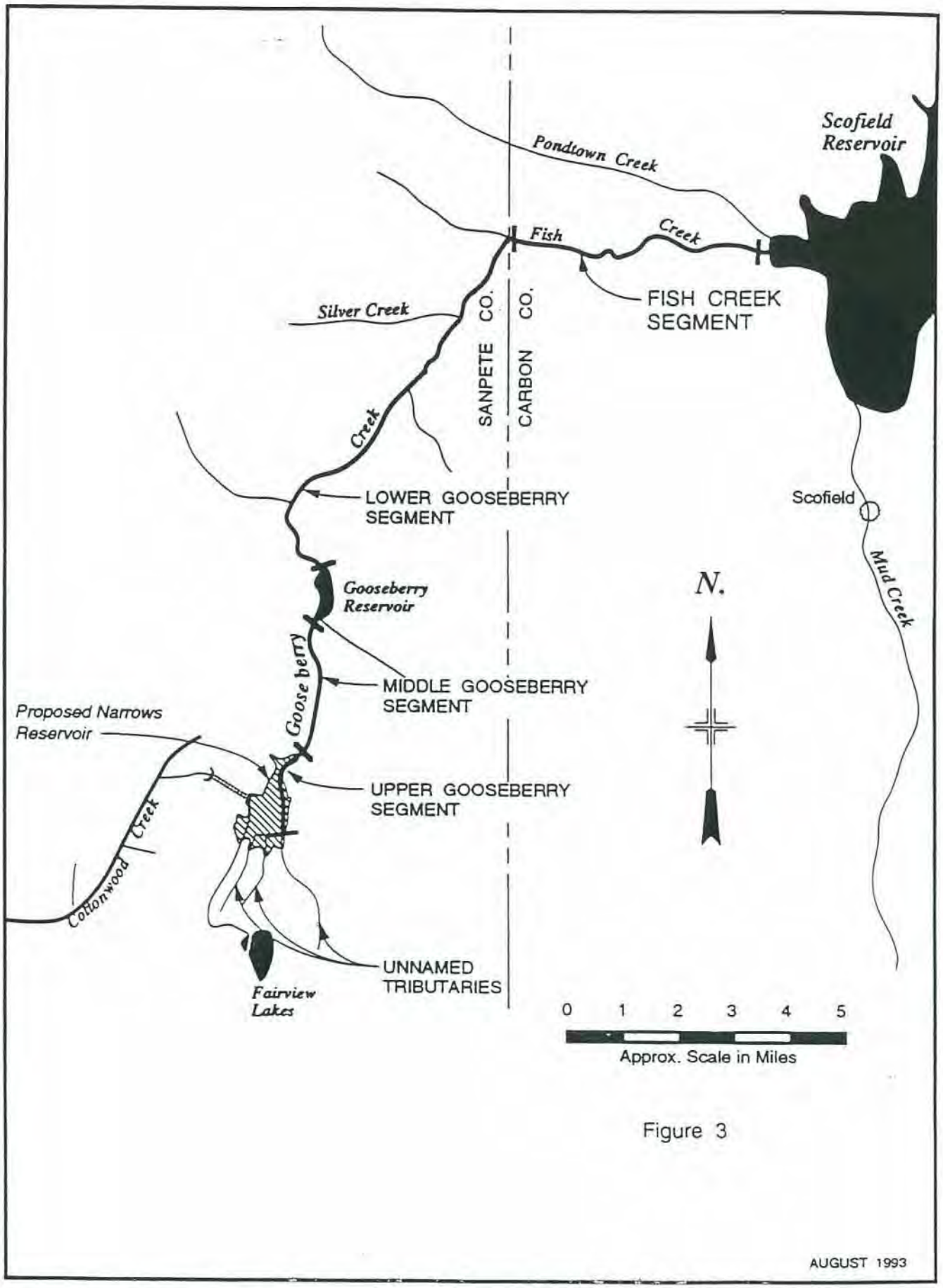



Figure 3. Streams and Reservoirs in the Narrows Project Area

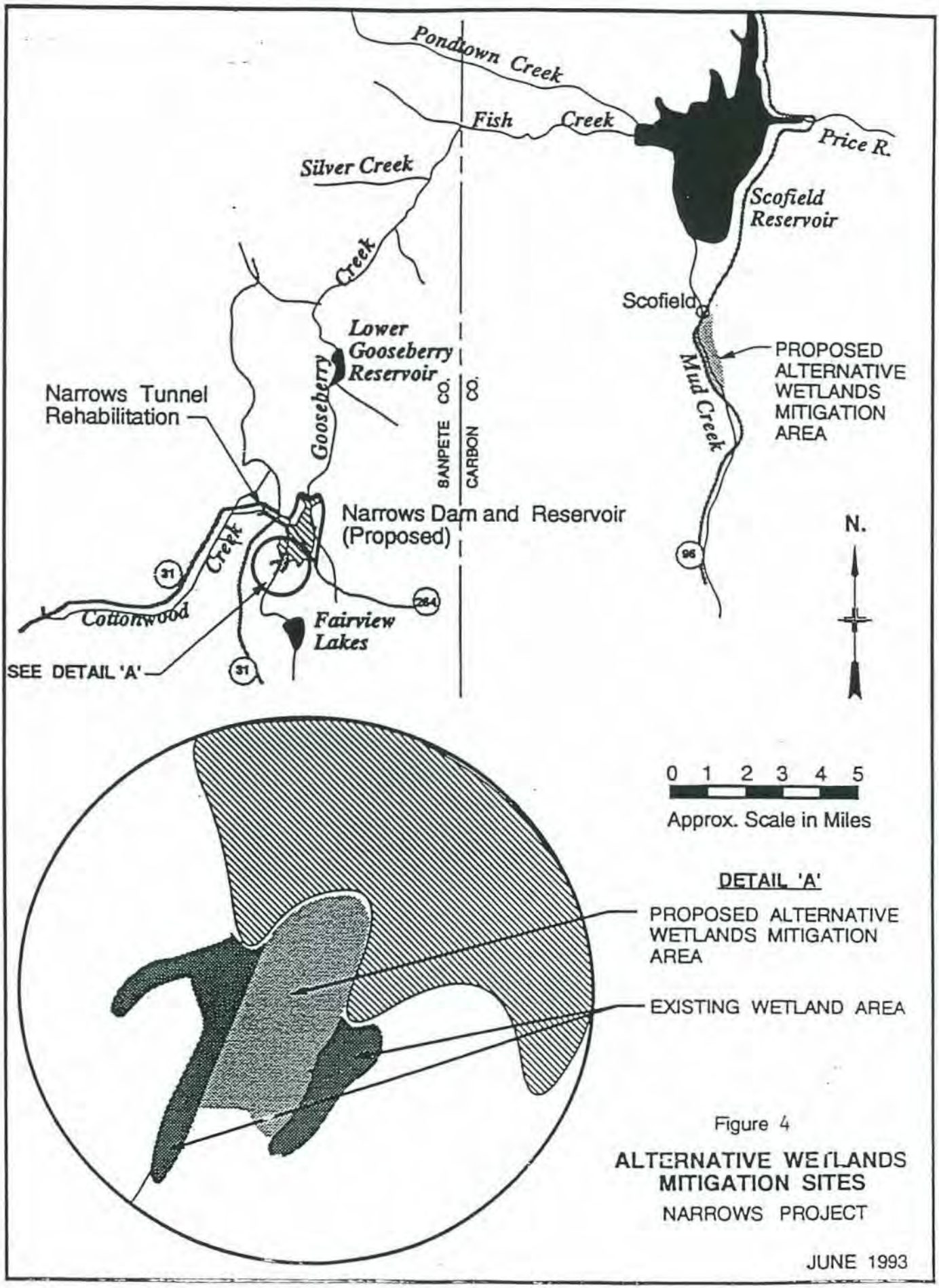



Figure 4

**ALTERNATIVE WETLANDS MITIGATION SITES**

NARROWS PROJECT

JUNE 1993

TABLE 1: Wildlife Feeding Guilds for the Narrows Basin Study.

| COVER | FEEDING TYPES: CARNIVORE | INSECTIVORE | HERBIVORE | OMNIVORE |
|---|---|---|---|---|
| AERIAL | | Common Nighthawk<br>Poor-will<br>Townsend's Solitaire<br>Tree Swallow<br>Small Footed Myotis<br>Western Pipistrelle | | |
| SHRUB LAYER | | Willow Flycatcher | | Mtn. Bluebird<br>Greentailed Towhee<br>Brewer's Sparrow<br>Sage Sparrow |
| TERRESTRIAL SURFACE | Cooper's Hawk<br>Gt. Horned Owl<br>Northern Harrier | Killdeer<br>Vagrant Shrew<br>Northern Flicker<br>Sagebrush Lizard<br>Short-horned Lizard<br>Western Garter Snake | Broadtail Hummingbird<br>Montane Vole<br>Jumping Mouse<br>Deer Mouse<br>Uinta Ground Squirrel<br>Cottontail Rabbit<br>Least Chipmunk<br>Moose<br>Elk<br>Mule Deer | Magpie<br>Raven<br>Rock Wren<br>Coyote |
| TERRESTRIAL SUBSURFACE | Badger | | Pocket Gopher | |
| RIPARIAN/ WETLAND | Belted Kingfisher | Tiger Salamander<br>Northern Leopard Frog<br>Water Shrew<br>Common Snipe<br>Yellow Warbler | Green-winged Teal<br>Cinnamon Teal<br>Mallard<br>Canada Goose<br>Sandhill Crane<br>American Dipper<br>Beaver<br>Montane Vole | |

Bolded names were evaluation species.

TABLE 2: Wildlife Reproductive Guilds for the Narrows Basin Study

| COVER TYPES | REPRODUCTIVE GUILD SPECIES |
|---|---|
| SHRUB | |
| Vegetation | Green-tailed Towhee, **Brewer's Sparrow**, Willow Flycatcher, **Yellow Warbler** |
| Bareground | Cottontail, Deer Mouse, Common Nighthawk, Poor-will, Sagebrush Lizard, Short-horned Lizard |
| RIPARIAN/WETLAND | |
| Vegetation | **Montane Vole**, Harvest Mouse, Common Snipe, Vagrant Shrew, Water Shrew, Tiger Salamander, Northern Leopard Frog, Western Garder Snake, Green-winged Teal, Cinnamon Teal, Mallard |
| Organic Litter | Northern Harrier, Poor-will, Jumping Mouse, **Beaver** |
| Bareground | Killdeer |
| Bank | Belted Kingfisher, Muskrat, Dipper |
| SUBSURFACE | |
| Borrow | Badger, Uinta Ground Squirrel, Least Chipmunk, Pocket Gopher |

Bolded names were evaluation species.

TABLE 3: Baseline Habitat Conditions Within the Narrows Reservoir Basin for (A) Affected Areas; and (B) Evaluation Species.

(A) AFFECTED AREAS

Vegetation type (HEP cover type)

| Reservoir inundation | Acres |
|---|---|
| Vasey sagebrush (USHE) | 331 |
| Silver sagebrush (USHE) | 156 |
| Wetlands (PEM, PSS) | 100 |
| Aspen | 0.19 |
| Previously disturbed | 17 |
| Subtotal | 604.19 |

Potential Disturbance in wetland mitigation area

| | |
|---|---|
| Vasey sagebrush | 110.00 |
| TOTAL | 714.19 |

(B) EVALUATION SPECIES

(Smaller Reservoir Alternative in Parentheses)

| Species | Cover Type(s) Used | Acres | HSI | HUs |
|---|---|---|---|---|
| Richardson's vole | PEM | 63 (18) | 1.00 | 63 (18) |
| Yellow warbler | PSS | 37 (10) | 0.70 | 26 (7) |
| Beaver | PEM,PSS | 100 (28) | 0.13 | 13 (4) |
| Mule deer | PEM,PSS, USHE | 587 (246) | 0.23 | 135 (57) |
| Brewer's sparrow | USHE | 487[a](218) | 0.98 | 624 (214) |

HEP = Habitat Evaluation Procedures
PEM = Palustrine emergent wetland cover (herbaceous wetlands)
PSS = Palustrine scrub/shrub cover (shrubby wetlands)
USHE = Shrub cover (Vasey sagebrush; silver sagebrush)
HSI = Habitat Suitability Index
HUs = Habitat Units
a = all USHE habitat type areas, including area disturbed for mitigation

**TABLE 4**

Average Existing and Projected Flows
**(unit—cfs)**

| Month | Recommended Plan | | | Smaller Reservoir Plan | | | No Action Plan | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) |
| | | | | Gooseberry Creek at Proposed Narrows Damsite | | | | | |
| October | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 4.7 | 1.6 |
| November | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 | 3.3 | 1.4 |
| December | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.4 | 4.2 | 0.7 |
| January | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.3 | 2.4 | 1.0 |
| February | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.3 | 2.4 | 1.2 |
| March | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.4 | 2.4 | 1.2 |
| April | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.5 | 5.3 | 5.5 |
| May | 5.9 | 79.3 | 5.9 | 1.0 | 87.2 | 1.0 | 45.3 | 102.9 | 15.1 |
| June | 10.5 | 100.0 | 1.0 | 37.7 | 102.0 | 1.0 | 61.8 | 92.8 | 6.5 |
| July | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 7.2 | 12.8 | 3.0 |
| August | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4.9 | 6.0 | 1.5 |
| September | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.2 | 4.3 | 0.9 |
| | | | | Gooseberry Creek Below Lower Gooseberry Reservoir | | | | | |
| October | 2.9 | 5.8 | 2.4 | 2.9 | 5.8 | 2.4 | 4.1 | 10.2 | 3.0 |
| November | 3.1 | 5.9 | 2.2 | 3.1 | 5.9 | 2.2 | 3.8 | 8.8 | 2.7 |
| December | 3.2 | 5.4 | 2.1 | 3.2 | 5.4 | 2.1 | 3.8 | 9.0 | 1.9 |
| January | 3.6 | 6.2 | 2.1 | 3.6 | 6.2 | 2.1 | 4.0 | 7.8 | 2.1 |
| February | 3.7 | 6.1 | 2.2 | 3.7 | 6.1 | 2.2 | 4.1 | 7.6 | 2.4 |
| March | 3.7 | 5.2 | 2.3 | 3.7 | 5.2 | 2.3 | 4.2 | 7.0 | 2.6 |
| April | 4.6 | 6.4 | 6.5 | 4.6 | 6.4 | 6.5 | 7.5 | 11.2 | 10.9 |
| May | 38.2 | 172.5 | 0.9 | 33.3 | 180.5 | 0.9 | 82.1 | 199.3 | 12.9 |
| June | 34.8 | 156.9 | 3.9 | 62.0 | 159.0 | 3.9 | 92.1 | 162.0 | 9.8 |
| July | 5.9 | 9.9 | 1.5 | 5.9 | 9.9 | 1.5 | 12.8 | 24.1 | 3.8 |
| August | 5.6 | 4.9 | 1.3 | 5.6 | 4.9 | 1.3 | 10.0 | 10.7 | 2.0 |
| September | 3.9 | 3.6 | 1.9 | 3.9 | 3.6 | 1.9 | 6.4 | 7.4 | 1.9 |
| | | | | Fish Creek Above Scofield Reservoir | | | | | |
| October | 9.4 | 18.9 | 7.6 | 9.4 | 18.9 | 7.6 | 10.6 | 23.3 | 8.2 |
| November | 9.5 | 17.3 | 7.9 | 9.5 | 17.3 | 7.9 | 10.2 | 20.2 | 8.4 |
| December | 8.4 | 15.6 | 7.5 | 8.4 | 15.6 | 7.5 | 9.1 | 19.2 | 7.3 |
| January | 9.1 | 16.3 | 5.5 | 9.1 | 16.3 | 5.5 | 9.5 | 17.9 | 5.6 |
| February | 10.6 | 19.0 | 5.3 | 10.6 | 19.0 | 5.3 | 11.1 | 20.6 | 5.5 |
| March | 14.1 | 17.3 | 5.4 | 14.1 | 17.3 | 5.4 | 14.6 | 19.1 | 5.7 |
| April | 17.8 | 43.7 | 24.5 | 17.8 | 43.7 | 24.5 | 20.7 | 48.5 | 29.0 |
| May | 211.7 | 614.5 | 11.4 | 206.8 | 622.5 | 6.5 | 255.6 | 641.3 | 23.5 |
| June | 173.5 | 360.8 | 8.5 | 200.7 | 362.8 | 8.5 | 230.8 | 365.8 | 14.4 |
| July | 29.6 | 51.4 | 4.6 | 29.6 | 51.4 | 4.6 | 36.5 | 65.7 | 6.8 |
| August | 17.6 | 21.6 | 3.5 | 17.6 | 21.6 | 3.5 | 22.0 | 27.4 | 4.1 |
| September | 12.2 | 17.3 | 3.5 | 12.2 | 17.3 | 3.5 | 14.7 | 21.0 | 3.5 |

TABLE 4 (continued)

(unit—cfs)

| Month | Recommended Plan | | | Smaller Reservoir Plan | | | No Action Plan | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) | Average year (1968) | Wet year (1984) | Dry year (1977) |
| **Price River Below Scofield Dam** | | | | | | | | | |
| October | 40.0 | 176.5 | 22.8 | 40.0 | 176.5 | 22.8 | 40.0 | 204.0 | 22.8 |
| November | 2.8 | 5.1 | 10.1 | 2.8 | 5.1 | 10.1 | 2.8 | 5.1 | 10.1 |
| December | 3.4 | 0.0 | 11.4 | 3.4 | 0.0 | 11.4 | 3.4 | 0.0 | 11.4 |
| January | 3.7 | 0.0 | 13.0 | 3.7 | 0.0 | 13.0 | 3.7 | 0.0 | 13.0 |
| February | 0.3 | 0.0 | 7.2 | 0.3 | 0.0 | 7.2 | 0.3 | 0.0 | 7.2 |
| March | 0.0 | 0.0 | 6.5 | 0.0 | 0.0 | 6.5 | 0.0 | 199.0 | 6.5 |
| April | 0.0 | 274.6 | 32.0 | 0.0 | 274.6 | 32.0 | 0.0 | 309.8 | 32.0 |
| May | 0.0 | 661.9 | 41.1 | 0.0 | 669.9 | 41.1 | 27.7 | 463.7 | 41.1 |
| June | 4.4 | 529.2 | 43.8 | 4.4 | 531.2 | 43.8 | 4.4 | 534.2 | 43.8 |
| July | 152.8 | 149.3 | 61.9 | 152.8 | 149.3 | 61.9 | 152.8 | 155.3 | 61.9 |
| August | 87.2 | 108.5 | 39.1 | 87.2 | 108.5 | 39.1 | 87.2 | 124.2 | 39.1 |
| September | 163.8 | 114.1 | 21.9 | 163.8 | 114.1 | 21.9 | 163.8 | 135.6 | 21.9 |
| **Fairview Tunnel at Outlet** | | | | | | | | | |
| October | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| November | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| December | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| January | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.3 | 0.0 | 0.0 | 0.0 |
| February | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| March | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| April | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| May | 0.6 | 1.2 | 0.0 | 0.6 | 1.2 | 0.0 | 0.6 | 1.2 | 0.0 |
| June | 4.3 | 12.3 | 8.8 | 4.3 | 12.3 | 8.8 | 4.1 | 12.1 | 8.6 |
| July | 45.3 | 45.0 | 43.3 | 45.3 | 45.0 | 25.3 | 14.7 | 12.4 | 0.3 |
| August | 43.5 | 45.5 | 33.1 | 43.5 | 45.5 | 0.2 | 13.4 | 16.3 | 0.2 |
| September | 17.4 | 24.9 | 0.1 | 17.4 | 24.9 | 0.1 | 1.6 | 10.3 | 0.1 |
| **Cottonwood Creek at Mouth of Canyon** | | | | | | | | | |
| October | 3.3 | 5.1 | 3.1 | 3.3 | 5.1 | 3.1 | 1.3 | 3.1 | 1.1 |
| November | 3.6 | 5.0 | 3.3 | 3.6 | 5.0 | 3.3 | 1.6 | 3.0 | 1.3 |
| December | 3.4 | 4.8 | 3.2 | 3.4 | 4.8 | 3.2 | 1.4 | 2.8 | 1.2 |
| January | 3.4 | 4.7 | 3.0 | 3.4 | 4.7 | 2.3 | 1.4 | 2.7 | 1.0 |
| February | 3.6 | 4.6 | 3.2 | 3.6 | 4.6 | 1.4 | 1.6 | 2.6 | 1.2 |
| March | 4.0 | 4.7 | 3.3 | 4.0 | 4.7 | 1.5 | 2.0 | 2.7 | 1.3 |
| April | 3.7 | 8.1 | 3.2 | 3.7 | 8.1 | 3.2 | 3.7 | 8.1 | 3.2 |
| May | 45.0 | 117.1 | 4.9 | 45.0 | 117.1 | 4.9 | 45.0 | 117.1 | 4.9 |
| June | 46.6 | 63.4 | 12.8 | 46.6 | 63.4 | 12.8 | 46.4 | 63.2 | 12.6 |
| July | 49.4 | 53.5 | 44.6 | 49.4 | 53.5 | 26.6 | 18.8 | 20.9 | 1.6 |
| August | 46.0 | 49.2 | 34.0 | 46.0 | 49.2 | 1.1 | 15.9 | 20.0 | 1.1 |
| September | 19.1 | 27.9 | 1.0 | 19.1 | 27.9 | 1.0 | 3.3 | 13.3 | 1.0 |

**Table 5**
**Weighted Usable Area for**
**Cutthroat Life Stages in**
**Upper Gooseberry Creek with Existing Flows**

| Month | Life Stage | Average Weighted Usable Area (1,000 units) |
|---|---|---|
| January | Adult | 8.4 |
| | Juvenile | 1.9 |
| February | Adult | 8.4 |
| | Juvenile | 1.9 |
| March | Adult | 8.7 |
| | Juvenile | 1.9 |
| April | Adult | 11.3 |
| | Juvenile | 3.3 |
| May | Adult | 11.7 |
| | Juvenile | 2.7 |
| | Spawning | 0.0 |
| June | Adult | 10.7 |
| | Juvenile | 2.5 |
| | Spawning | 0.0 |
| July | Adult | 13.2 |
| | Juvenile | 3.5 |
| | Spawning | 1.5 |
| August | Adult | 12.2 |
| | Juvenile | 3.7 |
| | Spawning | 1.3 |
| | Fry | 4.7 |
| September | Adult | 11.1 |
| | Juvenile | 3.0 |
| | Fry | 4.8 |
| October | Adult | 10.2 |
| | Juvenile | 2.0 |
| November | Adult | 8.9 |
| | Juvenile | 2.0 |
| December | Adult | 8.7 |
| | Juvenile | 1.9 |

## Table 6
## Monthly Pre- and Post-Project Cutthroat Trout Habitat In Middle and Lower Gooseberry Creek During Average Water Year[1/]

| Month | Life Stage | Middle Gooseberry Creek | | | Lower Gooseberry Creek | | |
|---|---|---|---|---|---|---|---|
| | | Pre-project | Post-project | Change (%) | Pre-project | Post-project | Change (%) |
| January | Adult | 62.9 | 57.6 | 8.4 | 355.4 | 344.7 | -3.0 |
| | Juvenile | 18.0 | 16.7 | 7.2 | 61.6 | 60.9 | -1.1 |
| February | Adult | 62.9 | 57.6 | -8.4 | 359.0 | 348.5 | -2.9 |
| | Juvenile | 18.0 | 16.7 | -7.2 | 63.0 | 61.1 | -3.0 |
| March | Adult | 64.7 | 57.6 | -11.0 | 359.0 | 344.7 | -4.0 |
| | Juvenile | 18.3 | 16.7 | -8.7 | 62.6 | 60.9 | -2.7 |
| April | Adult | 106.2 | 57.6 | -45.8 | 404.9 | 393.1 | -2.9 |
| | Juvenile | 30.1 | 16.7 | -44.5 | 73.2 | 68.7 | -6.1 |
| May | Adult | 205.8 | 57.6 | -72.0 | 562.1 | 548.3 | -2.5 |
| | Juvenile | 91.0 | 16.7 | -81.6 | 75.0 | 56.0 | -25.3 |
| | Spawning | 1.5 | 0.1 | -93.3 | 0.0 | 0.0 | - |
| June | Adult | 202.6 | 57.6 | -71.6 | 553.2 | 548.1 | -0.9 |
| | Juvenile | 88.7 | 16.7 | -81.2 | 79.6 | 56.1 | -29.5 |
| | Spawning | 0.4 | 0.1 | -75.0 | 0.0 | 0.0 | - |
| July | Adult | 144.4 | 57.6 | -60.1 | 430.6 | 405.3 | -5.9 |
| | Juvenile | 42.7 | 16.7 | -60.9 | 71.3 | 73.4 | +2.9 |
| | Spawning | 0.9 | 0.1 | -88.9 | 0.0 | 0.0 | - |
| August | Adult | 127.4 | 57.6 | -54.8 | 413.9 | 398.7 | -3.7 |
| | Juvenile | 36.6 | 16.7 | -54.4 | 73.0 | 70.4 | -3.6 |
| | Spawning | 2.8 | 0.1 | -96.4 | 0.0 | 0.0 | - |
| | Fry | 57.3 | 28.1 | -51.0 | 65.3 | 73.1 | +11.9 |
| September | Adult | 100.2 | 57.6 | -42.5 | 397.3 | 355.4 | -10.5 |
| | Juvenile | 28.4 | 16.7 | -41.2 | 69.8 | 61.6 | -11.7 |
| | Fry | 44.5 | 28.1 | -36.9 | 73.6 | 67.1 | -8.8 |
| October | Adult | 75.4 | 57.6 | -23.6 | 362.2 | 327.4 | -9.6 |
| | Juvenile | 20.9 | 16.7 | -20.1 | 63.2 | 58.0 | -8.2 |
| November | Adult | 66.4 | 57.6 | -13.3 | 341.5 | 323.9 | -5.2 |
| | Juvenile | 18.8 | 16.7 | -11.2 | 60.0 | 57.5 | -4.2 |
| December | Adult | 64.7 | 57.6 | -11.0 | 348.5 | 330.9 | -5.1 |
| | Juvenile | 18.3 | 16.7 | -8.7 | 61.1 | 58.5 | -4.3 |

1/ The amount of Weighted Usable Area is expressed in 1,000 units. Average water year is defined as 1968 flows.

**Table 7**
**Monthly Pre- and Post-Project Rainbow Trout Habitat**
**In Lower Gooseberry Creek During Average Water Year1/**

| Month | Life Stage | Pre-project | Post-project | Change (%) |
|---|---|---|---|---|
| January | Adult | 44.1 | 43.2 | -2.0 |
| | Juvenile | 21.0 | 21.0 | 0.0 |
| February | Adult | 44.5 | 43.5 | -2.2 |
| | Juvenile | 21.1 | 21.0 | -0.5 |
| March | Adult | 44.5 | 43.2 | -2.9 |
| | Juvenile | 21.1 | 21.0 | -0.5 |
| April | Adult | 65.6 | 50.0 | -23.8 |
| | Juvenile | 29.4 | 22.3 | -24.1 |
| May | Adult | 142.1 | 133.0 | -6.4 |
| | Juvenile | 49.7 | 51.9 | +4.4 |
| | Spawning | 0.0 | 0.0 | - |
| June | Adult | 141.9 | 132.9 | -6.3 |
| | Juvenile | 47.8 | 51.9 | +8.6 |
| | Spawning | 0.3 | 0.0 | -100.0 |
| July | Adult | 87.0 | 66.3 | -23.8 |
| | Juvenile | 35.1 | 29.7 | -15.4 |
| | Spawning | 0.0 | 0.0 | - |
| August | Adult | 79.4 | 56.3 | -29.1 |
| | Juvenile | 35.3 | 25.2 | -28.6 |
| | Spawning | 0.1 | 0.0 | -100.0 |
| | Fry | 62.6 | 51.8 | -17.3 |
| September | Adult | 54.4 | 44.2 | -18.8 |
| | Juvenile | 24.3 | 21.0 | -13.6 |
| | Fry | 49.7 | 48.8 | -1.8 |
| October | Adult | 44.8 | 41.7 | -6.9 |
| | Juvenile | 21.1 | 20.9 | -0.9 |
| November | Adult | 42.9 | 41.4 | -3.5 |
| | Juvenile | 21.0 | 20.9 | -0.5 |
| December | Adult | 43.5 | 42.0 | -3.4 |
| | Juvenile | 21.0 | 20.9 | -0.5 |

1/ The amount of Weighted Usable Area is expressed in 1,000 units.
Average water year is defined as 1968 flows.

## Table 8
## Monthly Pre- and Post-Project Cutthroat Trout Habitat In Fish Creek During Average Water Year1/

| Month | Life Stage | Pre-project | Post-project | Change (%) |
|---|---|---|---|---|
| January | Adult | 362.7 | 363.0 | +0.1 |
| | Juvenile | 85.3 | 85.5 | +0.2 |
| February | Adult | 370.4 | 365.7 | -1.3 |
| | Juvenile | 85.8 | 85.3 | -0.6 |
| March | Adult | 414.2 | 406.6 | -1.8 |
| | Juvenile | 88.3 | 88.3 | 0.0 |
| April | Adult | 476.9 | 456.1 | -4.4 |
| | Juvenile | 87.5 | 87.8 | +0.3 |
| May | Adult | 666.4 | 694.6 | +4.2 |
| | Juvenile | 226.7 | 235.4 | +3.8 |
| | Spawning | 0.8 | 6.0 | +650.0 |
| June | Adult | 680.8 | 714.1 | +5.0 |
| | Juvenile | 231.2 | 229.4 | -0.7 |
| | Spawning | 1.7 | 21.8 | +1,182.4 |
| July | Adult | 603.4 | 575.2 | -4.7 |
| | Juvenile | 91.3 | 88.3 | -3.3 |
| | Spawning | 39.8 | 27.3 | -31.4 |
| August | Adult | 489.6 | 454.1 | -7.3 |
| | Juvenile | 87.4 | 87.8 | +0.5 |
| | Spawning | 17.8 | 14.2 | -20.2 |
| | Fry | 88.6 | 84.2 | -5.0 |
| September | Adult | 415.2 | 387.8 | -6.6 |
| | Juvenile | 88.2 | 87.6 | -0.7 |
| | Fry | 82.2 | 81.3 | -1.1 |
| October | Adult | 369.2 | 362.5 | -1.8 |
| | Juvenile | 86.0 | 85.2 | -0.9 |
| November | Adult | 364.5 | 362.8 | -0.5 |
| | Juvenile | 82.1 | 85.3 | +3.9 |
| December | Adult | 363.1 | 363.9 | +0.2 |
| | Juvenile | 85.5 | 85.9 | +0.5 |

1/ The amount of Weighted Usable Area is expressed in 1,000 units. Average water year is defined as 1968 flows.

## Table 9
## Monthly Pre- and Post-Project Rainbow Trout Habitat In Fish Creek During Average Water Year1/

| Month | Life Stage | Pre-project | Post-project | Change (%) |
|---|---|---|---|---|
| January | Juvenile | 170.7 | 171.0 | +0.2 |
| February | Juvenile | 173.1 | 171.5 | -0.9 |
| March | Juvenile | 187.2 | 185.0 | -1.1 |
| April | Juvenile | 203.1 | 198.4 | -2.3 |
| May | Juvenile | 239.5 | 239.6 | <0.1 |
| | Spawning | 45.9 | 44.9 | -2.2 |
| June | Juvenile | 240.2 | 238.8 | -0.6 |
| | Spawning | 48.4 | 36.9 | -23.8 |
| July | Juvenile | 224.0 | 219.5 | -2.0 |
| | Spawning | 23.6 | 18.2 | -22.9 |
| August | Juvenile | 202.6 | 197.9 | -2.3 |
| | Spawning | 11.0 | 8.2 | -25.5 |
| | Fry | 226.4 | 223.1 | -1.5 |
| September | Juvenile | 183.7 | 179.0 | -2.6 |
| | Fry | 219.0 | 214.9 | -1.9 |
| October | Juvenile | 172.7 | 170.5 | -1.3 |
| November | Juvenile | 171.1 | 170.8 | -0.2 |
| December | Juvenile | 171.0 | 171.6 | +0.4 |

1/ The amount of Weighted Usable Area is expressed in 1,000 units. Average water year is defined as 1968 flows.

Table 10

## Narrows Project
## Aquatic Impacts and Recommended Mitigation Measures

| Impacts | Mitigation Commitment |
|---|---|
| **Stream Fisheries** | |
| Gooseberry Creek tributaries - Loss of 4.3 miles (spawning cutthroat). | Restore year-round flows in 2.3 miles of tributaries and stabilize 3.0 miles of middle Gooseberry Creek. |
| Upper Gooseberry Creek - Loss of 1.0 mile (all life stages cutthroat);<br>Middle Gooseberry Creek - 72% reduction in average annual flow for 3.0 miles (all life stages cutthroat);<br>Lower Gooseberry Creek - 47% flow reduction for 7.1 miles. (Decrease of 5% adult and 4% juvenile low-flow habitat for cutthroat);<br>Fish Creek - Average 17% flow reduction of 6.0 miles. (Decrease of less than 1% adult and juvenile low-flow habitat for cutthroat. Overall increase of 15% spawning and 3% fry habitat for cutthroat. Decrease of 1.3% adult and 0.5% juvenile low-flow habitat for rainbow. Overall decrease of 16% spawning and 2% fry habitat for rainbow.) | Acquire, fence, and improve fishery habitat on the following stream segments:<br>Mud Creek 4.0 miles<br>Winterquarters Creek 2.5 miles<br>Upper Fish Creek 1.0 mile<br>Pondtown Creek 2.0 miles<br>Price River below Scofield Reservoir 2.0 miles |
| Upper Cottonwood Creek - No summer flow increase, 2 cfs winter flow provided. | Construct Upper Cottonwood Creek Pipeline and provide 2 cfs winter release. |
| Lower Cottonwood Creek - Average 162% annual flow increase. Average 300% summer flow increase. Loss of 4.9 miles of habitat for all life stages for Rainbow, Cutthroat, and Brown Trout. | Provide 2 cfs minimum flow during irrigation season in lower Cottonwood Creek, Acquire (as necessary), fence, and improve fishery habitat on 4.0 miles of Starvation Creek. |
| **Reservoir Fisheries** | |
| Scofield Reservoir - Increased potential for poor water quality resulting in fish kills, loss of some natural reproduction in rainbows. Reduced surface area resulting in reduced standing crop of fish and loss of 4,500 angler days per year. | Reduce external phosphorus loading by improving riparian areas along Mud Creek, Winterquarters Creek, Upper Fish Creek, and Pondtown Creek. These measures will also improve habitat for all life stages of cutthroat and rainbow trout including spawning. Lost angler days would be replaced by fishery in Narrows Reservoir. |
| Lower Gooseberry Reservoir - Increased potential for poor water quality resulting in fish kills. | Provide 300 acre-feet of water from Narrows Reservoir to be used for instream flow augmentation in consultation with UDWR. |
| Fairview Lakes - Lower fishing pressure, less severe drawdown during fishing season. | Beneficial impact. No mitigation required. |
| Narrows Reservoir - New reservoir fishery. | Would provide approximately 13,700 angler days use. |

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX E

# CULTURAL RESOURCE COORDINATION

SEP 10 1997

UC-325
ENV-3.00

CERTIFIED - RETURN RECEIPT REQUESTED

Mr. Max J. Evans
Utah State Historic Preservation Officer
300 South Rio Grande
Salt Lake City UT 84101

Subject: Gooseberry Narrows Environmental Commitments - Cultural Resources

Dear Mr. Evans:

In order to comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966, the Provo Area Office of the Bureau of Reclamation wishes to consult with you concerning proposed environmental commitments regarding cultural resources compliance with NHPA on the Gooseberry Narrows Project.

The Gooseberry Narrows Project consists of construction of a dam and a small reservoir on Gooseberry Creek for the purpose of diverting water from the Price River drainage for the use of farmers in Sanpete County. The area of potential effect includes the zone of construction of the dam and reservoir, a 1/4 mile zone around the reservoir that will be used by fishermen and other recreational visitors, the zone of construction and use of recreational facilities associated with the project, improvements to an existing tunnel (which may itself be National Register eligible), the zone of construction of a delivery system (pipeline) for the water, and the zone of construction associated with enhancing wetlands as part of wildlife mitigation associated with the project.

Current Status of Project

The current status of this project is as follows: An environmental impact statement (EIS) is being prepared by the Provo Area Office, working with the Sanpete Water Conservancy District and with a private contractor. Because the project has been controversial, all parties wish to see a record of decision on the EIS prior to commencing with the environmental compliance work required, including cultural resources compliance. Therefore, the cultural resources work necessary to comply

with Section 106 takes the form of environmental commitments in the EIS. These commitments must be met prior to any construction on the project.

The current status of cultural resources compliance on the Gooseberry Narrows project is as follows: An inventory of the reservoir pool area was done by the University of Utah in 1976, and three sites (two prehistoric lithic scatters and one historic foundation) were recorded. The sites were not evaluated as to their National Register eligibility, and a testing program was recommended (but never completed). The current pool area is slightly different than the area inventoried in 1976, but there is a great deal of overlap with the 1976 inventory. A1992 letter from your office outlines steps that need to be taken in order to complete NHPA Section 106 requirements. The project has changed somewhat in scope since 1992, and the environmental commitments for cultural resources compliance for the present configuration of the project are outlined below.

Native American consultation regarding the project has been initiated. On August 5, 1997, Betsy Chapoose and Clifford Duncan of the Uintah-Ouray Ute Tribe toured the project area with Signa Larralde and Kerry Schwartz of the Provo Area Office and were briefed on the scope of the proposed project. The Uintah-Ouray Ute Tribe is the only tribe believed to have aboriginal ties to the project area. We are currently awaiting feedback from Ms. Chapoose and Mr. Duncan regarding any areas of traditional cultural importance within the project area. The only concerns expressed on the tour were that the Utes be provided with a list of plants in the project area, with the possible intent of plant collecting for medicinal use in the future.

Environmental Commitments for Cultural Resources Compliance

The following environmental commitments to be included in the EIS provide compliance with Section 106 of the National Historic Preservation Act:

- Evaluate three previously recorded sites in pool area as to National Register eligibility. Limited testing necessary in order to evaluate the sites will be accomplished through placing auger holes in a pattern on each site, or excavating test units.

- Inventory any of the pool area, dam construction zone, and road realignments not inventoried in 1976, including a 1/4 mile zone around pool area that would be impacted by recreational use of the reservoir. Inventory the location of all recreational facilities proposed in the project plan, plus all areas slated for wetlands enhancement.

- Inventory the rights of way for the proposed East Bench and Oak Creek pipelines, consisting of 16.1 linear miles of proposed water pipeline near Fairfield in Sanpete County.

- Inventory and evaluate the existing historic tunnel delivery system on Gooseberry Creek as to its National Register eligibility.

- Conduct a cultural resources overview of U.S. Forest Service information on historic features in and near project area; evaluate any features within the project area as to their National Register eligibility.

- Conduct a paleontological literature search and survey of the project area and its immediate vicinity, with the particular view of assessing the likelihood of recovering Pleistocene fauna during the project (the project area is near the site of the Huntington mammoth discovery).

- Consult with your office regarding the National Register eligibility of any historic or archaeological sites found during work associated with any of the above commitments. If we jointly reach the conclusion that significant sites will be impacted by the project, Reclamation will then consult with your office and with the Advisory Council on Historic Preservation to negotiate a Memorandum of Agreement that outlines mitigation measures to be taken prior to project construction to avoid adverse effects of the project on historic properties.

We would appreciate it if you would review the above environmental commitments and respond as to whether or not your office believes they will provide compliance with Section 106 of the National Historic Preservation Act. We would also appreciate any suggestions you may have as to how best to complete the cultural resources work and the consultation necessary for compliance. We would very much appreciate a response within 30 days of receipt of this letter, or by October 15, 1997.

Should you have any questions about the Gooseberry Narrows Project, please contact Signa Larralde at 524-3684.

Sincerely,

Larry Walkoviak

Larry Walkoviak
Manager, Resources Management Division

cc: Area Manager, Provo UT
Attention: PRO-406

David Peterson, President, Sanpete Water Conservancy District,
1484 South 70 West, Box 265, Mount Pleasant UT 84647

WBR:SLarralde:lw:09/03/97:801-524-3684:NARRWSHP.997

ORIGINAL

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September 16, 1997

Larry Walkoviak
Manager, Resources Management Division
Bureau of Reclamation
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City UT 84138-1102

RE: Gooseberry Narrows Environmental Commitments

In Reply Please Refer to Case No. 94-0609

Dear Mr. Walkoviak:

The Utah State Historic Preservation Office received information on the project referenced above on September 11, 1997. After consideration of the letter and the seven environmental commitments, the Utah Preservation Office concur with the Bureau of Reclamation that they do meet the standards for Section 106 of the National Historic Preservation Act.

This information is being provided on request to assist the Bureau of Reclamation in identifying historic properties, as specified in §36CFR800, for Section 106 consultation procedures. If you have questions, please contact me at (801) 533-3555, or Barbara L. Murphy at (801) 533-3563. My email address is: jdykman@history.state.ut.us

As ever,

James L. Dykmann
Compliance Archaeologist

JLD:94-0609 BOR/NAE

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# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX F

# 2006 EUTROPHICATION STUDY

## Appendix F

# Eutrophication Study
# Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir

**EUTROPHICATION STUDY**

**Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir**

Prepared For:

US Bureau of Reclamation

Updated

October 2006

Prepared By:

FRANSON NOBLE

ENGINEERING

FRANSON NOBLE
ENGINEERING

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Project: Scofield
Control No: 06036940
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November 8, 2006

Mr. Kerry Schwartz
Bureau of Reclamation
302 East 1860 South
Provo, Utah 84606-7317

Re: Narrows Project - Final Updated Scofield Reservoir Eutrophication Study Report

Dear Mr. Schwartz:

Attached is the final version of the updated Scofield Reservoir Eutrophication Study Report for the Narrows Project. The Eutrophication Study has been updated to include data through 2005. Steve Noyes' comments on the current draft as well as his comments on the August 2003 Draft Eutrophication Report have been addressed in this final version of the report.

Please contact me if you require any additional water quality information related to the Narrows Project.

Thank you for your assistance with this project.

Sincerely,

Layne Jensen

Layne D. Jensen, P.E.

Enclosures

cc: Edwin Sunderland
Chairman, Sanpete Water Conservancy District

NOTICE: IF YOU DETACH ENCLOSURES PLEASE INSERT CODE NO. PRO-700

1276 South 820 East, Suite 100, American Fork, Utah 84003
T 801 756-0309 or 888 756-3726 (toll free) F 801 756-0481

# EUTROPHICATION STUDY
## Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir

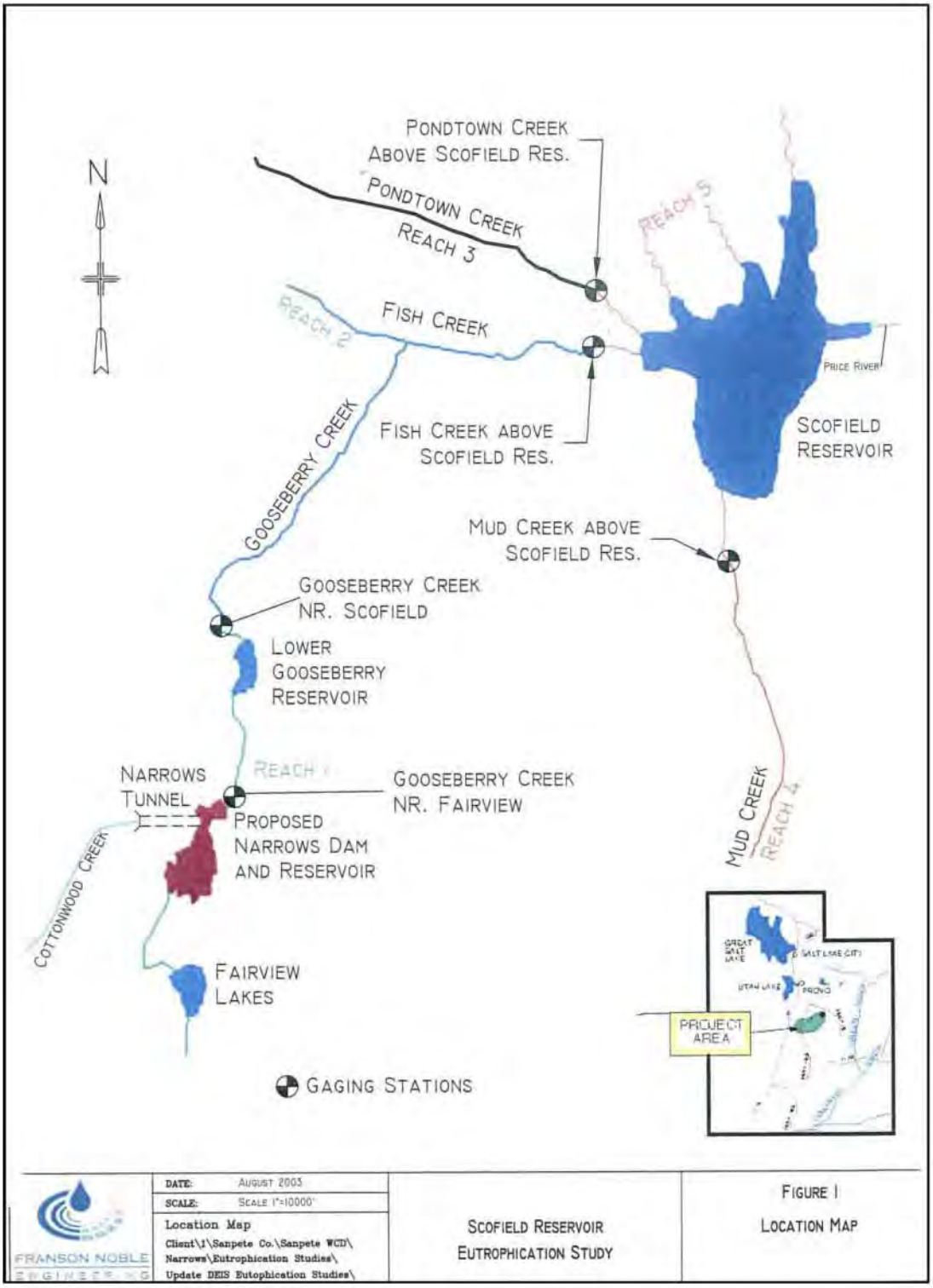
**Introduction-**
The proposed Narrows Project is comprised of new features and facilities to develop a supplemental water supply to be used on presently irrigated lands and by municipal water users in northern Sanpete County, Utah. The project would divert water from Gooseberry Creek in the upper Price River drainage basin through an existing tunnel to Cottonwood Creek in the San Pitch/Sevier River drainage for delivery to lands and water users in the Sanpete Valley area surrounding Fairview, Utah. The proposed Narrows Dam and Reservoir would be constructed on Gooseberry Creek. Water stored in the reservoir would be diverted and delivered through a rehabilitated (existing) Narrows Tunnel to Cottonwood Creek. Diverted project water would reduce the normal flow in Gooseberry Creek, through Lower Gooseberry Reservoir, downstream to Fish Creek, and Fish Creek flows into Scofield Reservoir. (See location map included as Figure 1).

Several studies have been conducted to determine the various impacts of the Proposed Narrows Project on Scofield Reservoir drainage system and the river below. An initial Eutrophication Study was conducted by Cloward, Madden and Associates in November 1991 using data from 1978 - 1989. A study was conducted in 2001 to update the 1991 Eutrophication Study. This study was specific to the phosphorus changes in Scofield Reservoir from 1978-1992 and was designed to provide a response to the comments received from the 1998 Narrow Project DEIS including the need for additional modeling studies to further define the flow and phosphorus impacts of the Narrows Project on Scofield Reservoir. The 2001 Eutrophication Study was updated in 2003 during an effort to update the DEIS. The 2003 update included data up through 2002 and incorporated changes to respond to previous comments. The 2003 study relied on previous studies for much of the basic data and procedures. The 2003 study was never finalized since efforts to update the DEIS ended soon thereafter.

This update is being prepared to provide current information for the Supplemental Draft EIS (SDEIS) currently being prepared. All of the water supply and water quality models, including those done for phosphorus loading and modeling have been updated through 2005. In response to comments made regarding the 2003 draft eutrophication study some of the procedures have been changed. Namely, the monthly phosphorus distributions for the various creeks and reservoirs were updated based on all of the data currently available rather than using a distribution developed using only data collected prior to 1990 as was the case up to the 2003 update. Also, phosphorus concentrations measured in Lower Gooseberry Reservoir are no longer used to estimate the phosphorus concentration for the inflow to the proposed Narrows Reservoir. Phosphorus concentrations for the inflow to the Narrows Reservoir were estimated based on samples taken from Fairview Lakes and on Gooseberry Creek above Lower Gooseberry Reservoir

Inflow to Scofield Reservoir is composed of measured Fish Creek Flows above Scofield Reservoir (60%), Mud Creek Flows above Scofield Reservoir (18%), Pondtown Creek Flows above Scofield Reservoir (7%), and the unmeasured inflow to Scofield Reservoir (15%). Gooseberry Creek flow contributes about 38% of Fish Creek's flow or approximately 23% of the total inflow to Scofield Reservoir. Impacts of the Narrows Project are confined to only the contribution of Gooseberry Creek to Scofield Reservoir inflow.

FRANSON NOBLE
ENGINEERING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PONDTOWN CREEK ABOVE SCOFIELD RES.
PONDTOWN CREEK
REACH 3
REACH 5
REACH 2
FISH CREEK
PRICE RIVER
FISH CREEK ABOVE SCOFIELD RES.
SCOFIELD RESERVOIR
GOOSEBERRY CREEK
MUD CREEK ABOVE SCOFIELD RES.
GOOSEBERRY CREEK NR. SCOFIELD
LOWER GOOSEBERRY RESERVOIR
NARROWS TUNNEL
REACH 1
GOOSEBERRY CREEK NR. FAIRVIEW
PROPOSED NARROWS DAM AND RESERVOIR
COTTONWOOD CREEK
MUD CREEK
REACH 4
FAIRVIEW LAKES
GAGING STATIONS
PROJECT AREA
FRANSON NOBLE ENGINEERING
DATE: AUGUST 2003
SCALE: SCALE 1"=10000'
Location Map
Client\J\Sanpete Co.\Sanpete WCD\Narrows\Eutrophication Studies\Update DEIS Eutophication Studies\
SCOFIELD RESERVOIR EUTROPHICATION STUDY
FIGURE 1
LOCATION MAP

## Modeling Procedures-

The period of study has been extended through water years 1978-2005 because of data availability. In most cases, the Utah State Department of Water Quality collects phosphorus data at selected sites twice per year, every other year. The results are posted on STORET (short for STOage RETreival, www.epa.gov/storet). Therefore, phosphorus concentrations had to be estimated for the missing months by applying typical monthly distributions of phosphorus. The monthly distributions were calculated by averaging all of the phosphorus concentration data available for a particular month. When less than three sample results were available for a particular month the value used in previous studies was used. Previous studies used the principles of "The General Time Interval Method" outlined in the publication "Guidelines for Studies of Potential Eutrophication" Bureau of Reclamation, December 1981. Measured phosphorus concentrations were used in calculations whenever available. Shaded concentrations values in the tables represent observed data. Shaded blocks in the column headings indicate stream flow control points. Previously, samples below the detection limit were not used in calculations. For this study the non-detects have been included in the calculations by assuming a value equal to half the detection limit. In the last 10 years many of the samples have been non-detects. If non-detect values were not used the older data would have a greater influence on the monthly distributions used when sample results are not available. To evaluate the sensitivity of the model to the use of non-detect values the eutrophication potential was calculated using the detection limit rather than half the detection limit for non-detect samples. The use of half the detection limit resulted in an increase of the eutrophication potential for Scofield Reservoir of 0.09% over the use of the detection limit for non-detect values.

## Operation and Eutrophication Studies without Narrows Project

Studies for conditions without Narrows Project are found in Appendix A and B.

### Narrows Reservoir Site Operation without Narrows Project (Table A-1)

River operations at the Narrows Reservoir site were taken from Franson Noble Engineering operations study conducted for the 2006 Narrows Project Supplemental Draft EIS. Phosphorus concentrations at Fairview Lakes No. 2 and Gooseberry Creek above Lower Gooseberry Reservoir are the basis for the concentrations in the column "Natural Flow-Gooseberry Creek near Fairview". These same concentrations were used for the columns "Diversion by Cottonwood-Gooseberry", "Other Inflows at Narrows Reservoir Site", "Net Inflow at Narrows Reservoir Site", "Stream Flow Below Narrows Reservoir Site", and "Reach Gains between Narrows Reservoir Site and Lower Gooseberry Reservoir". Flows for "Reach Gains between Narrows Reservoir and Lower Gooseberry Reservoir" are estimated by subtracting the flows below Narrows Reservoir from the flows at Gooseberry Creek near Scofield.

### Lower Gooseberry Reservoir Operation without Narrows Project (Table A-2)

Net inflow to Lower Gooseberry Reservoir, for both acre-feet and grams of phosphorus, is the sum of the columns "Stream Flow below Narrows Reservoir Site" and "Reach Gains between Narrows Reservoir Site and Lower Gooseberry Reservoir" from the Narrows Reservoir Site Operation, Table A-1 (see Reach 1 in Figure 1). Since Lower Gooseberry Reservoir is a stabilized reservoir, storage is assumed constant and the discharge is equal to the inflow. Reservoir discharge is represented by the stream gage, Gooseberry Creek near Scofield, which is only a short distance downstream from the reservoir. However, this does not hold for the

phosphorus because some uptake or removal takes place in Lower Gooseberry Reservoir. To estimate the phosphorus concentration and probability of eutrophication in the reservoir, an empirical annual eutrophication model for Lower Gooseberry Reservoir was developed according to the *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981* (See Table B-1). Phosphorus uptake in the Lower Gooseberry Reservoir is calculated as the difference between the phosphorus inflow and the phosphorus outflow.

**Scofield Reservoir Operation <u>without</u> Narrows Project (Table A-3)**
The column "Stream Flow-Fish Creek Above Scofield Reservoir" is a control point for this study where the flows are measured by the USGS. Phosphorus concentrations are obtained from STORET and estimates calculated for the missing months. The column "Gains for Fish Creek Above Fish Creek Above Scofield Reservoir" (see Reach 2 in Figure 1) are the differences between the columns "Stream Flow-Fish Creek Above Scofield Reservoir" and "Stream Flow-Gooseberry Creek near Scofield". The columns "Stream Flow-Mud Creek Above Scofield Reservoir" (see Reach 4 in Figure1) and "Stream Flow-Pondtown Creek Above Scofield Reservoir" (see Reach 3 in Figure 1) are obtained from averaging all sampling results for a particular month unless 3 or fewer samples were available. In the case of 3 or fewer samples the concentrations used for previous calculations have been used. As always actual sampling results were used where available. The values in the columns "Scofield Reservoir Contents", "Reservoir Evaporation", and "Price River Below Scofield Dam" are obtained from the Franson-Noble operations studies cited above.

The column "Other Inflow (flow only) Above Scofield Reservoir" (see Reach 5 in Figure 1) was calculated from the columns "Total Inflow Above Scofield Reservoir" minus "Stream Flow-Fish Creek Above Scofield Reservoir" minus Stream Flow-Mud Creek Above Scofield Reservoir" minus "Stream Flow-Pondtown Creek Above Scofield Reservoir".

During review of the 2003 draft Eutrophication Study a comment was made regarding how the phosphorus concentrations for the "Other Reservoir Inflows Above Scofield Reservoir" were being estimated. Previously, the phosphorus concentrations were estimated by taking a flow weighted average of the concentrations in Fish Creek, Pondtown Creek and Mud Creek. The phosphorus concentration in Scofield Reservoir calculated using this method to calculate the "Other Inflows" phosphorus concentration does not correlate well with actual measurements of phosphorus concentration in the reservoir. In Table A-3 the concentration column for Scofield Reservoir has been changed from showing the phosphorus concentration calculated in Table B-2 to showing the phosphorus concentrations in Scofield Reservoir based on actual data. As can be seen the estimated and measured have a poor correlation. To address this problem, the phosphorus concentrations for the "Other Reservoir Inflows Above Scofield Reservoir" were estimated using the measured phosphorus concentrations of the reservoir. By using the measured phosphorus concentration in the reservoir and other knowns, such as flow in the three creeks and outflow to the Price River, a value could be estimated to represent the unknowns, such as phosphorus uptake and recycling, phosphorus contributions from other tributaries, and errors in data. However, the empirical formula to estimate the eutrophication potential requires the total inflow of phosphorus into the reservoir. To our knowledge there are no methods available to estimate directly the uptake and recycling of phosphorus in a reservoir. Without being able to remove the phosphorus uptake and recycling from the "Other Inflows" estimating the actual

phosphorus inflow to the reservoir from other sources cannot be determined. Although certainly not ideal, estimating the phosphorus concentration from the other inflow to Scofield Reservoir using a flow weighted average of the three measured creeks is the best estimate that can be made. Using the phosphorus concentrations estimated for Scofield Reservoir by the empirical equation presented in the *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981* allows direct comparison of the eutrophication potential for the with and without Narrows Reservoir conditions. Although the estimated phosphorus concentration in Scofield Reservoir is likely too low when compared to measured concentrations using the same methodology to estimate the phosphorus concentrations for both conditions allows comparison of the eutrophication potential to be valid. See Table E-5 in Appendix E for a comparison of total phosphorus values for the three reservoir sample sites and the estimated monthly average phosphorus concentration for Scofield Reservoir.

The column "Total Inflow (flow only) Above Scofield Reservoir" was calculated from the change in reservoir contents, evaporation, and reservoir discharge. Phosphorus mass (grams) in "Total Inflow" column is the sum of the phosphorus mass in the columns "Fish Creek Above Scofield Reservoir", "Mud Creek Above Scofield Reservoir", 'Pondtown Creek Above Scofield Reservoir", and "Other Inflow Above Scofield Reservoir".

## Operation and Eutrophication Studies with Narrows Project

Studies for conditions with Narrows Project are found in Appendix C and D.

### Narrows Reservoir Operation with Narrows Project (Table C-1)

River operations at Narrows Reservoir were taken from the Franson Noble Engineering, Inc. operation study updated for the Supplemental Draft EIS. Phosphorus concentrations at Fairview Lakes No. 2 and Gooseberry Creek above Lower Gooseberry Reservoir were used in the same manner as used in the "without Narrows" case. To estimate the phosphorus concentration and probability of eutrophication in the reservoir, an empirical eutrophication model for Narrows Reservoir was developed according to the *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981* (See Table D-1). This same in-lake phosphorus concentration is used as the concentration for the columns "Diversion by Cottonwood-Gooseberry", "Project Irrigation Delivery" and "Stream Flow Below Narrows Reservoir". Phosphorus uptake in the Narrows Reservoir is calculated from the change in reservoir phosphorus mass, the phosphorus inflow, phosphorus outflow, and phosphorus diverted for "Diversion by Cottonwood-Gooseberry", and "Project Irrigation Delivery". The "Diversion by Cottonwood-Gooseberry" represents water from Fairview Lakes currently being diverted through the Narrows Tunnel. "Project Irrigation Delivery" represents water to be diverted through the Narrows Tunnel in addition to "Diversion by Cottonwood-Gooseberry".

### Lower Gooseberry Reservoir Operation with Narrows Project (Table C-2)

Net inflow to Lower Gooseberry Reservoir, for both flow and phosphorus, is the sum of the columns "Stream Flow below Narrows Reservoir Site" and "Reach Gains between Narrows Reservoir and Lower Gooseberry Reservoir" in Table C-1. The values in the column "Reach Gains between Narrows Reservoir and Lower Gooseberry Reservoir" are held the same as in the

"without" Narrows Project. Since Lower Gooseberry Reservoir is a stabilized reservoir, storage is assumed constant and the discharge is equal to the inflow. Because the flow and phosphorus inflow to Lower Gooseberry Reservoir have been changed by the Narrows Project, another annual eutrophication model for Lower Gooseberry Reservoir was developed to estimate the phosphorus concentration and eutrophication probability in the reservoir (See Table D-2). Again, phosphorus uptake in the Lower Gooseberry Reservoir was calculated as the difference between the phosphorus inflow and the phosphorus outflow.

**Scofield Reservoir Operation with Narrows Project (Table C-3)**

The model for Scofield Reservoir with the Narrows Project is slightly different from that used for the reservoir without the Narrows Project. However, the data changes are confined to the flow and phosphorus concentrations in Fish Creek caused by the projects impact on Gooseberry Creek. This means flow and phosphorus data for the columns "Gains for Fish Creek Above Fish Creek Above Scofield Reservoir", "Mud Creek Above Scofield Reservoir", "Pondtown Creek Above Scofield Reservoir", and "Other Reservoir Inflow Above Scofield Reservoir" (including any errors in data, methods, and assumptions made in the WITHOUT model) remain the same. Because the total flow and phosphorus load into Scofield Reservoir have been changed by the Narrows Project, an empirical annual eutrophication model for Scofield Reservoir was developed to estimate the phosphorus concentration and eutrophication probability in the reservoir (See Table D-3). The column "Total Inflow Above Scofield Reservoir" is now the sum of the columns "Fish Creek Above Scofield Reservoir", "Mud Creek Above Scofield Reservoir", "Pondtown Creek Above Scofield Reservoir", and "Other Reservoir Inflow Above Scofield Reservoir". The values in the columns "reservoir evaporation", "end-of-month contents", and flows for "Price River Below Scofield Reservoir", are taken from the Franson-Noble operation study for the proposed project.

## Operation and Eutrophication Studies of Scofield Reservoir to show proposed Mitigation Target with Narrows Project

Studies are found in Appendix F.

According to the phosphorus loading models and eutrophication studies that have been presented in Appendix A through Appendix D, Scofield Reservoir shows a slight increase in annual average phosphorus concentration from 0.0279 to 0.0309 mg/l. This increase is primarily a result of the reduced dilution affects of water coming from Gooseberry Creek under the Narrows Project. The phosphorus concentrations in Table A-3 and C-3 do not match the values reported above from Tables B-2 and D-3. The value in Table A-3 is different because the values in the concentration column represent actual measurements made in Scofield Reservoir. As discussed above the value calculated in Table B-2 needs to be used so that the with and without eutrophication potential can be compared. The Table C-3 and D-3 results vary by 0.0006 mg/l. The difference is because Table C-3 uses the average contents for Scofield Reservoir for the entire year while Table D-3 only uses the average contents for June through September.

To mitigate the potential affects of the project, the Environmental Impact Statement (EIS) proposes several miles of stream bank enhancement and fencing to help reduce cattle grazing in and around the stream. Also, with the enhanced stream banks, they will become more stable and high flows will not cause as much erosion, which directly leads to phosphorus loading. The proposed mitigation is on the following lengths and creeks, which are tributaries to Scofield Reservoir:

Mud Creek – 6.5 miles (2.5 miles in Winter Quarters Ck)
Pond Town Creek – 2.0 miles
Fish Creek – 1.0 mile

The "Scofield Reservoir Operation with Narrows Project" phosphorous routing model and eutrophication study were used as the basis for the mitigation target. The mitigation target was determined by reducing the phosphorous concentration in each of the creeks mentioned above by a percentage. The percentages were loosely based on a proportionate amount of stream bank treatment on each creek. Some consideration of total phosphorous loading from each creek was given in allocating the percent reduction. This was done until the 25 year average in-lake phosphorous concentration in Scofield Reservoir with the Narrows Project was below the phosphorous concentration of the pre-project operation (0.0279 mg/l). It was determined that by reducing the phosphorous loading by an annual average of 530 kilograms per year, this goal could be met. The results of both the phosphorous routing model and the eutrophication study are found in Appendix F.

This mitigation goal will be presented in the Narrows Reservoir Project EIS. Once the project is operating, the effectiveness of the mitigation on phosphorous loading will need to be monitored. Because this area is regularly sampled and monitored for water quality, including phosphorous, the post-project phosphorous samples will be compared with pre-project data to determine if the mitigation goal is being met. Because of the variability of water years, it will be important to compare averages during similar hydrologic periods to determine the effectiveness of the proposed mitigation.

Table 1 Date: 25-Sep-06

## Flow and Phosphorus Routing Summary

| Location | Water Years 1978 - 2005 | | | | | |
|---|---|---|---|---|---|---|
| | **Without** Narrows Project | | **With** Narrows Project | | Change (With-Without) | |
| | Flow acre-feet | Phosphorus grams | Flow acre-feet | Phosphorus grams | Flow acre-feet | Phosphorus grams |
| Natural Flow-Gooseberry Creek Near Fairview | 9,230 | 162,408 | 9,230 | 162,408 | 0 | 0 |
| Other Inflow at Narrows Reservoir Site | 748 | 13,155 | 748 | 13,155 | 0 | 0 |
| Reservoir Evaporation at Narrows | 0 | | 843 | | 843 | |
| Phosphorus Uptake at Narrows | | 0 | | 66,180 | | 66,180 |
| Diversion-Cottonwood-Gooseberry | 2,070 | 36,548 | 2,070 | 25,098 | 0 | -11,450 |
| Diversion-Narrows Project | 0 | 0 | 4,932 | 58,709 | 4,932 | 58,709 |
| Stream flow below Narrows Reservoir (site) | 7,907 | 139,015 | * 2,182 | * 26,376 | -5,725 | -112,639 |
| Reach Gains Between Narrows and Lower Gooseberry Reservoir | 6,397 | 113,875 | 6,397 | 113,875 | 0 | 0 |
| Inflow to Gooseberry Reservoir | 14,304 | 252,890 | 8,578 | 140,252 | -5,726 | -112,638 |
| Reservoir Evap at Gooseberry | 0 | | 0 | | 0 | |
| Phosphorus Uptake at Gooseberry | | 21,939 | | 14,068 | | -7,871 |
| Gooseberry Creek below Lower Gooseberry Reservoir | 14,304 | 230,951 | 8,578 | 126,184 | -5,726 | -104,767 |
| Gooseberry Creek near Scofield | 14,304 | 230,951 | 8,578 | 126,184 | -5,726 | -104,767 |
| Fish Creek GAINS above Fish Creek above Scofield Reservoir | 23,165 | 1,937,841 | 23,165 | 1,937,841 | 0 | 0 |
| Fish Creek above Scofield Reservoir | 37,469 | 2,168,792 | 31,743 | 2,064,025 | -5,726 | -104,767 |
| Fish Creek above Scofield Reservoir Concentration (mg/l) | | 0.0469 | | 0.0527 | | 0.0058 |
| Mud Creek above Scofield Reservoir | 11,074 | 1,265,200 | 11,074 | 1,265,200 | 0 | 0 |
| Pondtown Creek above Scofield Reservoir | 4,093 | 374,420 | 4,093 | 374,420 | 0 | 0 |
| Other Reservoir Inflow above Scofield Reservoir | 9,377 | 625,708 | 9,377 | 625,708 | 0 | 0 |
| Total Reservoir Inflow above Scofield Reservoir | 62,013 | 4,434,120 | 56,287 | 4,329,353 | -5,726 | -104,767 |
| Scofield Evaporation | 5,472 | | 4,874 | | -598 | |
| Scofield Phosphorus Uptake | | 1,397,727 | | 2,370,171 | | 972,444 |
| Ave. Reservoir End-of-Month Contents Scofield Reservoir | 42,635 | 2,393,857 | 32,056 | 1,197,455 | -10,579 | -1,196,402 |
| Reservoir EOM Concentration Scofield Reservoir (mg/l) | | # 0.0455 & 0.0279 | | + 0.0303 & 0.0309 | | -0.0030 |
| Probability of Eutrophication Scofield Reservoir | 68.3% | | 73.5% | | 5.2% | |
| Price River below Scofield Reservoir | * 55,402 | * 3,088,417 | * 50,307 | * 1,906,182 | -5,095 | -1,182,235 |

* Change in reservoir contents over the period 1978-2005 not included
\# Phosphorus concentration based on actual measurements of Scofield Reservoir.
& Phosphorus concentration is based on the model shown on Tables B-2 and D-3
\+ Phosphorus concentration is based on the model shown on Table C-3
Phosphorus concentrations based on actual measurements in Scofield Reservoir can be seen on Table A-3

## Results

This study relies heavily on data and methods of earlier studies and, therefore, is limited in scope and study period. It could be improved with additional data, especially with additional monthly phosphorus samples at major control points. When possible, actual sampling results have been used. When sampling results are not available monthly distributions have been developed based on available sample results. The method used in the empirical estimates of in-lake phosphorus depends heavily on statistical correlation. It assumes that the data provided represents homogeneous and continuous lake conditions, which are rarely true.

Reservoir operations under "without" Narrows Project and "with" Narrows Project are summarized in Table 1. The flow and phosphorus impacts of the proposed Narrows Project are further described as follows:

1. Narrows Reservoir
   - The Narrows Reservoir will consume (uptake) about 66 kilograms of Phosphorus annually.
   - The project will divert an average annual amount of about 4,932 acre-feet of water and about 59 kilograms of phosphorus annually. In addition to the water to be diverted by the Narrows Project, the Cottonwood-Gooseberry project, which is currently diverting water through the Narrows Tunnel, will divert an average annual amount of 2,070 acre-feet of water and about 25 kilograms of phosphorus annually.
   - Water deliveries to Cottonwood-Gooseberry project are not affected, but the phosphorus diverted is reduced by about 11.5 kilograms annually (about 31 percent) because diversions are taken from the reservoir, which has a lower concentration. The average annual concentration of Cottonwood-Gooseberry deliveries is reduced by 0.0045 mg/l.

2. Gooseberry Creek near Scofield
   - Flow is reduced by 5,726 acre-feet (about 40 percent).
   - Phosphorus uptake in Lower Gooseberry Reservoir is reduced by about 8 kilograms (about 36 percent).
   - Phosphorus mass is reduced by 105 kilograms (about 45 percent). The resulting phosphorus concentration is reduced by 9 percent.

3. Fish Creek Above Scofield Reservoir
   - Flow is reduced by 5,726 acre-feet or about 15 percent.
   - Phosphorus mass is reduced by 105 kilograms or about 5 percent.
   - Concentration of phosphorus is increased by an annual average of 0.0058 mg/l or about 12 percent.

4. Scofield Reservoir
   - Reservoir inflow is reduced by 5,726 acre-feet or about 9 percent.
   - Phosphorus mass inflow is reduced by 105 kilograms or about 2 percent.
   - In-lake phosphorus concentration is increased by an annual average of 0.003 mg/l or about 10.8 percent.

- Average reservoir content is reduced by about 10,579 acre-feet or about 24.8 percent.
- Discharge is reduced by 5,095 acre-feet or about 9 percent.

The following figures compare conditions in Scofield Reservoir without and with Narrows Project. Figure 2 compares the reservoir monthly content. Figure 3 compares average annual Total Phosphorus inflow. Figure 4 compares average annual in-lake phosphorus concentration. Figure 5 compares the probability of eutrophication.

## Conclusion

The proposed Narrows Project will reduce the total phosphorus mass loading into Scofield Reservoir, but the phosphorus concentration is increased as shown above. The probability of eutrophication at Scofield Reservoir is increased slightly every year except 1987 without any mitigation. The average annual increase is about 5.2 percent. The 1998 Narrows Project Draft EIS stated there would be essentially no increase in eutrophication and a small increase in the Trophic State Index. However this study includes an estimate of phosphorus inflow to Scofield Reservoir from sources other than Mud Creek, Pondtown Creek, and Fish Creek. This study also includes data collected through 2005. Average monthly phosphorus concentrations have been updated to reflect the additional data. Mitigation measures are offered as part of the project plan. This study indicates a small increase in the annual average in-lake phosphorus concentration (0.0279 mg/l to 0.0309 mg/l). Also, the annual average probability of eutrophication is increased 5.2 percent, which may require changes in the presentation of that conclusion.

As a result of the increase in potential eutrophication in Scofield Reservoir, a mitigation target has been established. The goal will be to reduce the total phosphorus loading to Scofield Reservoir by an annual average of 530 kilograms through stream bank treatment and fencing along 9.5 miles of tributaries. The effectiveness of the mitigation will be determined by comparing post-project phosphorus concentrations in Fish Creek, Mud Creek, and Pond Town Creek with pre-project measurements.

## Appendix E - Supplemental Information

**Phosphorus Data Development**

This section is provided to document the development of phosphorus data for Gooseberry Creek and Fish Creek. The Utah State Department of Water Quality collects water quality samples about twice per bi-annually on most Utah streams. The laboratory analytical results from these samples are posted on STORET for public use. In order to estimate phosphorus concentration for the Natural Flow above Narrows Reservoir, all available Total Phosphorus data from Fairview Lakes #2, and Gooseberry Creek above Lower Gooseberry Reservoir were evaluated to generate a composite monthly concentration for all points above Lower Gooseberry Reservoir (see Table E-1). Sample results for Lower Gooseberry Reservoir have been included in Table E-1 to allow comparison of the composite monthly concentrations with the reservoir measurements.

Substantially more data for Fish Creek are available. See Table E-2 for a list of Total Phosphorus at Fish Creek above Scofield Reservoir that is used in this study. A typical monthly distribution was estimated for both Gooseberry Creek and Fish Creek based on all sample results posted on STORET. This typical monthly distribution was used when measured data was not available. Previously the typical monthly distribution was estimated using the procedures outlined in the *State of Utah Scofield Reservoir Phase I Clean Lakes Study, December 1983.* This monthly distribution was based on only 4 years of data. The additional 24 years of data collected since this study was published warranted the update of the monthly distribution.

Table E-3 shows a list of Total Phosphorus at Mud Creek above Scofield Reservoir for 1992 – 2005 and Table E-4 is a list of Total Phosphorus at Pond Town Creek for the same period. As with Fish Creek and Gooseberry Creek, a typical monthly distribution is used when measured data is not available. This typical monthly distribution was generated using all of the available data posted on STORET.

Table E-5 was created to determine whether the model in Table B-2 was accurately predicting the average annual phosphorus concentrations in Scofield Reservoir. Table E-5 contains all of the phosphorus concentration data reported for the Scofield Reservoir in the STORET database. The samples were collected from three sites at various depths. As can be seen in the table the phosphorus concentration can vary by an order of magnitude at different sites for a given month. However, there are months that phosphorus data for the three sites agree very well. The sample results from all three sites have been averaged to estimate a phosphorus concentration for the given month. This monthly data was then used in conjunction with the end of month reservoir contents to determine an actual average reservoir phosphorus concentration that could be compared to the predicted values in Table B-2. The results of the comparison are discussed in the Scofield Reservoir Operation <u>without</u> Narrows Project Section

FRANSON NOBLE
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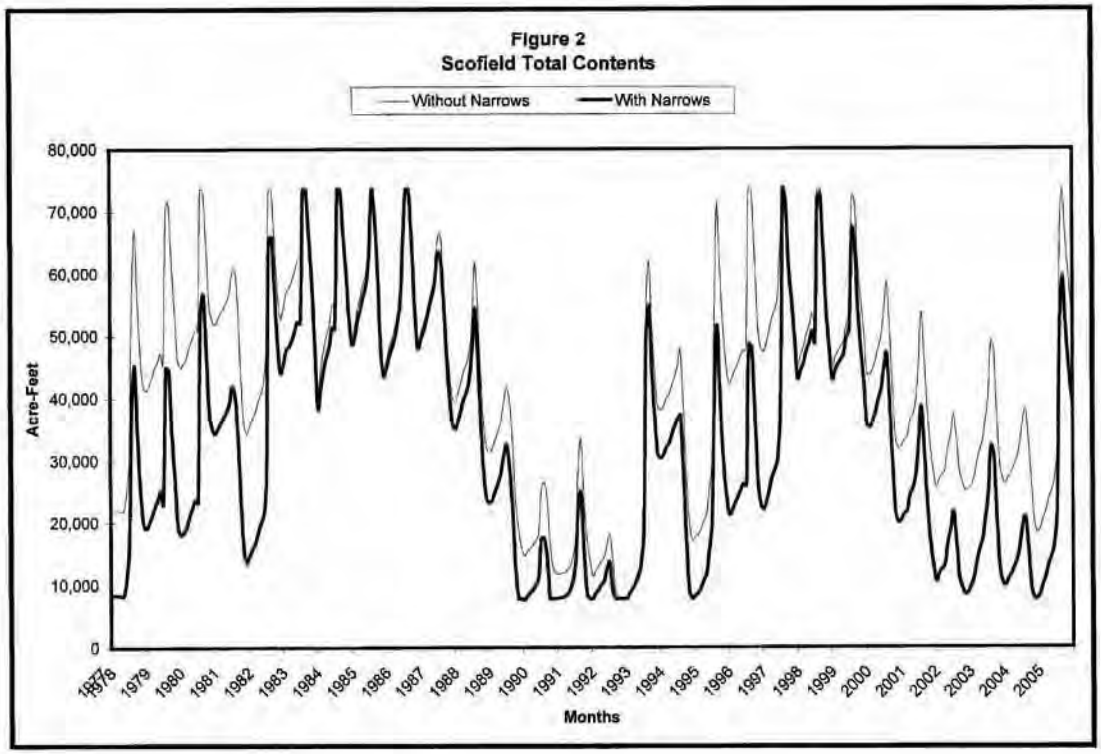
Figure 2
Scofield Total Contents
Without Narrows
With Narrows
Acre-Feet
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Months

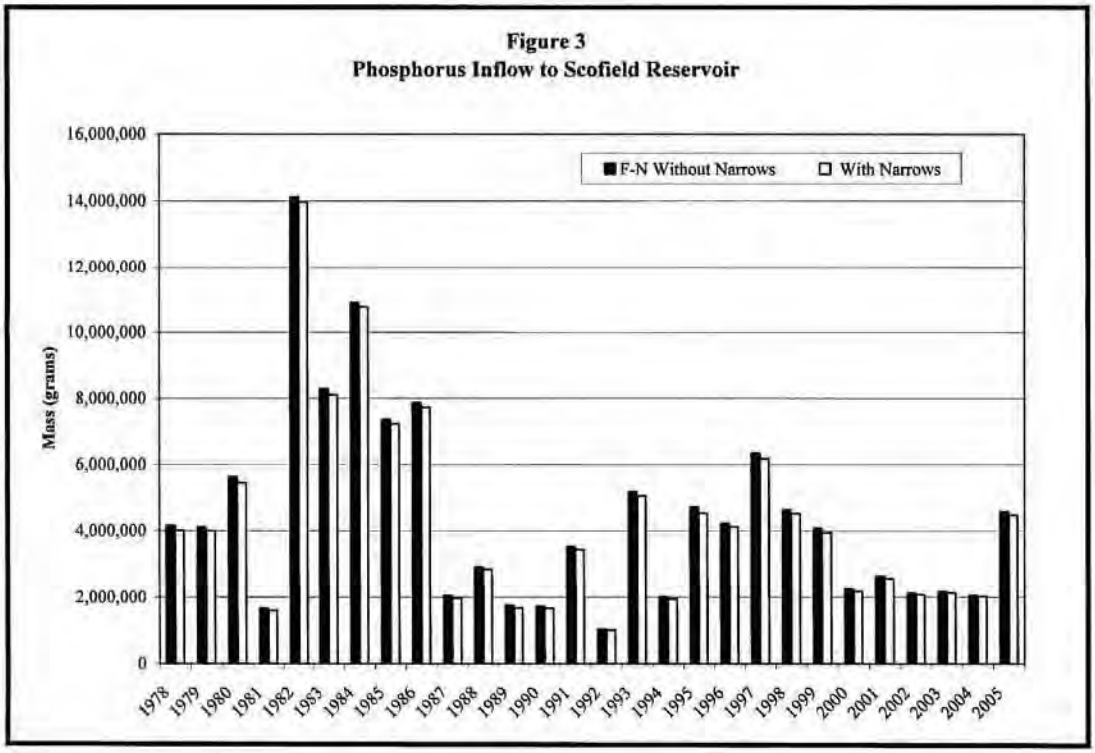
Figure 3
Phosphorus Inflow to Scofield Reservoir
F-N Without Narrows
With Narrows
Mass (grams)
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

**Figure 4**
**Scofield Reservoir-Average Annual In-Lake Phosphorus Comparison**

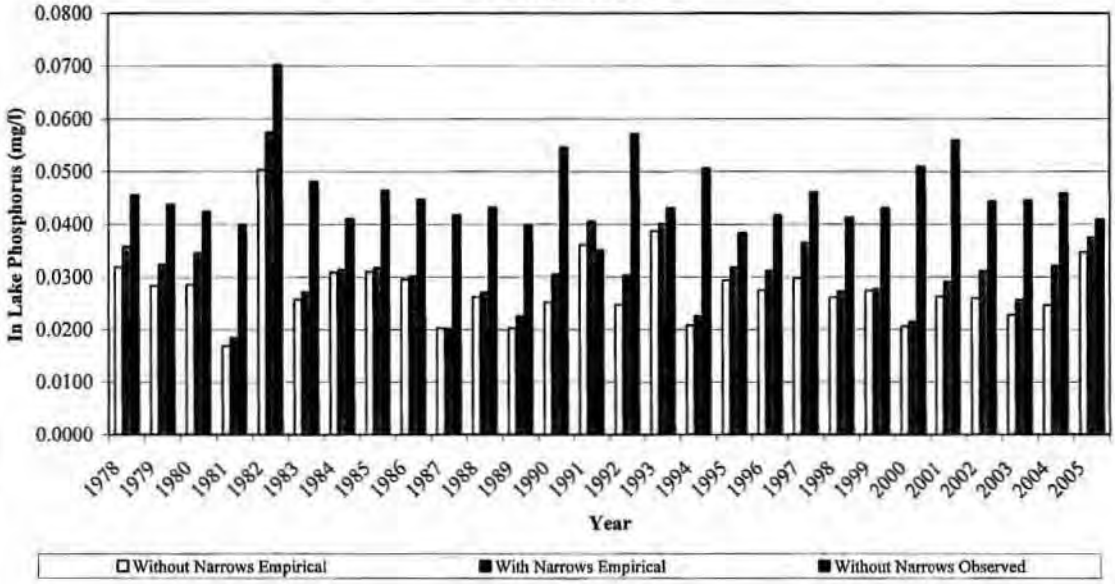


**Figure 5**
**Scofield Reservoir Eutrophication Potential**

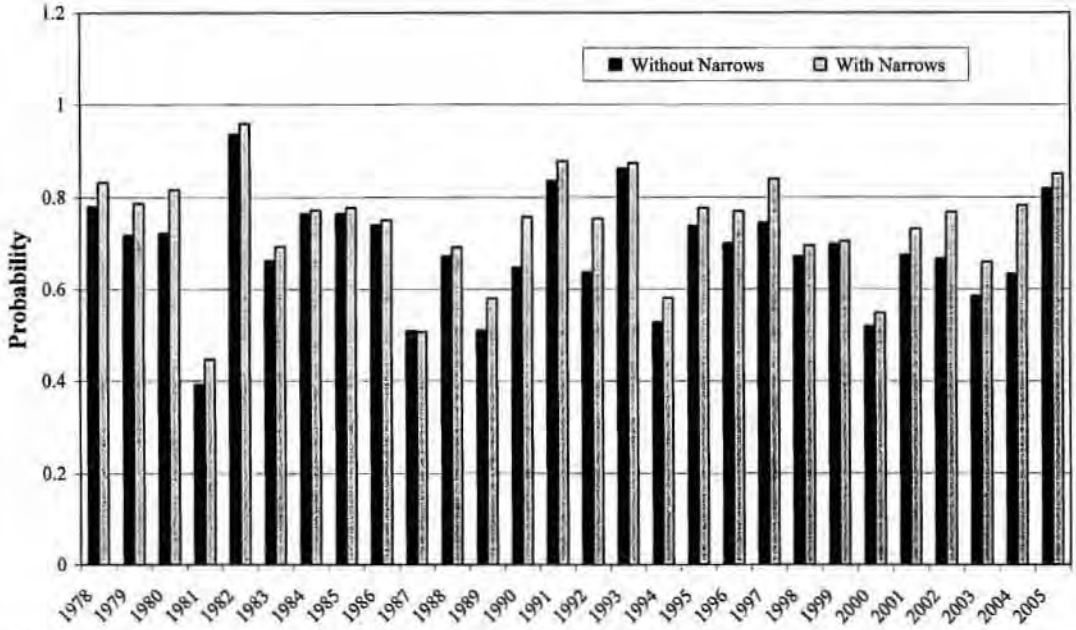

**Table A-1**

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gain Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Goosberry Creek Near Fairview | | | Diversion by Cottonwood-Goosberry | | | Other Inflow at Narrows Reservoir Site | | | No Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Goosberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams |
| | Oct | 96 | 0.0209 | 2,475 | 17 | 0.0209 | 438 | 8 | 0.0209 | 200 | 104 | 0.0209 | 2,675 | 87 | 0.0209 | 2,237 | 63 | 0.0209 | 1,630 |
| | Nov | 104 | 0.0198 | 2,540 | 18 | 0.0198 | 440 | 8 | 0.0198 | 206 | 112 | 0.0198 | 2,746 | 94 | 0.0198 | 2,306 | 68 | 0.0198 | 1,650 |
| | Dec | 87 | 0.0187 | 2,007 | 18 | 0.0187 | 415 | 7 | 0.0187 | 163 | 94 | 0.0187 | 2,169 | 76 | 0.0187 | 1,754 | 88 | 0.0187 | 2,029 |
| 1978 | Jan | 84 | 0.0176 | 1,824 | 17 | 0.0176 | 369 | 7 | 0.0176 | 148 | 91 | 0.0176 | 1,971 | 74 | 0.0176 | 1,602 | 80 | 0.0176 | 1,741 |
| | Feb | 83 | 0.0165 | 1,689 | 16 | 0.0165 | 326 | 7 | 0.0165 | 137 | 90 | 0.0165 | 1,826 | 74 | 0.0165 | 1,500 | 73 | 0.0165 | 1,491 |
| | Mar | 103 | 0.0154 | 1,997 | 21 | 0.0154 | 399 | 8 | 0.0154 | 158 | 111 | 0.0154 | 2,115 | 90 | 0.0154 | 1,716 | 101 | 0.0154 | 1,912 |
| | Apr | 582 | 0.0143 | 10,266 | 114 | 0.0143 | 2,011 | 47 | 0.0143 | 832 | 629 | 0.0143 | 11,097 | 515 | 0.0143 | 9,087 | 515 | 0.0143 | 9,082 |
| | May | 4,143 | 0.0131 | 66,946 | 715 | 0.0131 | 11,553 | 336 | 0.0131 | 5,423 | 4,479 | 0.0131 | 72,368 | 3,764 | 0.0131 | 60,815 | 2,716 | 0.0131 | 43,894 |
| | Jun | 5,070 | 0.0141 | 88,178 | 799 | 0.0141 | 13,896 | 411 | 0.0141 | 7,142 | 5,481 | 0.0141 | 95,321 | 4,682 | 0.0141 | 81,425 | 2,558 | 0.0141 | 44,495 |
| | Jul | 649 | 0.0110 | 8,805 | 101 | 0.0110 | 1,370 | 53 | 0.0110 | 713 | 702 | 0.0110 | 9,519 | 601 | 0.0110 | 8,149 | 313 | 0.0110 | 4,251 |
| | Aug | 378 | 0.0176 | 8,206 | 60 | 0.0176 | 1,303 | 31 | 0.0176 | 665 | 409 | 0.0176 | 8,871 | 349 | 0.0176 | 7,568 | 197 | 0.0176 | 4,285 |
| | Sep | 171 | 0.0240 | 5,062 | 28 | 0.0240 | 829 | 14 | 0.0240 | 410 | 185 | 0.0240 | 5,472 | 157 | 0.0240 | 4,643 | 99 | 0.0240 | 2,935 |
| WY | Total | 11,550 | 0.0140 | 199,955 | 1,924 | 0.0140 | 33,349 | 936 | 0.0140 | 16,196 | 12,480 | 0.0140 | 216,151 | 10,562 | 0.0140 | 182,802 | 6,872 | 0.0140 | 119,397 |
| | Oct | 34 | 0.0209 | 877 | 6 | 0.0209 | 155 | 3 | 0.0209 | 71 | 37 | 0.0209 | 948 | 31 | 0.0209 | 793 | 9 | 0.0209 | 238 |
| | Nov | 153 | 0.0198 | 3,737 | 42 | 0.0198 | 1,026 | 12 | 0.0198 | 303 | 165 | 0.0198 | 4,039 | 123 | 0.0198 | 3,014 | 138 | 0.0198 | 3,361 |
| | Dec | 97 | 0.0187 | 2,237 | 28 | 0.0187 | 646 | 8 | 0.0187 | 181 | 105 | 0.0187 | 2,419 | 77 | 0.0187 | 1,773 | 96 | 0.0187 | 2,218 |
| 1979 | Jan | 93 | 0.0176 | 2,019 | 28 | 0.0176 | 608 | 8 | 0.0176 | 164 | 101 | 0.0176 | 2,183 | 73 | 0.0176 | 1,575 | 99 | 0.0176 | 2,139 |
| | Feb | 88 | 0.0165 | 1,791 | 25 | 0.0165 | 509 | 7 | 0.0165 | 145 | 95 | 0.0165 | 1,936 | 70 | 0.0165 | 1,427 | 86 | 0.0165 | 1,748 |
| | Mar | 99 | 0.0154 | 1,841 | 28 | 0.0154 | 532 | 8 | 0.0154 | 152 | 107 | 0.0154 | 2,033 | 79 | 0.0154 | 1,501 | 93 | 0.0154 | 1,766 |
| | Apr | 294 | 0.0143 | 5,184 | 76 | 0.0143 | 1,341 | 24 | 0.0143 | 420 | 318 | 0.0143 | 5,606 | 242 | 0.0143 | 4,265 | 234 | 0.0143 | 4,131 |
| | May | 4,186 | 0.0131 | 67,640 | 1,006 | 0.0131 | 16,256 | 339 | 0.0131 | 5,479 | 4,525 | 0.0131 | 73,119 | 3,519 | 0.0131 | 56,864 | 2,761 | 0.0131 | 44,613 |
| | Jun | 2,256 | 0.0141 | 39,237 | 489 | 0.0141 | 8,505 | 183 | 0.0141 | 3,178 | 2,439 | 0.0141 | 42,415 | 1,950 | 0.0141 | 33,910 | 1,100 | 0.0141 | 19,136 |
| | Jul | 471 | 0.0110 | 6,391 | 98 | 0.0110 | 1,330 | 38 | 0.0110 | 518 | 509 | 0.0110 | 6,908 | 411 | 0.0110 | 5,579 | 198 | 0.0110 | 2,684 |
| | Aug | 247 | 0.0176 | 5,362 | 52 | 0.0176 | 1,129 | 20 | 0.0176 | 434 | 267 | 0.0176 | 5,797 | 215 | 0.0176 | 4,668 | 112 | 0.0176 | 2,431 |
| | Sep | 137 | 0.0240 | 4,058 | 32 | 0.0240 | 947 | 11 | 0.0240 | 329 | 148 | 0.0240 | 4,384 | 116 | 0.0240 | 3,437 | 84 | 0.0240 | 2,484 |
| WY | Total | 8,155 | 0.0140 | 140,413 | 1,910 | 0.0140 | 32,982 | 661 | 0.0140 | 11,373 | 8,816 | 0.0140 | 151,786 | 6,906 | 0.0140 | 118,805 | 5,010 | 0.0140 | 86,976 |
| | Oct | 139 | 0.0209 | 3,383 | 22 | 0.0209 | 567 | 11 | 0.0209 | 290 | 150 | 0.0209 | 3,874 | 128 | 0.0209 | 3,307 | 101 | 0.0209 | 2,597 |
| | Nov | 120 | 0.0198 | 2,931 | 19 | 0.0198 | 464 | 10 | 0.0198 | 237 | 130 | 0.0198 | 3,168 | 111 | 0.0198 | 2,704 | 90 | 0.0198 | 2,205 |
| | Dec | 116 | 0.0187 | 2,676 | 21 | 0.0187 | 484 | 9 | 0.0187 | 217 | 125 | 0.0187 | 2,892 | 104 | 0.0187 | 2,408 | 111 | 0.0187 | 2,551 |
| 1980 | Jan | 104 | 0.0176 | 2,258 | 21 | 0.0176 | 456 | 8 | 0.0176 | 183 | 112 | 0.0176 | 2,441 | 91 | 0.0176 | 1,985 | 124 | 0.0176 | 2,683 |
| | Feb | 99 | 0.0165 | 2,015 | 19 | 0.0165 | 387 | 8 | 0.0165 | 163 | 107 | 0.0165 | 2,178 | 88 | 0.0165 | 1,791 | 113 | 0.0165 | 2,299 |
| | Mar | 112 | 0.0154 | 2,128 | 21 | 0.0154 | 399 | 9 | 0.0154 | 172 | 121 | 0.0154 | 2,300 | 100 | 0.0154 | 1,901 | 115 | 0.0154 | 2,183 |
| | Apr | 530 | 0.0143 | 9,349 | 91 | 0.0143 | 1,605 | 43 | 0.0143 | 757 | 573 | 0.0143 | 10,106 | 482 | 0.0143 | 8,501 | 464 | 0.0143 | 8,186 |
| | May | 4,179 | 0.0131 | 67,527 | 640 | 0.0131 | 10,343 | 338 | 0.0131 | 5,470 | 4,517 | 0.0131 | 72,997 | 3,877 | 0.0131 | 62,655 | 2,752 | 0.0131 | 44,477 |
| | Jun | 5,391 | 0.0141 | 93,761 | 753 | 0.0141 | 13,096 | 437 | 0.0141 | 7,595 | 5,828 | 0.0141 | 101,356 | 5,075 | 0.0141 | 88,260 | 2,725 | 0.0141 | 47,399 |
| | Jul | 727 | 0.0110 | 9,864 | 101 | 0.0110 | 1,370 | 59 | 0.0110 | 799 | 786 | 0.0110 | 10,663 | 685 | 0.0110 | 9,293 | 365 | 0.0110 | 4,954 |
| | Aug | 302 | 0.0176 | 6,556 | 42 | 0.0176 | 912 | 24 | 0.0176 | 531 | 326 | 0.0176 | 7,087 | 284 | 0.0176 | 6,176 | 148 | 0.0176 | 3,203 |
| | Sep | 235 | 0.0240 | 6,957 | 33 | 0.0240 | 977 | 19 | 0.0240 | 564 | 254 | 0.0240 | 7,520 | 221 | 0.0240 | 6,543 | 125 | 0.0240 | 3,699 |
| WY | Total | 12,054 | 0.0141 | 209,605 | 1,783 | 0.0141 | 31,059 | 976 | 0.0141 | 16,978 | 13,030 | 0.0141 | 226,583 | 11,247 | 0.0141 | 195,523 | 7,233 | 0.0141 | 126,437 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
## Narrows Reservoir Site Operation

| | | (Franson-Noble) Natural Flow-Gooseberry Creek Near Fairview | | | (Franson-Noble) Diversion by Cottonwood-Gooseberry | | | (Franson-Noble) Other Inflow at Narrows Reservoir Site | | | (CALC) Net Flow at Narrows Reservoir Site | | | (Franson-Noble) Stream Flow below Narrows Reservoir Site | | | (CALC) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | Oct | 196 | 0.0209 | 5,053 | 55 | 0.0209 | 1,418 | 16 | 0.0209 | 409 | 212 | 0.0209 | 5,462 | 157 | 0.0209 | 4,044 | 152 | 0.0209 | 3,922 |
| | Nov | 165 | 0.0198 | 4,030 | 50 | 0.0198 | 1,221 | 13 | 0.0198 | 326 | 178 | 0.0198 | 4,356 | 128 | 0.0198 | 3,135 | 154 | 0.0198 | 3,752 |
| | Dec | 138 | 0.0187 | 3,183 | 42 | 0.0187 | 969 | 11 | 0.0187 | 258 | 149 | 0.0187 | 3,441 | 107 | 0.0187 | 2,472 | 130 | 0.0187 | 2,995 |
| 1981 | Jan | 113 | 0.0176 | 2,453 | 40 | 0.0176 | 868 | 9 | 0.0176 | 199 | 122 | 0.0176 | 2,652 | 82 | 0.0176 | 1,783 | 144 | 0.0176 | 3,123 |
| | Feb | 106 | 0.0165 | 2,157 | 36 | 0.0165 | 733 | 9 | 0.0165 | 175 | 115 | 0.0165 | 2,332 | 79 | 0.0165 | 1,599 | 126 | 0.0165 | 2,573 |
| | Mar | 162 | 0.0154 | 3,077 | 56 | 0.0154 | 1,064 | 13 | 0.0154 | 249 | 175 | 0.0154 | 3,327 | 119 | 0.0154 | 2,263 | 198 | 0.0154 | 3,759 |
| | Apr | 891 | 0.0143 | 15,716 | 268 | 0.0143 | 4,727 | 72 | 0.0143 | 1,273 | 963 | 0.0143 | 16,989 | 695 | 0.0143 | 12,262 | 815 | 0.0143 | 14,373 |
| | May | 2,753 | 0.0131 | 44,485 | 649 | 0.0131 | 10,487 | 223 | 0.0131 | 3,603 | 2,976 | 0.0131 | 48,088 | 2,327 | 0.0131 | 37,601 | 1,323 | 0.0131 | 21,378 |
| | Jun | 1,214 | 0.0100 | 14,975 | 283 | 0.0100 | 3,491 | 98 | 0.0100 | 1,213 | 1,312 | 0.0100 | 16,187 | 1,029 | 0.0100 | 12,697 | 561 | 0.0100 | 6,916 |
| | Jul | 361 | 0.0110 | 4,898 | 78 | 0.0110 | 1,058 | 29 | 0.0110 | 397 | 390 | 0.0110 | 5,295 | 312 | 0.0110 | 4,237 | 125 | 0.0110 | 1,693 |
| | Aug | 189 | 0.0176 | 4,103 | 42 | 0.0176 | 912 | 15 | 0.0176 | 332 | 204 | 0.0176 | 4,435 | 162 | 0.0176 | 3,524 | 75 | 0.0176 | 1,621 |
| | Sep | 149 | 0.0240 | 4,411 | 38 | 0.0240 | 1,125 | 12 | 0.0240 | 357 | 161 | 0.0240 | 4,768 | 123 | 0.0240 | 3,643 | 90 | 0.0240 | 2,662 |
| WY | Total | 6,437 | 0.0137 | 108,542 | 1,637 | 0.0137 | 28,073 | 521 | 0.0137 | 8,792 | 6,958 | 0.0137 | 117,333 | 5,321 | 0.0137 | 89,261 | 3,892 | 0.0137 | 68,769 |
| | Oct | 205 | 0.0209 | 5,285 | 44 | 0.0209 | 1,134 | 17 | 0.0209 | 428 | 222 | 0.0209 | 5,713 | 178 | 0.0209 | 4,579 | 159 | 0.0209 | 4,109 |
| | Nov | 147 | 0.0198 | 3,590 | 33 | 0.0198 | 806 | 12 | 0.0198 | 291 | 159 | 0.0198 | 3,881 | 126 | 0.0198 | 3,075 | 129 | 0.0198 | 3,153 |
| | Dec | 101 | 0.0187 | 2,330 | 24 | 0.0187 | 554 | 8 | 0.0187 | 189 | 109 | 0.0187 | 2,518 | 85 | 0.0187 | 1,965 | 100 | 0.0187 | 2,302 |
| 1982 | Jan | 80 | 0.0176 | 1,737 | 18 | 0.0176 | 391 | 6 | 0.0176 | 141 | 86 | 0.0176 | 1,877 | 68 | 0.0176 | 1,487 | 72 | 0.0176 | 1,553 |
| | Feb | 76 | 0.0165 | 1,547 | 16 | 0.0165 | 326 | 6 | 0.0165 | 125 | 82 | 0.0165 | 1,672 | 66 | 0.0165 | 1,346 | 57 | 0.0165 | 1,157 |
| | Mar | 102 | 0.0154 | 1,938 | 24 | 0.0154 | 456 | 8 | 0.0154 | 157 | 110 | 0.0154 | 2,095 | 86 | 0.0154 | 1,639 | 99 | 0.0154 | 1,876 |
| | Apr | 664 | 0.0143 | 11,712 | 152 | 0.0143 | 2,681 | 54 | 0.0143 | 949 | 718 | 0.0143 | 12,661 | 566 | 0.0143 | 9,980 | 594 | 0.0143 | 10,481 |
| | May | 5,446 | 0.0131 | 88,000 | 1,150 | 0.0131 | 18,583 | 441 | 0.0131 | 7,128 | 5,887 | 0.0131 | 95,128 | 4,737 | 0.0131 | 76,546 | 4,023 | 0.0131 | 65,004 |
| | Jun | 3,227 | 0.0141 | 56,125 | 591 | 0.0141 | 10,279 | 261 | 0.0141 | 4,546 | 3,488 | 0.0141 | 60,671 | 2,897 | 0.0141 | 50,392 | 1,603 | 0.0141 | 27,873 |
| | Jul | 788 | 0.0110 | 10,692 | 146 | 0.0110 | 1,981 | 64 | 0.0110 | 866 | 852 | 0.0110 | 11,558 | 706 | 0.0110 | 9,577 | 404 | 0.0110 | 5,484 |
| | Aug | 360 | 0.0176 | 7,815 | 67 | 0.0176 | 1,455 | 29 | 0.0176 | 633 | 389 | 0.0176 | 8,448 | 322 | 0.0176 | 6,994 | 186 | 0.0176 | 4,034 |
| | Sep | 357 | 0.0240 | 10,569 | 65 | 0.0240 | 1,924 | 29 | 0.0240 | 856 | 386 | 0.0240 | 11,425 | 321 | 0.0240 | 9,500 | 177 | 0.0240 | 5,242 |
| WY | Total | 11,553 | 0.0141 | 201,339 | 2,330 | 0.0141 | 40,568 | 936 | 0.0141 | 16,308 | 12,489 | 0.0141 | 217,647 | 10,159 | 0.0141 | 177,079 | 7,602 | 0.0141 | 132,269 |
| | Oct | 453 | 0.0209 | 11,678 | 37 | 0.0209 | 954 | 37 | 0.0209 | 946 | 490 | 0.0209 | 12,624 | 453 | 0.0209 | 11,670 | 377 | 0.0209 | 9,727 |
| | Nov | 322 | 0.0198 | 7,864 | 31 | 0.0198 | 757 | 26 | 0.0198 | 637 | 348 | 0.0198 | 8,501 | 317 | 0.0198 | 7,744 | 374 | 0.0198 | 9,132 |
| | Dec | 268 | 0.0187 | 6,182 | 22 | 0.0187 | 507 | 22 | 0.0187 | 501 | 290 | 0.0187 | 6,682 | 268 | 0.0187 | 6,175 | 232 | 0.0187 | 5,358 |
| 1983 | Jan | 167 | 0.0176 | 3,625 | 19 | 0.0176 | 412 | 14 | 0.0176 | 294 | 181 | 0.0176 | 3,919 | 162 | 0.0176 | 3,507 | 265 | 0.0176 | 5,763 |
| | Feb | 149 | 0.0165 | 3,033 | 17 | 0.0165 | 346 | 12 | 0.0165 | 246 | 161 | 0.0165 | 3,278 | 144 | 0.0165 | 2,932 | 230 | 0.0165 | 4,680 |
| | Mar | 213 | 0.0154 | 4,046 | 22 | 0.0154 | 418 | 17 | 0.0154 | 328 | 230 | 0.0154 | 4,374 | 208 | 0.0154 | 3,956 | 283 | 0.0154 | 5,371 |
| | Apr | 350 | 0.0143 | 6,174 | 29 | 0.0143 | 512 | 28 | 0.0143 | 500 | 378 | 0.0143 | 6,674 | 349 | 0.0143 | 6,162 | 289 | 0.0143 | 5,091 |
| | May | 2,961 | 0.0131 | 47,846 | 203 | 0.0131 | 3,280 | 240 | 0.0131 | 3,876 | 3,201 | 0.0131 | 51,721 | 2,998 | 0.0131 | 48,441 | 1,532 | 0.0131 | 24,758 |
| | Jun | 9,328 | 0.0141 | 162,234 | 638 | 0.0141 | 11,096 | 756 | 0.0141 | 13,141 | 10,084 | 0.0141 | 175,375 | 9,446 | 0.0141 | 164,279 | 4,764 | 0.0141 | 82,864 |
| | Jul | 1,841 | 0.0100 | 22,709 | 132 | 0.0100 | 1,628 | 149 | 0.0100 | 1,839 | 1,990 | 0.0100 | 24,548 | 1,858 | 0.0100 | 22,920 | 1,092 | 0.0100 | 13,468 |
| | Aug | 548 | 0.0176 | 11,897 | 39 | 0.0176 | 847 | 44 | 0.0176 | 964 | 592 | 0.0176 | 12,860 | 553 | 0.0176 | 12,014 | 308 | 0.0176 | 6,678 |
| | Sep | 399 | 0.0240 | 11,812 | 27 | 0.0240 | 799 | 32 | 0.0240 | 957 | 431 | 0.0240 | 12,769 | 404 | 0.0240 | 11,969 | 195 | 0.0240 | 5,763 |
| WY | Total | 16,999 | 0.0143 | 299,099 | 1,216 | 0.0143 | 21,557 | 1,377 | 0.0143 | 24,227 | 18,376 | 0.0143 | 323,327 | 17,160 | 0.0143 | 301,770 | 9,941 | 0.0143 | 178,654 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
## Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | Oct | 361 | 0.0209 | 9,307 | 62 | 0.0209 | 1,598 | 29 | 0.0209 | 754 | 390 | 0.0209 | 10,060 | 328 | 0.0209 | 8,462 | 296 | 0.0209 | 7,625 |
| | Nov | 262 | 0.0198 | 6,399 | 52 | 0.0198 | 1,270 | 21 | 0.0198 | 518 | 283 | 0.0198 | 6,917 | 231 | 0.0198 | 5,647 | 289 | 0.0198 | 7,053 |
| | Dec | 313 | 0.0187 | 7,220 | 55 | 0.0187 | 1,269 | 25 | 0.0187 | 585 | 338 | 0.0187 | 7,805 | 283 | 0.0187 | 6,536 | 269 | 0.0187 | 6,197 |
| 1984 | Jan | 192 | 0.0176 | 4,168 | 48 | 0.0176 | 1,042 | 16 | 0.0176 | 338 | 208 | 0.0176 | 4,506 | 160 | 0.0176 | 3,464 | 321 | 0.0176 | 6,978 |
| | Feb | 171 | 0.0165 | 3,480 | 42 | 0.0165 | 855 | 14 | 0.0165 | 282 | 185 | 0.0165 | 3,762 | 143 | 0.0165 | 2,907 | 281 | 0.0165 | 5,722 |
| | Mar | 197 | 0.0154 | 3,742 | 42 | 0.0154 | 798 | 16 | 0.0154 | 303 | 213 | 0.0154 | 4,045 | 171 | 0.0154 | 3,247 | 256 | 0.0154 | 4,864 |
| | Apr | 380 | 0.0143 | 6,703 | 66 | 0.0143 | 1,164 | 31 | 0.0143 | 543 | 411 | 0.0143 | 7,246 | 345 | 0.0143 | 6,082 | 318 | 0.0143 | 5,613 |
| | May | 7,142 | 0.0131 | 115,405 | 1,215 | 0.0131 | 19,633 | 579 | 0.0131 | 9,348 | 7,721 | 0.0131 | 124,753 | 6,506 | 0.0131 | 105,120 | 5,724 | 0.0131 | 92,500 |
| | Jun | 6,656 | 0.0141 | 115,782 | 956 | 0.0141 | 16,627 | 539 | 0.0141 | 9,377 | 7,195 | 0.0141 | 125,139 | 6,239 | 0.0141 | 108,512 | 3,381 | 0.0141 | 58,801 |
| | Jul | 1,002 | 0.0110 | 13,596 | 147 | 0.0110 | 1,995 | 81 | 0.0110 | 1,101 | 1,083 | 0.0110 | 14,697 | 936 | 0.0110 | 12,702 | 544 | 0.0110 | 7,379 |
| | Aug | 443 | 0.0176 | 9,617 | 65 | 0.0176 | 1,411 | 36 | 0.0176 | 779 | 479 | 0.0176 | 10,396 | 414 | 0.0176 | 8,985 | 240 | 0.0176 | 5,213 |
| | Sep | 304 | 0.0240 | 9,000 | 44 | 0.0240 | 1,303 | 25 | 0.0240 | 729 | 329 | 0.0240 | 9,728 | 285 | 0.0240 | 8,426 | 154 | 0.0240 | 4,570 |
| WY | Total | 17,423 | 0.0142 | 304,399 | 2,794 | 0.0142 | 48,964 | 1,411 | 0.0142 | 24,656 | 18,834 | 0.0142 | 329,055 | 16,040 | 0.0142 | 280,091 | 12,074 | 0.0142 | 212,515 |
| | Oct | 333 | 0.0209 | 8,585 | 71 | 0.0209 | 1,830 | 27 | 0.0209 | 695 | 360 | 0.0209 | 9,280 | 289 | 0.0209 | 7,450 | 272 | 0.0209 | 7,013 |
| | Nov | 239 | 0.0198 | 5,837 | 58 | 0.0198 | 1,417 | 19 | 0.0198 | 473 | 258 | 0.0198 | 6,310 | 200 | 0.0198 | 4,893 | 258 | 0.0198 | 6,292 |
| | Dec | 268 | 0.0187 | 6,182 | 58 | 0.0187 | 1,338 | 22 | 0.0187 | 501 | 290 | 0.0187 | 6,682 | 232 | 0.0187 | 5,345 | 232 | 0.0187 | 5,358 |
| 1985 | Jan | 182 | 0.0176 | 3,951 | 55 | 0.0176 | 1,194 | 15 | 0.0176 | 320 | 197 | 0.0176 | 4,271 | 142 | 0.0176 | 3,077 | 298 | 0.0176 | 6,475 |
| | Feb | 146 | 0.0165 | 2,971 | 43 | 0.0165 | 875 | 12 | 0.0165 | 241 | 158 | 0.0165 | 3,212 | 115 | 0.0165 | 2,337 | 223 | 0.0165 | 4,542 |
| | Mar | 176 | 0.0154 | 3,343 | 46 | 0.0154 | 874 | 14 | 0.0154 | 271 | 190 | 0.0154 | 3,614 | 144 | 0.0154 | 2,740 | 222 | 0.0154 | 4,212 |
| | Apr | 1,675 | 0.0143 | 29,545 | 379 | 0.0143 | 6,685 | 136 | 0.0143 | 2,393 | 1,811 | 0.0143 | 31,938 | 1,432 | 0.0143 | 25,253 | 1,578 | 0.0143 | 27,840 |
| | May | 6,282 | 0.0131 | 101,509 | 1,303 | 0.0131 | 21,055 | 509 | 0.0131 | 8,222 | 6,791 | 0.0131 | 109,731 | 5,488 | 0.0131 | 88,676 | 4,862 | 0.0131 | 78,566 |
| | Jun | 1,733 | 0.0141 | 30,141 | 302 | 0.0141 | 5,252 | 140 | 0.0141 | 2,441 | 1,873 | 0.0141 | 32,582 | 1,571 | 0.0141 | 27,330 | 829 | 0.0141 | 14,412 |
| | Jul | 657 | 0.0110 | 8,914 | 115 | 0.0110 | 1,560 | 53 | 0.0110 | 722 | 710 | 0.0110 | 9,636 | 595 | 0.0110 | 8,076 | 319 | 0.0110 | 4,325 |
| | Aug | 311 | 0.0176 | 6,752 | 55 | 0.0176 | 1,194 | 25 | 0.0176 | 547 | 336 | 0.0176 | 7,299 | 281 | 0.0176 | 6,104 | 153 | 0.0176 | 3,317 |
| | Sep | 218 | 0.0240 | 6,454 | 40 | 0.0240 | 1,184 | 18 | 0.0240 | 523 | 236 | 0.0240 | 6,976 | 196 | 0.0240 | 5,792 | 118 | 0.0240 | 3,503 |
| WY | Total | 12,220 | 0.0142 | 214,184 | 2,525 | 0.0142 | 44,459 | 990 | 0.0142 | 17,349 | 13,210 | 0.0142 | 231,533 | 10,685 | 0.0142 | 187,074 | 9,364 | 0.0142 | 165,857 |
| | Oct | 231 | 0.0209 | 5,955 | 46 | 0.0209 | 1,186 | 19 | 0.0209 | 482 | 250 | 0.0209 | 6,438 | 204 | 0.0209 | 5,252 | 182 | 0.0209 | 4,699 |
| | Nov | 202 | 0.0198 | 4,933 | 45 | 0.0198 | 1,099 | 16 | 0.0198 | 400 | 218 | 0.0198 | 5,333 | 173 | 0.0198 | 4,234 | 207 | 0.0198 | 5,047 |
| | Dec | 196 | 0.0187 | 4,521 | 41 | 0.0187 | 946 | 16 | 0.0187 | 366 | 212 | 0.0187 | 4,887 | 171 | 0.0187 | 3,941 | 176 | 0.0187 | 4,063 |
| 1986 | Jan | 150 | 0.0176 | 3,256 | 41 | 0.0176 | 890 | 12 | 0.0176 | 264 | 162 | 0.0176 | 3,520 | 121 | 0.0176 | 2,630 | 227 | 0.0176 | 4,925 |
| | Feb | 151 | 0.0165 | 3,073 | 42 | 0.0165 | 855 | 12 | 0.0165 | 249 | 163 | 0.0165 | 3,322 | 121 | 0.0165 | 2,467 | 236 | 0.0165 | 4,799 |
| | Mar | 243 | 0.0154 | 4,616 | 63 | 0.0154 | 1,197 | 20 | 0.0154 | 374 | 263 | 0.0154 | 4,990 | 200 | 0.0154 | 3,793 | 333 | 0.0154 | 6,332 |
| | Apr | 1,050 | 0.0143 | 18,521 | 224 | 0.0143 | 3,951 | 85 | 0.0143 | 1,500 | 1,135 | 0.0143 | 20,021 | 911 | 0.0143 | 16,070 | 960 | 0.0143 | 17,091 |
| | May | 6,624 | 0.0131 | 107,035 | 1,315 | 0.0131 | 21,249 | 537 | 0.0131 | 8,670 | 7,161 | 0.0131 | 115,705 | 5,846 | 0.0131 | 94,456 | 5,204 | 0.0131 | 84,097 |
| | Jun | 5,312 | 0.0141 | 92,387 | 896 | 0.0141 | 15,583 | 430 | 0.0141 | 7,483 | 5,742 | 0.0141 | 99,871 | 4,846 | 0.0141 | 84,287 | 2,684 | 0.0141 | 46,676 |
| | Jul | 644 | 0.0110 | 8,738 | 107 | 0.0110 | 1,452 | 52 | 0.0110 | 708 | 696 | 0.0110 | 9,446 | 589 | 0.0110 | 7,994 | 311 | 0.0110 | 4,218 |
| | Aug | 324 | 0.0176 | 7,024 | 55 | 0.0176 | 1,194 | 26 | 0.0176 | 570 | 350 | 0.0176 | 7,604 | 295 | 0.0176 | 6,410 | 163 | 0.0176 | 3,533 |
| | Sep | 252 | 0.0240 | 7,460 | 43 | 0.0240 | 1,273 | 20 | 0.0240 | 604 | 272 | 0.0240 | 8,064 | 229 | 0.0240 | 6,791 | 133 | 0.0240 | 3,925 |
| WY | Total | 15,379 | 0.0141 | 267,531 | 2,918 | 0.0141 | 50,874 | 1,246 | 0.0141 | 21,670 | 16,625 | 0.0141 | 289,201 | 13,707 | 0.0141 | 238,326 | 10,824 | 0.0141 | 189,404 |

**Table A-1**

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams |
| | Oct | 296 | 0.0209 | 7,631 | 111 | 0.0209 | 2,862 | 24 | 0.0209 | 618 | 320 | 0.0209 | 8,249 | 209 | 0.0209 | 5,387 | 239 | 0.0209 | 6,162 |
| | Nov | 231 | 0.0198 | 5,642 | 99 | 0.0198 | 2,418 | 19 | 0.0198 | 457 | 250 | 0.0198 | 6,099 | 151 | 0.0198 | 3,681 | 247 | 0.0198 | 6,040 |
| | Dec | 170 | 0.0187 | 3,921 | 67 | 0.0187 | 1,545 | 14 | 0.0187 | 318 | 184 | 0.0187 | 4,239 | 117 | 0.0187 | 2,693 | 154 | 0.0187 | 3,558 |
| 1987 | Jan | 89 | 0.0176 | 1,932 | 37 | 0.0176 | 803 | 7 | 0.0176 | 157 | 96 | 0.0176 | 2,089 | 59 | 0.0176 | 1,285 | 91 | 0.0176 | 1,971 |
| | Feb | 81 | 0.0165 | 1,649 | 31 | 0.0165 | 631 | 7 | 0.0165 | 134 | 88 | 0.0165 | 1,782 | 57 | 0.0165 | 1,151 | 69 | 0.0165 | 1,413 |
| | Mar | 109 | 0.0154 | 2,071 | 45 | 0.0154 | 855 | 9 | 0.0154 | 168 | 118 | 0.0154 | 2,238 | 73 | 0.0154 | 1,383 | 110 | 0.0154 | 2,093 |
| | Apr | 1,083 | 0.0143 | 19,103 | 433 | 0.0143 | 7,638 | 88 | 0.0143 | 1,547 | 1,171 | 0.0143 | 20,650 | 738 | 0.0143 | 13,013 | 1,002 | 0.0143 | 17,679 |
| | May | 2,577 | 0.0131 | 41,641 | 783 | 0.0131 | 12,652 | 209 | 0.0131 | 3,373 | 2,786 | 0.0131 | 45,014 | 2,003 | 0.0131 | 32,362 | 1,147 | 0.0131 | 18,538 |
| | Jun | 757 | 0.0141 | 13,166 | 227 | 0.0141 | 3,948 | 61 | 0.0141 | 1,066 | 818 | 0.0141 | 14,232 | 591 | 0.0141 | 10,284 | 324 | 0.0141 | 5,630 |
| | Jul | 396 | 0.0110 | 5,373 | 115 | 0.0110 | 1,560 | 32 | 0.0110 | 435 | 428 | 0.0110 | 5,808 | 313 | 0.0110 | 4,248 | 148 | 0.0110 | 2,007 |
| | Aug | 215 | 0.0176 | 4,668 | 64 | 0.0176 | 1,389 | 17 | 0.0176 | 378 | 232 | 0.0176 | 5,046 | 168 | 0.0176 | 3,656 | 91 | 0.0176 | 1,967 |
| | Sep | 152 | 0.0240 | 4,500 | 51 | 0.0240 | 1,510 | 12 | 0.0240 | 364 | 164 | 0.0240 | 4,864 | 113 | 0.0240 | 3,354 | 91 | 0.0240 | 2,685 |
| WY | Total | 6,156 | 0.0147 | 111,295 | 2,063 | 0.0147 | 37,811 | 499 | 0.0147 | 9,015 | 6,655 | 0.0147 | 120,310 | 4,592 | 0.0147 | 82,499 | 3,713 | 0.0147 | 69,741 |
| | Oct | 144 | 0.0209 | 3,712 | 47 | 0.0209 | 1,212 | 12 | 0.0209 | 301 | 156 | 0.0209 | 4,013 | 109 | 0.0209 | 2,801 | 105 | 0.0209 | 2,716 |
| | Nov | 126 | 0.0198 | 3,077 | 42 | 0.0198 | 1,026 | 10 | 0.0198 | 249 | 136 | 0.0198 | 3,327 | 94 | 0.0198 | 2,301 | 99 | 0.0198 | 2,413 |
| | Dec | 99 | 0.0187 | 2,284 | 37 | 0.0187 | 853 | 8 | 0.0187 | 185 | 107 | 0.0187 | 2,469 | 70 | 0.0187 | 1,615 | 98 | 0.0187 | 2,260 |
| 1988 | Jan | 102 | 0.0176 | 2,214 | 41 | 0.0176 | 890 | 8 | 0.0176 | 179 | 110 | 0.0176 | 2,394 | 69 | 0.0176 | 1,504 | 119 | 0.0176 | 2,578 |
| | Feb | 98 | 0.0165 | 1,995 | 39 | 0.0165 | 794 | 8 | 0.0165 | 162 | 106 | 0.0165 | 2,156 | 67 | 0.0165 | 1,362 | 109 | 0.0165 | 2,220 |
| | Mar | 125 | 0.0154 | 2,374 | 49 | 0.0154 | 931 | 10 | 0.0154 | 192 | 135 | 0.0154 | 2,567 | 86 | 0.0154 | 1,636 | 136 | 0.0154 | 2,581 |
| | Apr | 564 | 0.0143 | 9,948 | 199 | 0.0143 | 3,510 | 46 | 0.0143 | 806 | 610 | 0.0143 | 10,754 | 411 | 0.0143 | 7,244 | 466 | 0.0143 | 8,754 |
| | May | 3,714 | 0.0131 | 60,013 | 1,132 | 0.0131 | 18,292 | 301 | 0.0131 | 4,861 | 4,015 | 0.0131 | 64,875 | 2,883 | 0.0131 | 46,583 | 2,287 | 0.0131 | 36,958 |
| | Jun | 958 | 0.0141 | 16,662 | 263 | 0.0141 | 4,574 | 78 | 0.0141 | 1,350 | 1,038 | 0.0141 | 18,011 | 773 | 0.0141 | 13,437 | 427 | 0.0141 | 7,433 |
| | Jul | 358 | 0.0110 | 4,857 | 92 | 0.0110 | 1,248 | 29 | 0.0110 | 393 | 387 | 0.0110 | 5,251 | 295 | 0.0110 | 4,003 | 123 | 0.0110 | 1,669 |
| | Aug | 209 | 0.0176 | 4,537 | 56 | 0.0176 | 1,216 | 17 | 0.0176 | 368 | 226 | 0.0176 | 4,905 | 170 | 0.0176 | 3,689 | 87 | 0.0176 | 1,890 |
| | Sep | 142 | 0.0240 | 4,204 | 43 | 0.0240 | 1,273 | 12 | 0.0240 | 341 | 154 | 0.0240 | 4,544 | 111 | 0.0240 | 3,271 | 86 | 0.0240 | 2,561 |
| WY | Total | 6,639 | 0.0142 | 115,879 | 2,040 | 0.0142 | 35,818 | 538 | 0.0142 | 9,386 | 7,177 | 0.0142 | 125,265 | 5,137 | 0.0142 | 89,446 | 4,173 | 0.0142 | 74,032 |
| | Oct | 153 | 0.0209 | 3,944 | 49 | 0.0209 | 1,263 | 12 | 0.0209 | 310 | 165 | 0.0209 | 4,264 | 116 | 0.0209 | 3,001 | 115 | 0.0209 | 2,955 |
| | Nov | 167 | 0.0198 | 4,079 | 59 | 0.0198 | 1,441 | 14 | 0.0198 | 330 | 181 | 0.0198 | 4,409 | 122 | 0.0198 | 2,968 | 156 | 0.0198 | 3,822 |
| | Dec | 150 | 0.0187 | 3,460 | 53 | 0.0187 | 1,223 | 13 | 0.0187 | 280 | 162 | 0.0187 | 3,740 | 109 | 0.0187 | 2,518 | 139 | 0.0187 | 3,203 |
| 1989 | Jan | 121 | 0.0176 | 2,627 | 51 | 0.0176 | 1,107 | 10 | 0.0176 | 217 | 131 | 0.0176 | 2,840 | 80 | 0.0176 | 1,732 | 161 | 0.0176 | 3,500 |
| | Feb | 101 | 0.0165 | 2,056 | 39 | 0.0165 | 794 | 8 | 0.0165 | 167 | 109 | 0.0165 | 2,222 | 70 | 0.0165 | 1,428 | 118 | 0.0165 | 2,357 |
| | Mar | 166 | 0.0154 | 3,153 | 67 | 0.0154 | 1,273 | 13 | 0.0154 | 255 | 179 | 0.0154 | 3,409 | 112 | 0.0154 | 2,136 | 206 | 0.0154 | 3,905 |
| | Apr | 1,312 | 0.0143 | 23,142 | 462 | 0.0143 | 8,149 | 106 | 0.0143 | 1,875 | 1,418 | 0.0143 | 25,017 | 956 | 0.0143 | 16,868 | 1,224 | 0.0143 | 21,585 |
| | May | 2,470 | 0.0131 | 39,912 | 649 | 0.0131 | 10,487 | 200 | 0.0131 | 3,233 | 2,670 | 0.0131 | 43,145 | 2,021 | 0.0131 | 32,658 | 1,039 | 0.0131 | 16,788 |
| | Jun | 763 | 0.0141 | 13,270 | 202 | 0.0141 | 3,513 | 62 | 0.0141 | 1,075 | 825 | 0.0141 | 14,345 | 623 | 0.0141 | 10,832 | 327 | 0.0141 | 5,691 |
| | Jul | 368 | 0.0110 | 4,993 | 92 | 0.0110 | 1,248 | 29 | 0.0110 | 393 | 397 | 0.0110 | 5,387 | 305 | 0.0110 | 4,138 | 131 | 0.0110 | 1,777 |
| | Aug | 180 | 0.0176 | 3,908 | 46 | 0.0176 | 999 | 15 | 0.0176 | 317 | 195 | 0.0176 | 4,224 | 149 | 0.0176 | 3,226 | 68 | 0.0176 | 1,485 |
| | Sep | 161 | 0.0240 | 4,766 | 47 | 0.0240 | 1,391 | 13 | 0.0240 | 386 | 174 | 0.0240 | 5,152 | 127 | 0.0240 | 3,761 | 94 | 0.0240 | 2,782 |
| WY | Total | 6,112 | 0.0145 | 109,310 | 1,816 | 0.0145 | 32,888 | 494 | 0.0145 | 8,843 | 6,606 | 0.0145 | 118,153 | 4,790 | 0.0145 | 85,265 | 3,776 | 0.0145 | 69,848 |

**Table A-1**

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Goosberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Goosberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | Oct | 132 | 0.0209 | 3,401 | 59 | 0.0209 | 1,532 | 11 | 0.0209 | 275 | 143 | 0.0209 | 3,676 | 83 | 0.0209 | 2,144 | 95 | 0.0209 | 2,460 |
| | Nov | 230 | 0.0198 | 5,628 | 72 | 0.0198 | 1,747 | 19 | 0.0198 | 456 | 249 | 0.0198 | 6,084 | 178 | 0.0198 | 4,337 | 245 | 0.0198 | 5,992 |
| | Dec | 114 | 0.0187 | 2,632 | 64 | 0.0187 | 1,472 | 9 | 0.0187 | 213 | 123 | 0.0187 | 2,845 | 60 | 0.0187 | 1,374 | 110 | 0.0187 | 2,534 |
| 1990 | Jan | 101 | 0.0176 | 2,185 | 62 | 0.0176 | 1,346 | 8 | 0.0176 | 177 | 109 | 0.0176 | 2,361 | 47 | 0.0176 | 1,016 | 117 | 0.0176 | 2,542 |
| | Feb | 97 | 0.0165 | 1,970 | 48 | 0.0165 | 974 | 8 | 0.0165 | 160 | 105 | 0.0165 | 2,130 | 57 | 0.0165 | 1,156 | 106 | 0.0165 | 2,161 |
| | Mar | 128 | 0.0154 | 2,424 | 82 | 0.0154 | 1,554 | 10 | 0.0154 | 196 | 138 | 0.0154 | 2,621 | 56 | 0.0154 | 1,067 | 141 | 0.0154 | 2,676 |
| | Apr | 1,120 | 0.0143 | 19,751 | 561 | 0.0143 | 9,892 | 91 | 0.0143 | 1,600 | 1,210 | 0.0143 | 21,351 | 650 | 0.0143 | 11,460 | 1,037 | 0.0143 | 18,296 |
| | May | 2,564 | 0.0131 | 41,432 | 787 | 0.0131 | 12,719 | 208 | 0.0131 | 3,356 | 2,772 | 0.0131 | 44,787 | 1,985 | 0.0131 | 32,068 | 1,134 | 0.0131 | 18,317 |
| | Jun | 913 | 0.0230 | 25,895 | 244 | 0.0230 | 6,933 | 74 | 0.0230 | 2,098 | 987 | 0.0230 | 27,993 | 742 | 0.0230 | 21,060 | 404 | 0.0230 | 11,464 |
| | Jul | 401 | 0.0110 | 5,439 | 112 | 0.0110 | 1,522 | 32 | 0.0110 | 441 | 433 | 0.0110 | 5,879 | 321 | 0.0110 | 4,358 | 151 | 0.0110 | 2,055 |
| | Aug | 174 | 0.0280 | 6,020 | 56 | 0.0280 | 1,928 | 14 | 0.0280 | 488 | 188 | 0.0280 | 6,507 | 133 | 0.0280 | 4,579 | 64 | 0.0280 | 2,226 |
| | Sep | 127 | 0.0240 | 3,747 | 57 | 0.0240 | 1,683 | 10 | 0.0240 | 303 | 137 | 0.0240 | 4,050 | 80 | 0.0240 | 2,367 | 80 | 0.0240 | 2,363 |
| WY | Total | 6,100 | 0.0160 | 120,524 | 2,204 | 0.0160 | 43,301 | 494 | 0.0160 | 9,762 | 6,594 | 0.0160 | 130,286 | 4,390 | 0.0160 | 86,986 | 3,685 | 0.0160 | 73,087 |
| | Oct | 150 | 0.0209 | 3,878 | 70 | 0.0209 | 1,801 | 12 | 0.0209 | 314 | 163 | 0.0209 | 4,192 | 93 | 0.0209 | 2,391 | 112 | 0.0209 | 2,879 |
| | Nov | 144 | 0.0198 | 3,509 | 153 | 0.0198 | 4,040 | 12 | 0.0198 | 284 | 155 | 0.0198 | 3,793 | -10 | 0.0198 | -247 | 124 | 0.0198 | 3,033 |
| | Dec | 120 | 0.0187 | 2,760 | 66 | 0.0187 | 1,528 | 10 | 0.0187 | 224 | 129 | 0.0187 | 2,984 | 63 | 0.0187 | 1,456 | 114 | 0.0187 | 2,636 |
| 1991 | Jan | 106 | 0.0176 | 2,298 | 64 | 0.0176 | 1,392 | 9 | 0.0176 | 186 | 114 | 0.0176 | 2,485 | 50 | 0.0176 | 1,093 | 129 | 0.0176 | 2,798 |
| | Feb | 104 | 0.0165 | 2,116 | 64 | 0.0165 | 1,298 | 8 | 0.0165 | 171 | 112 | 0.0165 | 2,288 | 49 | 0.0165 | 990 | 123 | 0.0165 | 2,508 |
| | Mar | 125 | 0.0154 | 2,383 | 77 | 0.0154 | 1,464 | 10 | 0.0154 | 193 | 136 | 0.0154 | 2,576 | 59 | 0.0154 | 1,112 | 137 | 0.0154 | 2,607 |
| | Apr | 504 | 0.0143 | 8,889 | 660 | 0.0143 | 11,639 | 41 | 0.0143 | 720 | 545 | 0.0143 | 9,609 | -115 | 0.0143 | -2,030 | 438 | 0.0143 | 7,730 |
| | May | 3,864 | 0.0131 | 62,444 | 1,220 | 0.0131 | 19,708 | 313 | 0.0131 | 5,058 | 4,177 | 0.0131 | 67,502 | 2,958 | 0.0131 | 47,794 | 2,438 | 0.0131 | 39,387 |
| | Jun | 2,537 | 0.0190 | 59,463 | 448 | 0.0190 | 10,509 | 205 | 0.0190 | 4,816 | 2,743 | 0.0190 | 64,279 | 2,294 | 0.0190 | 53,770 | 1,246 | 0.0190 | 29,200 |
| | Jul | 567 | 0.0110 | 7,688 | 185 | 0.0110 | 2,508 | 46 | 0.0110 | 623 | 613 | 0.0110 | 8,311 | 428 | 0.0110 | 5,803 | 260 | 0.0110 | 3,525 |
| | Aug | 296 | 0.0050 | 1,824 | 77 | 0.0050 | 475 | 24 | 0.0050 | 148 | 320 | 0.0050 | 1,971 | 243 | 0.0050 | 1,496 | 144 | 0.0050 | 885 |
| | Sep | 249 | 0.0240 | 7,374 | 62 | 0.0240 | 1,850 | 20 | 0.0240 | 597 | 269 | 0.0240 | 7,972 | 207 | 0.0240 | 6,122 | 131 | 0.0240 | 3,884 |
| WY | Total | 8,766 | 0.0152 | 164,627 | 3,159 | 0.0152 | 58,213 | 710 | 0.0152 | 13,335 | 9,476 | 0.0152 | 177,962 | 6,317 | 0.0152 | 119,749 | 5,396 | 0.0152 | 101,071 |
| | Oct | 154 | 0.0400 | 7,619 | 24 | 0.0400 | 1,199 | 13 | 0.0400 | 617 | 167 | 0.0400 | 8,236 | 143 | 0.0400 | 7,037 | 115 | 0.0400 | 5,682 |
| | Nov | 145 | 0.0198 | 3,534 | 14 | 0.0198 | 331 | 12 | 0.0198 | 286 | 156 | 0.0198 | 3,820 | 143 | 0.0198 | 3,489 | 126 | 0.0198 | 3,068 |
| | Dec | 124 | 0.0187 | 2,854 | 21 | 0.0187 | 486 | 10 | 0.0187 | 231 | 134 | 0.0187 | 3,085 | 113 | 0.0187 | 2,599 | 118 | 0.0187 | 2,711 |
| 1992 | Jan | 90 | 0.0176 | 1,951 | 21 | 0.0176 | 462 | 7 | 0.0176 | 158 | 97 | 0.0176 | 2,109 | 76 | 0.0176 | 1,646 | 93 | 0.0176 | 2,018 |
| | Feb | 82 | 0.0165 | 1,660 | 20 | 0.0165 | 416 | 7 | 0.0165 | 134 | 88 | 0.0165 | 1,795 | 68 | 0.0165 | 1,379 | 70 | 0.0165 | 1,426 |
| | Mar | 141 | 0.0154 | 2,682 | 23 | 0.0154 | 442 | 11 | 0.0154 | 217 | 153 | 0.0154 | 2,900 | 129 | 0.0154 | 2,457 | 163 | 0.0154 | 3,104 |
| | Apr | 741 | 0.0143 | 13,071 | 38 | 0.0143 | 677 | 60 | 0.0143 | 1,059 | 801 | 0.0143 | 14,130 | 763 | 0.0143 | 13,453 | 669 | 0.0143 | 11,798 |
| | May | 1,705 | 0.0131 | 27,544 | 641 | 0.0131 | 10,362 | 138 | 0.0131 | 2,231 | 1,843 | 0.0131 | 29,775 | 1,201 | 0.0131 | 19,413 | 272 | 0.0131 | 4,391 |
| | Jun | 654 | 0.0090 | 7,255 | 421 | 0.0090 | 4,671 | 53 | 0.0090 | 588 | 706 | 0.0090 | 7,842 | 256 | 0.0090 | 3,171 | 270 | 0.0090 | 2,994 |
| | Jul | 263 | 0.0110 | 3,568 | 82 | 0.0110 | 1,109 | 21 | 0.0110 | 289 | 284 | 0.0110 | 3,857 | 209 | 0.0110 | 2,748 | 61 | 0.0110 | 833 |
| | Aug | 136 | 0.0210 | 3,513 | 46 | 0.0210 | 1,189 | 11 | 0.0210 | 285 | 147 | 0.0210 | 3,797 | 101 | 0.0210 | 2,609 | 39 | 0.0210 | 1,016 |
| | Sep | 118 | 0.0240 | 3,488 | 40 | 0.0240 | 1,189 | 10 | 0.0240 | 283 | 127 | 0.0240 | 3,771 | 87 | 0.0240 | 2,581 | 76 | 0.0240 | 2,254 |
| WY | Total | 4,351 | 0.0147 | 78,739 | 1,392 | 0.0147 | 22,534 | 352 | 0.0147 | 6,378 | 4,703 | 0.0147 | 85,117 | 3,311 | 0.0147 | 62,583 | 2,072 | 0.0147 | 41,296 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | Concentration mg/L | Weight grams |
| | Oct | 235 | 0.0209 | 6,063 | 195 | 0.0209 | 5,036 | 19 | 0.0209 | 491 | 254 | 0.0209 | 6,554 | 59 | 0.0209 | 1,518 | 186 | 0.0209 | 4,795 |
| | Nov | 176 | 0.0198 | 4,305 | 203 | 0.0198 | 4,969 | 14 | 0.0198 | 349 | 191 | 0.0198 | 4,654 | -13 | 0.0198 | -315 | 170 | 0.0198 | 4,145 |
| | Dec | 160 | 0.0187 | 3,089 | 174 | 0.0187 | 4,023 | 13 | 0.0187 | 299 | 173 | 0.0187 | 3,987 | -2 | 0.0187 | -36 | 146 | 0.0187 | 3,377 |
| 1993 | Jan | 127 | 0.0176 | 2,755 | 128 | 0.0176 | 2,777 | 10 | 0.0176 | 223 | 137 | 0.0176 | 2,978 | 9 | 0.0176 | 202 | 176 | 0.0176 | 3,823 |
| | Feb | 127 | 0.0165 | 2,575 | 104 | 0.0165 | 2,125 | 10 | 0.0165 | 209 | 137 | 0.0165 | 2,784 | 32 | 0.0165 | 658 | 177 | 0.0165 | 3,596 |
| | Mar | 234 | 0.0154 | 4,454 | 222 | 0.0154 | 4,214 | 19 | 0.0154 | 361 | 253 | 0.0154 | 4,814 | 32 | 0.0154 | 600 | 318 | 0.0154 | 6,046 |
| | Apr | 993 | 0.0143 | 17,518 | 1,085 | 0.0143 | 19,134 | 80 | 0.0143 | 1,419 | 1,074 | 0.0143 | 18,937 | -11 | 0.0143 | -197 | 914 | 0.0143 | 16,123 |
| | May | 5,968 | 0.0131 | 96,426 | 1,116 | 0.0131 | 18,037 | 483 | 0.0131 | 7,811 | 6,451 | 0.0131 | 104,247 | 3,335 | 0.0131 | 86,210 | 4,547 | 0.0131 | 73,473 |
| | Jun | 2,602 | 0.0150 | 48,137 | 421 | 0.0150 | 7,787 | 211 | 0.0150 | 3,899 | 2,812 | 0.0150 | 52,036 | 2,392 | 0.0150 | 44,250 | 1,279 | 0.0150 | 23,671 |
| | Jul | 632 | 0.0110 | 8,575 | 200 | 0.0110 | 2,714 | 51 | 0.0110 | 695 | 683 | 0.0110 | 9,270 | 483 | 0.0110 | 6,556 | 302 | 0.0110 | 4,104 |
| | Aug | 305 | 0.0050 | 1,883 | 106 | 0.0050 | 654 | 25 | 0.0050 | 153 | 330 | 0.0050 | 2,036 | 224 | 0.0050 | 1,382 | 150 | 0.0050 | 924 |
| | Sep | 226 | 0.0240 | 6,683 | 124 | 0.0240 | 3,664 | 18 | 0.0240 | 541 | 244 | 0.0240 | 7,226 | 120 | 0.0240 | 3,562 | 121 | 0.0240 | 3,595 |
| WY | Total | 11,785 | 0.0140 | 203,075 | 4,079 | 0.0140 | 75,135 | 955 | 0.0140 | 16,449 | 12,740 | 0.0140 | 219,524 | 8,661 | 0.0140 | 144,389 | 8,487 | 0.0140 | 147,672 |
| | Oct | 180 | 0.0209 | 4,708 | 27 | 0.0209 | 689 | 15 | 0.0209 | 381 | 197 | 0.0209 | 5,089 | 171 | 0.0209 | 4,400 | 140 | 0.0209 | 3,607 |
| | Nov | 142 | 0.0198 | 3,470 | 17 | 0.0198 | 418 | 12 | 0.0198 | 281 | 154 | 0.0198 | 3,751 | 136 | 0.0198 | 3,333 | 122 | 0.0198 | 2,978 |
| | Dec | 124 | 0.0187 | 3,083 | 16 | 0.0187 | 365 | 11 | 0.0187 | 250 | 144 | 0.0187 | 3,333 | 129 | 0.0187 | 2,968 | 125 | 0.0187 | 2,894 |
| 1994 | Jan | 99 | 0.0176 | 2,140 | 20 | 0.0176 | 439 | 8 | 0.0176 | 173 | 107 | 0.0176 | 2,314 | 86 | 0.0176 | 1,874 | 112 | 0.0176 | 2,463 |
| | Feb | 94 | 0.0165 | 1,908 | 23 | 0.0165 | 464 | 8 | 0.0165 | 155 | 101 | 0.0165 | 2,062 | 79 | 0.0165 | 1,598 | 99 | 0.0165 | 2,013 |
| | Mar | 129 | 0.0154 | 2,445 | 38 | 0.0154 | 725 | 10 | 0.0154 | 198 | 139 | 0.0154 | 2,644 | 101 | 0.0154 | 1,918 | 143 | 0.0154 | 2,711 |
| | Apr | 652 | 0.0143 | 11,496 | 99 | 0.0143 | 1,738 | 53 | 0.0143 | 931 | 705 | 0.0143 | 12,427 | 606 | 0.0143 | 10,689 | 582 | 0.0143 | 10,266 |
| | May | 3,411 | 0.0131 | 55,114 | 1,079 | 0.0131 | 17,428 | 276 | 0.0131 | 4,464 | 3,687 | 0.0131 | 59,579 | 2,609 | 0.0131 | 42,151 | 1,983 | 0.0131 | 32,037 |
| | Jun | 936 | 0.0141 | 16,282 | 401 | 0.0141 | 6,968 | 76 | 0.0141 | 1,319 | 1,012 | 0.0141 | 17,601 | 611 | 0.0141 | 10,633 | 416 | 0.0141 | 7,239 |
| | Jul | 294 | 0.0190 | 6,881 | 66 | 0.0190 | 2,010 | 24 | 0.0190 | 557 | 317 | 0.0190 | 7,438 | 232 | 0.0190 | 5,429 | 81 | 0.0190 | 1,908 |
| | Aug | 206 | 0.0220 | 5,581 | 41 | 0.0220 | 1,107 | 17 | 0.0220 | 452 | 222 | 0.0220 | 6,033 | 182 | 0.0220 | 4,926 | 83 | 0.0220 | 2,303 |
| | Sep | 162 | 0.0240 | 4,787 | 26 | 0.0240 | 781 | 13 | 0.0240 | 388 | 175 | 0.0240 | 5,174 | 148 | 0.0240 | 4,393 | 95 | 0.0240 | 2,799 |
| WY | Total | 6,439 | 0.0148 | 117,895 | 1,872 | 0.0148 | 33,132 | 522 | 0.0148 | 9,550 | 6,961 | 0.0148 | 127,445 | 5,089 | 0.0148 | 94,312 | 3,981 | 0.0148 | 73,197 |
| | Oct | 217 | 0.0209 | 5,587 | 76 | 0.0209 | 1,968 | 18 | 0.0209 | 453 | 234 | 0.0209 | 6,040 | 158 | 0.0209 | 4,072 | 170 | 0.0209 | 4,378 |
| | Nov | 148 | 0.0198 | 3,617 | 64 | 0.0198 | 1,551 | 12 | 0.0198 | 293 | 160 | 0.0198 | 3,910 | 97 | 0.0198 | 2,358 | 130 | 0.0198 | 3,182 |
| | Dec | 154 | 0.0187 | 3,550 | 62 | 0.0187 | 1,441 | 12 | 0.0187 | 288 | 166 | 0.0187 | 3,838 | 104 | 0.0187 | 2,397 | 142 | 0.0187 | 3,266 |
| 1995 | Jan | 121 | 0.0176 | 2,628 | 49 | 0.0176 | 1,061 | 10 | 0.0176 | 213 | 131 | 0.0176 | 2,841 | 82 | 0.0176 | 1,780 | 163 | 0.0176 | 3,537 |
| | Feb | 113 | 0.0165 | 2,298 | 44 | 0.0165 | 888 | 9 | 0.0165 | 186 | 122 | 0.0165 | 2,484 | 78 | 0.0165 | 1,597 | 144 | 0.0165 | 2,939 |
| | Mar | 196 | 0.0154 | 3,723 | 60 | 0.0154 | 1,138 | 16 | 0.0154 | 302 | 212 | 0.0154 | 4,024 | 152 | 0.0154 | 2,886 | 254 | 0.0154 | 4,832 |
| | Apr | 570 | 0.0143 | 10,046 | 292 | 0.0143 | 5,151 | 46 | 0.0143 | 814 | 616 | 0.0143 | 10,860 | 324 | 0.0143 | 5,709 | 502 | 0.0143 | 8,855 |
| | May | 4,413 | 0.0131 | 71,304 | 1,129 | 0.0131 | 18,235 | 357 | 0.0131 | 5,776 | 4,770 | 0.0131 | 77,080 | 3,642 | 0.0131 | 58,845 | 2,987 | 0.0131 | 48,272 |
| | Jun | 6,590 | 0.0141 | 114,608 | 253 | 0.0141 | 4,393 | 534 | 0.0141 | 9,283 | 7,123 | 0.0141 | 123,891 | 6,871 | 0.0141 | 119,498 | 3,346 | 0.0141 | 58,195 |
| | Jul | 1,329 | 0.0050 | 8,197 | 77 | 0.0050 | 475 | 108 | 0.0050 | 664 | 1,437 | 0.0050 | 8,861 | 1,360 | 0.0050 | 8,386 | 758 | 0.0050 | 4,674 |
| | Aug | 513 | 0.0176 | 11,127 | 65 | 0.0176 | 1,421 | 42 | 0.0176 | 901 | 554 | 0.0176 | 12,028 | 489 | 0.0176 | 10,607 | 285 | 0.0176 | 6,183 |
| | Sep | 284 | 0.0240 | 8,398 | 60 | 0.0240 | 1,768 | 23 | 0.0240 | 680 | 307 | 0.0240 | 9,078 | 247 | 0.0240 | 7,310 | 146 | 0.0240 | 4,313 |
| WY | Total | 14,646 | 0.0136 | 245,082 | 2,230 | 0.0136 | 39,489 | 1,186 | 0.0136 | 19,852 | 15,832 | 0.0136 | 264,934 | 13,602 | 0.0136 | 225,445 | 9,027 | 0.0136 | 152,628 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | Oct | 179 | 0.0050 | 1,106 | 37 | 0.0050 | 231 | 15 | 0.0050 | 90 | 194 | 0.0050 | 1,195 | 156 | 0.0050 | 965 | 137 | 0.0050 | 845 |
| | Nov | 162 | 0.0198 | 3,960 | 26 | 0.0198 | 632 | 13 | 0.0198 | 321 | 175 | 0.0198 | 4,281 | 149 | 0.0198 | 3,649 | 150 | 0.0198 | 3,663 |
| | Dec | 140 | 0.0187 | 3,225 | 28 | 0.0187 | 646 | 11 | 0.0187 | 261 | 151 | 0.0187 | 3,486 | 123 | 0.0187 | 2,840 | 130 | 0.0187 | 3,007 |
| 1996 | Jan | 92 | 0.0176 | 1,990 | 28 | 0.0176 | 606 | 7 | 0.0176 | 161 | 99 | 0.0176 | 2,151 | 71 | 0.0176 | 1,545 | 97 | 0.0176 | 2,106 |
| | Feb | 99 | 0.0165 | 2,021 | 25 | 0.0165 | 517 | 8 | 0.0165 | 164 | 107 | 0.0165 | 2,185 | 82 | 0.0165 | 1,668 | 112 | 0.0165 | 2,282 |
| | Mar | 140 | 0.0154 | 2,668 | 46 | 0.0154 | 880 | 11 | 0.0154 | 216 | 152 | 0.0154 | 2,884 | 105 | 0.0154 | 2,004 | 162 | 0.0154 | 3,080 |
| | Apr | 427 | 0.0143 | 7,531 | 94 | 0.0143 | 1,661 | 35 | 0.0143 | 610 | 462 | 0.0143 | 8,140 | 367 | 0.0143 | 6,480 | 363 | 0.0143 | 6,408 |
| | May | 5,177 | 0.0131 | 83,647 | 756 | 0.0131 | 12,216 | 419 | 0.0131 | 6,775 | 5,596 | 0.0131 | 90,422 | 4,840 | 0.0131 | 78,206 | 3,753 | 0.0131 | 60,649 |
| | Jun | 2,465 | 0.0120 | 36,492 | 1,165 | 0.0120 | 17,247 | 200 | 0.0120 | 2,956 | 2,665 | 0.0120 | 39,448 | 1,500 | 0.0120 | 22,202 | 1,209 | 0.0120 | 17,891 |
| | Jul | 519 | 0.0110 | 7,037 | 242 | 0.0110 | 3,277 | 42 | 0.0110 | 570 | 561 | 0.0110 | 7,607 | 319 | 0.0110 | 4,330 | 228 | 0.0110 | 3,099 |
| | Aug | 206 | 0.0250 | 6,344 | 88 | 0.0250 | 2,720 | 17 | 0.0250 | 514 | 222 | 0.0250 | 6,858 | 134 | 0.0250 | 4,138 | 85 | 0.0250 | 2,619 |
| | Sep | 142 | 0.0240 | 4,200 | 45 | 0.0240 | 1,326 | 11 | 0.0240 | 340 | 153 | 0.0240 | 4,540 | 109 | 0.0240 | 3,215 | 86 | 0.0240 | 2,553 |
| WY | Total | 9,748 | 0.0133 | 160,221 | 2,581 | 0.0133 | 41,958 | 790 | 0.0133 | 12,978 | 10,537 | 0.0133 | 173,199 | 7,957 | 0.0133 | 131,241 | 6,513 | 0.0133 | 108,202 |
| | Oct | 144 | 0.0209 | 3,722 | 37 | 0.0209 | 958 | 12 | 0.0209 | 301 | 156 | 0.0209 | 4,023 | 119 | 0.0209 | 3,065 | 106 | 0.0209 | 2,742 |
| | Nov | 167 | 0.0198 | 4,090 | 38 | 0.0198 | 926 | 14 | 0.0198 | 331 | 181 | 0.0198 | 4,422 | 143 | 0.0198 | 3,496 | 157 | 0.0198 | 3,845 |
| | Dec | 147 | 0.0187 | 3,396 | 32 | 0.0187 | 741 | 12 | 0.0187 | 275 | 159 | 0.0187 | 3,671 | 127 | 0.0187 | 2,930 | 136 | 0.0187 | 3,143 |
| 1997 | Jan | 116 | 0.0176 | 2,520 | 21 | 0.0176 | 463 | 9 | 0.0176 | 204 | 125 | 0.0176 | 2,724 | 104 | 0.0176 | 2,262 | 152 | 0.0176 | 3,295 |
| | Feb | 114 | 0.0165 | 2,317 | 25 | 0.0165 | 500 | 9 | 0.0165 | 188 | 123 | 0.0165 | 2,505 | 98 | 0.0165 | 2,004 | 147 | 0.0165 | 2,983 |
| | Mar | 166 | 0.0154 | 3,151 | 34 | 0.0154 | 644 | 13 | 0.0154 | 255 | 179 | 0.0154 | 3,407 | 145 | 0.0154 | 2,763 | 204 | 0.0154 | 3,883 |
| | Apr | 634 | 0.0143 | 11,190 | 95 | 0.0143 | 1,633 | 51 | 0.0143 | 906 | 686 | 0.0143 | 12,096 | 593 | 0.0143 | 10,464 | 565 | 0.0143 | 9,968 |
| | May | 7,428 | 0.0131 | 120,020 | 1,089 | 0.0131 | 17,591 | 602 | 0.0131 | 9,722 | 8,029 | 0.0131 | 129,742 | 6,941 | 0.0131 | 112,151 | 6,011 | 0.0131 | 97,123 |
| | Jun | 3,025 | 0.0141 | 52,608 | 343 | 0.0141 | 5,968 | 245 | 0.0141 | 4,261 | 3,270 | 0.0141 | 56,869 | 2,927 | 0.0141 | 50,901 | 1,499 | 0.0141 | 26,064 |
| | Jul | 543 | 0.0110 | 7,361 | 69 | 0.0110 | 941 | 44 | 0.0110 | 596 | 586 | 0.0110 | 7,957 | 517 | 0.0110 | 7,016 | 244 | 0.0110 | 3,311 |
| | Aug | 248 | 0.0176 | 5,394 | 28 | 0.0176 | 603 | 20 | 0.0176 | 437 | 269 | 0.0176 | 5,830 | 241 | 0.0176 | 5,228 | 113 | 0.0176 | 2,448 |
| | Sep | 255 | 0.0240 | 7,542 | 25 | 0.0240 | 731 | 21 | 0.0240 | 611 | 275 | 0.0240 | 8,153 | 251 | 0.0240 | 7,423 | 134 | 0.0240 | 3,955 |
| WY | Total | 12,987 | 0.0139 | 223,312 | 1,833 | 0.0139 | 31,698 | 1,052 | 0.0139 | 18,088 | 14,039 | 0.0139 | 241,400 | 12,206 | 0.0139 | 209,702 | 9,467 | 0.0139 | 162,760 |
| | Oct | 210 | 0.0209 | 5,404 | 19 | 0.0209 | 485 | 17 | 0.0209 | 438 | 227 | 0.0209 | 5,841 | 208 | 0.0209 | 5,356 | 164 | 0.0209 | 4,217 |
| | Nov | 170 | 0.0198 | 4,146 | 25 | 0.0198 | 613 | 14 | 0.0198 | 336 | 183 | 0.0198 | 4,481 | 158 | 0.0198 | 3,868 | 161 | 0.0198 | 3,922 |
| | Dec | 168 | 0.0187 | 3,875 | 22 | 0.0187 | 507 | 14 | 0.0187 | 314 | 182 | 0.0187 | 4,186 | 160 | 0.0187 | 3,681 | 153 | 0.0187 | 3,525 |
| 1998 | Jan | 130 | 0.0176 | 2,813 | 21 | 0.0176 | 464 | 10 | 0.0176 | 228 | 140 | 0.0176 | 3,041 | 119 | 0.0176 | 2,577 | 182 | 0.0176 | 3,952 |
| | Feb | 140 | 0.0165 | 2,851 | 20 | 0.0165 | 416 | 11 | 0.0165 | 231 | 151 | 0.0165 | 3,082 | 131 | 0.0165 | 2,666 | 209 | 0.0165 | 4,251 |
| | Mar | 204 | 0.0154 | 3,867 | 29 | 0.0154 | 555 | 16 | 0.0154 | 313 | 220 | 0.0154 | 4,181 | 191 | 0.0154 | 3,626 | 267 | 0.0154 | 5,072 |
| | Apr | 642 | 0.0143 | 11,328 | 97 | 0.0143 | 1,706 | 52 | 0.0143 | 918 | 694 | 0.0143 | 12,245 | 597 | 0.0143 | 10,539 | 573 | 0.0143 | 10,102 |
| | May | 4,626 | 0.0131 | 74,747 | 1,081 | 0.0131 | 17,474 | 375 | 0.0131 | 6,054 | 5,000 | 0.0131 | 80,801 | 3,919 | 0.0131 | 63,327 | 3,201 | 0.0131 | 51,724 |
| | Jun | 2,818 | 0.0100 | 34,765 | 370 | 0.0100 | 4,558 | 228 | 0.0100 | 2,816 | 3,047 | 0.0100 | 37,581 | 2,677 | 0.0100 | 33,023 | 1,392 | 0.0100 | 17,166 |
| | Jul | 759 | 0.0110 | 10,293 | 64 | 0.0110 | 862 | 61 | 0.0110 | 834 | 820 | 0.0110 | 11,127 | 756 | 0.0110 | 10,264 | 385 | 0.0110 | 5,226 |
| | Aug | 337 | 0.0176 | 7,323 | 30 | 0.0176 | 641 | 27 | 0.0176 | 593 | 365 | 0.0176 | 7,916 | 335 | 0.0176 | 7,275 | 171 | 0.0176 | 3,705 |
| | Sep | 240 | 0.0150 | 4,446 | 32 | 0.0150 | 594 | 19 | 0.0150 | 360 | 260 | 0.0150 | 4,807 | 228 | 0.0150 | 4,213 | 128 | 0.0150 | 2,359 |
| WY | Total | 10,443 | 0.0129 | 165,857 | 1,810 | 0.0129 | 28,875 | 946 | 0.0129 | 13,434 | 11,289 | 0.0129 | 179,291 | 9,479 | 0.0129 | 150,416 | 6,984 | 0.0129 | 115,222 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/L | Weight Tons | Flow Acre-Feet | Concentration mg/L | Weight Tons | Flow Acre-Feet | Concentration mg/L | Weight Tons | Flow Acre-Feet | Concentration mg/L | Weight Tons | Flow Acre-Feet | Concentration mg/L | Weight Tons | Flow Acre-Feet | Concentration mg/L | Weight Tons |
| | Oct | 197 | 0.0209 | 5,084 | 33 | 0.0209 | 855 | 16 | 0.0209 | 412 | 211 | 0.0209 | 5,495 | 180 | 0.0209 | 4,640 | 153 | 0.0209 | 3,936 |
| | Nov | 167 | 0.0198 | 4,079 | 28 | 0.0198 | 696 | 14 | 0.0198 | 330 | 181 | 0.0198 | 4,410 | 152 | 0.0198 | 3,714 | 157 | 0.0198 | 3,830 |
| | Dec | 85 | 0.0187 | 1,966 | 28 | 0.0187 | 644 | 7 | 0.0187 | 159 | 92 | 0.0187 | 2,125 | 64 | 0.0187 | 1,481 | 87 | 0.0187 | 2,002 |
| 1999 | Jan | 67 | 0.0176 | 1,458 | 27 | 0.0176 | 583 | 5 | 0.0176 | 118 | 73 | 0.0176 | 1,576 | 46 | 0.0176 | 993 | 42 | 0.0176 | 913 |
| | Feb | 85 | 0.0165 | 1,737 | 30 | 0.0165 | 618 | 7 | 0.0165 | 141 | 92 | 0.0165 | 1,877 | 62 | 0.0165 | 1,259 | 79 | 0.0165 | 1,607 |
| | Mar | 127 | 0.0154 | 2,413 | 41 | 0.0154 | 777 | 10 | 0.0154 | 195 | 137 | 0.0154 | 2,609 | 96 | 0.0154 | 1,832 | 140 | 0.0154 | 2,657 |
| | Apr | 339 | 0.0143 | 5,977 | 105 | 0.0143 | 1,844 | 27 | 0.0143 | 484 | 366 | 0.0143 | 6,461 | 262 | 0.0143 | 4,617 | 278 | 0.0143 | 4,896 |
| | May | 3,776 | 0.0131 | 61,012 | 636 | 0.0131 | 10,277 | 306 | 0.0131 | 4,942 | 4,082 | 0.0131 | 65,954 | 3,446 | 0.0131 | 55,677 | 2,349 | 0.0131 | 37,951 |
| | Jun | 2,882 | 0.0230 | 81,749 | 363 | 0.0230 | 10,311 | 233 | 0.0230 | 6,622 | 3,115 | 0.0230 | 88,371 | 2,751 | 0.0230 | 78,059 | 1,424 | 0.0230 | 40,410 |
| | Jul | 618 | 0.0110 | 8,385 | 102 | 0.0110 | 1,384 | 50 | 0.0110 | 679 | 668 | 0.0110 | 9,064 | 566 | 0.0110 | 7,680 | 293 | 0.0110 | 3,980 |
| | Aug | 416 | 0.0250 | 12,822 | 45 | 0.0250 | 1,393 | 34 | 0.0250 | 1,039 | 449 | 0.0250 | 13,861 | 404 | 0.0250 | 12,467 | 222 | 0.0250 | 6,839 |
| | Sep | 293 | 0.0240 | 8,678 | 32 | 0.0240 | 939 | 24 | 0.0240 | 703 | 317 | 0.0240 | 9,381 | 285 | 0.0240 | 8,441 | 150 | 0.0240 | 4,431 |
| WY | Total | 9,052 | 0.0175 | 195,359 | 1,471 | 0.0175 | 30,321 | 733 | 0.0175 | 15,824 | 9,785 | 0.0175 | 211,183 | 8,315 | 0.0175 | 180,561 | 5,372 | 0.0175 | 113,451 |
| | Oct | 158 | 0.0209 | 4,077 | 41 | 0.0209 | 1,053 | 13 | 0.0209 | 330 | 171 | 0.0209 | 4,408 | 130 | 0.0209 | 3,355 | 118 | 0.0209 | 3,054 |
| | Nov | 139 | 0.0198 | 3,394 | 38 | 0.0198 | 926 | 11 | 0.0198 | 275 | 150 | 0.0198 | 3,669 | 112 | 0.0198 | 2,742 | 118 | 0.0198 | 2,872 |
| | Dec | 94 | 0.0187 | 2,159 | 19 | 0.0187 | 428 | 8 | 0.0187 | 175 | 101 | 0.0187 | 2,334 | 83 | 0.0187 | 1,907 | 93 | 0.0187 | 2,157 |
| 2000 | Jan | 82 | 0.0176 | 1,790 | 11 | 0.0176 | 234 | 7 | 0.0176 | 145 | 89 | 0.0176 | 1,935 | 78 | 0.0176 | 1,701 | 76 | 0.0176 | 1,657 |
| | Feb | 80 | 0.0165 | 1,635 | 17 | 0.0165 | 352 | 7 | 0.0165 | 132 | 87 | 0.0165 | 1,767 | 70 | 0.0165 | 1,416 | 67 | 0.0165 | 1,366 |
| | Mar | 123 | 0.0154 | 2,331 | 29 | 0.0154 | 551 | 10 | 0.0154 | 189 | 133 | 0.0154 | 2,520 | 104 | 0.0154 | 1,969 | 133 | 0.0154 | 2,520 |
| | Apr | 821 | 0.0143 | 14,484 | 66 | 0.0143 | 1,168 | 67 | 0.0143 | 1,173 | 888 | 0.0143 | 15,657 | 821 | 0.0143 | 14,489 | 747 | 0.0143 | 13,172 |
| | May | 3,179 | 0.0131 | 51,363 | 711 | 0.0131 | 11,496 | 257 | 0.0131 | 4,160 | 3,436 | 0.0131 | 55,524 | 2,725 | 0.0131 | 44,028 | 1,750 | 0.0131 | 28,276 |
| | Jun | 1,040 | 0.0100 | 12,825 | 513 | 0.0100 | 6,324 | 84 | 0.0100 | 1,039 | 1,124 | 0.0100 | 13,864 | 611 | 0.0100 | 7,539 | 470 | 0.0100 | 5,796 |
| | Jul | 322 | 0.0110 | 4,304 | 106 | 0.0110 | 1,432 | 26 | 0.0110 | 353 | 348 | 0.0110 | 4,717 | 242 | 0.0110 | 3,286 | 100 | 0.0110 | 1,353 |
| | Aug | 196 | 0.0180 | 4,360 | 77 | 0.0180 | 1,707 | 16 | 0.0180 | 353 | 212 | 0.0180 | 4,713 | 135 | 0.0180 | 3,006 | 79 | 0.0180 | 1,750 |
| | Sep | 150 | 0.0240 | 4,429 | 53 | 0.0240 | 1,580 | 12 | 0.0240 | 359 | 162 | 0.0240 | 4,787 | 108 | 0.0240 | 3,207 | 89 | 0.0240 | 2,649 |
| WY | Total | 6,383 | 0.0136 | 107,211 | 1,681 | 0.0136 | 27,252 | 517 | 0.0136 | 8,684 | 6,900 | 0.0136 | 115,895 | 5,220 | 0.0136 | 88,643 | 3,840 | 0.0136 | 66,621 |
| | Oct | 153 | 0.0209 | 3,956 | 49 | 0.0209 | 1,259 | 12 | 0.0209 | 320 | 166 | 0.0209 | 4,277 | 117 | 0.0209 | 3,018 | 114 | 0.0209 | 2,948 |
| | Nov | 127 | 0.0198 | 3,090 | 45 | 0.0198 | 1,103 | 10 | 0.0198 | 250 | 137 | 0.0198 | 3,341 | 92 | 0.0198 | 2,238 | 100 | 0.0198 | 2,448 |
| | Dec | 38 | 0.0187 | 887 | 35 | 0.0187 | 798 | 3 | 0.0187 | 72 | 42 | 0.0187 | 959 | 7 | 0.0187 | 161 | 49 | 0.0187 | 1,142 |
| 2001 | Jan | 46 | 0.0176 | 996 | 38 | 0.0176 | 660 | 4 | 0.0176 | 81 | 50 | 0.0176 | 1,077 | 19 | 0.0176 | 417 | -6 | 0.0176 | -124 |
| | Feb | 58 | 0.0165 | 1,180 | 27 | 0.0165 | 546 | 5 | 0.0165 | 96 | 63 | 0.0165 | 1,279 | 36 | 0.0165 | 733 | 14 | 0.0165 | 294 |
| | Mar | 131 | 0.0154 | 2,494 | 46 | 0.0154 | 882 | 11 | 0.0154 | 202 | 142 | 0.0154 | 2,696 | 96 | 0.0154 | 1,814 | 147 | 0.0154 | 2,791 |
| | Apr | 907 | 0.0143 | 15,999 | 308 | 0.0143 | 5,434 | 73 | 0.0143 | 1,296 | 981 | 0.0143 | 17,295 | 672 | 0.0143 | 11,862 | 830 | 0.0143 | 14,646 |
| | May | 3,624 | 0.0131 | 58,565 | 879 | 0.0131 | 14,203 | 294 | 0.0131 | 4,746 | 3,918 | 0.0131 | 63,309 | 3,039 | 0.0131 | 49,103 | 2,197 | 0.0131 | 35,497 |
| | Jun | 696 | 0.0100 | 8,584 | 212 | 0.0100 | 2,620 | 56 | 0.0100 | 695 | 752 | 0.0100 | 9,279 | 540 | 0.0100 | 6,660 | 292 | 0.0100 | 3,598 |
| | Jul | 277 | 0.0110 | 3,757 | 67 | 0.0110 | 911 | 22 | 0.0110 | 304 | 299 | 0.0110 | 4,061 | 222 | 0.0110 | 3,150 | 70 | 0.0110 | 958 |
| | Aug | 184 | 0.0100 | 2,273 | 42 | 0.0100 | 519 | 15 | 0.0100 | 188 | 199 | 0.0100 | 2,459 | 157 | 0.0100 | 1,940 | 71 | 0.0100 | 876 |
| | Sep | 110 | 0.0240 | 3,263 | 39 | 0.0240 | 1,156 | 9 | 0.0240 | 264 | 119 | 0.0240 | 3,527 | 80 | 0.0240 | 2,377 | 73 | 0.0240 | 2,160 |
| WY | Total | 6,353 | 0.0134 | 105,050 | 1,780 | 0.0134 | 30,085 | 515 | 0.0134 | 8,509 | 6,867 | 0.0134 | 113,559 | 5,087 | 0.0134 | 83,474 | 3,953 | 0.0134 | 67,233 |

**Table A-1**

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Reach Gain Between Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/liter | Weight grams | Flow Acre-Feet | Concentration mg/liter | Weight grams | Flow Acre-Feet | Concentration mg/liter | Weight grams | Flow Acre-Feet | Concentration mg/liter | Weight grams | Flow Acre-Feet | Concentration mg/liter | Weight grams | Flow Acre-Feet | Concentration mg/liter | Weight grams |
| | Oct | 92 | 0.0209 | 2,384 | 28 | 0.0209 | 712 | 7 | 0.0209 | 193 | 100 | 0.0209 | 2,577 | 72 | 0.0209 | 1,865 | 61 | 0.0209 | 1,569 |
| | Nov | 121 | 0.0198 | 2,953 | 23 | 0.0198 | 559 | 10 | 0.0198 | 239 | 131 | 0.0198 | 3,192 | 108 | 0.0198 | 2,633 | 92 | 0.0198 | 2,256 |
| | Dec | 79 | 0.0187 | 1,834 | 7 | 0.0187 | 155 | 6 | 0.0187 | 149 | 86 | 0.0187 | 1,982 | 79 | 0.0187 | 1,827 | 82 | 0.0187 | 1,897 |
| 2002 | Jan | 56 | 0.0176 | 1,209 | 2 | 0.0176 | 35 | 5 | 0.0176 | 98 | 60 | 0.0176 | 1,307 | 59 | 0.0176 | 1,272 | 16 | 0.0176 | 354 |
| | Feb | 46 | 0.0165 | 936 | 6 | 0.0165 | 123 | 4 | 0.0165 | 76 | 50 | 0.0165 | 1,012 | 44 | 0.0165 | 890 | -14 | 0.0165 | -292 |
| | Mar | 58 | 0.0154 | 1,097 | 29 | 0.0154 | 550 | 5 | 0.0154 | 89 | 62 | 0.0154 | 1,186 | 34 | 0.0154 | 636 | 25 | 0.0154 | 471 |
| | Apr | 740 | 0.0143 | 13,057 | 179 | 0.0143 | 3,163 | 60 | 0.0143 | 1,058 | 800 | 0.0143 | 14,115 | 621 | 0.0143 | 10,952 | 668 | 0.0143 | 11,784 |
| | May | 2,448 | 0.0131 | 39,554 | 625 | 0.0131 | 10,096 | 198 | 0.0131 | 3,204 | 2,646 | 0.0131 | 42,757 | 2,021 | 0.0131 | 32,662 | 1,017 | 0.0131 | 16,433 |
| | Jun | 503 | 0.0141 | 8,741 | 99 | 0.0141 | 1,726 | 41 | 0.0141 | 708 | 543 | 0.0141 | 9,449 | 444 | 0.0141 | 7,723 | 192 | 0.0141 | 3,331 |
| | Jul | 232 | 0.0110 | 3,149 | 36 | 0.0110 | 490 | 19 | 0.0110 | 255 | 251 | 0.0110 | 3,404 | 215 | 0.0110 | 2,914 | 41 | 0.0110 | 559 |
| | Aug | 114 | 0.0176 | 2,464 | 27 | 0.0176 | 592 | 9 | 0.0176 | 200 | 123 | 0.0176 | 2,664 | 95 | 0.0176 | 2,072 | 25 | 0.0176 | 539 |
| | Sep | 104 | 0.0240 | 3,080 | 18 | 0.0240 | 541 | 8 | 0.0240 | 249 | 112 | 0.0240 | 3,329 | 94 | 0.0240 | 2,788 | 70 | 0.0240 | 2,083 |
| WY | Total | 4,593 | 0.0142 | 80,458 | 1,079 | 0.0142 | 18,741 | 372 | 0.0142 | 6,517 | 4,965 | 0.0142 | 86,975 | 3,886 | 0.0142 | 68,234 | 2,275 | 0.0142 | 40,985 |
| | Oct | 60 | 0.0209 | 1,538 | 58 | 0.0209 | 1,483 | 5 | 0.0209 | 125 | 64 | 0.0209 | 1,663 | 7 | 0.0209 | 180 | 180 | 0.0209 | 4,631 |
| | Nov | 53 | 0.0198 | 1,293 | 48 | 0.0198 | 1,165 | 4 | 0.0198 | 103 | 57 | 0.0198 | 1,398 | 10 | 0.0198 | 233 | 115 | 0.0198 | 2,814 |
| | Dec | 14 | 0.0187 | 323 | 14 | 0.0187 | 324 | 1 | 0.0187 | 26 | 15 | 0.0187 | 349 | 1 | 0.0187 | 25 | 26 | 0.0187 | 592 |
| 2003 | Jan | 45 | 0.0176 | 968 | 3 | 0.0176 | 73 | 4 | 0.0176 | 78 | 48 | 0.0176 | 1,046 | 45 | 0.0176 | 974 | 9 | 0.0176 | 194 |
| | Feb | 52 | 0.0165 | 1,055 | 13 | 0.0165 | 255 | 4 | 0.0165 | 85 | 56 | 0.0165 | 1,141 | 43 | 0.0165 | 885 | 54 | 0.0165 | 1,089 |
| | Mar | 60 | 0.0154 | 1,140 | 60 | 0.0154 | 1,145 | 5 | 0.0154 | 92 | 65 | 0.0154 | 1,232 | 5 | 0.0154 | 87 | 130 | 0.0154 | 2,478 |
| | Apr | 374 | 0.0143 | 6,597 | 374 | 0.0143 | 6,590 | 30 | 0.0143 | 534 | 404 | 0.0143 | 7,131 | 31 | 0.0143 | 541 | 712 | 0.0143 | 12,556 |
| | May | 2,638 | 0.0131 | 42,626 | 1,302 | 0.0131 | 21,033 | 214 | 0.0131 | 3,453 | 2,852 | 0.0131 | 46,079 | 1,550 | 0.0131 | 25,046 | 8,355 | 0.0131 | 70,367 |
| | Jun | 704 | 0.0180 | 15,623 | 207 | 0.0180 | 4,590 | 57 | 0.0180 | 1,265 | 761 | 0.0180 | 16,888 | 554 | 0.0180 | 12,298 | 1,163 | 0.0180 | 25,817 |
| | Jul | 169 | 0.0173 | 3,615 | 75 | 0.0173 | 1,605 | 14 | 0.0173 | 299 | 183 | 0.0173 | 3,908 | 108 | 0.0173 | 2,303 | 245 | 0.0173 | 5,229 |
| | Aug | 125 | 0.0160 | 2,473 | 57 | 0.0160 | 1,120 | 10 | 0.0160 | 200 | 135 | 0.0160 | 2,673 | 79 | 0.0160 | 1,553 | 155 | 0.0160 | 3,081 |
| | Sep | 61 | 0.0240 | 1,515 | 38 | 0.0240 | 1,128 | 3 | 0.0240 | 147 | 66 | 0.0240 | 1,963 | 28 | 0.0240 | 835 | 139 | 0.0240 | 4,124 |
| WY | Total | 4,355 | 0.0147 | 79,067 | 2,248 | 0.0147 | 40,512 | 353 | 0.0147 | 6,404 | 4,707 | 0.0147 | 85,471 | 2,460 | 0.0147 | 44,950 | 7,282 | 0.0147 | 132,940 |
| | Oct | 37 | 0.0209 | 954 | 37 | 0.0209 | 948 | 3 | 0.0209 | 77 | 40 | 0.0209 | 1,031 | 3 | 0.0209 | 83 | 113 | 0.0209 | 2,965 |
| | Nov | 75 | 0.0198 | 1,836 | 30 | 0.0198 | 744 | 6 | 0.0198 | 149 | 81 | 0.0198 | 1,985 | 51 | 0.0198 | 1,240 | 122 | 0.0198 | 2,983 |
| | Dec | 51 | 0.0187 | 1,186 | 9 | 0.0187 | 207 | 4 | 0.0187 | 86 | 56 | 0.0187 | 1,282 | 47 | 0.0187 | 1,075 | 86 | 0.0187 | 1,994 |
| 2004 | Jan | 60 | 0.0176 | 1,312 | 2 | 0.0176 | 47 | 5 | 0.0176 | 106 | 65 | 0.0176 | 1,419 | 63 | 0.0176 | 1,372 | 73 | 0.0176 | 1,582 |
| | Feb | 62 | 0.0165 | 1,257 | 8 | 0.0165 | 163 | 5 | 0.0165 | 102 | 67 | 0.0165 | 1,359 | 59 | 0.0165 | 1,196 | 46 | 0.0165 | 1,749 |
| | Mar | 87 | 0.0154 | 1,644 | 39 | 0.0154 | 732 | 7 | 0.0154 | 131 | 94 | 0.0154 | 1,777 | 55 | 0.0154 | 1,046 | 198 | 0.0154 | 3,768 |
| | Apr | 674 | 0.0143 | 11,894 | 239 | 0.0143 | 4,211 | 55 | 0.0143 | 963 | 729 | 0.0143 | 12,858 | 490 | 0.0143 | 8,647 | 1,193 | 0.0143 | 21,050 |
| | May | 1,854 | 0.0131 | 29,956 | 832 | 0.0131 | 13,440 | 150 | 0.0131 | 2,426 | 2,004 | 0.0131 | 32,382 | 1,172 | 0.0131 | 18,942 | 2,558 | 0.0131 | 41,333 |
| | Jun | 377 | 0.0195 | 9,076 | 132 | 0.0195 | 3,178 | 31 | 0.0195 | 755 | 408 | 0.0195 | 9,811 | 276 | 0.0195 | 6,633 | 840 | 0.0195 | 20,203 |
| | Jul | 169 | 0.0173 | 3,608 | 48 | 0.0173 | 1,026 | 14 | 0.0173 | 292 | 183 | 0.0173 | 3,900 | 135 | 0.0173 | 2,874 | 190 | 0.0173 | 4,058 |
| | Aug | 111 | 0.0211 | 2,890 | 36 | 0.0211 | 944 | 9 | 0.0211 | 234 | 120 | 0.0211 | 3,124 | 84 | 0.0211 | 2,180 | 81 | 0.0211 | 2,121 |
| | Sep | 52 | 0.0240 | 1,552 | 24 | 0.0240 | 721 | 4 | 0.0240 | 126 | 57 | 0.0240 | 1,678 | 32 | 0.0240 | 957 | 105 | 0.0240 | 3,098 |
| WY | Total | 3,610 | 0.0151 | 67,166 | 1,436 | 0.0151 | 26,360 | 292 | 0.0151 | 5,440 | 3,903 | 0.0151 | 72,606 | 2,467 | 0.0151 | 46,247 | 5,648 | 0.0151 | 106,903 |

Table A-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Narrows Reservoir Site Operation

| | | (Franson-Noble) | | | | | | | | | (CALC) | | | (Franson-Noble) | | | (CALC) Reach Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Diversion by Cottonwood-Gooseberry | | | Other Inflow at Narrows Reservoir Site | | | Net Flow at Narrows Reservoir Site | | | Stream Flow below Narrows Reservoir Site | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | Oct | 84 | 0.0209 | 2,154 | 55 | 0.0209 | 1,414 | 7 | 0.0209 | 174 | 90 | 0.0209 | 2,329 | 35 | 0.0209 | 914 | 196 | 0.0209 | 5,059 |
| | Nov | 67 | 0.0198 | 1,642 | 45 | 0.0198 | 1,111 | 5 | 0.0198 | 123 | 73 | 0.0198 | 1,775 | 27 | 0.0198 | 664 | 137 | 0.0198 | 3,355 |
| | Dec | 52 | 0.0187 | 1,193 | 13 | 0.0187 | 309 | 4 | 0.0187 | 97 | 56 | 0.0187 | 1,290 | 43 | 0.0187 | 981 | 96 | 0.0187 | 2,207 |
| 2005 | Jan | 61 | 0.0176 | 1,321 | 3 | 0.0176 | 70 | 5 | 0.0176 | 107 | 66 | 0.0176 | 1,428 | 63 | 0.0176 | 1,359 | 77 | 0.0176 | 1,664 |
| | Feb | 61 | 0.0165 | 1,251 | 12 | 0.0165 | 243 | 5 | 0.0165 | 161 | 66 | 0.0165 | 1,353 | 54 | 0.0165 | 1,109 | 93 | 0.0165 | 1,886 |
| | Mar | 66 | 0.0154 | 1,251 | 57 | 0.0154 | 1,092 | 5 | 0.0154 | 101 | 71 | 0.0154 | 1,352 | 14 | 0.0154 | 261 | 190 | 0.0154 | 3,603 |
| | Apr | 356 | 0.0143 | 6,279 | 356 | 0.0143 | 6,285 | 29 | 0.0143 | 509 | 385 | 0.0143 | 6,788 | 29 | 0.0143 | 503 | 817 | 0.0143 | 14,410 |
| | May | 4,223 | 0.0131 | 68,235 | 1,241 | 0.0131 | 20,058 | 342 | 0.0131 | 5,527 | 4,565 | 0.0131 | 73,762 | 3,324 | 0.0131 | 53,704 | 5,968 | 0.0131 | 96,405 |
| | Jun | 2,544 | 0.0195 | 61,179 | 197 | 0.0195 | 4,742 | 206 | 0.0195 | 4,956 | 2,750 | 0.0195 | 66,135 | 2,552 | 0.0195 | 61,393 | 2,122 | 0.0195 | 51,046 |
| | Jul | 310 | 0.0100 | 3,822 | 72 | 0.0100 | 885 | 25 | 0.0100 | 310 | 335 | 0.0100 | 4,131 | 263 | 0.0100 | 3,247 | 466 | 0.0100 | 5,748 |
| | Aug | 191 | 0.0100 | 2,360 | 54 | 0.0100 | 668 | 15 | 0.0100 | 191 | 207 | 0.0100 | 2,551 | 153 | 0.0100 | 1,883 | 298 | 0.0100 | 3,675 |
| | Sep | 124 | 0.0100 | 1,533 | 36 | 0.0100 | 448 | 10 | 0.0100 | 124 | 134 | 0.0100 | 1,657 | 98 | 0.0100 | 1,209 | 187 | 0.0100 | 2,301 |
| WY | Total | 8,138 | 0.0152 | 152,220 | 2,143 | 0.0152 | 37,324 | 659 | 0.0152 | 12,330 | 8,798 | 0.0152 | 164,550 | 6,654 | 0.0152 | 127,226 | 10,644 | 0.0152 | 191,356 |
| 78-05 | Total | 258,427 | | 4,547,412 | 57,951 | | 1,023,333 | 20,932 | | 368,329 | 279,358 | | 4,915,741 | 221,407 | | 3,892,408 | 179,105 | | 3,188,314 |
| 78-05 | Average | 9,230 | 0.0143 | 162,408 | 2,070 | 0.0143 | 36,548 | 748 | 0.0143 | 13,155 | 9,977 | 0.0143 | 175,562 | 7,907 | 0.0143 | 139,015 | 6,397 | 0.0144 | 113,875 |
| 78-89 | Total | 130,677 | | 2,281,550 | 24,956 | | 438,403 | 10,584 | | 184,795 | 141,261 | | 2,466,344 | 116,305 | | 2,027,942 | 84,475 | | 1,493,889 |
| 78-89 | Average | 10,890 | 0.0142 | 190,129 | 2,080 | 0.0142 | 36,534 | 882 | 0.0142 | 15,400 | 11,772 | 0.0142 | 205,529 | 9,692 | 0.0141 | 168,995 | 7,040 | 0.0143 | 124,491 |

NOTE: Average Annual Concentrations are Flow Weighted. Highlighted cells represent actual measurements.

**Table A-2** Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l From Table 3 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CAL) grams | Flow Acre-Feet | mg/l From Table B-1 | Weight grams |
| | Oct | 150 | 0.0209 | 3,867 | 150 | 0.0129 | 2,389 | | | 1,478 | 150 | 0.0129 | 2,389 |
| | Nov | 162 | 0.0198 | 3,957 | 162 | 0.0129 | 2,580 | | | 1,376 | 162 | 0.0129 | 2,580 |
| | Dec | 164 | 0.0187 | 3,783 | 164 | 0.0129 | 2,612 | | | 1,171 | 164 | 0.0129 | 2,612 |
| 1978 | Jan | 154 | 0.0176 | 3,343 | 154 | 0.0129 | 2,453 | | | 890 | 154 | 0.0129 | 2,453 |
| | Feb | 147 | 0.0165 | 2,992 | 147 | 0.0129 | 2,341 | | | 651 | 147 | 0.0129 | 2,341 |
| | Mar | 191 | 0.0154 | 3,628 | 191 | 0.0129 | 3,042 | | | 586 | 191 | 0.0129 | 3,042 |
| | Apr | 1,030 | 0.0143 | 18,168 | 1,030 | 0.0129 | 16,405 | | | 1,763 | 1,030 | 0.0129 | 16,405 |
| | May | 6,480 | 0.0131 | 104,708 | 6,480 | 0.0129 | 103,208 | | | 1,500 | 6,480 | 0.0129 | 103,208 |
| | Jun | 7,240 | 0.0141 | 125,919 | 7,240 | 0.0129 | 115,313 | | | 10,607 | 7,240 | 0.0129 | 115,313 |
| | Jul | 914 | 0.0110 | 12,401 | 914 | 0.0129 | 14,557 | | | -2,156 | 914 | 0.0129 | 14,557 |
| | Aug | 546 | 0.0176 | 11,853 | 546 | 0.0129 | 8,696 | | | 3,157 | 546 | 0.0129 | 8,696 |
| | Sep | 256 | 0.0240 | 7,579 | 256 | 0.0129 | 4,077 | | | 3,501 | 256 | 0.0129 | 4,077 |
| WY | Total | 17,434 | 0.0140 | 302,199 | 17,434 | 0.0129 | 277,674 | | | 24,525 | 17,434 | 0.0129 | 277,674 |
| | Oct | 40 | 0.0209 | 1,031 | 40 | 0.0127 | 626 | | | 405 | 40 | 0.0127 | 626 |
| | Nov | 261 | 0.0198 | 6,374 | 261 | 0.0127 | 4,086 | | | 2,288 | 261 | 0.0127 | 4,086 |
| | Dec | 173 | 0.0187 | 3,990 | 173 | 0.0127 | 2,708 | | | 1,282 | 173 | 0.0127 | 2,708 |
| 1979 | Jan | 172 | 0.0176 | 3,734 | 172 | 0.0127 | 2,693 | | | 1,041 | 172 | 0.0127 | 2,693 |
| | Feb | 156 | 0.0165 | 3,175 | 156 | 0.0127 | 2,442 | | | 733 | 156 | 0.0127 | 2,442 |
| | Mar | 172 | 0.0154 | 3,267 | 172 | 0.0127 | 2,693 | | | 575 | 172 | 0.0127 | 2,693 |
| | Apr | 476 | 0.0143 | 8,396 | 476 | 0.0127 | 7,452 | | | 944 | 476 | 0.0127 | 7,452 |
| | May | 6,280 | 0.0131 | 101,477 | 6,280 | 0.0127 | 98,317 | | | 3,160 | 6,280 | 0.0127 | 98,317 |
| | Jun | 3,050 | 0.0141 | 53,046 | 3,050 | 0.0127 | 47,749 | | | 5,297 | 3,050 | 0.0127 | 47,749 |
| | Jul | 609 | 0.0110 | 8,263 | 609 | 0.0127 | 9,534 | | | -1,271 | 609 | 0.0127 | 9,534 |
| | Aug | 327 | 0.0176 | 7,099 | 327 | 0.0127 | 5,119 | | | 1,980 | 327 | 0.0127 | 5,119 |
| | Sep | 200 | 0.0240 | 5,921 | 200 | 0.0127 | 3,131 | | | 2,790 | 200 | 0.0127 | 3,131 |
| WY | Total | 11,916 | 0.0140 | 205,774 | 11,916 | 0.0127 | 186,551 | | | 19,223 | 11,916 | 0.0127 | 186,551 |
| | Oct | 229 | 0.0209 | 5,904 | 229 | 0.0130 | 3,672 | | | 2,232 | 229 | 0.0130 | 3,672 |
| | Nov | 201 | 0.0198 | 4,909 | 201 | 0.0130 | 3,223 | | | 1,686 | 201 | 0.0130 | 3,223 |
| | Dec | 215 | 0.0187 | 4,959 | 215 | 0.0130 | 3,448 | | | 1,512 | 215 | 0.0130 | 3,448 |
| 1980 | Jan | 215 | 0.0176 | 4,668 | 215 | 0.0130 | 3,448 | | | 1,220 | 215 | 0.0130 | 3,448 |
| | Feb | 201 | 0.0165 | 4,091 | 201 | 0.0130 | 3,223 | | | 868 | 201 | 0.0130 | 3,223 |
| | Mar | 215 | 0.0154 | 4,084 | 215 | 0.0130 | 3,448 | | | 637 | 215 | 0.0130 | 3,448 |
| | Apr | 946 | 0.0143 | 16,686 | 946 | 0.0130 | 15,169 | | | 1,517 | 946 | 0.0130 | 15,169 |
| | May | 6,630 | 0.0131 | 107,132 | 6,630 | 0.0130 | 106,313 | | | 819 | 6,630 | 0.0130 | 106,313 |
| | Jun | 7,800 | 0.0141 | 135,659 | 7,800 | 0.0130 | 125,075 | | | 10,584 | 7,800 | 0.0130 | 125,075 |
| | Jul | 1,050 | 0.0110 | 14,247 | 1,050 | 0.0130 | 16,837 | | | -2,590 | 1,050 | 0.0130 | 16,837 |
| | Aug | 432 | 0.0176 | 9,378 | 432 | 0.0130 | 6,927 | | | 2,451 | 432 | 0.0130 | 6,927 |
| | Sep | 346 | 0.0240 | 10,243 | 346 | 0.0130 | 5,548 | | | 4,695 | 346 | 0.0130 | 5,548 |
| WY | Total | 18,480 | 0.0141 | 321,960 | 18,480 | 0.0130 | 296,331 | | | 25,630 | 18,480 | 0.0130 | 296,331 |

**Table A-2** Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/L Gb From Table 3 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/L From Table B-1 | Weight grams |
| | Oct | 309 | 0.0209 | 7,966 | 309 | 0.0125 | 4,757 | | | 3,209 | 309 | 0.0125 | 4,757 |
| | Nov | 282 | 0.0198 | 6,887 | 282 | 0.0125 | 4,342 | | | 2,546 | 282 | 0.0125 | 4,342 |
| | Dec | 237 | 0.0187 | 5,467 | 237 | 0.0125 | 3,649 | | | 1,818 | 237 | 0.0125 | 3,649 |
| 1981 | Jan | 226 | 0.0176 | 4,906 | 226 | 0.0125 | 3,480 | | | 1,427 | 226 | 0.0125 | 3,480 |
| | Feb | 205 | 0.0165 | 4,172 | 205 | 0.0125 | 3,156 | | | 1,016 | 205 | 0.0125 | 3,156 |
| | Mar | 317 | 0.0154 | 6,022 | 317 | 0.0125 | 4,881 | | | 1,141 | 317 | 0.0125 | 4,881 |
| | Apr | 1,510 | 0.0143 | 26,635 | 1,510 | 0.0125 | 23,248 | | | 3,387 | 1,510 | 0.0125 | 23,248 |
| | May | 3,650 | 0.0131 | 58,979 | 3,650 | 0.0125 | 56,196 | | | 2,783 | 3,650 | 0.0125 | 56,196 |
| | Jun | 1,590 | 0.0100 | 19,612 | 1,590 | 0.0125 | 24,480 | | | -4,867 | 1,590 | 0.0125 | 24,480 |
| | Jul | 437 | 0.0110 | 5,929 | 437 | 0.0125 | 6,728 | | | -799 | 437 | 0.0125 | 6,728 |
| | Aug | 237 | 0.0176 | 5,145 | 237 | 0.0125 | 3,649 | | | 1,496 | 237 | 0.0125 | 3,649 |
| | Sep | 213 | 0.0240 | 6,306 | 213 | 0.0125 | 3,279 | | | 3,026 | 213 | 0.0125 | 3,279 |
| WY | Total | 9,213 | 0.0137 | 158,027 | 9,213 | 0.0125 | 141,845 | | | 16,182 | 9,213 | 0.0125 | 141,845 |
| | Oct | 337 | 0.0209 | 8,688 | 337 | 0.0130 | 5,395 | | | 3,292 | 337 | 0.0130 | 5,395 |
| | Nov | 255 | 0.0198 | 6,228 | 255 | 0.0130 | 4,083 | | | 2,145 | 255 | 0.0130 | 4,083 |
| | Dec | 185 | 0.0187 | 4,267 | 185 | 0.0130 | 2,962 | | | 1,305 | 185 | 0.0130 | 2,962 |
| 1982 | Jan | 140 | 0.0176 | 3,039 | 140 | 0.0130 | 2,241 | | | 798 | 140 | 0.0130 | 2,241 |
| | Feb | 123 | 0.0165 | 2,503 | 123 | 0.0130 | 1,969 | | | 534 | 123 | 0.0130 | 1,969 |
| | Mar | 185 | 0.0154 | 3,514 | 185 | 0.0130 | 2,962 | | | 552 | 185 | 0.0130 | 2,962 |
| | Apr | 1,160 | 0.0143 | 20,461 | 1,160 | 0.0130 | 18,572 | | | 1,889 | 1,160 | 0.0130 | 18,572 |
| | May | 8,760 | 0.0131 | 141,550 | 8,760 | 0.0130 | 140,248 | | | 1,302 | 8,760 | 0.0130 | 140,248 |
| | Jun | 4,500 | 0.0141 | 78,265 | 4,500 | 0.0130 | 72,045 | | | 6,220 | 4,500 | 0.0130 | 72,045 |
| | Jul | 1,110 | 0.0110 | 15,061 | 1,110 | 0.0130 | 17,771 | | | -2,710 | 1,110 | 0.0130 | 17,771 |
| | Aug | 508 | 0.0176 | 11,028 | 508 | 0.0130 | 8,133 | | | 2,895 | 508 | 0.0130 | 8,133 |
| | Sep | 498 | 0.0240 | 14,743 | 498 | 0.0130 | 7,973 | | | 6,770 | 498 | 0.0130 | 7,973 |
| WY | Total | 17,761 | 0.0141 | 309,348 | 17,761 | 0.0130 | 284,354 | | | 24,994 | 17,761 | 0.0130 | 284,354 |
| | Oct | 830 | 0.0209 | 21,397 | 830 | 0.0134 | 13,691 | | | 7,706 | 830 | 0.0134 | 13,691 |
| | Nov | 691 | 0.0198 | 16,876 | 691 | 0.0134 | 11,398 | | | 5,478 | 691 | 0.0134 | 11,398 |
| | Dec | 500 | 0.0187 | 11,533 | 500 | 0.0134 | 8,248 | | | 3,285 | 500 | 0.0134 | 8,248 |
| 1983 | Jan | 427 | 0.0176 | 9,270 | 427 | 0.0134 | 7,044 | | | 2,226 | 427 | 0.0134 | 7,044 |
| | Feb | 374 | 0.0165 | 7,612 | 374 | 0.0134 | 6,169 | | | 1,442 | 374 | 0.0134 | 6,169 |
| | Mar | 491 | 0.0154 | 9,327 | 491 | 0.0134 | 8,099 | | | 1,228 | 491 | 0.0134 | 8,099 |
| | Apr | 638 | 0.0143 | 11,254 | 638 | 0.0134 | 10,524 | | | 729 | 638 | 0.0134 | 10,524 |
| | May | 4,530 | 0.0131 | 73,199 | 4,530 | 0.0134 | 74,725 | | | -1,526 | 4,530 | 0.0134 | 74,725 |
| | Jun | 14,210 | 0.0141 | 247,143 | 14,210 | 0.0134 | 234,403 | | | 12,740 | 14,210 | 0.0134 | 234,403 |
| | Jul | 2,950 | 0.0100 | 36,388 | 2,950 | 0.0134 | 48,662 | | | -12,274 | 2,950 | 0.0134 | 48,662 |
| | Aug | 861 | 0.0176 | 18,692 | 861 | 0.0134 | 14,203 | | | 4,489 | 861 | 0.0134 | 14,203 |
| | Sep | 599 | 0.0240 | 17,733 | 599 | 0.0134 | 9,881 | | | 7,852 | 599 | 0.0134 | 9,881 |
| WY | Total | 27,101 | 0.0142 | 480,423 | 27,101 | 0.0134 | 447,049 | | | 33,375 | 27,101 | 0.0134 | 447,049 |

**Table A-2**

Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l From Table 3 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l From Table B-1 | Weight grams |
| | Oct | 624 | 0.0209 | 16,087 | 624 | 0.0132 | 10,189 | | | 5,897 | 624 | 0.0132 | 10,189 |
| | Nov | 520 | 0.0198 | 12,700 | 520 | 0.0132 | 8,491 | | | 4,209 | 520 | 0.0132 | 8,491 |
| | Dec | 552 | 0.0187 | 12,733 | 552 | 0.0132 | 9,014 | | | 3,719 | 552 | 0.0132 | 9,014 |
| 1984 | Jan | 481 | 0.0176 | 10,442 | 481 | 0.0132 | 7,854 | | | 2,588 | 481 | 0.0132 | 7,854 |
| | Feb | 424 | 0.0165 | 8,629 | 424 | 0.0132 | 6,924 | | | 1,706 | 424 | 0.0132 | 6,924 |
| | Mar | 427 | 0.0154 | 8,111 | 427 | 0.0132 | 6,973 | | | 1,139 | 427 | 0.0132 | 6,973 |
| | Apr | 663 | 0.0143 | 11,695 | 663 | 0.0132 | 10,826 | | | 868 | 663 | 0.0132 | 10,826 |
| | May | 12,230 | 0.0131 | 197,621 | 12,230 | 0.0132 | 199,705 | | | -2,084 | 12,230 | 0.0132 | 199,705 |
| | Jun | 9,620 | 0.0141 | 167,313 | 9,620 | 0.0132 | 157,086 | | | 10,227 | 9,620 | 0.0132 | 157,086 |
| | Jul | 1,480 | 0.0110 | 20,081 | 1,480 | 0.0132 | 24,167 | | | -4,086 | 1,480 | 0.0132 | 24,167 |
| | Aug | 654 | 0.0176 | 14,198 | 654 | 0.0132 | 10,679 | | | 3,519 | 654 | 0.0132 | 10,679 |
| | Sep | 439 | 0.0240 | 12,996 | 439 | 0.0132 | 7,168 | | | 5,828 | 439 | 0.0132 | 7,168 |
| WY | Total | 28,114 | 0.0142 | 492,606 | 28,114 | 0.0132 | 459,077 | | | 33,529 | 28,114 | 0.0132 | 459,077 |
| | Oct | 561 | 0.0209 | 14,463 | 561 | 0.0132 | 9,109 | | | 5,354 | 561 | 0.0132 | 9,109 |
| | Nov | 458 | 0.0198 | 11,186 | 458 | 0.0132 | 7,437 | | | 3,749 | 458 | 0.0132 | 7,437 |
| | Dec | 464 | 0.0187 | 10,703 | 464 | 0.0132 | 7,534 | | | 3,169 | 464 | 0.0132 | 7,534 |
| 1985 | Jan | 440 | 0.0176 | 9,552 | 440 | 0.0132 | 7,144 | | | 2,408 | 440 | 0.0132 | 7,144 |
| | Feb | 338 | 0.0165 | 6,879 | 338 | 0.0132 | 5,488 | | | 1,391 | 338 | 0.0132 | 5,488 |
| | Mar | 366 | 0.0154 | 6,952 | 366 | 0.0132 | 5,943 | | | 1,010 | 366 | 0.0132 | 5,943 |
| | Apr | 3,010 | 0.0143 | 53,093 | 3,010 | 0.0132 | 48,873 | | | 4,220 | 3,010 | 0.0132 | 48,873 |
| | May | 10,350 | 0.0131 | 167,243 | 10,350 | 0.0132 | 168,053 | | | -811 | 10,350 | 0.0132 | 168,053 |
| | Jun | 2,400 | 0.0141 | 41,741 | 2,400 | 0.0132 | 38,969 | | | 2,772 | 2,400 | 0.0132 | 38,969 |
| | Jul | 914 | 0.0110 | 12,401 | 914 | 0.0132 | 14,841 | | | -2,439 | 914 | 0.0132 | 14,841 |
| | Aug | 434 | 0.0176 | 9,422 | 434 | 0.0132 | 7,047 | | | 2,375 | 434 | 0.0132 | 7,047 |
| | Sep | 314 | 0.0240 | 9,296 | 314 | 0.0132 | 5,098 | | | 4,197 | 314 | 0.0132 | 5,098 |
| WY | Total | 20,049 | 0.0142 | 352,931 | 20,049 | 0.0132 | 325,536 | | | 27,395 | 20,049 | 0.0132 | 325,536 |
| | Oct | 386 | 0.0209 | 9,951 | 386 | 0.0131 | 6,249 | | | 3,702 | 386 | 0.0131 | 6,249 |
| | Nov | 380 | 0.0198 | 9,281 | 380 | 0.0131 | 6,152 | | | 3,129 | 380 | 0.0131 | 6,152 |
| | Dec | 347 | 0.0187 | 8,004 | 347 | 0.0131 | 5,618 | | | 2,386 | 347 | 0.0131 | 5,618 |
| 1986 | Jan | 348 | 0.0176 | 7,553 | 348 | 0.0131 | 5,634 | | | 1,921 | 348 | 0.0131 | 5,634 |
| | Feb | 357 | 0.0165 | 7,266 | 357 | 0.0131 | 5,780 | | | 1,486 | 357 | 0.0131 | 5,780 |
| | Mar | 533 | 0.0154 | 10,125 | 533 | 0.0131 | 8,629 | | | 1,496 | 533 | 0.0131 | 8,629 |
| | Apr | 1,880 | 0.0143 | 33,161 | 1,880 | 0.0131 | 30,436 | | | 2,725 | 1,880 | 0.0131 | 30,436 |
| | May | 11,050 | 0.0131 | 178,554 | 11,050 | 0.0131 | 178,893 | | | -339 | 11,050 | 0.0131 | 178,893 |
| | Jun | 7,530 | 0.0141 | 130,963 | 7,530 | 0.0131 | 121,906 | | | 9,057 | 7,530 | 0.0131 | 121,906 |
| | Jul | 900 | 0.0110 | 12,212 | 900 | 0.0131 | 14,570 | | | -2,359 | 900 | 0.0131 | 14,570 |
| | Aug | 458 | 0.0176 | 9,943 | 458 | 0.0131 | 7,415 | | | 2,528 | 458 | 0.0131 | 7,415 |
| | Sep | 362 | 0.0240 | 10,717 | 362 | 0.0131 | 5,861 | | | 4,856 | 362 | 0.0131 | 5,861 |
| WY | Total | 24,531 | 0.0141 | 427,730 | 24,531 | 0.0131 | 397,142 | | | 30,589 | 24,531 | 0.0131 | 397,142 |

**Table A-2**

Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | [redacted] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l From Table 3 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l From Table B-1 | Weight grams |
| | Oct | 448 | 0.0209 | 11,549 | 448 | 0.0132 | 7,308 | | | 4,242 | 448 | 0.0132 | 7,308 |
| | Nov | 398 | 0.0198 | 9,720 | 398 | 0.0132 | 6,492 | | | 3,228 | 398 | 0.0132 | 6,492 |
| | Dec | 271 | 0.0187 | 6,251 | 271 | 0.0132 | 4,420 | | | 1,830 | 271 | 0.0132 | 4,420 |
| 1987 | Jan | 150 | 0.0176 | 3,256 | 150 | 0.0132 | 2,447 | | | 810 | 150 | 0.0132 | 2,447 |
| | Feb | 126 | 0.0165 | 2,564 | 126 | 0.0132 | 2,055 | | | 509 | 126 | 0.0132 | 2,055 |
| | Mar | 183 | 0.0154 | 3,476 | 183 | 0.0132 | 2,985 | | | 491 | 183 | 0.0132 | 2,985 |
| | Apr | 1,740 | 0.0143 | 30,692 | 1,740 | 0.0132 | 28,382 | | | 2,309 | 1,740 | 0.0132 | 28,382 |
| | May | 3,150 | 0.0131 | 50,900 | 3,150 | 0.0132 | 51,382 | | | -482 | 3,150 | 0.0132 | 51,382 |
| | Jun | 915 | 0.0141 | 15,914 | 915 | 0.0132 | 14,925 | | | 989 | 915 | 0.0132 | 14,925 |
| | Jul | 461 | 0.0110 | 6,255 | 461 | 0.0132 | 7,520 | | | -1,265 | 461 | 0.0132 | 7,520 |
| | Aug | 259 | 0.0176 | 5,623 | 259 | 0.0132 | 4,225 | | | 1,398 | 259 | 0.0132 | 4,225 |
| | Sep | 204 | 0.0240 | 6,039 | 204 | 0.0132 | 3,328 | | | 2,712 | 204 | 0.0132 | 3,328 |
| WY | Total | 8,305 | 0.0147 | 152,240 | 8,305 | 0.0132 | 135,468 | | | 16,772 | 8,305 | 0.0132 | 135,468 |
| | Oct | 214 | 0.0209 | 5,517 | 214 | 0.0128 | 3,370 | | | 2,147 | 214 | 0.0128 | 3,370 |
| | Nov | 193 | 0.0198 | 4,714 | 193 | 0.0128 | 3,039 | | | 1,675 | 193 | 0.0128 | 3,039 |
| | Dec | 168 | 0.0187 | 3,875 | 168 | 0.0128 | 2,645 | | | 1,230 | 168 | 0.0128 | 2,645 |
| 1988 | Jan | 188 | 0.0176 | 4,081 | 188 | 0.0128 | 2,960 | | | 1,121 | 188 | 0.0128 | 2,960 |
| | Feb | 176 | 0.0165 | 3,582 | 176 | 0.0128 | 2,771 | | | 811 | 176 | 0.0128 | 2,771 |
| | Mar | 222 | 0.0154 | 4,217 | 222 | 0.0128 | 3,496 | | | 721 | 222 | 0.0128 | 3,496 |
| | Apr | 907 | 0.0143 | 15,998 | 907 | 0.0128 | 14,282 | | | 1,717 | 907 | 0.0128 | 14,282 |
| | May | 5,170 | 0.0131 | 83,541 | 5,170 | 0.0128 | 81,407 | | | 2,134 | 5,170 | 0.0128 | 81,407 |
| | Jun | 1,200 | 0.0141 | 20,871 | 1,200 | 0.0128 | 18,895 | | | 1,975 | 1,200 | 0.0128 | 18,895 |
| | Jul | 418 | 0.0110 | 5,672 | 418 | 0.0128 | 6,582 | | | -910 | 418 | 0.0128 | 6,582 |
| | Aug | 257 | 0.0176 | 5,579 | 257 | 0.0128 | 4,047 | | | 1,533 | 257 | 0.0128 | 4,047 |
| | Sep | 197 | 0.0240 | 5,832 | 197 | 0.0128 | 3,102 | | | 2,730 | 197 | 0.0128 | 3,102 |
| WY | Total | 9,310 | 0.0142 | 163,479 | 9,310 | 0.0128 | 146,595 | | | 16,884 | 9,310 | 0.0128 | 146,595 |
| | Oct | 231 | 0.0209 | 5,955 | 231 | 0.0131 | 3,730 | | | 2,225 | 231 | 0.0131 | 3,730 |
| | Nov | 278 | 0.0198 | 6,790 | 278 | 0.0131 | 4,489 | | | 2,300 | 278 | 0.0131 | 4,489 |
| | Dec | 248 | 0.0187 | 5,720 | 248 | 0.0131 | 4,005 | | | 1,716 | 248 | 0.0131 | 4,005 |
| 1989 | Jan | 241 | 0.0176 | 5,232 | 241 | 0.0131 | 3,892 | | | 1,340 | 241 | 0.0131 | 3,892 |
| | Feb | 186 | 0.0165 | 3,786 | 186 | 0.0131 | 3,004 | | | 782 | 186 | 0.0131 | 3,004 |
| | Mar | 318 | 0.0154 | 6,041 | 318 | 0.0131 | 5,135 | | | 905 | 318 | 0.0131 | 5,135 |
| | Apr | 2,180 | 0.0143 | 38,453 | 2,180 | 0.0131 | 35,203 | | | 3,250 | 2,180 | 0.0131 | 35,203 |
| | May | 3,060 | 0.0131 | 49,446 | 3,060 | 0.0131 | 49,414 | | | 32 | 3,060 | 0.0131 | 49,414 |
| | Jun | 950 | 0.0141 | 16,523 | 950 | 0.0131 | 15,341 | | | 1,182 | 950 | 0.0131 | 15,341 |
| | Jul | 436 | 0.0110 | 5,916 | 436 | 0.0131 | 7,041 | | | -1,125 | 436 | 0.0131 | 7,041 |
| | Aug | 217 | 0.0176 | 4,711 | 217 | 0.0131 | 3,504 | | | 1,207 | 217 | 0.0131 | 3,504 |
| | Sep | 221 | 0.0240 | 6,542 | 221 | 0.0131 | 3,569 | | | 2,974 | 221 | 0.0131 | 3,569 |
| WY | Total | 8,566 | 0.0145 | 155,114 | 8,566 | 0.0131 | 138,326 | | | 16,788 | 8,566 | 0.0131 | 138,326 |

**Table A-2**

Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Conc. mg/l (Est. From Table 3) | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | Conc. mg/l (From Table D-1) | Weight grams |
| | Oct | 179 | 0.0209 | 4,605 | 179 | 0.0142 | 3,130 | | | 1,475 | 179 | 0.0142 | 3,130 |
| | Nov | 423 | 0.0198 | 10,329 | 423 | 0.0142 | 7,411 | | | 2,918 | 423 | 0.0142 | 7,411 |
| | Dec | 169 | 0.0187 | 3,998 | 169 | 0.0142 | 2,969 | | | 939 | 169 | 0.0142 | 2,969 |
| 1990 | Jan | 164 | 0.0176 | 3,558 | 164 | 0.0142 | 2,872 | | | 686 | 164 | 0.0142 | 2,872 |
| | Feb | 163 | 0.0165 | 3,317 | 163 | 0.0142 | 2,856 | | | 461 | 163 | 0.0142 | 2,856 |
| | Mar | 197 | 0.0154 | 3,743 | 197 | 0.0142 | 3,453 | | | 290 | 197 | 0.0142 | 3,453 |
| | Apr | 1,687 | 0.0143 | 29,756 | 1,687 | 0.0142 | 29,561 | | | 195 | 1,687 | 0.0142 | 29,561 |
| | May | 3,118 | 0.0131 | 50,385 | 3,118 | 0.0142 | 54,639 | | | -4,255 | 3,118 | 0.0142 | 54,639 |
| | Jun | 1,146 | 0.0230 | 32,524 | 1,146 | 0.0142 | 20,089 | | | 12,435 | 1,146 | 0.0142 | 20,089 |
| | Jul | 473 | 0.0110 | 6,413 | 473 | 0.0142 | 8,282 | | | -1,869 | 473 | 0.0142 | 8,282 |
| | Aug | 197 | 0.0280 | 6,805 | 197 | 0.0142 | 3,453 | | | 3,352 | 197 | 0.0142 | 3,453 |
| | Sep | 160 | 0.0240 | 4,730 | 160 | 0.0142 | 2,800 | | | 1,930 | 160 | 0.0142 | 2,800 |
| WY | Total | 8,076 | 0.0160 | 160,072 | 8,076 | 0.0142 | 141,514 | | | 18,558 | 8,076 | 0.0142 | 141,514 |
| | Oct | 204 | 0.0209 | 5,269 | 204 | 0.0138 | 3,474 | | | 1,796 | 204 | 0.0138 | 3,474 |
| | Nov | 114 | 0.0198 | 2,785 | 114 | 0.0138 | 1,938 | | | 847 | 114 | 0.0138 | 1,938 |
| | Dec | 177 | 0.0187 | 4,092 | 177 | 0.0138 | 3,015 | | | 1,077 | 177 | 0.0138 | 3,015 |
| 1991 | Jan | 179 | 0.0176 | 3,891 | 179 | 0.0138 | 3,046 | | | 845 | 179 | 0.0138 | 3,046 |
| | Feb | 172 | 0.0165 | 3,498 | 172 | 0.0138 | 2,921 | | | 577 | 172 | 0.0138 | 2,921 |
| | Mar | 196 | 0.0154 | 3,719 | 196 | 0.0138 | 3,328 | | | 392 | 196 | 0.0138 | 3,328 |
| | Apr | 323 | 0.0143 | 5,700 | 323 | 0.0138 | 5,492 | | | 208 | 323 | 0.0138 | 5,492 |
| | May | 5,395 | 0.0121 | 87,181 | 5,395 | 0.0138 | 91,695 | | | -4,514 | 5,395 | 0.0138 | 91,695 |
| | Jun | 3,540 | 0.0190 | 82,970 | 3,540 | 0.0138 | 60,168 | | | 22,802 | 3,540 | 0.0138 | 60,168 |
| | Jul | 687 | 0.0110 | 9,328 | 687 | 0.0138 | 11,684 | | | -2,356 | 687 | 0.0138 | 11,684 |
| | Aug | 386 | 0.0050 | 2,381 | 386 | 0.0138 | 6,562 | | | -4,180 | 386 | 0.0138 | 6,562 |
| | Sep | 338 | 0.0240 | 10,006 | 338 | 0.0138 | 5,744 | | | 4,261 | 338 | 0.0138 | 5,744 |
| WY | Total | 11,713 | 0.0152 | 220,820 | 11,713 | 0.0138 | 199,066 | | | 21,754 | 11,713 | 0.0138 | 199,066 |
| | Oct | 258 | 0.0400 | 12,720 | 258 | 0.0136 | 4,316 | | | 8,403 | 258 | 0.0136 | 4,316 |
| | Nov | 268 | 0.0198 | 6,557 | 268 | 0.0136 | 4,495 | | | 2,062 | 268 | 0.0136 | 4,495 |
| | Dec | 230 | 0.0187 | 5,309 | 230 | 0.0136 | 3,854 | | | 1,455 | 230 | 0.0136 | 3,854 |
| 1992 | Jan | 169 | 0.0176 | 3,664 | 169 | 0.0136 | 2,826 | | | 838 | 169 | 0.0136 | 2,826 |
| | Feb | 138 | 0.0165 | 2,805 | 138 | 0.0136 | 2,307 | | | 497 | 138 | 0.0136 | 2,307 |
| | Mar | 293 | 0.0154 | 5,562 | 293 | 0.0136 | 4,902 | | | 659 | 293 | 0.0136 | 4,902 |
| | Apr | 1,432 | 0.0143 | 25,251 | 1,432 | 0.0136 | 23,969 | | | 1,281 | 1,432 | 0.0136 | 23,969 |
| | May | 1,473 | 0.0131 | 23,804 | 1,473 | 0.0136 | 24,666 | | | -862 | 1,473 | 0.0136 | 24,666 |
| | Jun | 555 | 0.0090 | 6,166 | 555 | 0.0136 | 9,299 | | | -3,134 | 555 | 0.0136 | 9,299 |
| | Jul | 264 | 0.0110 | 3,581 | 264 | 0.0136 | 4,419 | | | -838 | 264 | 0.0136 | 4,419 |
| | Aug | 140 | 0.0210 | 5,625 | 140 | 0.0136 | 2,343 | | | 1,282 | 140 | 0.0136 | 2,343 |
| | Sep | 163 | 0.0240 | 4,836 | 163 | 0.0136 | 2,735 | | | 2,101 | 163 | 0.0136 | 2,735 |
| WY | Total | 5,383 | 0.0147 | 103,879 | 5,382 | 0.0136 | 90,134 | | | 13,745 | 5,383 | 0.0136 | 90,134 |

**Table A-2**

Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l (From Table 3) | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l (From Table B-1) | Weight grams |
| | Oct | 245 | 0.0209 | 6,314 | 245 | 0.0127 | 3,834 | | | 2,480 | 245 | 0.0127 | 3,834 |
| | Nov | 157 | 0.0198 | 3,830 | 157 | 0.0127 | 2,455 | | | 1,375 | 157 | 0.0127 | 2,455 |
| | Dec | 145 | 0.0187 | 3,341 | 145 | 0.0127 | 2,268 | | | 1,074 | 145 | 0.0127 | 2,268 |
| 1993 | Jan | 185 | 0.0176 | 4,024 | 185 | 0.0127 | 2,902 | | | 1,122 | 185 | 0.0127 | 2,902 |
| | Feb | 209 | 0.0165 | 4,254 | 209 | 0.0127 | 3,272 | | | 982 | 209 | 0.0127 | 3,272 |
| | Mar | 350 | 0.0154 | 6,646 | 350 | 0.0127 | 5,477 | | | 1,169 | 350 | 0.0127 | 5,477 |
| | Apr | 903 | 0.0143 | 15,926 | 903 | 0.0127 | 14,134 | | | 1,792 | 903 | 0.0127 | 14,134 |
| | May | 9,882 | 0.0131 | 159,683 | 9,882 | 0.0127 | 154,696 | | | 4,987 | 9,882 | 0.0127 | 154,696 |
| | Jun | 3,671 | 0.0150 | 67,921 | 3,671 | 0.0127 | 57,465 | | | 10,456 | 3,671 | 0.0127 | 57,465 |
| | Jul | 786 | 0.0110 | 10,660 | 786 | 0.0127 | 12,299 | | | -1,639 | 786 | 0.0127 | 12,299 |
| | Aug | 374 | 0.0050 | 2,305 | 374 | 0.0127 | 5,852 | | | -3,546 | 374 | 0.0127 | 5,852 |
| | Sep | 242 | 0.0240 | 7,157 | 242 | 0.0127 | 3,784 | | | 3,372 | 242 | 0.0127 | 3,784 |
| WY | Total | 17,148 | 0.0140 | 292,061 | 17,148 | 0.0127 | 268,437 | | | 23,625 | 17,148 | 0.0127 | 268,437 |
| | Oct | 311 | 0.0209 | 8,007 | 311 | 0.0134 | 5,121 | | | 2,886 | 311 | 0.0134 | 5,121 |
| | Nov | 258 | 0.0198 | 6,311 | 258 | 0.0134 | 4,260 | | | 2,051 | 258 | 0.0134 | 4,260 |
| | Dec | 254 | 0.0187 | 5,861 | 254 | 0.0134 | 4,190 | | | 1,672 | 254 | 0.0134 | 4,190 |
| 1994 | Jan | 199 | 0.0176 | 4,317 | 199 | 0.0134 | 3,279 | | | 1,039 | 199 | 0.0134 | 3,279 |
| | Feb | 177 | 0.0165 | 3,611 | 177 | 0.0134 | 2,925 | | | 686 | 177 | 0.0134 | 2,925 |
| | Mar | 244 | 0.0154 | 4,629 | 244 | 0.0134 | 4,018 | | | 611 | 244 | 0.0134 | 4,018 |
| | Apr | 1,188 | 0.0143 | 20,955 | 1,188 | 0.0134 | 19,587 | | | 1,368 | 1,188 | 0.0134 | 19,587 |
| | May | 4,591 | 0.0131 | 74,188 | 4,591 | 0.0134 | 75,696 | | | -1,508 | 4,591 | 0.0134 | 75,696 |
| | Jun | 1,028 | 0.0141 | 17,873 | 1,028 | 0.0134 | 16,942 | | | 930 | 1,028 | 0.0134 | 16,942 |
| | Jul | 313 | 0.0190 | 7,336 | 313 | 0.0134 | 5,161 | | | 2,175 | 313 | 0.0134 | 5,161 |
| | Aug | 266 | 0.0220 | 7,229 | 266 | 0.0134 | 4,392 | | | 2,837 | 266 | 0.0134 | 4,392 |
| | Sep | 243 | 0.0240 | 7,192 | 243 | 0.0134 | 4,005 | | | 3,187 | 243 | 0.0134 | 4,005 |
| WY | Total | 9,072 | 0.0148 | 167,509 | 9,072 | 0.0134 | 149,575 | | | 17,934 | 9,072 | 0.0134 | 149,575 |
| | Oct | 328 | 0.0209 | 8,450 | 328 | 0.0126 | 5,082 | | | 3,368 | 328 | 0.0126 | 5,082 |
| | Nov | 227 | 0.0198 | 5,542 | 227 | 0.0126 | 3,518 | | | 2,024 | 227 | 0.0126 | 3,518 |
| | Dec | 246 | 0.0187 | 5,663 | 246 | 0.0126 | 3,806 | | | 1,857 | 246 | 0.0126 | 3,806 |
| 1995 | Jan | 245 | 0.0176 | 5,317 | 245 | 0.0126 | 3,797 | | | 1,520 | 245 | 0.0126 | 3,797 |
| | Feb | 223 | 0.0165 | 4,536 | 223 | 0.0126 | 3,455 | | | 1,081 | 223 | 0.0126 | 3,455 |
| | Mar | 406 | 0.0154 | 7,719 | 406 | 0.0126 | 6,300 | | | 1,419 | 406 | 0.0126 | 6,300 |
| | Apr | 826 | 0.0143 | 14,564 | 826 | 0.0126 | 12,801 | | | 1,763 | 826 | 0.0126 | 12,801 |
| | May | 6,629 | 0.0131 | 107,117 | 6,629 | 0.0126 | 102,773 | | | 4,344 | 6,629 | 0.0126 | 102,773 |
| | Jun | 10,217 | 0.0141 | 177,693 | 10,217 | 0.0126 | 158,395 | | | 19,297 | 10,217 | 0.0126 | 158,395 |
| | Jul | 2,118 | 0.0050 | 13,060 | 2,118 | 0.0126 | 32,830 | | | -19,770 | 2,118 | 0.0126 | 32,830 |
| | Aug | 773 | 0.0176 | 16,790 | 773 | 0.0126 | 11,990 | | | 4,800 | 773 | 0.0126 | 11,990 |
| | Sep | 393 | 0.0240 | 11,623 | 393 | 0.0126 | 6,087 | | | 5,536 | 393 | 0.0126 | 6,087 |
| WY | Total | 22,629 | 0.0136 | 378,073 | 22,629 | 0.0126 | 350,834 | | | 27,239 | 22,629 | 0.0126 | 350,834 |

**Table A-2**

Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l From Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l From Table B-1 | Weight grams |
| | Oct | 293 | 0.0050 | 1,810 | 293 | 0.0123 | 4,443 | | | -2,633 | 293 | 0.0123 | 4,443 |
| | Nov | 299 | 0.0198 | 7,312 | 299 | 0.0123 | 4,533 | | | 2,778 | 299 | 0.0123 | 4,533 |
| | Dec | 253 | 0.0187 | 5,847 | 253 | 0.0123 | 3,839 | | | 2,009 | 253 | 0.0123 | 3,839 |
| 1996 | Jan | 168 | 0.0176 | 3,651 | 168 | 0.0123 | 2,547 | | | 1,104 | 168 | 0.0123 | 2,547 |
| | Feb | 194 | 0.0165 | 3,950 | 194 | 0.0123 | 2,939 | | | 1,011 | 194 | 0.0123 | 2,939 |
| | Mar | 268 | 0.0154 | 5,084 | 268 | 0.0123 | 4,052 | | | 1,031 | 268 | 0.0123 | 4,052 |
| | Apr | 731 | 0.0143 | 12,887 | 731 | 0.0123 | 11,063 | | | 1,824 | 731 | 0.0123 | 11,063 |
| | May | 8,593 | 0.0131 | 138,855 | 8,593 | 0.0123 | 130,123 | | | 8,732 | 8,593 | 0.0123 | 130,123 |
| | Jun | 2,709 | 0.0120 | 40,093 | 2,709 | 0.0123 | 41,016 | | | -923 | 2,709 | 0.0123 | 41,016 |
| | Jul | 548 | 0.0110 | 7,429 | 548 | 0.0123 | 8,291 | | | -862 | 548 | 0.0123 | 8,291 |
| | Aug | 219 | 0.0250 | 6,757 | 219 | 0.0123 | 3,318 | | | 3,439 | 219 | 0.0123 | 3,318 |
| | Sep | 195 | 0.0240 | 5,768 | 195 | 0.0123 | 2,950 | | | 2,818 | 195 | 0.0123 | 2,950 |
| WY | Total | 14,470 | 0.0133 | 239,442 | 14,470 | 0.0123 | 219,113 | | | 20,329 | 14,470 | 0.0123 | 219,113 |
| | Oct | 225 | 0.0209 | 5,807 | 225 | 0.0129 | 3,583 | | | 2,224 | 225 | 0.0129 | 3,583 |
| | Nov | 301 | 0.0198 | 7,341 | 301 | 0.0129 | 4,781 | | | 2,560 | 301 | 0.0129 | 4,781 |
| | Dec | 263 | 0.0187 | 6,074 | 263 | 0.0129 | 4,189 | | | 1,885 | 263 | 0.0129 | 4,189 |
| 1997 | Jan | 256 | 0.0176 | 5,557 | 256 | 0.0129 | 4,071 | | | 1,485 | 256 | 0.0129 | 4,071 |
| | Feb | 245 | 0.0165 | 4,987 | 245 | 0.0129 | 3,898 | | | 1,089 | 245 | 0.0129 | 3,898 |
| | Mar | 350 | 0.0154 | 6,646 | 350 | 0.0129 | 5,565 | | | 1,081 | 350 | 0.0129 | 5,565 |
| | Apr | 1,158 | 0.0143 | 20,431 | 1,158 | 0.0129 | 18,425 | | | 2,006 | 1,158 | 0.0129 | 18,425 |
| | May | 12,951 | 0.0131 | 209,274 | 12,951 | 0.0129 | 206,011 | | | 3,263 | 12,951 | 0.0129 | 206,011 |
| | Jun | 4,425 | 0.0141 | 76,966 | 4,425 | 0.0129 | 70,392 | | | 6,573 | 4,425 | 0.0129 | 70,392 |
| | Jul | 761 | 0.0110 | 10,327 | 761 | 0.0129 | 12,107 | | | -1,780 | 761 | 0.0129 | 12,107 |
| | Aug | 354 | 0.0176 | 7,675 | 354 | 0.0129 | 5,624 | | | 2,052 | 354 | 0.0129 | 5,624 |
| | Sep | 384 | 0.0240 | 11,377 | 384 | 0.0129 | 6,113 | | | 5,264 | 384 | 0.0129 | 6,113 |
| WY | Total | 21,674 | 0.0139 | 372,462 | 21,674 | 0.0129 | 344,760 | | | 27,703 | 21,674 | 0.0129 | 344,760 |
| | Oct | 371 | 0.0209 | 9,573 | 371 | 0.0120 | 5,514 | | | 4,059 | 371 | 0.0120 | 5,514 |
| | Nov | 319 | 0.0198 | 7,790 | 319 | 0.0120 | 4,736 | | | 3,054 | 319 | 0.0120 | 4,736 |
| | Dec | 312 | 0.0187 | 7,206 | 312 | 0.0120 | 4,639 | | | 2,568 | 312 | 0.0120 | 4,639 |
| 1998 | Jan | 301 | 0.0176 | 6,529 | 301 | 0.0120 | 4,466 | | | 2,064 | 301 | 0.0120 | 4,466 |
| | Feb | 340 | 0.0165 | 6,917 | 340 | 0.0120 | 5,046 | | | 1,871 | 340 | 0.0120 | 5,046 |
| | Mar | 458 | 0.0154 | 8,698 | 458 | 0.0120 | 6,799 | | | 1,899 | 458 | 0.0120 | 6,799 |
| | Apr | 1,170 | 0.0143 | 20,641 | 1,170 | 0.0120 | 17,375 | | | 3,266 | 1,170 | 0.0120 | 17,375 |
| | May | 7,120 | 0.0131 | 115,051 | 7,120 | 0.0120 | 105,721 | | | 9,331 | 7,120 | 0.0120 | 105,721 |
| | Jun | 4,069 | 0.0100 | 50,189 | 4,069 | 0.0120 | 60,416 | | | -10,227 | 4,069 | 0.0120 | 60,416 |
| | Jul | 1,142 | 0.0110 | 15,491 | 1,142 | 0.0120 | 16,952 | | | -1,461 | 1,142 | 0.0120 | 16,952 |
| | Aug | 506 | 0.0176 | 10,980 | 506 | 0.0120 | 7,510 | | | 3,470 | 506 | 0.0120 | 7,510 |
| | Sep | 355 | 0.0150 | 6,572 | 355 | 0.0120 | 5,274 | | | 1,298 | 355 | 0.0120 | 5,274 |
| WY | Total | 16,463 | 0.0129 | 265,639 | 16,463 | 0.0120 | 244,448 | | | 21,191 | 16,463 | 0.0120 | 244,448 |

**Table A-2** Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l From Table 3 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l From Table B-1 | Weight grams |
| | Oct | 333 | 0.0209 | 8,576 | 333 | 0.0157 | 6,440 | | | 2,136 | 333 | 0.0157 | 6,440 |
| | Nov | 309 | 0.0198 | 7,544 | 309 | 0.0157 | 5,980 | | | 1,564 | 309 | 0.0157 | 5,980 |
| | Dec | 151 | 0.0187 | 3,483 | 151 | 0.0157 | 2,923 | | | 560 | 151 | 0.0157 | 2,923 |
| 1999 | Jan | 88 | 0.0176 | 1,906 | 88 | 0.0157 | 1,699 | | | 206 | 88 | 0.0157 | 1,699 |
| | Feb | 141 | 0.0165 | 2,866 | 141 | 0.0157 | 2,726 | | | 140 | 141 | 0.0157 | 2,726 |
| | Mar | 236 | 0.0154 | 4,489 | 236 | 0.0157 | 4,575 | | | -86 | 236 | 0.0157 | 4,575 |
| | Apr | 539 | 0.0143 | 9,514 | 539 | 0.0157 | 10,441 | | | -928 | 539 | 0.0157 | 10,441 |
| | May | 5,794 | 0.0131 | 93,628 | 5,794 | 0.0157 | 112,169 | | | -18,542 | 5,794 | 0.0157 | 112,169 |
| | Jun | 4,176 | 0.0230 | 118,469 | 4,176 | 0.0157 | 80,838 | | | 37,631 | 4,176 | 0.0157 | 80,838 |
| | Jul | 859 | 0.0110 | 11,660 | 859 | 0.0157 | 16,635 | | | -4,976 | 859 | 0.0157 | 16,635 |
| | Aug | 626 | 0.0250 | 19,306 | 626 | 0.0157 | 12,120 | | | 7,186 | 626 | 0.0157 | 12,120 |
| | Sep | 435 | 0.0240 | 12,872 | 435 | 0.0157 | 8,417 | | | 4,455 | 435 | 0.0157 | 8,417 |
| WY | Total | 13,687 | 0.0175 | 294,312 | 13,687 | 0.0157 | 264,964 | | | 29,348 | 13,687 | 0.0157 | 264,964 |
| | Oct | 249 | 0.0209 | 6,409 | 249 | 0.0125 | 3,821 | | | 2,587 | 249 | 0.0125 | 3,821 |
| | Nov | 230 | 0.0198 | 5,614 | 230 | 0.0125 | 3,534 | | | 2,081 | 230 | 0.0125 | 3,534 |
| | Dec | 176 | 0.0187 | 4,063 | 176 | 0.0125 | 2,708 | | | 1,355 | 176 | 0.0125 | 2,708 |
| 2000 | Jan | 155 | 0.0176 | 3,358 | 155 | 0.0125 | 2,378 | | | 980 | 155 | 0.0125 | 2,378 |
| | Feb | 137 | 0.0165 | 2,781 | 137 | 0.0125 | 2,101 | | | 681 | 137 | 0.0125 | 2,101 |
| | Mar | 236 | 0.0154 | 4,489 | 236 | 0.0125 | 3,633 | | | 856 | 236 | 0.0125 | 3,633 |
| | Apr | 1,568 | 0.0143 | 27,661 | 1,568 | 0.0125 | 24,106 | | | 3,554 | 1,568 | 0.0125 | 24,106 |
| | May | 4,475 | 0.0131 | 72,304 | 4,475 | 0.0125 | 68,785 | | | 3,518 | 4,475 | 0.0125 | 68,785 |
| | Jun | 1,081 | 0.0100 | 13,335 | 1,081 | 0.0125 | 16,619 | | | -3,284 | 1,081 | 0.0125 | 16,619 |
| | Jul | 342 | 0.0110 | 4,639 | 342 | 0.0125 | 5,256 | | | -617 | 342 | 0.0125 | 5,256 |
| | Aug | 214 | 0.0180 | 4,756 | 214 | 0.0125 | 3,293 | | | 1,463 | 214 | 0.0125 | 3,293 |
| | Sep | 198 | 0.0240 | 5,856 | 198 | 0.0125 | 3,041 | | | 2,815 | 198 | 0.0125 | 3,041 |
| WY | Total | 9,060 | 0.0136 | 155,265 | 9,060 | 0.0125 | 139,274 | | | 15,990 | 9,060 | 0.0125 | 139,274 |
| | Oct | 231 | 0.0209 | 5,966 | 231 | 0.0121 | 3,466 | | | 2,500 | 231 | 0.0121 | 3,466 |
| | Nov | 192 | 0.0198 | 4,686 | 192 | 0.0121 | 2,874 | | | 1,812 | 192 | 0.0121 | 2,874 |
| | Dec | 56 | 0.0187 | 1,303 | 56 | 0.0121 | 846 | | | 457 | 56 | 0.0121 | 846 |
| 2001 | Jan | 14 | 0.0176 | 293 | 14 | 0.0121 | 202 | | | 91 | 14 | 0.0121 | 202 |
| | Feb | 50 | 0.0165 | 1,027 | 50 | 0.0121 | 756 | | | 271 | 50 | 0.0121 | 756 |
| | Mar | 242 | 0.0154 | 4,606 | 242 | 0.0121 | 3,631 | | | 974 | 242 | 0.0121 | 3,631 |
| | Apr | 1,503 | 0.0143 | 26,508 | 1,503 | 0.0121 | 22,508 | | | 4,000 | 1,503 | 0.0121 | 22,508 |
| | May | 5,236 | 0.0131 | 84,602 | 5,236 | 0.0121 | 78,415 | | | 6,187 | 5,236 | 0.0121 | 78,415 |
| | Jun | 832 | 0.0100 | 10,258 | 832 | 0.0121 | 12,455 | | | -2,197 | 832 | 0.0121 | 12,455 |
| | Jul | 303 | 0.0110 | 4,106 | 303 | 0.0121 | 4,532 | | | -426 | 303 | 0.0121 | 4,532 |
| | Aug | 228 | 0.0100 | 2,816 | 228 | 0.0121 | 3,420 | | | -603 | 228 | 0.0121 | 3,420 |
| | Sep | 153 | 0.0240 | 4,537 | 153 | 0.0121 | 2,295 | | | 2,242 | 153 | 0.0121 | 2,295 |
| WY | Total | 9,040 | 0.0134 | 150,707 | 9,040 | 0.0121 | 135,399 | | | 15,308 | 9,040 | 0.0121 | 135,399 |

**Table A-2** Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l (From Table 3) | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l (From Table B) | Weight grams |
| | Oct | 133 | 0.0209 | 3,434 | 133 | 0.0126 | 2,076 | | | 1,358 | 133 | 0.0126 | 2,076 |
| | Nov | 200 | 0.0198 | 4,889 | 200 | 0.0126 | 3,120 | | | 1,769 | 200 | 0.0126 | 3,120 |
| | Dec | 161 | 0.0187 | 3,724 | 161 | 0.0126 | 2,516 | | | 1,207 | 161 | 0.0126 | 2,516 |
| 2002 | Jan | 75 | 0.0176 | 1,626 | 75 | 0.0126 | 1,167 | | | 458 | 75 | 0.0126 | 1,167 |
| | Feb | 29 | 0.0165 | 598 | 29 | 0.0126 | 458 | | | 140 | 29 | 0.0126 | 458 |
| | Mar | 58 | 0.0154 | 1,108 | 58 | 0.0126 | 909 | | | 199 | 58 | 0.0126 | 909 |
| | Apr | 1,289 | 0.0143 | 22,736 | 1,289 | 0.0126 | 20,093 | | | 2,644 | 1,289 | 0.0126 | 20,093 |
| | May | 3,038 | 0.0131 | 49,095 | 3,038 | 0.0126 | 47,361 | | | 1,734 | 3,038 | 0.0126 | 47,361 |
| | Jun | 636 | 0.0141 | 11,054 | 636 | 0.0126 | 9,907 | | | 1,147 | 636 | 0.0126 | 9,907 |
| | Jul | 256 | 0.0110 | 3,473 | 256 | 0.0126 | 3,990 | | | -517 | 256 | 0.0126 | 3,990 |
| | Aug | 120 | 0.0176 | 2,612 | 120 | 0.0126 | 1,875 | | | 736 | 120 | 0.0126 | 1,875 |
| | Sep | 165 | 0.0240 | 4,871 | 165 | 0.0126 | 2,565 | | | 2,306 | 165 | 0.0126 | 2,565 |
| WY | Total | 6,161 | 0.0142 | 109,219 | 6,161 | 0.0126 | 96,039 | | | 13,180 | 6,161 | 0.0126 | 96,039 |
| | Oct | 187 | 0.0209 | 4,810 | 187 | 0.0133 | 3,054 | | | 1,756 | 187 | 0.0133 | 3,054 |
| | Nov | 125 | 0.0198 | 3,047 | 125 | 0.0133 | 2,042 | | | 1,005 | 125 | 0.0133 | 2,042 |
| | Dec | 27 | 0.0187 | 617 | 27 | 0.0133 | 438 | | | 179 | 27 | 0.0133 | 438 |
| 2003 | Jan | 54 | 0.0176 | 1,167 | 54 | 0.0133 | 880 | | | 287 | 54 | 0.0133 | 880 |
| | Feb | 97 | 0.0165 | 1,975 | 97 | 0.0133 | 1,588 | | | 387 | 97 | 0.0133 | 1,588 |
| | Mar | 135 | 0.0154 | 2,565 | 135 | 0.0133 | 2,210 | | | 355 | 135 | 0.0133 | 2,210 |
| | Apr | 743 | 0.0143 | 13,097 | 743 | 0.0133 | 12,153 | | | 943 | 743 | 0.0133 | 12,153 |
| | May | 5,905 | 0.0131 | 95,413 | 5,905 | 0.0133 | 96,651 | | | -1,238 | 5,905 | 0.0133 | 96,651 |
| | Jun | 1,717 | 0.0180 | 38,115 | 1,717 | 0.0133 | 28,099 | | | 10,016 | 1,717 | 0.0133 | 28,099 |
| | Jul | 353 | 0.0173 | 7,531 | 353 | 0.0133 | 5,777 | | | 1,754 | 353 | 0.0133 | 5,777 |
| | Aug | 233 | 0.0160 | 4,603 | 233 | 0.0133 | 3,818 | | | 785 | 233 | 0.0133 | 3,818 |
| | Sep | 168 | 0.0240 | 4,959 | 168 | 0.0133 | 2,742 | | | 2,217 | 168 | 0.0133 | 2,742 |
| WY | Total | 9,742 | 0.0147 | 177,900 | 9,742 | 0.0133 | 159,452 | | | 18,447 | 9,742 | 0.0133 | 159,452 |
| | Oct | 118 | 0.0209 | 3,049 | 118 | 0.0136 | 1,980 | | | 1,069 | 118 | 0.0136 | 1,980 |
| | Nov | 173 | 0.0198 | 4,223 | 173 | 0.0136 | 2,895 | | | 1,328 | 173 | 0.0136 | 2,895 |
| | Dec | 133 | 0.0187 | 3,069 | 133 | 0.0136 | 2,228 | | | 841 | 133 | 0.0136 | 2,228 |
| 2004 | Jan | 136 | 0.0176 | 2,954 | 136 | 0.0136 | 2,278 | | | 676 | 136 | 0.0136 | 2,278 |
| | Feb | 145 | 0.0165 | 2,945 | 145 | 0.0136 | 2,423 | | | 522 | 145 | 0.0136 | 2,423 |
| | Mar | 253 | 0.0154 | 4,814 | 253 | 0.0136 | 4,243 | | | 571 | 253 | 0.0136 | 4,243 |
| | Apr | 1,684 | 0.0143 | 29,696 | 1,684 | 0.0136 | 28,189 | | | 1,507 | 1,684 | 0.0136 | 28,189 |
| | May | 3,730 | 0.0131 | 60,275 | 3,730 | 0.0136 | 62,456 | | | -2,182 | 3,730 | 0.0136 | 62,456 |
| | Jun | 1,116 | 0.0195 | 26,836 | 1,116 | 0.0136 | 18,681 | | | 8,155 | 1,116 | 0.0136 | 18,681 |
| | Jul | 325 | 0.0173 | 6,932 | 325 | 0.0136 | 5,439 | | | 1,493 | 325 | 0.0136 | 5,439 |
| | Aug | 165 | 0.0211 | 4,301 | 165 | 0.0136 | 2,767 | | | 1,534 | 165 | 0.0136 | 2,767 |
| | Sep | 137 | 0.0240 | 4,055 | 137 | 0.0136 | 2,293 | | | 1,761 | 137 | 0.0136 | 2,293 |
| WY | Total | 8,115 | 0.0151 | 153,150 | 8,115 | 0.0136 | 135,874 | | | 17,276 | 8,115 | 0.0136 | 135,874 |

**Table A-2** Date: September 25,2006

## Flow and Phosphorus Routing WITHOUT Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l (From Table 3) | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l (From Table B) | Weight grams |
| | Oct | 232 | 0.0209 | 5,973 | 232 | 0.0137 | 3,909 | | | 2,065 | 232 | 0.0137 | 3,909 |
| | Nov | 165 | 0.0198 | 4,019 | 165 | 0.0137 | 2,776 | | | 1,243 | 165 | 0.0137 | 2,776 |
| | Dec | 138 | 0.0187 | 3,188 | 138 | 0.0137 | 2,331 | | | 857 | 138 | 0.0137 | 2,331 |
| 2005 | Jan | 139 | 0.0176 | 3,022 | 139 | 0.0137 | 2,348 | | | 674 | 139 | 0.0137 | 2,348 |
| | Feb | 147 | 0.0165 | 2,995 | 147 | 0.0137 | 2,482 | | | 513 | 147 | 0.0137 | 2,482 |
| | Mar | 203 | 0.0154 | 3,863 | 203 | 0.0137 | 3,431 | | | 433 | 203 | 0.0137 | 3,431 |
| | Apr | 845 | 0.0143 | 14,914 | 845 | 0.0137 | 14,262 | | | 652 | 845 | 0.0137 | 14,262 |
| | May | 9,290 | 0.0131 | 150,109 | 9,290 | 0.0137 | 156,700 | | | -6,591 | 9,290 | 0.0137 | 156,700 |
| | Jun | 4,675 | 0.0195 | 112,439 | 4,675 | 0.0137 | 78,852 | | | 33,586 | 4,675 | 0.0137 | 78,852 |
| | Jul | 729 | 0.0100 | 8,992 | 729 | 0.0137 | 12,296 | | | -3,305 | 729 | 0.0137 | 12,296 |
| | Aug | 451 | 0.0100 | 5,558 | 451 | 0.0137 | 7,601 | | | -2,043 | 451 | 0.0137 | 7,601 |
| | Sep | 285 | 0.0100 | 3,510 | 285 | 0.0137 | 4,799 | | | -1,290 | 285 | 0.0137 | 4,799 |
| WY | Total | 17,298 | 0.0152 | 318,582 | 17,298 | 0.0137 | 291,788 | | | 26,794 | 17,298 | 0.0137 | 291,788 |
| 78-05 | Total | 400,512 | | 7,080,922 | 400,512 | | 6,466,618 | | | 614,305 | 400,512 | | 6,466,618 |
| 78-05 | Average | 14,304 | 0.0143 | 252,890 | 14,304 | 0.0131 | 230,951 | | | 21,939 | 14,304 | 0.0131 | 230,951 |
| 78-89 | Total | 200,780 | | 3,521,831 | 200,780 | | 3,235,948 | | | 285,883 | 200,780 | | 3,235,948 |
| 78-89 | Average | 16,732 | 0.0142 | 293,486 | 16,732 | 0.0131 | 269,662 | | | 23,824 | 16,732 | 0.0131 | 269,662 |

NOTE: Average Annual Concentrations are Flow Weighted

Date September 25, 2006

Table A-3

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year | Month | [redacted] Flow (Acre-Feet) | [redacted] Concentration | [redacted] Weight | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | [redacted] Flow (Acre-Feet) | [redacted] Concentration (mg/l) | [redacted] Weight | Stream Flow-Mud Creek Above Scofield Reservoir Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Stream Flow-Pondtown Creek Above Scofield Reservoir Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (CALC.) Other Reservoir Inflow Scofield Reservoir (Includes errors, uptake, P recycle, etc.) Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (CALC.) Total Inflow Above Scofield Reservoir Flow (Acre-Feet) | Weight (Grams) | Scofield Reservoir Evaporation (Acre-Feet) | Precipitation | Total (Acre-Feet) | End of Month Content Concentration | End of Month Content Weight (Grams) | Price River Below Scofield Dam Flow (Acre-Feet) | Weight (Grams) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 152 | 0.0129 | 2,389 | 178 | 0.0897 | 19,761 | 528 | 0.0346 | 22,590 | 359 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Nov | 162 | 0.0129 | 2,386 | 209 | 0.0622 | 10,674 | 371 | 0.0294 | 13,454 | 368 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Dec | 164 | 0.0129 | 2,612 | 221 | 0.0512 | 12,344 | 485 | 0.0207 | 14,956 | 391 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1978 | Jan | 154 | 0.0129 | 2,453 | 334 | 0.0184 | 7,682 | 492 | 0.0167 | 10,135 | 392 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Feb | 147 | 0.0129 | 2,341 | 329 | 0.0504 | 12,537 | 476 | 0.0250 | 14,679 | 389 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Mar | 191 | 0.0129 | 3,042 | 889 | 0.0337 | 36,923 | 1,060 | 0.0330 | 39,903 | 411 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Apr | 1,050 | 0.0129 | 15,905 | 2,000 | 0.0330 | 82,073 | 3,060 | 0.0269 | 99,080 | 910 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | May | 6,480 | 0.0129 | 103,208 | 14,482 | 0.0915 | 1,631,591 | 20,960 | 0.0671 | 1,734,799 | 6,521 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jun | 7,240 | 0.0129 | 115,313 | 9,310 | 0.0313 | 358,298 | 16,550 | 0.0232 | 473,610 | 1,632 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jul | 914 | 0.0129 | 14,557 | 1,226 | 0.0470 | 71,639 | 2,150 | 0.0325 | 86,190 | 727 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Aug | 548 | 0.0119 | 8,096 | 414 | 0.0326 | 16,643 | 960 | 0.0214 | 25,341 | 487 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Sep | 256 | 0.0129 | 4,077 | 337 | 0.0821 | 29,342 | 639 | 0.0421 | 33,420 | 422 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total/Average | | 17,434 | 0.0129 | 177,674 | 30,117 | 0.0610 | 2,290,044 | 47,551 | 0.0418 | 2,307,719 | 13,108 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Nov | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Dec | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1979 | Jan | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Feb | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Mar | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Apr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jun | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jul | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Aug | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Sep | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total/Average | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Nov | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Dec | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1980 | Jan | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Feb | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Mar | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Apr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jun | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jul | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Aug | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Sep | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total/Average | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Nov | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Dec | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1981 | Jan | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Feb | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Mar | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Apr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jun | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Jul | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Aug | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Sep | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total/Average | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Table A-3

Date: September 25, 2006

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year Month | [redacted] | | | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir | | | [redacted] | | | Stream Flow-Mud Creek Above Scofield Reservoir | | | Stream Flow-Pondtown Creek Above Scofield Reservoir | | | (CALC.) Other Reservoir Inflow Scofield Reservoir (Includes ... uptake, P recycle, etc.) | | | (CALC.) Total Inflow Above Scofield Reservoir | | (Empirical-Model) Scofield Reservoir | | End of Month Content | | | Price River Below Scofield Dam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flow Acre-Feet | mg/l Table 3 | Weight Grams | Flow Acre-Feet | Concentration mg/l | Weight Grams | Flow Acre-Feet | Concentration mg/l | Weight Grams | Flow Acre-Feet | Concentration mg/l | Weight Grams | Flow Acre-Feet | Concentration mg/l | Weight Grams | Flow Acre-Feet | Concentration mg/l | Weight Grams | Flow Acre-Feet | Weight Grams | Evaporation Acre-Feet | Phosphorus Uptake Grams | Total Acre-Feet | mg/l Measured | Weight Grams | Flow Acre-Feet | Weight Grams |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Oct | 337 | 0.0130 | 5,395 | 460 | 0.0851 | 48,281 | 797 | 0.0546 | 53,677 | 297 | 0.0900 | 25,664 | 88 | 0.0350 | 3,792 | 379 | 0.0570 | 68,840 | 1,161 | 151,582 | 374 | -863,731 | 35,450 | 0.0800 | 2,423,666 | 672 | 49,734 |
| Nov | 325 | 0.0130 | 4,083 | 465 | 0.0468 | 26,267 | 658 | 0.0306 | 24,349 | 232 | 0.0200 | 5,723 | 73 | 0.0300 | 2,698 | 535 | 0.0276 | 18,819 | 1,510 | 53,576 | 111 | 1,909,344 | 36,535 | 0.0156 | 676,349 | 300 | 3,551 |
| Dec | 183 | 0.0130 | 2,902 | 419 | 0.0512 | 26,839 | 604 | 0.0400 | 29,916 | 242 | 0.0500 | 14,925 | 67 | 0.0300 | 2,472 | 187 | 0.0419 | 39,020 | 1,300 | 67,219 | 0 | -400,421 | 37,555 | 0.0245 | 1,134,927 | 300 | 9,066 |
| 1982 Jan | 140 | 0.0130 | 2,241 | 351 | 0.0182 | 7,955 | 495 | 0.0167 | 10,197 | 211 | 0.0500 | 12,913 | 55 | 0.0500 | 3,328 | 1,339 | 0.0283 | 46,406 | 2,100 | 73,404 | 0 | -449,847 | 39,333 | 0.0370 | 1,643,638 | 300 | 15,545 |
| Feb | 123 | 0.0130 | 1,969 | 313 | 0.0297 | 11,377 | 438 | 0.0250 | 13,507 | 234 | 0.0500 | 14,432 | 48 | 0.0500 | 3,003 | 979 | 0.0348 | 42,044 | 1,300 | 72,988 | 0 | -1,060,614 | 40,755 | 0.0550 | 2,764,879 | 300 | 20,353 |
| Mar | 183 | 0.0130 | 2,902 | 401 | 0.0379 | 18,723 | 566 | 0.0300 | 21,085 | 405 | 0.0800 | 39,965 | 65 | 0.0500 | 4,000 | 844 | 0.0504 | 52,487 | 1,000 | 118,135 | 0 | -273,835 | 42,353 | 0.0600 | 3,134,685 | 300 | 22,203 |
| Apr | 1,160 | 0.0130 | 18,572 | 2,500 | 0.0323 | 101,879 | 3,720 | 0.0263 | 120,450 | 1,060 | 0.4000 | 522,867 | 400 | 0.0600 | 30,302 | 794 | 0.1084 | 110,451 | 6,200 | 813,830 | 0 | 283,105 | 48,255 | 0.0612 | 3,643,738 | 300 | 22,047 |
| May | 4,700 | 0.0130 | 140,248 | 14,400 | 0.2334 | 4,144,893 | 23,160 | 0.1500 | 4,285,141 | 3,200 | 0.2900 | 1,401,584 | 2,520 | 0.1900 | 456,903 | 12,792 | 0.1738 | 2,742,366 | 43,735 | 9,375,854 | 938 | 8,618,981 | 73,500 | 0.0392 | 3,553,829 | 17,352 | 848,672 |
| Jun | 4,500 | 0.0130 | 72,049 | 5,440 | 0.0751 | 504,216 | 9,940 | 0.0470 | 576,265 | 3,360 | 0.1470 | 645,500 | 1,084 | 0.0600 | 80,199 | 12,294 | 0.0724 | 1,089,516 | 20,788 | 2,391,486 | 1,204 | 1,079,325 | 73,300 | 0.0396 | 3,647,592 | 35,494 | 1,234,700 |
| Jul | 1,110 | 0.0130 | 17,771 | 1,420 | 0.0611 | 107,058 | 4,330 | 0.0600 | 124,829 | 1,250 | 0.0700 | 107,930 | 277 | 0.1550 | 52,839 | 2,813 | 0.0571 | 104,075 | 8,979 | 485,713 | 1,350 | -11,001,255 | 65,468 | 0.1611 | 13,069,655 | 13,151 | 2,615,392 |
| Aug | 508 | 0.0130 | 8,133 | 712 | 0.1450 | 127,304 | 4,220 | 0.0900 | 135,437 | 503 | 0.1500 | 93,067 | 134 | 0.0100 | 1,693 | 247 | 0.1085 | 80,613 | 2,104 | 280,768 | 1,133 | 5,410,582 | 57,541 | 0.0965 | 6,875,066 | 9,396 | 1,104,225 |
| Sep | 498 | 0.0130 | 7,975 | 642 | 0.1475 | 132,645 | 1,160 | 0.1200 | 140,618 | 475 | 0.1000 | 58,344 | 125 | 0.1100 | 13,443 | 388 | 0.1000 | 47,461 | 2,123 | 281,965 | 813 | -3,363,658 | 52,831 | 0.1365 | 8,573,394 | 5,959 | 1,086,535 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | 17,283 | 0.0130 | 284,354 | 27,337 | 0.1547 | 5,251,397 | 45,288 | 0.0905 | 5,535,951 | 13,797 | 0.2025 | 3,432,985 | 4,945 | 0.1095 | 668,484 | 34,536 | 0.1254 | 4,437,381 | 98,491 | 14,122,801 | 6,913 | -840,526 | 50,294 | 0.0702 | 4,357,445 | 73,982 | 7,049,835 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Oct | 830 | 0.0134 | 13,891 | 830 | 0.1078 | 107,444 | 1,640 | 0.1065 | 121,375 | 441 | 0.2500 | 108,724 | 180 | 0.0330 | 7,756 | 323 | 0.1060 | 42,207 | 2,755 | 360,082 | 453 | -1,300,142 | 54,946 | 0.0225 | 1,511,778 | 413 | 121,840 |
| Nov | 491 | 0.0134 | 11,398 | 1,019 | 0.0402 | 50,614 | 1,710 | 0.0294 | 62,912 | 400 | 0.0670 | 33,719 | 195 | 0.0190 | 4,569 | 724 | 0.0352 | 31,455 | 3,880 | 128,975 | 128 | 7,284,159 | 56,950 | 0.0156 | 1,053,698 | 298 | 3,334 |
| Dec | 308 | 0.0134 | 6,249 | 610 | 0.0345 | 23,981 | 1,310 | 0.0230 | 34,229 | 270 | 0.0900 | 23,839 | 122 | 0.0500 | 7,519 | -24 | 0.0353 | -1,045 | 1,484 | 64,529 | 0 | -667,651 | 57,750 | 0.0245 | 1,743,319 | 484 | 20,473 |
| 1983 Jan | 427 | 0.0134 | 7,044 | 557 | 0.0193 | 13,226 | 984 | 0.0167 | 20,270 | 319 | 0.0500 | 17,530 | 110 | 0.0500 | 6,673 | 583 | 0.0246 | 17,679 | 2,099 | 62,151 | 0 | -883,123 | 58,876 | 0.0329 | 2,461,991 | 921 | 38,712 |
| Feb | 374 | 0.0134 | 6,169 | 491 | 0.0339 | 20,505 | 865 | 0.0250 | 26,674 | 383 | 0.0700 | 25,616 | 55 | 0.0500 | 3,454 | 1,037 | 0.0387 | 50,407 | 2,160 | 112,571 | 0 | -1,579,959 | 60,400 | 0.0530 | 4,086,026 | 832 | 56,444 |
| Mar | 491 | 0.0134 | 8,098 | 679 | 0.0429 | 35,196 | 1,170 | 0.0316 | 43,295 | 470 | 0.0800 | 46,973 | 129 | 0.0500 | 7,922 | 826 | 0.0446 | 15,681 | 2,600 | 141,670 | 0 | -1,162,725 | 62,085 | 0.0490 | 3,343,330 | 921 | 79,250 |
| Apr | 638 | 0.0134 | 10,524 | 1,452 | 0.0319 | 57,148 | 2,090 | 0.0263 | 67,672 | 728 | 0.1000 | 98,798 | 229 | 0.0600 | 16,923 | 1,696 | 0.0464 | 57,100 | 4,743 | 271,493 | 0 | 272,039 | 42,083 | 0.0612 | 4,686,333 | 4,740 | 358,047 |
| May | 4,530 | 0.0134 | 74,725 | 14,190 | 0.0845 | 1,474,675 | 18,720 | 0.0671 | 1,549,400 | 4,600 | 0.1320 | 749,075 | 2,040 | 0.1000 | 256,653 | 1,896 | 0.0817 | 392,347 | 29,330 | 2,947,574 | 1,109 | 3,196,832 | 72,500 | 0.0488 | 4,424,278 | 13,892 | 1,012,156 |
| Jun | 14,210 | 0.0134 | 234,403 | 29,310 | 0.0280 | 1,011,096 | 43,520 | 0.0232 | 1,245,499 | 7,990 | 0.0720 | 709,602 | 4,741 | 0.0430 | 251,462 | 23,221 | 0.0318 | 871,646 | 78,470 | 3,078,119 | 1,294 | 2,838,890 | 73,500 | 0.0250 | 2,266,536 | 77,179 | 2,370,971 |
| Jul | 2,950 | 0.0134 | 48,662 | 3,170 | 0.0503 | 195,679 | 6,120 | 0.0325 | 245,341 | 1,890 | 0.0420 | 97,914 | 658 | 0.0520 | 42,820 | 9,464 | 0.0361 | 421,076 | 19,142 | 807,151 | 1,350 | -2,180,684 | 67,812 | 0.0470 | 3,931,313 | 22,486 | 1,303,373 |
| Aug | 861 | 0.0134 | 14,203 | 1,449 | 0.0262 | 46,774 | 2,310 | 0.0214 | 60,978 | 897 | 0.0700 | 77,451 | 251 | 0.0770 | 23,370 | 630 | 0.0375 | 29,490 | 4,680 | 193,247 | 1,146 | -1,113,954 | 60,813 | 0.0600 | 4,500,733 | 9,042 | 735,804 |
| Sep | 599 | 0.0134 | 9,881 | 1,001 | 0.0240 | 29,591 | 1,600 | 0.0200 | 39,472 | 781 | 0.0400 | 38,534 | 175 | 0.0730 | 15,794 | 875 | 0.0297 | 32,090 | 3,431 | 125,880 | 844 | 3,195,490 | 50,900 | 0.0143 | 1,148,999 | 12,408 | 282,115 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | 27,161 | 0.0134 | 447,049 | 54,778 | 0.0455 | 3,063,079 | 81,870 | 0.0346 | 3,510,127 | 19,375 | 0.0950 | 2,102,665 | 8,930 | 0.0540 | 667,141 | 42,271 | 0.0389 | 3,030,306 | 152,411 | 8,296,241 | 6,202 | 19,328,277 | 61,595 | 0.0481 | 3,656,217 | 148,143 | 6,393,666 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Oct | 634 | 0.0132 | 10,180 | 800 | 0.0866 | 86,119 | 1,430 | 0.0340 | 96,328 | 605 | 0.0700 | 51,893 | 151 | 0.0400 | 7,935 | 1,159 | 0.0578 | 83,151 | 5,340 | 238,083 | 426 | -770,526 | 41,298 | 0.0322 | 1,653,447 | 13,020 | 101,907 |
| Nov | 520 | 0.0132 | 8,491 | 680 | 0.0418 | 35,026 | 1,200 | 0.0294 | 43,517 | 540 | 0.0670 | 45,771 | 132 | 0.0190 | 2,067 | 2,251 | 0.0796 | 165,065 | 4,171 | 202,043 | 118 | 1,079,150 | 44,419 | 0.0270 | 825,949 | 891 | 16,466 |
| Dec | 552 | 0.0132 | 9,014 | 828 | 0.0373 | 27,374 | 1,380 | 0.0250 | 38,239 | 354 | 0.0700 | 47,835 | 129 | 0.0500 | 7,990 | 1,336 | 0.0461 | 66,131 | 3,200 | 158,343 | 0 | -458,567 | 47,619 | 0.0345 | 1,450,058 | 0 | 0 |
| 1984 Jan | 481 | 0.0132 | 7,854 | 619 | 0.0194 | 14,805 | 1,100 | 0.0167 | 22,659 | 524 | 0.0700 | 24,561 | 121 | 0.0500 | 7,452 | 555 | 0.0254 | 72,996 | 2,300 | 72,086 | 0 | -776,233 | 49,519 | 0.0370 | 2,087,342 | 0 | 0 |
| Feb | 424 | 0.0132 | 6,924 | 716 | 0.0720 | 28,231 | 1,140 | 0.0250 | 35,154 | 528 | 0.0700 | 45,596 | 125 | 0.0500 | 7,727 | -187 | 0.0400 | -8,531 | 1,609 | 78,934 | 0 | -1,328,828 | 51,519 | 0.0550 | 3,460,122 | 0 | 0 |
| Mar | 427 | 0.0132 | 6,973 | 743 | 0.0356 | 35,323 | 1,170 | 0.0300 | 43,295 | 579 | 0.0800 | 57,195 | 126 | 0.0500 | 7,921 | 2,436 | 0.0468 | 160,562 | 4,317 | 248,915 | 0 | 1,079,068 | 54,911 | 0.0300 | 2,031,050 | 551 | 34,081 |
| Apr | 665 | 0.0132 | 10,826 | 2,217 | 0.0601 | 82,426 | 2,880 | 0.0265 | 93,252 | 1,300 | 0.1000 | 160,234 | 315 | 0.0600 | 23,291 | -73 | 0.0495 | -4,679 | 4,422 | 272,417 | 0 | -3,174,625 | 54,911 | 0.0612 | 4,145,119 | 4,422 | 333,815 |
| May | 12,220 | 0.0132 | 199,305 | 27,130 | 0.0914 | 3,058,008 | 39,360 | 0.0671 | 3,257,714 | 8,700 | 0.1120 | 1,416,550 | 4,280 | 0.1020 | 539,485 | 32,216 | 0.0907 | 1,219,981 | 64,956 | 6,432,618 | 974 | 3,447,403 | 73,500 | 0.0480 | 4,434,208 | 45,023 | 2,718,115 |
| Jun | 9,620 | 0.0132 | 157,080 | 12,110 | 0.0031 | 464,760 | 21,730 | 0.0212 | 621,840 | 5,760 | 0.0720 | 511,552 | 2,300 | 0.0430 | 120,383 | 27,620 | 0.0542 | 1,104,610 | 97,473 | 2,423,564 | 1,294 | 2,048,794 | 73,500 | 0.0250 | 2,266,536 | 86,183 | 1,792,542 |
| Jul | 1,490 | 0.0132 | 24,167 | 2,550 | 0.0437 | 137,385 | 4,050 | 0.0325 | 161,550 | 1,000 | 0.0420 | 82,890 | 441 | 0.0520 | 28,219 | 5,885 | 0.0364 | 264,579 | 11,995 | 557,044 | 1,350 | -4,073,737 | 66,990 | 0.0470 | 3,883,693 | 17,119 | 992,225 |
| Aug | 654 | 0.0132 | 10,679 | 1,026 | 0.0266 | 33,667 | 1,680 | 0.0214 | 44,346 | 990 | 0.0700 | 85,135 | 164 | 0.0750 | 17,022 | 336 | 0.0417 | 27,540 | 3,186 | 174,053 | 1,142 | -1,006,264 | 61,488 | 0.0500 | 4,350,733 | 7,746 | 673,278 |
| Sep | 479 | 0.0132 | 7,168 | 814 | 0.0502 | 58,206 | 1,220 | 0.0424 | 65,375 | 609 | 0.0330 | 24,014 | 137 | 0.0510 | 8,567 | -412 | 0.0396 | -29,857 | 1,403 | 68,499 | 947 | 716,097 | 54,188 | 0.0510 | 3,408,303 | 7,883 | -494,771 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | 28,114 | 0.0132 | 459,077 | 50,036 | 0.0658 | 4,062,335 | 78,150 | 0.0469 | 4,521,412 | 22,309 | 0.0928 | 2,552,870 | 8,524 | 0.0746 | 784,877 | 53,132 | 0.0403 | 3,081,838 | 162,113 | 10,906,614 | 6,130 | 1,250,032 | 58,180 | 0.0411 | 2,850,840 | 152,686 | 7,389,217 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Oct | 503 | 0.0132 | 9,180 | 939 | 0.0794 | 91,914 | 1,300 | 0.0346 | 101,023 | 752 | 0.0900 | 64,931 | 164 | 0.0330 | 7,097 | 205 | 0.0581 | 14,321 | 2,619 | 187,572 | 434 | -515,628 | 50,583 | 0.0600 | 3,738,336 | 3,932 | 442,724 |
| Nov | 458 | 0.0132 | 7,437 | 852 | 0.0283 | 40,070 | 1,310 | 0.0294 | 47,507 | 585 | 0.0670 | 48,347 | 144 | 0.0190 | 3,368 | 348 | 0.0595 | 16,959 | 2,387 | 116,180 | 115 | 2,070,956 | 51,734 | 0.0130 | 837,575 | 891 | 16,488 |
| Dec | 464 | 0.0132 | 7,534 | 716 | 0.0327 | 28,854 | 1,180 | 0.0250 | 38,388 | 591 | 0.0700 | 51,029 | 130 | 0.0500 | 7,990 | 1,091 | 0.0407 | 84,014 | 3,592 | 180,318 | 0 | -334,701 | 54,334 | 0.0245 | 1,644,467 | 793 | 22,933 |
| 1985 Jan | 440 | 0.0132 | 7,144 | 560 | 0.0195 | 13,455 | 1,000 | 0.0167 | 20,599 | 515 | 0.0500 | 19,057 | 110 | 0.0500 | 6,780 | 375 | 0.0322 | 16,718 | 2,000 | 57,156 | 0 | -661,300 | 56,334 | 0.0325 | 2,267,179 | 0 | 0 |
| Feb | 338 | 0.0132 | 5,488 | 350 | 0.0364 | 15,728 | 688 | 0.0250 | 21,216 | 423 | 0.0700 | 36,524 | 78 | 0.0400 | 4,085 | 913 | 0.0426 | 46,019 | 2,180 | 110,443 | 0 | -1,071,611 | 58,654 | 0.0530 | 3,899,232 | 0 | 0 |
| Mar | 360 | 0.0132 | 3,042 | 956 | 0.0365 | 42,905 | 1,320 | 0.0300 | 48,846 | 335 | 0.0800 | 58,714 | 145 | 0.0500 | 8,938 | 832 | 0.0458 | 47,003 | 2,092 | 103,555 | 0 | -1,136,214 | 60,754 | 0.0608 | 5,230,413 | 792 | 68,199 |
| Apr | 3,010 | 0.0132 | 48,873 | 5,560 | 0.0337 | 228,615 | 8,570 | 0.0263 | 277,488 | 3,420 | 0.1000 | 298,504 | 538 | 0.0600 | 69,136 | 1,060 | 0.0435 | 54,080 | 12,924 | 609,229 | 0 | 388,087 | 53,614 | 0.0612 | 5,089,577 | 4,264 | 472,878 |
| May | 10,390 | 0.0132 | 166,833 | 13,500 | 0.1587 | 2,602,208 | 23,600 | 0.1100 | 2,771,341 | 3,410 | 0.1950 | 867,513 | 2,577 | 0.1650 | 524,653 | 9,098 | 0.1067 | 1,197,266 | 40,733 | 5,360,576 | 1,093 | 4,801,566 | 73,500 | 0.0490 | 3,602,064 | 35,614 | 2,695,071 |
| Jun | 2,400 | 0.0132 | 38,969 | 2,920 | 0.0256 | 92,234 | 5,320 | 0.0200 | 131,243 | 2,740 | 0.0360 | 93,429 | 580 | 0.0100 | 7,066 | 5,338 | 0.0152 | 100,519 | 13,946 | 278,569 | 1,204 | 1,695,426 | 69,607 | 0.0400 | 3,771,796 | 16,509 | 846,092 |
| Jul | 914 | 0.0132 | 14,841 | 1,106 | 0.0482 | 66,128 | 2,020 | 0.0325 | 80,979 | 1,040 | 0.0420 | 53,879 | 231 | 0.0620 | 14,577 | 382 | 0.0368 | 17,349 | 3,663 | 165,384 | 1,322 | -228,907 | 61,272 | 0.0470 | 3,580,595 | 10,836 | 630,025 |
| Aug | 436 | 0.0132 | 7,047 | 576 | -0.0012 | -418 | 1,010 | 0.0300 | 9,229 | 333 | 0.1800 | 7,866 | 111 | 0.1560 | 3,479 | -452 | 0.0090 | -5,004 | 1,305 | 14,402 | 1,169 | 2,043,667 | 49,124 | 0.0200 | 1,213,871 | 12,141 | 299,516 |
| Sep | 334 | 0.0132 | 5,098 | 515 | 0.0240 | 15,846 | 849 | 0.0200 | 20,945 | 319 | 0.1500 | 8,807 | 91 | 0.1000 | 6,517 | -735 | 0.0179 | -15,931 | 942 | 30,822 | 756 | -1,806,088 | 44,818 | 0.0500 | 2,764,147 | 6,433 | 274,626 |
| | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | 19,049 | 0.0132 | 325,546 | 28,168 | 0.0925 | 3,234,259 | 46,417 | 0.0697 | 3,562,504 | 18,333 | 0.0766 | 1,549,602 | 5,266 | 0.1022 | 686,196 | 19,009 | 0.0673 | 1,376,417 | 89,101 | 7,155,074 | 6,111 | 2,177,320 | 58,183 | 0.0465 | 3,340,750 | 93,353 | 5,822,057 |

Date September 21, 2006

Table A-3

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year | Month | [redacted] Flow Acre-Feet | [redacted] Concentration | [redacted] Weight Grams | (Calculated) Gain for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | [redacted] Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Research Inflow Scofield Reservoir (Includes errors, seeps, P recycle, etc.): Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | (Forecast/Yields) Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Content Acre-Feet | mg/l Measured | Weight Grams | Price River Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 386 | 0.0131 | 6,205 | 654 | 0.0591 | 47,793 | 1,040 | 0.0546 | 70,042 | 303 | 0.0706 | 43,411 | 116 | 0.0150 | 4,934 | 777 | 0.0275 | 32,662 | 2,394 | 171,070 | 400 | -328,508 | 46,150 | 0.0603 | 3,414,081 | 672 | 49,734 |
| | Nov | 380 | 0.0131 | 6,152 | 321 | 0.0413 | 16,572 | 901 | 0.0294 | 32,674 | 475 | 0.0679 | 39,255 | 99 | 0.0190 | 2,324 | 851 | 0.0408 | 47,846 | 2,426 | 122,100 | 122 | 2,040,015 | 46,138 | 0.0130 | 950,597 | 309 | 5,551 |
| | Dec | 347 | 0.0131 | 5,615 | 434 | 0.0345 | 18,460 | 781 | 0.0250 | 24,084 | 550 | 0.0706 | 48,859 | 86 | 0.0500 | 5,309 | 796 | 0.0422 | 41,348 | 2,115 | 109,594 | 0 | -416,347 | 49,838 | 0.0243 | 1,499,925 | 615 | 18,580 |
| 1986 | Jan | 348 | 0.0131 | 5,634 | 606 | 0.0187 | 14,059 | 996 | 0.0167 | 19,603 | 484 | 0.0205 | 17,094 | 105 | 0.0500 | 6,443 | 768 | 0.0231 | 21,918 | 2,315 | 66,080 | 0 | -356,315 | 51,314 | 0.0301 | 1,899,629 | 615 | 22,758 |
| | Feb | 357 | 0.0131 | 5,780 | 597 | 0.0323 | 23,639 | 954 | 0.0250 | 29,419 | 485 | 0.0700 | 41,877 | 105 | 0.0500 | 6,471 | 1,336 | 0.0406 | 68,303 | 2,900 | 146,072 | 0 | -4,633,677 | 53,954 | 0.0410 | 1,609,604 | 390 | 29,153 |
| | Mar | 533 | 0.0131 | 8,629 | 2,097 | 0.0343 | 88,683 | 2,640 | 0.0300 | 97,722 | 423 | 0.0800 | 41,213 | 287 | 0.0500 | 17,730 | 993 | 0.0423 | 46,937 | 4,635 | 243,201 | 0 | -1,140,466 | 57,698 | 0.0400 | 4,903,377 | 921 | 79,290 |
| | Apr | 1,880 | 0.0131 | 30,436 | 8,370 | 0.0301 | 236,601 | 8,350 | 0.0267 | 567,127 | 1,957 | 0.1000 | 241,314 | 900 | 0.0600 | 66,576 | 2,773 | 0.0420 | 143,608 | 13,830 | 714,706 | 0 | 282,441 | 58,721 | 0.0612 | 5,187,720 | 2,807 | 211,908 |
| | May | 11,050 | 0.0131 | 178,893 | 17,318 | 0.1012 | 2,184,916 | 28,560 | 0.0671 | 2,363,829 | 6,053 | 0.1320 | 983,878 | 3,412 | 0.1020 | 391,491 | 4,994 | 0.0606 | 697,613 | 44,721 | 4,434,814 | 1,042 | 2,856,683 | 73,308 | 0.0448 | 4,454,278 | 38,990 | 2,341,587 |
| | Jun | 7,530 | 0.0131 | 121,906 | 6,540 | 0.0346 | 283,596 | 14,170 | 0.0232 | 405,302 | 3,152 | 0.0720 | 279,913 | 1,594 | 0.0480 | 81,932 | 15,414 | 0.0330 | 626,921 | 54,280 | 1,394,268 | 1,259 | 2,514,907 | 71,500 | 0.0250 | 2,266,536 | 32,066 | 1,917,209 |
| | Jul | 900 | 0.0131 | 14,570 | 2,015 | 0.0412 | 102,087 | 2,910 | 0.0325 | 116,657 | 880 | 0.0420 | 45,590 | 318 | 0.0520 | 20,395 | 1,012 | 0.0360 | 45,006 | 5,120 | 227,647 | 1,330 | -1,985,471 | 63,363 | 0.0470 | 3,790,358 | 11,987 | 690,290 |
| | Aug | 458 | 0.0131 | 7,415 | 902 | 0.0256 | 28,485 | 1,360 | 0.0214 | 35,809 | 367 | 0.0702 | 48,957 | 140 | 0.0250 | 13,708 | 590 | 0.0585 | 18,547 | 2,466 | 117,207 | 1,132 | -1,029,047 | 54,923 | 0.0000 | 4,084,421 | 11,774 | 871,380 |
| | Sep | 362 | 0.0131 | 5,861 | 708 | 0.1142 | 99,726 | 1,070 | 0.0800 | 105,587 | 509 | 0.0100 | 6,278 | 116 | 0.0500 | 10,151 | 36 | 0.0583 | 2,580 | 1,712 | 124,506 | 820 | 1,778,882 | 49,010 | 0.0530 | 3,115,686 | 6,825 | 294,850 |
| Total/Average | | 28,331 | 0.0131 | 397,342 | 39,051 | 0.0558 | 3,170,695 | 63,882 | 0.0455 | 3,567,836 | 16,342 | 0.0926 | 1,870,043 | 6,937 | 0.0783 | 627,577 | 32,134 | 0.0457 | 1,000,259 | 118,585 | 7,873,240 | 6,175 | 2,999,308 | 57,003 | 0.0441 | 3,181,277 | 108,025 | 5,043,103 |
| | Oct | 448 | 0.0132 | 7,308 | 712 | 0.0886 | 70,617 | 1,160 | 0.0546 | 78,124 | 327 | 0.0706 | 48,328 | 127 | 0.0250 | 3,499 | 614 | 0.0577 | 43,703 | 2,428 | 172,829 | 422 | -1,487,076 | 51,521 | 0.0600 | 3,775,845 | 495 | 56,709 |
| | Nov | 398 | 0.0132 | 6,492 | 570 | 0.0407 | 28,612 | 968 | 0.0294 | 35,104 | 468 | 0.0679 | 40,750 | 106 | 0.0190 | 2,493 | -134 | 0.0464 | -6,709 | 1,428 | 71,226 | 125 | 2,851,472 | 51,826 | 0.0156 | 955,868 | 0 | 0 |
| | Dec | 271 | 0.0132 | 4,430 | 500 | 0.0314 | 19,353 | 771 | 0.0250 | 23,776 | 448 | 0.0706 | 38,682 | 87 | 0.0500 | 5,242 | 496 | 0.0423 | 25,711 | 1,800 | 93,453 | 0 | -568,225 | 55,624 | 0.0045 | 1,620,548 | 0 | 0 |
| 1987 | Jan | 150 | 0.0132 | 2,447 | 444 | 0.0179 | 9,788 | 594 | 0.0167 | 12,235 | 413 | 0.0380 | 19,358 | 86 | 0.0500 | 4,733 | 1,027 | 0.0259 | 34,538 | 2,146 | 69,785 | 0 | -439,782 | 55,720 | 0.0339 | 2,330,123 | 0 | 0 |
| | Feb | 126 | 0.0132 | 2,055 | 340 | 0.0294 | 12,313 | 466 | 0.0250 | 14,370 | 387 | 0.0700 | 33,411 | 52 | 0.0500 | 3,193 | 855 | 0.0467 | 50,640 | 1,800 | 101,819 | 0 | 913,069 | 53,526 | 0.0314 | 1,518,467 | 0 | 0 |
| | Mar | 183 | 0.0132 | 2,991 | 454 | 0.0368 | 20,387 | 637 | 0.0300 | 23,572 | 421 | 0.0800 | 41,544 | 70 | 0.0500 | 4,342 | 1,272 | 0.0499 | 78,272 | 2,400 | 147,750 | 0 | -1,497,348 | 59,924 | 0.0600 | 5,150,524 | 0 | 0 |
| | Apr | 1,780 | 0.0132 | 29,382 | 2,460 | 0.0357 | 110,667 | 4,140 | 0.0262 | 134,049 | 1,128 | 0.1000 | 139,118 | 452 | 0.0600 | 33,447 | 781 | 0.0424 | 41,872 | 6,509 | 348,566 | 0 | 493,424 | 65,324 | 0.0612 | 4,932,291 | 1,251 | 83,154 |
| | May | 1,180 | 0.0132 | 51,782 | 3,720 | 0.0904 | 414,092 | 4,970 | 0.0726 | 466,074 | 1,579 | 0.0800 | 186,310 | 145 | 0.0650 | 55,453 | 332 | 0.0637 | 20,103 | 9,680 | 757,050 | 1,024 | 2,474,428 | 66,469 | 0.0350 | 3,840,583 | 7,223 | 325,202 |
| | Jun | 913 | 0.0132 | 14,923 | 975 | 0.0306 | 40,223 | 1,939 | 0.0260 | 43,148 | 962 | 0.0720 | 58,795 | 209 | 0.0500 | 12,336 | 24 | 0.0330 | 1,048 | 2,777 | 117,342 | 1,347 | 363,318 | 66,427 | 0.0325 | 1,922,920 | 7,408 | 309,183 |
| | Jul | 461 | 0.0132 | 7,520 | 481 | 0.0010 | 30,244 | 942 | 0.0325 | 37,760 | 483 | 0.0420 | 25,019 | 104 | 0.0520 | 6,646 | 943 | 0.0368 | 38,232 | 2,373 | 107,714 | 1,284 | -1,037,287 | 53,296 | 0.0470 | 3,051,779 | 9,239 | 535,625 |
| | Aug | 259 | 0.0132 | 4,225 | 318 | 0.0427 | 17,127 | 577 | 0.0360 | 21,352 | 409 | 0.0780 | 35,315 | 64 | 0.0750 | 5,915 | -226 | 0.0480 | -13,407 | 823 | 48,779 | 1,063 | -78,897 | 49,475 | 0.0490 | 2,791,622 | 6,585 | 395,628 |
| | Sep | 204 | 0.0132 | 3,329 | 258 | 0.0653 | 20,833 | 462 | 0.0424 | 24,162 | 386 | 0.0110 | 14,750 | 55 | 0.0530 | 3,337 | -302 | 0.0381 | -14,201 | 577 | 28,074 | 776 | -61,646 | 40,603 | 0.0510 | 2,558,819 | 4,631 | 291,327 |
| Total/Average | | 8,308 | 0.0132 | 135,468 | 11,112 | 0.0569 | 780,200 | 18,417 | 0.0483 | 915,728 | 7,411 | 0.0690 | 638,259 | 3,127 | 0.0540 | 141,598 | 5,672 | 0.0443 | 308,291 | 34,647 | 2,043,871 | 5,919 | 370,141 | 24,083 | 0.0417 | 3,324,829 | 37,075 | 1,971,883 |
| | Oct | 216 | 0.0128 | 3,370 | 342 | 0.0408 | 17,203 | 558 | 0.0300 | 20,575 | 405 | 0.0706 | 34,969 | 92 | 0.0400 | 3,038 | -110 | 0.0464 | -6,290 | 913 | 52,286 | 397 | -477,261 | 39,349 | 0.0600 | 3,928,481 | 1,409 | 119,081 |
| | Nov | 193 | 0.0128 | 3,019 | 371 | 0.0381 | 17,434 | 564 | 0.0294 | 20,453 | 407 | 0.0679 | 35,056 | 62 | 0.0190 | 1,464 | 186 | 0.0436 | 10,013 | 1,220 | 63,505 | 116 | 2,241,301 | 40,673 | 0.0150 | 752,345 | 0 | 0 |
| | Dec | 168 | 0.0128 | 2,645 | 332 | 0.0312 | 12,775 | 500 | 0.0250 | 15,419 | 398 | 0.0700 | 34,020 | 55 | 0.0500 | 3,422 | 751 | 0.0451 | 41,785 | 1,700 | 98,643 | 0 | -433,344 | 42,375 | 0.0245 | 1,280,532 | 0 | 0 |
| 1988 | Jan | 188 | 0.0128 | 2,960 | 306 | 0.0191 | 7,216 | 494 | 0.0167 | 10,176 | 393 | 0.0380 | 18,421 | 55 | 0.0500 | 3,388 | 958 | 0.0275 | 32,533 | 1,900 | 64,512 | 0 | -506,283 | 44,273 | 0.0339 | 1,851,286 | 0 | 0 |
| | Feb | 176 | 0.0128 | 2,771 | 320 | 0.0317 | 12,524 | 496 | 0.0250 | 15,295 | 391 | 0.0700 | 33,933 | 55 | 0.0500 | 3,395 | 236 | 0.0452 | 14,207 | 1,200 | 66,891 | 0 | -465,663 | 43,473 | 0.0425 | 2,383,444 | 0 | 0 |
| | Mar | 222 | 0.0128 | 3,496 | 458 | 0.0384 | 21,668 | 680 | 0.0300 | 25,162 | 430 | 0.0800 | 42,472 | 75 | 0.0500 | 4,631 | 815 | 0.0494 | 49,666 | 2,000 | 121,892 | 0 | -1,591,572 | 47,473 | 0.0698 | 4,087,308 | 0 | 0 |
| | Apr | 907 | 0.0128 | 14,282 | 9,043 | 0.0276 | 307,690 | 9,950 | 0.0263 | 322,172 | 2,300 | 0.1000 | 283,702 | 1,080 | 0.0600 | 80,280 | -4,235 | 0.0417 | -433,727 | 9,100 | 252,437 | 0 | 381,024 | 52,373 | 0.0612 | 3,968,310 | 0 | 0 |
| | May | 5,170 | 0.0128 | 81,407 | 4,980 | 0.1772 | 1,049,366 | 10,150 | 0.0900 | 1,126,792 | 2,341 | 0.1320 | 381,162 | 1,107 | 0.1500 | 204,729 | 1,519 | 0.1023 | 191,365 | 15,117 | 1,004,050 | 982 | 1,203,864 | 61,833 | 0.0661 | 4,528,526 | 4,895 | 342,551 |
| | Jun | 1,200 | 0.0128 | 18,895 | 1,800 | 0.0302 | 66,958 | 3,000 | 0.0232 | 85,851 | 898 | 0.0720 | 79,752 | 328 | 0.0430 | 17,383 | 45 | 0.0351 | 1,956 | 4,271 | 184,935 | 1,219 | 2,308,615 | 55,713 | 0.0230 | 1,718,088 | 9,170 | 282,777 |
| | Jul | 418 | 0.0128 | 6,582 | 612 | 0.0460 | 34,709 | 1,030 | 0.0325 | 41,291 | 503 | 0.0420 | 25,955 | 113 | 0.0520 | 7,261 | -537 | 0.0382 | -25,240 | 1,087 | 49,268 | 1,235 | -1,434,080 | 44,560 | 0.0470 | 2,582,316 | 11,007 | 638,729 |
| | Aug | 257 | 0.0128 | 4,047 | 395 | -0.0042 | -2,036 | 652 | 0.0025 | 2,011 | 424 | 0.0780 | 36,610 | 75 | 0.1000 | 8,888 | -763 | 0.0338 | -31,590 | 389 | 15,937 | 1,012 | 1,320,238 | 36,017 | 0.0258 | 1,046,438 | 7,916 | 250,437 |
| | Sep | 193 | 0.0128 | 3,102 | 454 | 0.0513 | 30,045 | 653 | 0.0424 | 34,047 | 424 | 0.0331 | 16,213 | 75 | 0.0510 | 4,702 | -700 | 0.0289 | -23,304 | 443 | 21,398 | 716 | -1,178,910 | 33,989 | 0.0510 | 2,307,325 | 3,834 | 241,441 |
| Total/Average | | 9,319 | 0.0128 | 146,595 | 10,412 | 0.0607 | 1,570,650 | 28,723 | 0.0485 | 1,713,245 | 9,537 | 0.0880 | 1,026,807 | 3,161 | 0.0884 | 342,579 | -4,833 | 0.0298 | -179,823 | 23,339 | 2,983,904 | 5,038 | 1,096,287 | 45,303 | 0.0433 | 2,411,282 | 38,435 | 1,854,207 |
| | Oct | 231 | 0.0131 | 3,750 | 283 | 0.0863 | 30,087 | 514 | 0.0546 | 34,617 | 397 | 0.0700 | 34,279 | 37 | 0.0600 | 2,813 | -346 | 0.0601 | -25,609 | 422 | 46,591 | 362 | 775,091 | 31,420 | 0.0013 | 1,228,387 | 748 | 27,340 |
| | Nov | 278 | 0.0131 | 4,489 | 252 | 0.0474 | 14,731 | 530 | 0.0294 | 19,220 | 400 | 0.0679 | 33,658 | 59 | 0.0190 | 1,577 | -192 | 0.0446 | -5,537 | 697 | 48,117 | 196 | 696,910 | 31,925 | 0.0090 | 390,608 | 276 | 5,197 |
| | Dec | 248 | 0.0131 | 4,085 | 344 | 0.0336 | 14,251 | 592 | 0.0250 | 18,256 | 412 | 0.0700 | 35,576 | 66 | 0.0500 | 4,066 | 594 | 0.0439 | 30,903 | 1,620 | 87,832 | 0 | -038,209 | 33,825 | 0.0240 | 1,010,121 | 124 | 3,747 |
| 1989 | Jan | 241 | 0.0131 | 3,952 | 209 | 0.0209 | 5,378 | 450 | 0.0167 | 9,256 | 364 | 0.0380 | 17,099 | 50 | 0.0500 | 3,084 | 340 | 0.0378 | 18,540 | 1,424 | 48,895 | 0 | -398,208 | 34,925 | 0.0339 | 1,452,097 | 126 | 5,185 |
| | Feb | 186 | 0.0131 | 3,004 | 181 | 0.0371 | 9,314 | 367 | 0.0530 | 11,417 | 367 | 0.0700 | 31,688 | 41 | 0.0500 | 2,528 | 857 | 0.0476 | 49,177 | 1,612 | 94,731 | 0 | -918,425 | 36,225 | 0.0538 | 2,487,375 | 112 | 3,996 |
| | Mar | 359 | 0.0131 | 5,135 | 203 | 0.0565 | 14,144 | 521 | 0.0300 | 19,279 | 400 | 0.0800 | 39,376 | 58 | 0.0500 | 3,562 | 1,047 | 0.0516 | 175,832 | 2,924 | 185,549 | 0 | -727,112 | 39,025 | 0.0600 | 3,339,709 | 124 | 10,679 |
| | Apr | 2,160 | 0.0131 | 35,303 | 2,440 | 0.0380 | 114,398 | 4,620 | 0.0263 | 149,991 | 1,222 | 0.1000 | 151,100 | 508 | 0.0600 | 37,316 | 398 | 0.0432 | 21,177 | 6,747 | 359,137 | 0 | 263,837 | 41,825 | 0.0612 | 3,157,392 | 2,947 | 293,937 |
| | May | 3,060 | 0.0131 | 49,414 | 9,288 | 0.0112 | 99,038 | 3,340 | 0.1125 | 108,046 | 1,779 | 0.1320 | 208,844 | 600 | 0.1425 | 108,204 | -1,114 | 0.0440 | -60,435 | 8,800 | 477,230 | 897 | 1,658,352 | 35,933 | 0.1125 | 1,591,609 | 9,795 | 390,549 |
| | Jun | 900 | 0.0131 | 15,341 | 800 | -0.0024 | -2,386 | 1,700 | 0.0062 | 12,952 | 646 | 0.1200 | 234,087 | 192 | 0.0900 | 22,001 | 343 | 0.0031 | 18,385 | 2,803 | 329,152 | 1,068 | 1,692,391 | 35,903 | 0.0685 | 346,179 | 7,992 | 81,322 |
| | Jul | 436 | 0.0131 | 7,045 | 237 | 0.1151 | 33,036 | 673 | 0.0495 | 40,077 | 429 | 0.1700 | 49,317 | 74 | 0.0910 | 8,343 | -1,012 | 0.0477 | -84,496 | 163 | 73,720 | 1,049 | -431,990 | 23,919 | 0.0135 | 575,318 | 9,009 | 210,894 |
| | Aug | 217 | 0.0131 | 3,504 | 367 | 0.0404 | 20,698 | 584 | 0.0142 | 24,492 | 653 | 0.0390 | 10,368 | 45 | 0.0970 | 7,255 | -52 | 0.0580 | -1,556 | 1,027 | 49,858 | 790 | -1,734,520 | 18,983 | 0.0372 | 1,834,517 | 5,165 | 508,581 |
| | Sep | 221 | 0.0131 | 3,569 | 451 | 0.0174 | 7,694 | 672 | 0.0100 | 11,262 | 428 | 0.0380 | 17,950 | 74 | 0.0380 | 3,475 | -768 | 0.0240 | -21,997 | 430 | 12,104 | 738 | 518,516 | 10,088 | 0.0475 | 1,141,026 | 2,787 | 197,670 |
| Total/Average | | 8,068 | 0.0131 | 128,136 | 10,047 | 0.0263 | 153,234 | 18,613 | 0.0203 | 461,570 | 7,271 | 0.1085 | 975,331 | 3,040 | 0.0941 | 256,695 | 1,200 | 0.0522 | 81,668 | 29,193 | 1,753,174 | 4,811 | 698,959 | 11,779 | 0.0300 | 1,383,872 | 40,203 | 1,750,334 |

Table A-3

Date September 25, 2006

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year | Month | [redacted] | | | (Calculated) Gain in Fish Creek Above Fish Creek Above Scofield Reservoir | | | [redacted] | | | Lower Fish Creek Above Scofield Reservoir | | | Upper Fish/Pondtown Creek Above Scofield Reservoir | | | (CALC) Other Reservoir Inflow Scofield Reservoir (includes errors, springs, P seepage, etc.) | | | (CALC) Total Inflow Above Scofield Reservoir | | (Phosphorus Model) Scofield Reservoir | | | | | Price River Below Scofield Dam | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | End of Month Content | | | | | |
| | | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Weight (Grams) | Evaporation (Acre-Feet) | Phosphorus Uptake (Grams) | Total (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Flow (Acre-Feet) | Weight (Grams) |
| | Oct | 179 | 0.0142 | 3,139 | 250 | 0.0079 | 3,142 | 409 | 0.0105 | 5,292 | 379 | 0.0700 | 32,761 | 48 | 0.0200 | 1,178 | -871 | 0.0371 | -40,111 | -19 | -880 | 266 | 136,139 | 14,981 | 0.0115 | 419,203 | 1,224 | 77,754 |
| | Nov | 423 | 0.0142 | 7,411 | 293 | -0.0145 | -5,309 | 714 | 0.0025 | 2,202 | 437 | 0.1190 | 70,063 | 79 | 0.0025 | 243 | -288 | 0.0478 | -16,948 | 992 | 53,540 | 74 | 715,055 | 15,278 | 0.0160 | 202,702 | 179 | 5,001 |
| | Dec | 169 | 0.0142 | 2,969 | 304 | 0.0310 | 11,617 | 473 | 0.0250 | 14,586 | 388 | 0.0700 | 33,528 | 53 | 0.0500 | 3,240 | -203 | 0.0456 | -11,390 | 711 | 38,955 | 0 | -179,368 | 15,759 | 0.0245 | 477,193 | 191 | 5,772 |
| 1990 | Jan | 164 | 0.0142 | 2,972 | 239 | 0.0185 | 5,442 | 453 | 0.0157 | 8,711 | 379 | 0.0380 | 15,996 | 47 | 0.0260 | 1,510 | -124 | 0.0231 | -3,540 | 724 | 30,871 | 0 | -151,995 | 16,310 | 0.0370 | 642,708 | 204 | 8,052 |
| | Feb | 163 | 0.0142 | 2,856 | 149 | 0.0368 | 6,765 | 332 | 0.0230 | 9,629 | 359 | 0.0700 | 30,720 | 35 | 0.0500 | 2,159 | -68 | 0.0456 | 4,123 | 771 | 46,628 | 0 | -299,852 | 17,030 | 0.0470 | 993,319 | 61 | 2,957 |
| | Mar | 197 | 0.0142 | 3,453 | 187 | 0.0466 | 10,757 | 384 | 0.0300 | 14,210 | 370 | 0.0260 | 11,877 | 43 | 0.0240 | 1,268 | 569 | 0.0278 | 16,087 | 1,258 | 43,442 | 0 | -864,993 | 18,120 | 0.0440 | 1,877,509 | 176 | 18,226 |
| | Apr | 1,687 | 0.0142 | 29,561 | 3,193 | 0.0326 | 128,449 | 4,880 | 0.0263 | 158,010 | 1,277 | 0.1000 | 157,566 | 533 | 0.0600 | 39,412 | 2,405 | 0.0430 | 132,396 | 9,185 | 487,364 | 0 | -1,137,920 | 25,110 | 0.1040 | 3,253,253 | 2,195 | 281,581 |
| | May | 3,118 | 0.0142 | 54,639 | 5,452 | 0.0974 | 654,875 | 8,570 | 0.0671 | 709,514 | 2,023 | 0.0430 | 107,239 | 954 | 0.0530 | 63,393 | -1,671 | 0.0619 | -127,544 | 9,856 | 752,401 | 721 | 1,076,749 | 38,997 | 0.0690 | 2,250,582 | 7,638 | 640,307 |
| | Jun | 1,146 | 0.0142 | 20,089 | 1,754 | 0.0291 | 62,900 | 2,900 | 0.0232 | 82,989 | 878 | 0.0720 | 77,971 | 317 | 0.0430 | 16,807 | -459 | 0.0332 | -19,933 | 3,016 | 157,836 | 988 | 1,304,122 | 24,176 | 0.0130 | 765,570 | 5,147 | 158,719 |
| | Jul | 473 | 0.0142 | 8,282 | 727 | 0.0444 | 39,824 | 1,200 | 0.0325 | 48,106 | 535 | 0.0420 | 27,715 | 132 | 0.0025 | 406 | -211 | 0.0321 | -8,507 | 1,658 | 67,630 | 997 | -1,188,425 | 16,849 | 0.0601 | 1,352,244 | 8,087 | 649,387 |
| | Aug | 197 | 0.0142 | 3,457 | 358 | 0.0254 | 11,198 | 555 | 0.0214 | 14,656 | 405 | 0.0700 | 38,956 | 61 | 0.0750 | 5,687 | -413 | 0.0439 | -24,490 | 589 | 30,794 | 666 | 143,893 | 13,089 | 0.0600 | 968,715 | 3,654 | 270,430 |
| | Sep | 160 | 0.0142 | 2,800 | 256 | 0.0876 | 21,049 | 416 | 0.0434 | 27,849 | 385 | 0.0310 | 14,717 | 51 | 0.0330 | 3,314 | -215 | 0.0381 | -10,092 | 677 | 31,787 | 447 | 162,659 | 12,024 | 0.0516 | 750,308 | 1,295 | 81,466 |
| Total/Average | | 8,076 | 0.0142 | 141,514 | 13,220 | 0.0583 | 950,028 | 21,296 | 0.0411 | 1,091,542 | 7,811 | 0.0636 | 613,118 | 2,332 | 0.0482 | 138,618 | -1,466 | 0.0609 | -110,096 | 39,977 | 1,733,187 | 1,985 | -85,803 | 17,932 | 0.0348 | 1,205,877 | 30,041 | 2,208,751 |
| | Oct | 264 | 0.0136 | 3,474 | 305 | 0.0820 | 30,807 | 509 | 0.0546 | 34,280 | 396 | 0.0700 | 34,153 | 56 | 0.0350 | 2,438 | -429 | 0.0598 | -46,383 | 332 | 24,504 | 220 | -116,725 | 11,340 | 0.0600 | 840,826 | 350 | 28,790 |
| | Nov | 114 | 0.0136 | 1,938 | 287 | 0.0356 | 12,604 | 401 | 0.0204 | 14,542 | 374 | 0.0670 | 30,891 | 45 | 0.0190 | 1,046 | -444 | 0.0600 | -33,167 | 376 | 21,320 | 86 | 815,849 | 11,308 | 0.0050 | 73,464 | 141 | 870 |
| | Dec | 177 | 0.0136 | 3,015 | 282 | 0.0321 | 11,140 | 459 | 0.0251 | 14,154 | 385 | 0.0700 | 33,284 | 51 | 0.0500 | 3,146 | -761 | 0.0458 | -44,145 | 114 | 6,440 | 0 | -285,438 | 11,938 | 0.0240 | 350,874 | 114 | 3,445 |
| 1991 | Jan | 179 | 0.0138 | 3,046 | 362 | 0.0181 | 8,098 | 541 | 0.0157 | 11,144 | 402 | 0.0380 | 18,844 | 50 | 0.0580 | 3,697 | -111 | 0.0272 | -3,727 | 882 | 29,958 | 0 | -341,728 | 12,368 | 0.0400 | 610,286 | 432 | 21,315 |
| | Feb | 172 | 0.0138 | 2,921 | 377 | 0.0303 | 14,009 | 549 | 0.0250 | 16,930 | 464 | 0.0700 | 39,852 | 61 | 0.0500 | 3,751 | -271 | 0.0444 | -14,929 | 744 | 40,603 | 0 | 20,218 | 12,008 | 0.0500 | 623,290 | 111 | 3,340 |
| | Mar | 196 | 0.0138 | 3,228 | 435 | 0.0374 | 19,837 | 626 | 0.0300 | 23,165 | 411 | 0.0800 | 41,364 | 59 | 0.0580 | 4,268 | 390 | 0.0500 | 24,429 | 1,510 | 93,221 | 0 | 530,618 | 14,068 | 0.0300 | 183,380 | 40 | 518 |
| | Apr | 321 | 0.0136 | 5,402 | 1,787 | 0.0261 | 62,829 | 2,110 | 0.0263 | 68,320 | 739 | 0.1000 | 89,434 | 231 | 0.0500 | 17,084 | 1,261 | 0.0461 | 71,711 | 4,320 | 245,749 | 0 | 8,012 | 17,848 | 0.0400 | 395,695 | 1,270 | 26,410 |
| | May | 3,395 | 0.0136 | 91,655 | 6,625 | 0.2029 | 1,657,856 | 13,020 | 0.1164 | 1,749,581 | 2,718 | 0.0790 | 263,495 | 1,396 | 0.1390 | 239,788 | 1,207 | 0.1227 | 181,622 | 17,359 | 2,412,451 | 630 | 343,875 | 28,478 | 0.0500 | 2,000,816 | 5,529 | 425,637 |
| | Jun | 5,540 | 0.0136 | 69,168 | 2,932 | 0.0317 | 150,151 | 7,460 | 0.0272 | 219,482 | 1,788 | 0.0720 | 158,674 | 818 | 0.0430 | 43,149 | 2,117 | 0.0235 | 67,490 | 12,188 | 903,804 | 933 | 1,230,968 | 23,390 | 0.0250 | 1,629,808 | 6,286 | 173,843 |
| | Jul | 387 | 0.0136 | 11,684 | 1,122 | 0.0440 | 60,876 | 1,809 | 0.0325 | 72,560 | 656 | 0.0420 | 34,091 | 198 | 0.0725 | 12,715 | -1,484 | 0.0363 | -66,288 | 1,186 | 52,073 | 1,008 | -461,388 | 20,157 | 0.0475 | 1,400,671 | 9,348 | 943,796 |
| | Aug | 386 | 0.0135 | 6,565 | 471 | 0.0287 | 16,695 | 857 | 0.0256 | 23,236 | 466 | 0.0600 | 38,152 | 98 | 0.0360 | 4,190 | -191 | 0.0218 | -13,351 | 1,077 | 42,242 | 793 | -808,607 | 17,390 | 0.0400 | 725,974 | 7,043 | 200,008 |
| | Sep | 338 | 0.0138 | 3,744 | 361 | 0.0602 | 30,313 | 699 | 0.0424 | 36,558 | 404 | 0.0310 | 16,392 | 77 | 0.0330 | 5,044 | -185 | 0.0390 | -8,790 | 1,027 | 89,295 | 515 | -223,598 | 14,101 | 0.0432 | 794,368 | 3,996 | 314,407 |
| Total/Average | | 11,111 | 0.0136 | 199,840 | 16,328 | 0.1002 | 2,078,857 | 28,441 | 0.0609 | 2,377,923 | 9,172 | 0.0691 | 782,032 | 3,066 | 0.0847 | 320,314 | 836 | 0.1378 | 143,487 | 41,117 | 3,522,747 | 4,197 | 1,722,347 | 17,540 | 0.0351 | 760,351 | 34,943 | 1,302,431 |
| | Oct | 258 | 0.0136 | 4,318 | 27 | 0.2120 | 17,373 | 335 | 0.0546 | 21,888 | 338 | 0.0700 | 30,930 | 38 | 0.0350 | 1,372 | -480 | 0.0617 | -31,412 | 39 | 2,378 | 246 | -230,948 | 11,434 | 0.0600 | 844,223 | 2,460 | 182,003 |
| | Nov | 268 | 0.0136 | 4,493 | 434 | 0.0392 | 30,962 | 702 | 0.0294 | 25,458 | 435 | 0.0690 | 35,999 | 77 | 0.0190 | 1,816 | 63 | 0.0422 | 4,343 | 1,297 | 67,486 | 85 | 679,374 | 13,164 | 0.0150 | 226,771 | 302 | 5,380 |
| | Dec | 238 | 0.0136 | 3,854 | 344 | 0.0326 | 13,847 | 578 | 0.0250 | 17,703 | 409 | 0.0700 | 35,287 | 64 | 0.0500 | 3,919 | -119 | 0.0441 | -4,485 | 927 | 50,422 | 0 | -132,483 | 12,984 | 0.0240 | 393,796 | 307 | 9,278 |
| 1992 | Jan | 188 | 0.0136 | 3,526 | 291 | 0.0185 | 6,649 | 480 | 0.0165 | 9,476 | 386 | 0.0380 | 18,079 | 51 | 0.0500 | 3,155 | 220 | 0.0278 | 7,339 | 1,117 | 38,246 | 0 | -159,015 | 13,798 | 0.0330 | 576,818 | 307 | 13,897 |
| | Feb | 158 | 0.0136 | 2,307 | 271 | 0.0300 | 10,305 | 400 | 0.0250 | 12,612 | 375 | 0.0700 | 32,413 | 46 | 0.0500 | 2,811 | 108 | 0.0467 | 6,227 | 938 | 54,063 | 0 | -1,022,327 | 14,444 | 0.1400 | 2,503,296 | 288 | 49,912 |
| | Mar | 203 | 0.0136 | 4,902 | 379 | 0.0380 | 23,886 | 832 | 0.0300 | 30,788 | 461 | 0.0800 | 45,465 | 92 | 0.0580 | 5,653 | 546 | 0.0430 | 32,281 | 1,980 | 114,186 | 0 | 1,207,883 | 16,318 | 0.0698 | 1,406,335 | 48 | 3,444 |
| | Apr | 1,452 | 0.0136 | 23,969 | 2,118 | 0.0348 | 90,976 | 3,570 | 0.0263 | 114,946 | 1,009 | 0.1000 | 124,469 | 368 | 0.5600 | 26,691 | -583 | 0.0439 | -30,560 | 4,384 | 237,606 | 0 | 79,925 | 18,124 | 0.0612 | 1,368,395 | 2,594 | 195,820 |
| | May | 1,479 | 0.0136 | 24,666 | 1,867 | 0.1093 | 251,777 | 3,540 | 0.0671 | 276,443 | 907 | 0.1120 | 157,400 | 363 | 0.1020 | 45,398 | -1,047 | 0.0833 | -107,471 | 3,625 | 172,269 | 625 | 468,884 | 14,270 | 0.0448 | 659,558 | 6,855 | 412,038 |
| | Jun | 555 | 0.0136 | 9,299 | 715 | -0.0017 | -1,467 | 1,270 | 0.0050 | 7,833 | 549 | 0.0210 | 14,223 | 130 | 0.0500 | 4,469 | -1,650 | 0.0110 | -22,343 | 509 | 4,182 | 671 | 439,412 | 8,951 | 0.0200 | 270,425 | 4,953 | 150,904 |
| | Jul | 264 | 0.0136 | 4,410 | 425 | 0.0443 | 23,203 | 689 | 0.0325 | 27,623 | 432 | 0.0420 | 22,374 | 78 | 0.0320 | 4,979 | -400 | 0.0372 | -18,635 | 791 | 36,245 | 557 | -223,594 | 7,800 | 0.0470 | 452,197 | 1,288 | 80,465 |
| | Aug | 140 | 0.0136 | 2,343 | 126 | 0.0101 | 1,594 | 266 | 0.0120 | 3,937 | 347 | 0.0710 | 30,349 | 30 | 0.2650 | 9,405 | -377 | 0.0356 | -19,034 | 365 | 23,858 | 438 | -430,673 | 7,307 | 0.0950 | 907,928 | 0 | 0 |
| | Sep | 163 | 0.0136 | 2,715 | 196 | 0.0665 | 16,061 | 359 | 0.0424 | 18,776 | 305 | 0.0310 | 13,909 | 40 | 0.0530 | 2,623 | -3 | 0.0375 | -501 | 761 | 35,207 | 347 | 452,222 | 7,500 | 0.0410 | 390,482 | 322 | 10,331 |
| Total/Average | | 3,365 | 0.0136 | 50,134 | 2,901 | 0.0523 | 477,340 | 12,776 | 0.0060 | 567,473 | 6,493 | 0.0746 | 560,808 | 1,454 | 0.0666 | 115,228 | -3,789 | 0.0443 | -205,702 | 16,483 | 1,037,946 | 2,969 | 218,475 | 12,108 | 0.0572 | 858,722 | 19,845 | 1,125,155 |
| | Oct | 249 | 0.0127 | 3,924 | 226 | 0.1004 | 27,789 | 469 | 0.0546 | 31,583 | 389 | 0.0700 | 33,457 | 52 | 0.0350 | 2,249 | -279 | 0.0600 | -20,581 | 631 | 45,798 | 181 | -72,846 | 7,823 | 0.0600 | 778,960 | 422 | 31,257 |
| | Nov | 157 | 0.0127 | 2,455 | 212 | 0.0418 | 10,922 | 369 | 0.0294 | 13,377 | 307 | 0.0670 | 30,957 | 41 | 0.0190 | 966 | 345 | 0.0466 | 19,769 | 1,122 | 64,487 | 55 | 478,990 | 8,658 | 0.0150 | 168,194 | 232 | 4,207 |
| | Dec | 145 | 0.0127 | 2,268 | 245 | 0.0322 | 9,752 | 390 | 0.0250 | 12,019 | 372 | 0.0700 | 32,070 | 45 | 0.0500 | 2,481 | 156 | 0.0471 | 9,036 | 961 | 55,424 | 0 | 74,650 | 9,288 | 0.0240 | 286,556 | 335 | 10,122 |
| 1993 | Jan | 185 | 0.0127 | 2,905 | 317 | 0.0201 | 5,389 | 492 | 0.0167 | 8,282 | 378 | 0.0380 | 17,310 | 45 | 0.0500 | 2,764 | 383 | 0.0322 | 13,395 | 1,296 | 41,975 | 0 | -116,682 | 10,160 | 0.0330 | 425,875 | 220 | 12,330 |
| | Feb | 209 | 0.0127 | 3,272 | 156 | 0.0413 | 7,977 | 365 | 0.0250 | 11,249 | 506 | 0.0700 | 31,647 | 41 | 0.0500 | 2,516 | 589 | 0.0477 | 34,628 | 1,361 | 80,051 | 0 | -277,253 | 11,263 | 0.0250 | 763,482 | 279 | 18,998 |
| | Mar | 350 | 0.0127 | 5,477 | 399 | 0.0402 | 21,234 | 799 | 0.0300 | 27,710 | 644 | 0.0800 | 43,809 | 82 | 0.0500 | 5,093 | 950 | 0.0477 | 55,888 | 2,206 | 132,501 | 0 | -202,960 | 13,290 | 0.0400 | 1,164,276 | 177 | 15,158 |
| | Apr | 907 | 0.0127 | 14,134 | 1,301 | 0.0357 | 57,221 | 2,208 | 0.0263 | 71,355 | 737 | 0.1000 | 90,967 | 244 | 0.0600 | 17,840 | 2,618 | 0.0459 | 148,240 | 5,801 | 328,403 | 0 | 24,485 | 19,001 | 0.0642 | 1,441,083 | 0 | 0 |
| | May | 9,882 | 0.0127 | 154,696 | 17,739 | 0.0976 | 2,131,414 | 27,621 | 0.0671 | 2,285,110 | 3,865 | 0.1320 | 954,993 | 1,009 | 0.1000 | 178,624 | -606 | 0.0804 | -60,428 | 35,886 | 3,359,299 | 647 | 1,729,320 | 54,337 | 0.0480 | 3,278,754 | 0 | 0 |
| | Jun | 3,671 | 0.0127 | 52,465 | 4,942 | 0.0237 | 144,392 | 8,613 | 0.0276 | 196,857 | 2,011 | 0.0910 | 327,502 | 999 | 0.0500 | 48,632 | 1,872 | 0.0415 | 77,309 | 13,455 | 555,768 | 1,175 | 3,503,370 | 61,875 | 0.0151 | 1,270,768 | 4,647 | 92,181 |
| | Jul | 750 | 0.0127 | 12,299 | 1,123 | 0.0464 | 64,227 | 1,909 | 0.0325 | 76,525 | 678 | 0.0420 | 35,131 | 209 | 0.0520 | 13,461 | -669 | 0.0363 | -29,792 | 2,130 | 95,270 | 1,273 | -2,116,547 | 51,798 | 0.0470 | 3,002,375 | 12,043 | 640,309 |
| | Aug | 378 | 0.0127 | 5,852 | 541 | 0.0304 | 33,632 | 913 | 0.0258 | 39,484 | 477 | 0.0790 | 49,628 | 101 | 0.0750 | 4,910 | 491 | 0.0574 | 46,874 | 1,984 | 130,295 | 1,059 | -176,432 | 44,130 | 0.0670 | 3,020,029 | 8,578 | 568,091 |
| | Sep | 242 | 0.0127 | 3,794 | 307 | 0.0658 | 24,890 | 598 | 0.0424 | 28,674 | 403 | 0.0310 | 15,439 | 61 | 0.0530 | 3,971 | -332 | 0.0355 | -13,775 | 600 | 32,259 | 798 | 84,411 | 38,514 | 0.0510 | 2,424,097 | 3,514 | 346,876 |
| Total/Average | | 17,148 | 0.0127 | 266,437 | 27,495 | 0.0751 | 2,539,789 | 44,553 | 0.0511 | 2,806,226 | 12,303 | 0.1042 | 1,666,973 | 4,985 | 0.0815 | 468,564 | 3,091 | 0.0411 | 278,644 | 67,421 | 5,181,886 | 5,536 | 4,938,380 | 27,530 | 0.0421 | 1,461,901 | 31,351 | 1,720,118 |

Table A-3

Date September 25, 2006

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year Month | [redacted] Flow Acre-Feet | [redacted] Conc. mg/l | [redacted] Weight Grams | (Calculated) Gain for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | [redacted] Flow Acre-Feet | [redacted] Concentration mg/l | [redacted] Weight Grams | Steam Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | | | | | | | | |
| Oct | 311 | 0.0134 | 5,121 | 365 | 0.0897 | 80,352 | 675 | 0.0540 | 45,472 | 429 | 0.0700 | 37,030 |
| Nov | 258 | 0.0134 | 4,260 | 211 | 0.0490 | 12,757 | 469 | 0.0294 | 17,018 | 388 | 0.0670 | 32,029 |
| Dec | 254 | 0.0134 | 4,190 | 275 | 0.0358 | 12,126 | 529 | 0.0259 | 16,316 | 400 | 0.0700 | 34,503 |
| 1994 Jan | 198 | 0.0134 | 3,279 | 325 | 0.0187 | 7,506 | 524 | 0.0167 | 10,785 | 399 | 0.0380 | 18,679 |
| Feb | 177 | 0.0134 | 2,925 | 998 | 0.0271 | 33,319 | 1,175 | 0.0250 | 36,244 | 530 | 0.0700 | 45,762 |
| Mar | 244 | 0.0134 | 4,018 | 1,538 | 0.0328 | 61,851 | 1,782 | 0.0300 | 65,869 | 632 | 0.0800 | 64,338 |
| Apr | 1,188 | 0.0134 | 19,587 | 2,228 | 0.0331 | 91,008 | 3,416 | 0.0263 | 110,591 | 982 | 0.1000 | 121,131 |
| May | 4,391 | 0.0134 | 73,096 | 4,092 | 0.1287 | 615,338 | 8,399 | 0.0671 | 715,234 | 2,027 | 0.1320 | 329,959 |
| Jun | 1,028 | 0.0134 | 16,942 | 962 | 0.0337 | 40,002 | 1,990 | 0.0232 | 56,943 | 694 | 0.0720 | 61,665 |
| Jul | 311 | 0.0134 | 5,161 | 344 | 0.0241 | 10,231 | 637 | 0.0196 | 15,392 | 425 | 0.0460 | 24,136 |
| Aug | 266 | 0.0134 | 4,392 | 207 | -0.0058 | -1,473 | 473 | 0.0050 | 2,919 | 388 | 0.0435 | 20,598 |
| Sep | 243 | 0.0134 | 4,005 | 97 | 0.1153 | 13,764 | 340 | 0.0424 | 17,770 | 361 | 0.0310 | 13,820 |
| | | | | 0 | | | | | | | | |
| Total/Average | 9,072 | 0.0134 | 149,375 | 11,549 | 0.0672 | 956,979 | 20,621 | 0.0435 | 1,106,554 | 7,675 | 0.0849 | 803,663 |
| | | | | 0 | | | | | | | | |
| Oct | 328 | 0.0126 | 5,082 | 236 | 0.1130 | 32,887 | 563 | 0.0546 | 37,949 | 407 | 0.0700 | 35,104 |
| Nov | 227 | 0.0126 | 3,518 | 231 | 0.0457 | 13,220 | 462 | 0.0294 | 16,739 | 388 | 0.0670 | 32,000 |
| Dec | 246 | 0.0126 | 3,806 | 260 | 0.0368 | 11,771 | 505 | 0.0250 | 15,578 | 395 | 0.0700 | 34,088 |
| 1995 Jan | 245 | 0.0126 | 3,797 | 276 | 0.0204 | 6,918 | 521 | 0.0167 | 10,735 | 398 | 0.0380 | 18,650 |
| Feb | 223 | 0.0126 | 3,455 | 359 | 0.0327 | 14,496 | 582 | 0.0250 | 17,951 | 410 | 0.0700 | 35,429 |
| Mar | 404 | 0.0126 | 6,300 | 1,190 | 0.0454 | 92,983 | 1,600 | 0.0300 | 59,282 | 618 | 0.0800 | 60,794 |
| Apr | 826 | 0.0126 | 12,801 | 2,816 | 0.0301 | 105,099 | 3,641 | 0.0263 | 117,899 | 1,027 | 0.1000 | 126,739 |
| May | 6,625 | 0.0125 | 102,773 | 12,337 | 0.0964 | 1,467,023 | 18,966 | 0.0671 | 1,569,796 | 4,119 | 0.1320 | 670,703 |
| Jun | 10,217 | 0.0126 | 158,995 | 14,731 | 0.0082 | 149,335 | 24,948 | 0.0106 | 307,731 | 5,326 | 0.0800 | 525,569 |
| Jul | 2,118 | 0.0126 | 32,830 | 2,289 | 0.0509 | 143,643 | 4,407 | 0.0325 | 176,673 | 1,182 | 0.0420 | 61,235 |
| Aug | 773 | 0.0126 | 11,990 | 657 | 0.0070 | 5,651 | 1,430 | 0.0100 | 17,641 | 381 | 0.0500 | 21,513 |
| Sep | 395 | 0.0125 | 6,087 | 528 | 0.0646 | 42,063 | 921 | 0.0424 | 48,151 | 479 | 0.0310 | 18,305 |
| | | | | 0 | | | | | | | | |
| Total/Average | 22,629 | 0.0126 | 350,834 | 35,920 | 0.0462 | 2,045,290 | 58,549 | 0.0332 | 2,396,124 | 15,327 | 0.0868 | 1,640,932 |
| | | | | 0 | | | | | | | | |
| Oct | 293 | 0.0123 | 4,441 | 560 | 0.0768 | 53,018 | 853 | 0.0546 | 57,461 | 483 | 0.0700 | 49,150 |
| Nov | 299 | 0.0123 | 4,533 | 473 | 0.0400 | 23,470 | 772 | 0.0294 | 28,004 | 449 | 0.0670 | 37,080 |
| Dec | 257 | 0.0123 | 3,899 | 379 | 0.0335 | 15,657 | 632 | 0.0250 | 19,498 | 420 | 0.0700 | 36,301 |
| 1996 Jan | 168 | 0.0123 | 2,547 | 513 | 0.0181 | 11,488 | 681 | 0.0167 | 14,033 | 430 | 0.0380 | 20,171 |
| Feb | 194 | 0.0123 | 2,939 | 518 | 0.0298 | 19,018 | 712 | 0.0250 | 21,956 | 437 | 0.0700 | 37,691 |
| Mar | 268 | 0.0123 | 4,092 | 948 | 0.0350 | 40,920 | 1,215 | 0.0300 | 44,973 | 538 | 0.0800 | 53,096 |
| Apr | 731 | 0.0123 | 11,063 | 3,508 | 0.0292 | 126,069 | 4,235 | 0.0263 | 137,133 | 1,147 | 0.1000 | 141,520 |
| May | 8,593 | 0.0123 | 130,123 | 13,626 | 0.1017 | 1,708,926 | 22,220 | 0.0671 | 1,839,049 | 4,776 | 0.1320 | 777,563 |
| Jun | 2,709 | 0.0123 | 41,016 | 3,291 | 0.0264 | 106,988 | 5,999 | 0.0200 | 148,004 | 1,503 | 0.0400 | 74,169 |
| Jul | 548 | 0.0123 | 8,291 | 895 | 0.0449 | 49,534 | 1,442 | 0.0325 | 57,823 | 584 | 0.0420 | 30,249 |
| Aug | 219 | 0.0123 | 3,318 | 438 | 0.0014 | 733 | 657 | 0.0050 | 4,051 | 425 | 0.0400 | 20,998 |
| Sep | 195 | 0.0123 | 2,950 | 399 | 0.0571 | 28,119 | 594 | 0.0424 | 31,066 | 413 | 0.0310 | 15,782 |
| | | | | 0 | | | | | | | | |
| Total/Average | 14,470 | 0.0123 | 219,113 | 25,546 | 0.0699 | 2,183,917 | 40,014 | 0.0487 | 2,403,030 | 11,587 | 0.0896 | 1,284,200 |
| | | | | 0 | | | | | | | | |
| Oct | 325 | 0.0129 | 3,283 | 444 | 0.0758 | 41,470 | 669 | 0.0546 | 45,059 | 428 | 0.0700 | 36,943 |
| Nov | 301 | 0.0129 | 4,781 | 484 | 0.0397 | 23,653 | 784 | 0.0294 | 28,434 | 451 | 0.0670 | 37,279 |
| Dec | 263 | 0.0129 | 4,189 | 325 | 0.0348 | 13,944 | 588 | 0.0250 | 18,133 | 412 | 0.0700 | 35,531 |
| 1997 Jan | 256 | 0.0129 | 4,071 | 322 | 0.0197 | 7,839 | 578 | 0.0167 | 11,910 | 410 | 0.0380 | 19,196 |
| Feb | 245 | 0.0129 | 3,898 | 381 | 0.0328 | 15,421 | 626 | 0.0250 | 19,319 | 419 | 0.0700 | 36,201 |
| Mar | 350 | 0.0129 | 5,565 | 638 | 0.0494 | 81,003 | 988 | 0.0300 | 36,569 | 492 | 0.0800 | 48,575 |
| Apr | 1,158 | 0.0129 | 18,425 | 2,988 | 0.0318 | 115,823 | 4,146 | 0.0263 | 134,248 | 1,129 | 0.1000 | 139,303 |
| May | 12,951 | 0.0129 | 206,011 | 15,468 | 0.1125 | 2,146,142 | 28,419 | 0.0671 | 2,352,154 | 6,026 | 0.1320 | 981,203 |
| Jun | 4,425 | 0.0129 | 70,392 | 4,247 | 0.0339 | 177,785 | 8,672 | 0.0232 | 248,178 | 2,043 | 0.0720 | 181,397 |
| Jul | 761 | 0.0129 | 12,107 | 1,062 | 0.0466 | 60,974 | 1,823 | 0.0325 | 73,081 | 661 | 0.0420 | 34,226 |
| Aug | 354 | 0.0129 | 5,624 | 770 | 0.0253 | 24,026 | 1,123 | 0.0214 | 29,650 | 318 | 0.0700 | 44,855 |
| Sep | 384 | 0.0129 | 6,111 | 709 | 0.0584 | 51,040 | 1,093 | 0.0424 | 57,152 | 313 | 0.0510 | 19,831 |
| | | | | 0 | | | | | | | | |
| Total/Average | 21,674 | 0.0129 | 344,760 | 27,837 | 0.0780 | 2,709,135 | 49,511 | 0.0500 | 3,053,897 | 13,301 | 0.0809 | 1,614,339 |

| Year Month | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Scofield Reservoir (Includes errors, uptake, P recycle, etc.): Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | (Trimmed-Nobles) Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Total Acre-Feet | mg/l (Measured) | Weight Grams | Price River Inflow Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct | 75 | 0.0350 | 3,219 | -139 | 0.0590 | -10,079 | 1,040 | 73,603 | 390 | -400,232 | 18,080 | 0.0404 | 2,418,278 | 1,103 | 81,657 |
| Nov | 52 | 0.0190 | 1,222 | 35 | 0.0448 | 1,917 | 944 | 52,185 | 114 | 2,130,548 | 14,537 | 0.0130 | 713,022 | 373 | 6,093 |
| Dec | 59 | 0.0500 | 3,617 | 683 | 0.0447 | 37,600 | 1,670 | 92,098 | 0 | -409,961 | 19,900 | 0.0345 | 1,203,898 | 307 | 9,275 |
| 1994 Jan | 38 | 0.0500 | 2,380 | 15 | 0.0273 | 507 | 995 | 33,352 | 0 | -470,698 | 30,380 | 0.0339 | 1,697,225 | 307 | 12,833 |
| Feb | 129 | 0.0500 | 7,958 | -164 | 0.0398 | -8,048 | 1,670 | 81,910 | 0 | -1,087,782 | 41,985 | 0.0550 | 2,848,387 | 273 | 18,537 |
| Mar | 195 | 0.0500 | 12,030 | -1,162 | 0.0429 | -62,911 | 1,465 | 79,315 | 0 | -813,288 | 43,397 | 0.0608 | 3,736,387 | 51 | -4,603 |
| Apr | 375 | 0.0600 | 27,607 | -536 | 0.0461 | -30,207 | 4,215 | 229,113 | 0 | 371,298 | 41,084 | 0.0612 | 3,401,830 | 2,548 | 192,371 |
| May | 937 | 0.1020 | 117,885 | -495 | 0.0813 | -49,639 | 13,052 | 1,208,713 | 919 | 1,227,843 | 47,763 | 0.0488 | 2,874,909 | 8,436 | 507,705 |
| Jun | 216 | 0.0430 | 11,550 | -133 | 0.0364 | -5,945 | 2,769 | 124,214 | 1,132 | 1,475,831 | 39,640 | 0.0230 | 1,122,390 | 9,758 | 300,900 |
| Jul | 73 | 0.0670 | 5,996 | -1,071 | 0.0320 | -42,227 | 84 | 3,298 | 1,112 | -2,508,735 | 27,706 | 0.0803 | 2,744,291 | 10,905 | 1,080,132 |
| Aug | 53 | 0.0570 | 3,696 | -148 | 0.0241 | -4,405 | 766 | 23,808 | 844 | -1,571,174 | 19,818 | 0.1273 | 3,111,689 | 7,810 | 1,226,388 |
| Sep | 38 | 0.0530 | 2,480 | -326 | 0.0334 | -24,233 | 214 | 9,843 | 556 | 1,890,173 | 17,119 | 0.0810 | 1,078,166 | 2,343 | 147,393 |
| Total/Average | 2,258 | 0.0721 | 200,835 | -2,670 | 0.0299 | -98,332 | 27,884 | 2,012,730 | 5,083 | -230,178 | 16,633 | 0.0500 | 2,287,715 | 44,217 | 3,588,772 |
| Oct | 62 | 0.0350 | 2,694 | 362 | 0.0595 | 20,553 | 1,394 | 105,299 | 272 | 174,045 | 17,602 | 0.0600 | 1,307,152 | 599 | 44,359 |
| Nov | 51 | 0.0190 | 1,202 | 193 | 0.0450 | 10,606 | 1,090 | 60,495 | 81 | 1,022,141 | 18,027 | 0.0150 | 337,850 | 649 | 12,000 |
| Dec | 56 | 0.0500 | 3,456 | 241 | 0.0450 | 13,387 | 1,197 | 66,509 | 0 | -190,847 | 18,912 | 0.0245 | 591,531 | 307 | 9,275 |
| 1995 Jan | 58 | 0.0500 | 3,564 | 478 | 0.0273 | 16,132 | 1,455 | 49,080 | 0 | -233,042 | 20,184 | 0.0339 | 844,147 | 180 | 7,513 |
| Feb | 64 | 0.0500 | 3,973 | 107 | 0.0440 | 9,073 | 1,224 | 66,476 | 0 | -542,029 | 21,301 | 0.0550 | 1,445,080 | 111 | 7,322 |
| Mar | 176 | 0.0500 | 10,824 | 1,610 | 0.0443 | 88,384 | 4,010 | 219,254 | 0 | -514,884 | 25,184 | 0.0678 | 2,168,599 | 123 | 10,569 |
| Apr | 198 | 0.0600 | 29,427 | 148 | 0.0439 | 7,874 | 5,212 | 281,934 | 0 | 155,089 | 30,069 | 0.0612 | 2,269,887 | 231 | 24,961 |
| May | 2,067 | 0.1020 | 260,059 | -894 | 0.0806 | -88,839 | 24,259 | 2,414,689 | 791 | 1,458,995 | 53,814 | 0.0488 | 3,245,192 | 123 | 7,349 |
| Jun | 2,751 | 0.0200 | 67,058 | -1,323 | 0.0321 | -41,554 | 31,470 | 858,809 | 1,176 | 1,492,900 | 71,343 | 0.0230 | 2,199,963 | 12,372 | 381,309 |
| Jul | 481 | 0.0520 | 30,853 | 4,768 | 0.0350 | 211,135 | 10,836 | 479,874 | 1,334 | 1,433,328 | 60,908 | 0.0123 | 931,401 | 20,438 | 315,128 |
| Aug | 157 | 0.0200 | 3,868 | 1,330 | 0.0161 | 26,394 | 3,499 | 69,417 | 1,106 | -1,842,096 | 51,446 | 0.0387 | 2,339,716 | 11,315 | 512,200 |
| Sep | 104 | 0.0590 | 6,623 | -318 | 0.0095 | -6,724 | 1,363 | 66,353 | 605 | -876,866 | 45,302 | 0.0510 | 2,881,292 | 8,242 | 392,643 |
| Total/Average | 6,380 | 0.0517 | 433,571 | 4,745 | 0.0527 | 272,397 | 87,010 | 4,772,124 | 5,559 | 1,203,923 | 36,149 | 0.0383 | 1,708,201 | 32,788 | 1,725,074 |
| Oct | 86 | 0.0350 | 4,096 | -763 | 0.0584 | -53,522 | 560 | 48,143 | 413 | -479,236 | 42,420 | 0.0600 | 3,443,171 | 3,587 | 265,303 |
| Nov | 85 | 0.0100 | 1,005 | 226 | 0.0416 | 11,527 | 1,532 | 78,708 | 119 | 2,429,925 | 43,114 | 0.0150 | 597,709 | 770 | 14,242 |
| Dec | 70 | 0.0500 | 4,310 | 383 | 0.0454 | 31,329 | 1,708 | 91,436 | 0 | -465,384 | 44,208 | 0.0243 | 1,385,979 | 814 | 16,589 |
| 1996 Jan | 75 | 0.0500 | 4,640 | 275 | 0.0265 | 8,996 | 1,464 | 47,843 | 0 | -525,859 | 45,318 | 0.0339 | 1,894,974 | 351 | 14,696 |
| Feb | 79 | 0.0500 | 4,848 | 795 | 0.0430 | 38,910 | 1,907 | 103,408 | 0 | -1,229,539 | 46,453 | 0.0550 | 3,151,472 | 833 | 56,444 |
| Mar | 133 | 0.0500 | 8,227 | 122 | 0.0457 | 6,853 | 2,006 | 113,149 | 0 | -997,805 | 47,511 | 0.0608 | 4,093,430 | 921 | 79,298 |
| Apr | 462 | 0.0600 | 34,315 | 422 | 0.0434 | 22,577 | 6,267 | 333,443 | 0 | 366,692 | 47,541 | 0.0612 | 3,538,810 | 6,267 | 471,056 |
| May | 2,421 | 0.1000 | 304,607 | 72 | 0.0803 | 7,167 | 29,483 | 2,928,386 | 934 | 1,976,723 | 73,500 | 0.0488 | 4,424,278 | 2,395 | 136,309 |
| Jun | 634 | 0.0300 | 24,218 | 2,114 | 0.0245 | 63,847 | 10,271 | 310,337 | 1,294 | 2,659,134 | 73,500 | 0.0166 | 1,649,493 | 8,977 | 225,588 |
| Jul | 158 | 0.0520 | 10,142 | 390 | 0.0365 | 17,528 | 2,574 | 115,744 | 1,350 | -2,366,819 | 63,319 | 0.0470 | 3,670,875 | 11,600 | 661,182 |
| Aug | 73 | 0.0300 | 2,685 | -573 | 0.0195 | -13,749 | 582 | 13,975 | 1,121 | 2,116,079 | 51,077 | 0.0200 | 1,282,251 | 10,803 | 266,517 |
| Sep | 66 | 0.0510 | 4,296 | -162 | 0.0387 | -7,731 | 910 | 43,412 | 807 | -1,950,558 | 49,109 | 0.0510 | 3,032,690 | 3,881 | 244,133 |
| Total/Average | 4,370 | 0.0737 | 408,237 | 3,467 | 0.0313 | 153,822 | 59,434 | 4,228,809 | 6,098 | 1,603,334 | 52,262 | 0.0417 | 2,548,687 | 51,003 | 2,475,718 |
| Oct | 74 | 0.0350 | 3,190 | -64 | 0.0590 | -4,634 | 1,107 | 80,558 | 420 | -525,491 | 47,325 | 0.0600 | 3,502,383 | 1,568 | 113,768 |
| Nov | 86 | 0.0190 | 2,025 | 519 | 0.0416 | 26,605 | 1,441 | 94,342 | 123 | 2,607,269 | 48,549 | 0.0150 | 898,197 | 495 | 9,150 |
| Dec | 65 | 0.0500 | 4,013 | 917 | 0.0489 | 49,703 | 1,983 | 107,380 | 0 | -321,375 | 50,377 | 0.0345 | 1,526,933 | 0 | 0 |
| 1997 Jan | 64 | 0.0500 | 3,947 | 1,143 | 0.0270 | 38,104 | 2,395 | 73,158 | 0 | -604,478 | 52,722 | 0.0339 | 2,204,580 | 0 | 0 |
| Feb | 89 | 0.0500 | 4,271 | 761 | 0.0435 | 40,782 | 1,876 | 100,573 | 0 | -1,308,842 | 53,954 | 0.0550 | 3,660,347 | 644 | 43,680 |
| Mar | 109 | 0.0500 | 6,701 | 1,466 | 0.0469 | 84,710 | 3,055 | 176,355 | 0 | -1,071,422 | 56,098 | 0.0608 | 4,129,028 | 921 | 79,296 |
| Apr | 853 | 0.0600 | 33,896 | 3,483 | 0.0461 | 186,700 | 9,214 | 493,747 | 0 | 893,393 | 65,299 | 0.0612 | 4,409,383 | 0 | 0 |
| May | 1,096 | 0.1020 | 189,558 | 4,760 | 0.0804 | 472,081 | 42,305 | 4,195,506 | 1,021 | 2,759,320 | 73,500 | 0.0488 | 4,424,278 | 33,083 | 1,991,379 |
| Jun | 946 | 0.0430 | 50,153 | 3,963 | 0.0334 | 163,047 | 15,624 | 642,773 | 1,294 | 2,358,610 | 73,295 | 0.0230 | 2,259,894 | 14,542 | 448,530 |
| Jul | 200 | 0.0520 | 12,801 | 396 | 0.0363 | 17,716 | 3,079 | 137,824 | 1,380 | -1,951,206 | 62,909 | 0.0470 | 3,647,107 | 12,166 | 701,817 |
| Aug | 123 | 0.0750 | 11,413 | -70 | 0.0394 | -3,717 | 1,600 | 82,203 | 1,119 | -968,851 | 57,759 | 0.0606 | 4,274,851 | 5,723 | 421,496 |
| Sep | 120 | 0.0530 | 7,849 | 1,546 | 0.0397 | 75,820 | 3,273 | 160,402 | 832 | 548,088 | 51,864 | 0.0510 | 3,256,461 | 8,369 | 328,123 |
| Total/Average | 5,408 | 0.0794 | 529,419 | 18,821 | 0.0494 | 1,147,518 | 87,219 | 6,045,109 | 6,160 | 1,777,176 | 57,809 | 0.0461 | 3,284,628 | 77,474 | 4,341,223 |

Table A-3

Date: September 25, 2006

# Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model

## Scofield Reservoir Operation

| Year | Month | [redacted] Flow Acre-Feet | [redacted] mg/l | [redacted] Weight Grams | (Calculated) Gains for Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | [redacted] Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Scofield Reservoir (Includes errors, uptake, P recycle, etc.): Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Total Acre-Feet | mg/l Measured | Weight Grams | Price River Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| | Oct | 371 | 0.0120 | 5,514 | 586 | 0.0818 | 58,551 | 951 | 0.0546 | 64,075 | 485 | 0.0700 | 41,851 | 105 | 0.0316 | 4,116 | 448 | 0.0581 | 32,141 | 1,099 | 142,595 | 428 | -348,008 | 45,444 | 0.0600 | 3,363,300 | 7,020 | 586,134 |
| | Nov | 319 | 0.0120 | 4,730 | 501 | 0.0407 | 24,994 | 820 | 0.0294 | 29,727 | 458 | 0.0670 | 37,872 | 90 | 0.0190 | 2,116 | 118 | 0.0413 | 6,037 | 1,487 | 73,752 | 121 | 2,572,968 | 46,410 | 0.0150 | [illegible] | 0 | 0 |
| | Dec | 312 | 0.0120 | 4,639 | 344 | 0.0368 | 15,814 | 657 | 0.0250 | 20,253 | 425 | 0.0700 | 36,729 | 91 | 0.0500 | 4,475 | 39 | 0.0431 | 3,285 | 1,239 | 68,742 | 0 | -519,681 | 48,064 | [illegible] | 1,452,516 | 0 | 0 |
| 1998 | Jan | 301 | 0.0120 | 4,466 | 331 | 0.0209 | 8,557 | 632 | 0.0167 | 13,023 | 420 | 0.0580 | 19,706 | 70 | 0.0500 | 4,310 | 993 | 0.0268 | 32,792 | 2,116 | 69,821 | 0 | -375,952 | 50,180 | [illegible] | 2,098,200 | 0 | 0 |
| | Feb | 340 | 0.0120 | 5,086 | 452 | 0.0347 | 19,401 | 793 | 0.0250 | 24,448 | 453 | 0.0700 | 39,099 | 87 | 0.0500 | 5,189 | -47 | 0.0419 | -2,430 | 1,286 | 86,505 | 0 | -1,328,754 | 51,466 | [illegible] | 3,691,347 | 0 | 0 |
| | Mar | 458 | 0.0120 | 6,789 | 690 | 0.0418 | 35,902 | 1,154 | 0.0300 | 42,701 | 528 | 0.0800 | 51,473 | 127 | 0.0500 | 7,813 | 1,088 | 0.0460 | 61,551 | 2,892 | 163,941 | 0 | -1,024,614 | 51,437 | [illegible] | 4,630,600 | 951 | 75,296 |
| | Apr | 1,170 | 0.0120 | 17,375 | 2,020 | 0.0345 | 85,907 | 3,190 | 0.0263 | 103,282 | 936 | 0.1000 | 115,504 | 348 | 0.0600 | 25,788 | 532 | 0.0447 | 29,071 | 5,007 | 273,646 | 0 | 462,369 | 52,223 | 0.0612 | 3,942,699 | 8,216 | 469,213 |
| | May | 7,120 | 0.0120 | 103,721 | 11,417 | 0.1014 | 1,428,513 | 18,537 | 0.0671 | 1,534,234 | 4,033 | 0.1320 | 656,589 | 2,020 | 0.1020 | 254,141 | 3,175 | 0.0366 | 115,660 | 27,764 | 2,760,645 | 360 | 1,946,033 | 73,500 | 0.0488 | 4,424,279 | 3,332 | 333,003 |
| | Jun | 4,069 | 0.0120 | 60,416 | 6,683 | 0.0300 | 247,258 | 10,751 | 0.0232 | 307,672 | 2,462 | 0.0723 | 218,647 | 1,172 | 0.0430 | 62,162 | 1,308 | 0.0132 | 36,425 | 16,254 | 654,597 | 1,294 | 2,363,336 | 73,500 | 0.0330 | 3,248,936 | 14,980 | 653,314 |
| | Jul | 1,142 | 0.0120 | 16,952 | 3,609 | 0.0091 | 29,308 | 1,750 | 0.0106 | 46,360 | 1,049 | 0.0216 | 27,085 | 409 | 0.0920 | 36,265 | -908 | 0.0155 | -17,389 | 4,101 | 82,331 | 1,330 | 1,198,164 | 64,404 | 0.0122 | 979,312 | 11,046 | 175,361 |
| | Aug | 500 | 0.0120 | 7,310 | 691 | 0.0283 | 24,085 | 1,197 | 0.0214 | 31,394 | 534 | 0.0700 | 46,138 | 131 | 0.0750 | 12,155 | 1,085 | 0.0391 | 52,363 | 2,948 | 142,230 | 1,129 | -3,813,235 | 55,188 | 0.0000 | 4,084,437 | 11,435 | 846,260 |
| | Sep | 355 | 0.0120 | 5,274 | 447 | 0.1619 | 88,694 | 802 | 0.0950 | 93,968 | 455 | 0.0220 | 12,338 | 49 | 0.0470 | 3,121 | 124 | 0.0672 | 10,250 | 1,469 | 131,679 | 821 | 1,609,616 | 40,379 | 0.0071 | 3,305,546 | 6,237 | 200,997 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | | 16,461 | 0.0120 | 244,488 | 36,771 | 0.0626 | 2,066,789 | 42,234 | 0.0433 | 2,311,237 | 12,237 | 0.0804 | 1,303,543 | 4,721 | 0.0711 | 414,257 | 8,376 | 0.0509 | 401,766 | 68,706 | 4,620,800 | 6,106 | 2,342,665 | 55,350 | 0.0413 | 2,822,605 | 64,886 | 3,241,458 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| | Oct | 333 | 0.0157 | 6,460 | 435 | 0.0844 | 45,223 | 767 | 0.0546 | 51,673 | 448 | 0.0700 | 38,654 | 85 | 0.0300 | 3,032 | -426 | -0.1586 | -30,877 | 873 | 93,142 | 421 | -1,333,919 | 44,990 | 0.0600 | 3,328,928 | 5,049 | 373,673 |
| | Nov | 309 | 0.0177 | 3,080 | 552 | 0.0371 | 23,255 | 861 | 0.0294 | 31,235 | 487 | 0.0670 | 38,563 | 95 | 0.0190 | 2,223 | 423 | 0.0410 | 21,408 | 1,446 | 93,451 | 121 | 2,558,212 | 46,507 | 0.0150 | 860,481 | 198 | 3,603 |
| | Dec | 151 | 0.0157 | 2,923 | 462 | 0.0280 | 15,967 | 613 | 0.0250 | 18,890 | 414 | 0.0700 | 35,539 | 60 | 0.0500 | 4,178 | 52 | 0.0436 | 2,805 | 1,149 | 61,832 | 0 | -517,860 | 47,549 | 0.0243 | 1,430,901 | 307 | 8,273 |
| 1999 | Jan | 88 | 0.0157 | 1,699 | 428 | 0.0169 | 8,922 | 516 | 0.0167 | 10,621 | 397 | 0.0380 | 18,604 | 57 | 0.0500 | 3,327 | 140 | 0.0279 | 5,412 | 1,130 | 38,163 | 0 | -558,083 | 48,172 | 0.0339 | 2,014,331 | 307 | 12,837 |
| | Feb | 141 | 0.0157 | 2,726 | 96 | 0.0387 | 4,574 | 237 | 0.0250 | 7,300 | 341 | 0.0700 | 29,413 | 27 | 0.0500 | 1,053 | 475 | 0.0515 | 30,164 | 1,079 | 68,530 | 0 | -1,258,431 | 48,974 | [illegible] | 3,522,469 | 277 | 18,890 |
| | Mar | 236 | 0.0157 | 4,571 | 439 | 0.0377 | 20,410 | 675 | 0.0300 | 24,985 | 429 | 0.0800 | 42,343 | 75 | 0.0500 | 4,399 | 2,092 | 0.0491 | 127,638 | 3,271 | 199,560 | 0 | -976,089 | 51,819 | [illegible] | 4,461,862 | 438 | 38,652 |
| | Apr | 539 | 0.0157 | 10,461 | 1,326 | 0.0305 | 49,951 | 1,865 | 0.0263 | 60,392 | 669 | 0.1000 | 82,581 | 294 | 0.0600 | 15,110 | 682 | 0.0466 | 39,311 | 3,420 | 197,374 | 0 | 488,803 | 53,259 | 0.0612 | 4,120,474 | 1,969 | 149,469 |
| | May | 5,794 | 0.0157 | 112,689 | 8,323 | 0.1029 | 1,056,287 | 14,117 | 0.0671 | 1,168,456 | 3,141 | 0.1320 | 511,420 | 1,539 | 0.1020 | 193,182 | 3,273 | 0.0608 | 306,211 | 22,070 | 2,199,670 | 362 | 1,743,899 | 72,396 | 0.0488 | 4,337,801 | 1,907 | 118,424 |
| | Jun | 4,170 | 0.0157 | 80,828 | 4,378 | 0.0304 | 163,940 | 8,554 | 0.0232 | 244,778 | 2,019 | 0.0790 | 194,207 | 933 | 0.0424 | 74,776 | 2,073 | 0.0362 | 92,573 | 13,578 | 606,334 | 1,286 | 3,730,637 | 71,078 | [illegible] | 1,000,966 | 13,580 | 332,971 |
| | Jul | 559 | 0.0157 | 16,635 | 1,105 | 0.0466 | 62,105 | 1,664 | 0.0325 | 78,740 | 309 | 0.0420 | 35,702 | 215 | 0.0520 | 13,789 | 451 | 0.0362 | 6,772 | 3,020 | 135,001 | 1,332 | -3,057,050 | 61,914 | 0.0420 | 3,369,387 | 11,447 | 602,642 |
| | Aug | 626 | 0.0157 | 12,120 | 359 | 0.0503 | 34,639 | 1,185 | 0.0320 | 46,759 | 332 | 0.0270 | 214,535 | 130 | 0.0234 | 4,010 | 553 | 0.1165 | 79,492 | 2,400 | 344,764 | 1,154 | 384,048 | 55,555 | 0.0614 | 3,122,898 | 7,643 | 410,505 |
| | Sep | 435 | 0.0157 | 8,417 | 421 | 0.0760 | 36,318 | 855 | 0.0424 | 44,735 | 465 | 0.0110 | 17,708 | 96 | 0.0530 | 6,137 | 77 | 0.0086 | 3,734 | 1,491 | 72,498 | 820 | -354,348 | 54,094 | 0.0910 | 3,491,462 | 3,528 | 347,775 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | | 13,687 | 0.0157 | 264,564 | 19,323 | 0.0687 | 1,523,600 | 33,050 | 0.0430 | 1,788,563 | 10,013 | 0.1020 | 1,259,717 | 3,530 | 0.0754 | 371,234 | 9,364 | 0.0706 | 708,649 | 51,326 | 4,080,206 | 5,089 | 840,568 | 59,475 | 0.0421 | 3,897,598 | 47,981 | 2,543,604 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| | Oct | 248 | 0.0125 | 1,821 | 325 | 0.0746 | 46,265 | 773 | 0.0546 | 52,087 | 449 | 0.0700 | 38,704 | 85 | 0.0300 | 3,681 | -1,726 | -0.1586 | -424,643 | -417 | 232,115 | 422 | 332,734 | 44,026 | 0.0600 | 3,234,201 | 6,026 | 445,981 |
| | Nov | 230 | 0.0125 | 3,524 | 623 | 0.0350 | 27,485 | 855 | 0.0294 | 31,019 | 465 | 0.0670 | 38,486 | 94 | 0.0190 | 2,207 | -948 | 0.0411 | -47,029 | 875 | 24,064 | 120 | 2,461,235 | 43,392 | 0.0150 | 806,553 | 139 | 34,389 |
| | Dec | 176 | 0.0125 | 2,708 | 505 | 0.0294 | 18,302 | 681 | 0.0250 | 21,010 | 450 | 0.0700 | 37,517 | 77 | 0.0500 | 4,040 | -38 | 0.0429 | -1,502 | 1,157 | 61,244 | 0 | -484,549 | 44,448 | 0.0243 | 1,242,997 | 108 | 8,849 |
| 2000 | Jan | 155 | 0.0125 | 2,376 | 563 | 0.0179 | 12,416 | 718 | 0.0167 | 14,792 | 438 | 0.0380 | 20,549 | 78 | 0.0500 | 4,827 | 585 | 0.0294 | 18,395 | 1,800 | 58,592 | 0 | -331,940 | 40,351 | 0.0339 | 1,939,616 | 108 | 11,936 |
| | Feb | 137 | 0.0125 | 2,101 | 529 | 0.0382 | 18,429 | 666 | 0.0250 | 20,546 | 427 | 0.0700 | 36,851 | 76 | 0.0500 | 4,537 | 914 | 0.0491 | 49,603 | 2,181 | 111,572 | 0 | -1,226,389 | 46,012 | 0.0530 | 3,237,222 | 96 | 3,354 |
| | Mar | 236 | 0.0125 | 3,631 | 549 | 0.0376 | 25,215 | 785 | 0.0300 | 28,846 | 450 | 0.0800 | 44,426 | 86 | 0.0500 | 5,109 | 818 | 0.0484 | 34,906 | 1,734 | 103,932 | 0 | -822,239 | 43,740 | [illegible] | 4,203,695 | 8 | 0 |
| | Apr | 1,568 | 0.0125 | 24,196 | 2,406 | 0.0392 | 104,564 | 3,974 | 0.0263 | 128,679 | 1,095 | 0.1000 | 135,010 | 434 | 0.0600 | 32,108 | -280 | 0.0436 | -13,849 | 5,252 | 282,345 | 0 | 413,573 | 53,944 | 0.0612 | 4,072,309 | 3,038 | 79,374 |
| | May | 4,475 | 0.0125 | 66,785 | 8,610 | 0.1261 | 885,091 | [illegible] | 0.0671 | 751,876 | 2,126 | 0.1320 | 346,069 | 990 | 0.1020 | 124,612 | 1,463 | [illegible] | 116,804 | 15,363 | 1,329,072 | 389 | 1,418,118 | 75,549 | 0.0488 | 3,324,260 | 7,789 | 408,869 |
| | Jun | 1,087 | 0.0125 | 10,619 | 1,323 | 0.0623 | 102,077 | 2,496 | 0.0470 | 118,696 | 778 | [illegible] | 33,517 | 563 | [illegible] | 12,454 | 222 | 0.0392 | 10,747 | 5,059 | 177,615 | 1,200 | -1,197,249 | 51,602 | 0.0642 | 4,149,876 | 9,415 | 758,819 |
| | Jul | 342 | 0.0125 | 5,356 | 517 | 0.0457 | 95,192 | 859 | 0.0325 | 34,449 | 466 | 0.0420 | 24,154 | 95 | 0.0520 | 3,069 | 84 | 0.0369 | 3,835 | 1,504 | 88,487 | 1,208 | 1,205,440 | 61,629 | 0.0470 | 3,413,400 | 10,268 | 999,323 |
| | Aug | 214 | 0.0125 | 3,200 | 346 | 0.0287 | 16,332 | 560 | 0.0200 | 13,425 | 400 | 0.0213 | 10,515 | 62 | [illegible] | 2,003 | -403 | 0.0212 | -30,619 | 527 | 10,328 | 790 | -1,682,739 | 33,454 | [illegible] | 3,334,251 | 7,808 | 770,216 |
| | Sep | 198 | 0.0125 | 3,081 | 355 | 0.0591 | 25,882 | 553 | 0.0424 | 28,952 | 464 | 0.0516 | 19,405 | 61 | 0.0530 | [illegible] | -233 | 0.0385 | -31,047 | 786 | 33,346 | 690 | 1,261,599 | 31,907 | 0.0910 | 2,689,210 | 1,037 | 108,992 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | | 9,066 | 0.0125 | 139,294 | 12,830 | 0.0897 | 1,105,429 | [illegible] | 0.0461 | 1,244,704 | 7,935 | 0.0805 | 792,971 | 2,199 | 0.0701 | 287,362 | -796 | -0.0026 | 15,998 | 32,948 | 2,210,196 | 5,630 | 179,333 | [illegible] | 0.0505 | 2,860,654 | 49,826 | 3,165,280 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| | Oct | 231 | 0.0121 | 1,466 | 395 | 0.0790 | 18,900 | 626 | 0.0546 | 42,165 | 419 | 0.0700 | 36,159 | 49 | 0.0370 | 2,988 | 309 | 0.0592 | 19,634 | 1,203 | 100,592 | 385 | -328,763 | 32,205 | 0.0600 | 2,330,214 | 539 | 48,747 |
| | Nov | 195 | 0.0121 | 2,874 | 455 | 0.0368 | 20,391 | 642 | 0.0294 | 23,264 | 422 | 0.0670 | 34,803 | 31 | 0.0750 | 1,682 | 869 | 0.0627 | 24,709 | 1,603 | 84,531 | 107 | 1,848,098 | 33,186 | 0.0150 | 818,809 | 539 | 10,359 |
| | Dec | 56 | 0.0121 | 846 | 366 | 0.0371 | 11,552 | 402 | 0.0250 | 12,398 | 374 | 0.0700 | 33,292 | 45 | 0.0500 | 2,764 | -79 | 0.0469 | -4,535 | 741 | 42,858 | 0 | -368,428 | 33,618 | 0.0245 | 1,915,961 | 508 | 8,349 |
| 2001 | Jan | 14 | 0.0121 | 202 | 227 | 0.0176 | 4,754 | 241 | 0.0167 | 4,956 | 341 | 0.0380 | 16,003 | 27 | 0.0500 | 1,679 | 2,385 | 0.0301 | 88,626 | 2,994 | 111,265 | 0 | -403,742 | 36,301 | 0.0339 | 1,518,813 | 109 | 11,036 |
| | Feb | 50 | 0.0121 | 756 | 305 | 0.0271 | 10,220 | 356 | 0.0250 | 10,976 | 365 | 0.0700 | 31,488 | 40 | 0.0500 | 2,454 | 399 | 0.0479 | 21,299 | 1,129 | 66,377 | 0 | -904,757 | 37,131 | 0.0530 | 3,320,359 | 279 | 18,855 |
| | Mar | 242 | 0.0121 | 1,631 | 457 | 0.0395 | 22,342 | 900 | 0.0300 | 25,035 | 434 | 0.0800 | 42,821 | 77 | 0.0500 | 4,763 | 1,062 | 0.0492 | 64,443 | 2,273 | 137,931 | 0 | -710,024 | 39,426 | 0.0600 | 3,356,309 | 0 | 0 |
| | Apr | 1,503 | 0.0121 | 21,908 | 1,409 | 0.0277 | 60,352 | 3,342 | 0.0263 | 108,500 | 971 | 0.1000 | 119,791 | 367 | 0.0600 | 27,176 | 786 | 0.0441 | 42,805 | 5,487 | 298,652 | 0 | 392,660 | 44,833 | 0.0612 | 3,384,443 | 89 | 3,050 |
| | May | 5,236 | 0.0121 | 78,415 | 5,383 | 0.1206 | 800,407 | 10,639 | 0.0671 | 878,882 | 2,435 | 0.1320 | 396,695 | 1,158 | 0.1000 | 145,889 | 106 | 0.0811 | 10,567 | 14,317 | 1,431,584 | 917 | 1,310,727 | 53,639 | 0.0488 | 3,228,777 | 4,594 | 276,525 |
| | Jun | 832 | 0.0121 | 12,455 | 1,259 | 0.0505 | 47,380 | 2,091 | 0.0232 | 59,835 | 715 | 0.0720 | 63,438 | 229 | 0.0370 | 10,449 | -204 | 0.0357 | -8,970 | 2,831 | 124,778 | 1,171 | -2,846,813 | 46,797 | [illegible] | 3,244,836 | 8,904 | 853,312 |
| | Jul | 303 | 0.0121 | 4,532 | 459 | 0.0459 | 25,980 | 761 | 0.0225 | 30,512 | 446 | 0.0420 | 23,128 | 86 | 0.0520 | 5,383 | 329 | 0.0371 | 30,445 | 1,520 | 69,468 | 1,174 | 2,383,377 | 38,478 | 0.0470 | 2,230,737 | 8,063 | 504,217 |
| | Aug | 228 | 0.0121 | 3,426 | 500 | 0.0098 | 15,045 | 335 | 0.0240 | 18,485 | 491 | 0.0790 | 34,801 | 39 | [illegible] | 4,531 | 1,100 | 0.0489 | 63,724 | 2,095 | 121,321 | 962 | -2,751,663 | 33,240 | [illegible] | 4,156,904 | 7,341 | 948,813 |
| | Sep | 153 | 0.0121 | 2,205 | 313 | 0.0642 | 15,842 | 566 | 0.0459 | 19,137 | 367 | 0.0310 | 14,022 | 41 | 0.0530 | 2,072 | 74 | 0.0378 | 2,403 | 847 | 39,226 | 686 | 2,157,285 | 29,310 | 0.0516 | 1,798,949 | 4,100 | 257,912 |
| | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | |
| Total/Average | | 9,069 | 0.0121 | 138,959 | 11,619 | 0.0911 | 1,009,908 | 20,699 | 0.0484 | 1,235,343 | 7,491 | 0.0891 | 843,221 | 2,267 | 0.0723 | 212,151 | 6,565 | 0.0410 | 336,169 | 37,322 | 2,629,306 | 5,782 | -190,131 | 39,022 | 0.0158 | 2,613,329 | 35,437 | 3,043,704 |

Date: September 25, 2006

Table A-3

**Flow and Phosphorus Routing WITHOUT Narrows Project Using Empirical Reservoir Model**

## Scofield Reservoir Operation

| Year | Month | [redacted] Flow Acre-Feet | [redacted] mg/l Table | [redacted] Weight Grams | (Calculated) Gain fr Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | [redacted] Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 133 | 0.0126 | 2,076 | 332 | 0.0714 | 29,259 | [redacted] | 0.0549 | 31,335 |
| | Nov | 200 | 0.0126 | 3,120 | 245 | 0.0421 | 13,014 | 445 | 0.0294 | 16,134 |
| | Dec | 161 | 0.0126 | 2,510 | 166 | 0.0370 | 7,578 | 327 | 0.0250 | 10,089 |
| 2002 | Jan | 75 | 0.0126 | 1,167 | 189 | 0.0183 | 4,270 | 264 | 0.0167 | 5,437 |
| | Feb | 29 | 0.0126 | 458 | 162 | 0.0272 | 5,440 | 191 | 0.0250 | 5,898 |
| | Mar | 58 | 0.0126 | 909 | 350 | 0.0329 | 14,218 | 409 | 0.0300 | 15,127 |
| | Apr | 1,289 | 0.0126 | 20,093 | 1,764 | 0.0362 | 78,766 | 3,053 | 0.0263 | 98,859 |
| | May | 3,038 | 0.0126 | 47,361 | 3,838 | 0.1102 | 521,626 | 6,875 | 0.0671 | 568,987 |
| | Jun | 636 | 0.0126 | 9,907 | 1,111 | 0.0085 | 11,634 | 1,746 | 0.0100 | 21,541 |
| | Jul | 256 | 0.0126 | 3,990 | 288 | 0.0474 | 16,735 | 543 | 0.0310 | 20,725 |
| | Aug | 120 | 0.0126 | 1,875 | 173 | 0.0607 | 12,963 | 293 | 0.0410 | 14,838 |
| | Sep | 165 | 0.0126 | 2,565 | 277 | 0.0084 | 2,879 | 441 | 0.0100 | 5,444 |
| Total/Average | | 6,161 | 0.0126 | 96,039 | 8,891 | 0.0655 | 718,373 | 15,052 | 0.0419 | 814,411 |
| | Oct | 187 | 0.0133 | 3,054 | 262 | 0.0368 | 11,889 | 449 | 0.0270 | 14,943 |
| | Nov | 125 | 0.0133 | 2,042 | 418 | 0.0739 | 38,139 | 543 | 0.0602 | 40,181 |
| | Dec | 27 | 0.0133 | 438 | 357 | 0.0259 | 11,411 | 384 | 0.0250 | 11,849 |
| 2003 | Jan | 54 | 0.0133 | 880 | 413 | 0.0096 | 4,874 | 466 | 0.0100 | 5,754 |
| | Feb | 97 | 0.0133 | 1,586 | 267 | 0.0293 | 9,627 | 364 | 0.0250 | 11,213 |
| | Mar | 135 | 0.0133 | 2,210 | 393 | 0.0357 | 17,331 | 528 | 0.0300 | 19,541 |
| | Apr | 743 | 0.0133 | 12,153 | 1,608 | 0.0322 | 63,963 | 2,351 | 0.0263 | 76,119 |
| | May | 5,905 | 0.0133 | 96,651 | 6,371 | 0.0513 | 403,045 | 12,276 | 0.0330 | 499,696 |
| | Jun | 1,717 | 0.0133 | 28,099 | 2,180 | 0.0074 | 19,966 | 3,897 | 0.0120 | 48,065 |
| | Jul | 351 | 0.0133 | 5,777 | 586 | 0.0441 | 31,871 | 939 | 0.0325 | 37,648 |
| | Aug | 233 | 0.0133 | 3,818 | 292 | 0.0074 | 2,663 | 525 | 0.0100 | 5,481 |
| | Sep | 168 | 0.0133 | 2,742 | 215 | 0.0075 | 1,977 | 383 | 0.0100 | 4,719 |
| Total/Average | | 9,742 | 0.0133 | 159,452 | 13,363 | 0.0374 | 616,757 | 23,105 | 0.0272 | 776,209 |
| | Oct | 116 | 0.0136 | 1,980 | 215 | 0.0080 | 2,108 | 331 | 0.0100 | 4,088 |
| | Nov | 173 | 0.0136 | 2,895 | 262 | 0.0198 | 12,894 | 435 | 0.0294 | 11,790 |
| | Dec | 133 | 0.0136 | 2,229 | 226 | 0.0217 | 6,843 | 359 | 0.0250 | 11,073 |
| 2004 | Jan | 136 | 0.0136 | 2,279 | 219 | 0.0186 | 5,042 | 355 | 0.0167 | 7,321 |
| | Feb | 145 | 0.0136 | 2,423 | 186 | 0.0339 | 7,784 | 331 | 0.0250 | 10,206 |
| | Mar | 253 | 0.0136 | 4,243 | 495 | 0.0384 | 23,453 | 748 | 0.0300 | 27,696 |
| | Apr | 1,664 | 0.0136 | 28,189 | 4,678 | 0.0311 | 159,361 | 6,301 | 0.0203 | 197,550 |
| | May | 3,730 | 0.0136 | 62,456 | 4,869 | 0.1081 | 649,286 | 8,599 | 0.0671 | 711,742 |
| | Jun | 1,116 | 0.0136 | 18,681 | 738 | 0.0322 | 29,325 | 1,855 | 0.0210 | 48,006 |
| | Jul | 325 | 0.0136 | 5,439 | 363 | 0.0495 | 22,120 | 687 | 0.0325 | 27,559 |
| | Aug | 165 | 0.0136 | 2,767 | 121 | 0.0051 | 769 | 287 | 0.0100 | 3,536 |
| | Sep | 137 | 0.0136 | 2,293 | 142 | 0.0702 | 12,308 | 279 | 0.0424 | 14,601 |
| Total/Average | | 8,415 | 0.0136 | 133,874 | 12,232 | 0.0624 | 943,295 | 20,368 | 0.0430 | 1,070,169 |
| | Oct | 232 | 0.0137 | 3,909 | 342 | 0.0075 | 3,170 | 574 | 0.0100 | 7,079 |
| | Nov | 165 | 0.0137 | 2,770 | 249 | 0.0398 | 12,239 | 414 | 0.0294 | 15,014 |
| | Dec | 138 | 0.0137 | 2,331 | 234 | 0.0078 | 2,257 | 372 | 0.0100 | 4,588 |
| 2005 | Jan | 139 | 0.0137 | 2,348 | 225 | 0.0186 | 5,149 | 364 | 0.0167 | 7,498 |
| | Feb | 147 | 0.0137 | 2,482 | 195 | 0.0335 | 8,066 | 342 | 0.0250 | 10,548 |
| | Mar | 203 | 0.0137 | 3,431 | 281 | 0.0418 | 14,484 | 484 | 0.0300 | 17,914 |
| | Apr | 843 | 0.0137 | 14,282 | 1,809 | 0.0303 | 67,306 | 2,652 | 0.0250 | 81,788 |
| | May | 9,290 | 0.0137 | 156,760 | 16,655 | 0.0874 | 1,795,300 | 25,945 | 0.0610 | 1,952,200 |
| | Jun | 4,675 | 0.0137 | 78,852 | 6,736 | 0.0298 | 247,688 | 11,411 | 0.0232 | 326,541 |
| | Jul | 729 | 0.0137 | 12,296 | 910 | 0.0071 | 7,919 | 1,639 | 0.0100 | 20,215 |
| | Aug | 451 | 0.0137 | 7,601 | 507 | 0.0067 | 4,210 | 958 | 0.0100 | 11,811 |
| | Sep | 285 | 0.0137 | 4,799 | 357 | 0.0071 | 3,114 | 642 | 0.0100 | 7,913 |
| Total/Average | | 17,298 | 0.0137 | 291,788 | 28,498 | 0.0618 | 2,171,302 | 45,796 | 0.0436 | 2,463,090 |
| 78-05 | Total | 403,512 | | 6,466,610 | 648,615 | | 54,259,545 | 1,049,126 | | 60,726,163 |
| 78-05 | Average | 14,304 | 0.0131 | 230,951 | 23,165 | 0.0678 | 1,937,841 | 37,469 | 0.0409 | 2,168,792 |
| 78-89 | Total | 260,780 | | 3,235,948 | 350,614 | | 30,072,665 | 551,394 | | 33,308,613 |
| 78-89 | Average | 16,737 | 0.0131 | 269,662 | 29,218 | 0.0695 | 2,506,055 | 45,950 | 0.0490 | 2,775,718 |

| Year | Month | Strm Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Strm Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|
| | Oct | 387 | 0.0700 | 33,393 | 52 | 0.0350 | 2,232 |
| | Nov | 383 | 0.0670 | 31,623 | 49 | 0.0190 | 1,160 |
| | Dec | 359 | 0.0700 | 30,987 | 37 | 0.0500 | 2,261 |
| 2002 | Jan | 346 | 0.0380 | 16,224 | 30 | 0.0500 | 1,836 |
| | Feb | 331 | 0.0700 | 28,620 | 22 | 0.0500 | 1,348 |
| | Mar | 375 | 0.0800 | 37,039 | 46 | 0.0500 | 2,809 |
| | Apr | 909 | 0.1000 | 112,103 | 334 | 0.0600 | 24,686 |
| | May | 1,680 | 0.1320 | 271,509 | 750 | 0.1020 | 94,372 |
| | Jun | 646 | 0.0300 | 23,878 | 191 | 0.0570 | 13,445 |
| | Jul | 402 | 0.0420 | 20,838 | 60 | 0.0520 | 3,832 |
| | Aug | 352 | 0.0100 | 4,343 | 33 | 0.0750 | 3,051 |
| | Sep | 382 | 0.0310 | 14,606 | 49 | 0.0530 | 3,209 |
| Total/Average | | 6,551 | 0.0776 | 627,156 | 1,652 | 0.0757 | 154,222 |
| | Oct | 383 | 0.0700 | 33,104 | 50 | 0.0350 | 2,154 |
| | Nov | 402 | 0.0670 | 33,237 | 60 | 0.0190 | 1,410 |
| | Dec | 370 | 0.0700 | 31,982 | 43 | 0.0500 | 2,644 |
| 2003 | Jan | 387 | 0.0380 | 18,139 | 52 | 0.0500 | 3,197 |
| | Feb | 366 | 0.0700 | 31,654 | 41 | 0.0500 | 2,506 |
| | Mar | 399 | 0.0800 | 39,414 | 59 | 0.0500 | 3,610 |
| | Apr | 767 | 0.1000 | 94,626 | 257 | 0.0600 | 19,025 |
| | May | 2,770 | 0.1320 | 450,933 | 1,328 | 0.1020 | 168,349 |
| | Jun | 1,079 | 0.0100 | 13,309 | 425 | 0.0240 | 12,594 |
| | Jul | 482 | 0.0420 | 24,988 | 103 | 0.0520 | 5,626 |
| | Aug | 399 | 0.0100 | 4,920 | 58 | 0.0750 | 5,389 |
| | Sep | 370 | 0.0310 | 14,150 | 43 | 0.0530 | 2,791 |
| Total/Average | | 8,176 | 0.0784 | 790,449 | 2,226 | 0.0738 | 230,296 |
| | Oct | 360 | 0.0700 | 31,062 | 37 | 0.0350 | 1,603 |
| | Nov | 381 | 0.0670 | 31,464 | 48 | 0.0190 | 1,115 |
| | Dec | 365 | 0.0700 | 31,543 | 46 | 0.0500 | 2,475 |
| 2004 | Jan | 365 | 0.0380 | 17,088 | 40 | 0.0500 | 2,450 |
| | Feb | 360 | 0.0700 | 31,054 | 37 | 0.0500 | 2,286 |
| | Mar | 444 | 0.0800 | 43,801 | 83 | 0.0500 | 5,091 |
| | Apr | 1,524 | 0.1000 | 187,955 | 666 | 0.0600 | 49,255 |
| | May | 2,028 | 0.1320 | 330,163 | 938 | 0.1020 | 117,967 |
| | Jun | 667 | 0.0390 | 32,079 | 203 | 0.0480 | 12,012 |
| | Jul | 432 | 0.0420 | 22,358 | 76 | 0.0520 | 4,868 |
| | Aug | 351 | 0.0100 | 4,326 | 73 | 0.0400 | 3,750 |
| | Sep | 349 | 0.0310 | 13,353 | 31 | 0.0530 | 2,055 |
| Total/Average | | 7,624 | 0.0823 | 776,242 | 2,231 | 0.0738 | 202,948 |
| | Oct | 403 | 0.0700 | 35,206 | 64 | 0.0350 | 2,743 |
| | Nov | 378 | 0.0670 | 31,168 | 46 | 0.0190 | 1,081 |
| | Dec | 368 | 0.0700 | 31,768 | 42 | 0.0500 | 2,562 |
| 2005 | Jan | 365 | 0.0380 | 17,170 | 41 | 0.0500 | 2,509 |
| | Feb | 362 | 0.0700 | 31,247 | 38 | 0.0500 | 2,361 |
| | Mar | 391 | 0.0800 | 38,539 | 54 | 0.0500 | 3,315 |
| | Apr | 828 | 0.1000 | 102,112 | 290 | 0.0600 | 21,450 |
| | May | 5,527 | 0.1320 | 899,949 | 2,677 | 0.1020 | 335,662 |
| | Jun | 2,595 | 0.0720 | 230,461 | 1,244 | 0.0450 | 63,972 |
| | Jul | 624 | 0.0100 | 7,691 | 180 | 0.0200 | 4,430 |
| | Aug | 486 | 0.0100 | 5,985 | 105 | 0.0100 | 1,299 |
| | Sep | 422 | 0.0100 | 5,209 | 71 | 0.0100 | 874 |
| Total/Average | | 12,754 | 0.0913 | 1,436,514 | 5,060 | 0.0753 | 464,230 |
| 78-05 | Total | 310,066 | | 35,425,594 | 114,609 | | 10,483,772 |
| 78-05 | Average | 11,074 | 0.0926 | 1,265,200 | 4,093 | 0.0742 | 374,420 |
| 78-89 | Total | 153,418 | | 18,697,996 | 60,202 | | 5,646,719 |
| 78-89 | Average | 12,785 | 0.0988 | 1,558,166 | 5,017 | 0.0760 | 470,560 |

| Year | Month | (CALC) Other Reservoir Inflow Scofield Reservoir (Includes errors, uptake, P recycle, etc.): Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|
| | Oct | 417 | 0.0601 | 30,889 | 1,321 | 97,849 |
| | Nov | 1,270 | 0.0452 | 70,811 | 2,147 | 119,727 |
| | Dec | 209 | 0.0486 | 12,536 | 932 | 55,873 |
| 2002 | Jan | 343 | 0.0298 | 12,652 | 984 | 36,149 |
| | Feb | 3,379 | 0.0534 | 222,527 | 3,923 | 258,394 |
| | Mar | 1,233 | 0.0577 | 83,148 | 2,085 | 138,124 |
| | Apr | 296 | 0.0447 | 13,681 | 4,544 | 249,293 |
| | May | 419 | 0.0816 | 41,122 | 9,713 | 977,947 |
| | Jun | 359 | 0.0193 | 8,414 | 2,952 | 57,276 |
| | Jul | -722 | 0.0367 | 34,023 | 282 | 11,391 |
| | Aug | 1,272 | 0.0266 | 41,690 | 1,951 | 63,971 |
| | Sep | 1,209 | 0.0216 | 32,160 | 2,079 | 55,417 |
| Total/Average | | 8,426 | 0.0461 | 535,567 | 32,881 | 2,131,358 |
| | Oct | 437 | 0.0461 | 24,854 | 1,319 | 75,056 |
| | Nov | 612 | 0.0501 | 47,010 | 1,607 | 121,857 |
| | Dec | 1,891 | 0.0472 | 110,189 | 2,688 | 156,663 |
| 2003 | Jan | 1,516 | 0.0241 | 45,410 | 2,424 | 72,570 |
| | Feb | 849 | 0.0477 | 49,219 | 1,590 | 93,569 |
| | Mar | 2,367 | 0.0514 | 150,160 | 3,351 | 212,759 |
| | Apr | 590 | 0.0456 | 32,189 | 3,965 | 222,960 |
| | May | -2,193 | 0.0534 | -149,773 | 14,101 | 969,205 |
| | Jun | 3,079 | 0.0111 | 42,156 | 8,479 | 116,127 |
| | Jul | 18 | 0.0368 | 3,394 | 1,611 | 73,254 |
| | Aug | -170 | 0.0139 | -2,912 | 811 | 13,877 |
| | Sep | 662 | 0.0221 | 18,027 | 1,457 | 39,086 |
| Total/Average | | 9,718 | 0.0289 | 370,369 | 43,528 | 2,167,523 |
| | Oct | 299 | 0.0409 | 15,105 | 1,028 | 51,858 |
| | Nov | 593 | 0.0454 | 33,327 | 1,460 | 81,718 |
| | Dec | 252 | 0.0478 | 14,853 | 1,018 | 59,944 |
| 2004 | Jan | 637 | 0.0287 | 22,510 | 1,396 | 69,569 |
| | Feb | 433 | 0.0485 | 35,207 | 1,050 | 98,753 |
| | Mar | 995 | 0.0487 | 59,784 | 2,276 | 136,371 |
| | Apr | -1,963 | 0.0425 | -102,984 | 6,327 | 311,796 |
| | May | -704 | 0.0813 | -70,565 | 10,804 | 1,089,395 |
| | Jun | 254 | 0.0274 | 8,584 | 2,977 | 100,678 |
| | Jul | -342 | 0.0372 | -15,667 | 853 | 39,118 |
| | Aug | -491 | 0.0116 | -7,051 | 178 | 2,561 |
| | Sep | -236 | 0.0369 | -11,043 | 404 | 18,366 |
| Total/Average | | 199 | 0.0090 | 1,478 | 30,421 | 2,059,837 |
| | Oct | 981 | 0.0350 | 24,179 | 1,007 | 69,285 |
| | Nov | 878 | 0.0457 | 49,356 | 1,211 | 96,538 |
| | Dec | 885 | 0.0486 | 54,140 | 1,467 | 73,050 |
| 2005 | Jan | 1,385 | 0.0286 | 45,269 | 2,056 | 72,484 |
| | Feb | 882 | 0.0482 | 34,635 | 1,324 | 78,192 |
| | Mar | 1,160 | 0.0522 | 74,630 | 2,088 | 134,418 |
| | Apr | 1,645 | 0.0442 | 100,491 | 5,614 | 305,923 |
| | May | -1,901 | 0.0758 | -140,422 | 32,798 | 3,067,388 |
| | Jun | -860 | 0.0031 | -9,833 | 15,009 | 615,153 |
| | Jul | -277 | 0.0107 | -3,672 | 2,165 | 28,683 |
| | Aug | -497 | 0.0100 | -4,891 | 1,045 | 23,997 |
| | Sep | 139 | 0.0100 | 1,717 | 1,274 | 15,711 |
| Total/Average | | 5,509 | 0.0317 | 215,611 | 69,058 | 4,379,309 |
| 78-05 | Total | 262,562 | | 17,519,835 | 1,736,364 | 124,153,364 |
| 78-05 | Average | 9,377 | 0.0541 | 625,708 | 62,013 | 4,434,120 |
| 78-89 | Total | 185,575 | | 13,177,944 | 950,949 | 70,851,292 |
| 78-89 | Average | 13,461 | 0.0576 | 1,098,162 | 79,242 | 5,902,608 |

| Year | Month | (Fransen-Noble) Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | Exit at Mouth Contour: Total Acre-Feet | mg/l Measured | Weight Grams | Price River Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|
| | Oct | 345 | -238,639 | 23,593 | 0.0600 | 1,894,106 | 3,693 | 273,323 |
| | Nov | 97 | 1,302,385 | 26,934 | 0.0450 | 498,339 | 709 | 13,110 |
| | Dec | 0 | -287,900 | 27,556 | 0.0345 | 832,362 | 309 | 9,349 |
| 2002 | Jan | 0 | -314,521 | 28,231 | 0.0339 | 1,180,956 | 309 | 12,936 |
| | Feb | 0 | -742,542 | 31,875 | 0.0550 | 2,162,875 | 279 | 18,956 |
| | Mar | 0 | -621,259 | 33,730 | 0.0898 | 2,905,811 | 310 | 18,042 |
| | Apr | 0 | 264,272 | 37,282 | 0.0842 | 3,814,417 | 1,012 | 76,412 |
| | May | 862 | 1,033,469 | 37,834 | 0.0488 | 2,036,601 | 13,293 | 740,554 |
| | Jun | 1,085 | 1,582,984 | 38,325 | 0.0118 | 412,382 | 7,455 | 108,510 |
| | Jul | 936 | -1,176,386 | 26,412 | 0.0470 | 1,531,287 | 1,190 | 65,972 |
| | Aug | 827 | 134,619 | 25,143 | 0.0430 | 1,333,585 | 2,395 | 127,006 |
| | Sep | 816 | -284,717 | 25,254 | 0.0510 | 1,588,821 | 1,350 | 84,897 |
| Total/Average | | 4,725 | 771,610 | 29,183 | 0.0444 | 1,599,249 | 31,210 | 1,551,875 |
| | Oct | 328 | -278,655 | 25,888 | 0.0600 | 1,901,174 | 539 | 41,359 |
| | Nov | 97 | 1,149,242 | 26,929 | 0.0150 | 498,245 | 299 | 5,530 |
| | Dec | 0 | -240,135 | 29,308 | 0.0045 | 863,696 | 309 | 9,349 |
| 2003 | Jan | 0 | -308,607 | 31,470 | 0.0370 | 1,319,917 | 310 | 10,935 |
| | Feb | 0 | -833,355 | 32,948 | 0.0550 | 2,237,389 | 112 | 7,598 |
| | Mar | 0 | -677,412 | 36,280 | 0.0698 | 3,124,372 | 12 | 1,031 |
| | Apr | 0 | 308,570 | 39,933 | 0.0672 | 3,014,639 | 319 | 24,106 |
| | May | 893 | 778,966 | 48,990 | 0.0488 | 2,948,923 | 4,232 | 255,972 |
| | Jun | 1,141 | 2,092,319 | 47,776 | 0.0146 | 429,028 | 8,557 | 147,698 |
| | Jul | 1,182 | -1,896,449 | 38,126 | 0.0470 | 2,210,399 | 10,080 | 584,389 |
| | Aug | 960 | -511,594 | 29,755 | 0.0584 | 2,145,432 | 8,323 | 592,389 |
| | Sep | 663 | 281,355 | 28,916 | 0.0510 | 1,669,497 | 3,613 | 227,273 |
| Total/Average | | 5,254 | 154,219 | 34,512 | 0.0646 | 1,599,793 | 36,394 | 1,907,639 |
| | Oct | 337 | -298,247 | 26,192 | 0.0600 | 1,938,456 | 1,434 | 106,157 |
| | Nov | 98 | 1,510,342 | 27,214 | 0.0150 | 503,611 | 339 | 6,278 |
| | Dec | 6 | -289,674 | 27,921 | 0.0265 | 841,800 | 309 | 9,349 |
| 2004 | Jan | 6 | -372,768 | 29,088 | 0.0330 | 1,212,997 | 309 | 12,936 |
| | Feb | 0 | -388,149 | 30,299 | 0.0550 | 2,055,573 | 339 | 24,372 |
| | Mar | 0 | -412,236 | 32,569 | 0.0698 | 2,804,151 | 0 | 0 |
| | Apr | 0 | 199,668 | 36,102 | 0.0612 | 2,723,358 | 2,794 | 210,921 |
| | May | 871 | 1,038,976 | 38,281 | 0.0488 | 2,304,300 | 7,871 | 471,393 |
| | Jun | 1,051 | 1,646,317 | 33,517 | 0.0152 | 632,537 | 8,688 | 120,225 |
| | Jul | 1,043 | -1,280,312 | 30,822 | 0.0470 | 1,554,973 | 6,303 | 376,994 |
| | Aug | 832 | -885,280 | 30,267 | 0.0383 | 1,907,349 | 5,992 | 555,425 |
| | Sep | 556 | 660,391 | 18,826 | 0.0310 | 1,159,170 | 1,088 | 108,194 |
| Total/Average | | 4,773 | 568,011 | 29,685 | 0.0459 | 1,636,851 | 34,158 | 2,006,245 |
| | Oct | 282 | -253,341 | 19,035 | 0.0600 | 1,408,296 | 712 | 53,041 |
| | Nov | 84 | 1,123,008 | 20,560 | 0.0150 | 380,460 | 102 | 1,856 |
| | Dec | 0 | -212,193 | 21,895 | 0.0245 | 661,665 | 132 | 3,986 |
| 2005 | Jan | 0 | -267,865 | 23,783 | 0.0379 | 994,419 | 168 | 7,038 |
| | Feb | 0 | -630,040 | 24,980 | 0.0550 | 1,693,948 | 167 | 11,139 |
| | Mar | 0 | -500,646 | 27,022 | 0.0908 | 2,226,491 | 0 | 185 |
| | Apr | 8 | 168,668 | 32,626 | 0.0612 | 2,403,644 | 0 | 0 |
| | May | 639 | 1,641,582 | 54,587 | 0.0488 | 1,487,759 | 28 | 1,691 |
| | Jun | 1,236 | 2,084,496 | 73,500 | 0.0250 | 2,266,536 | 4,860 | 149,877 |
| | Jul | 1,350 | 562,710 | 65,897 | 0.0185 | 1,596,243 | 8,418 | 196,243 |
| | Aug | 1,135 | -3,806,820 | 59,875 | 0.0465 | 4,099,244 | 6,431 | 557,617 |
| | Sep | 846 | 2,472,891 | 54,169 | 0.0313 | 2,189,720 | 8,120 | 246,836 |
| Total/Average | | 5,746 | 2,322,457 | 30,660 | 0.0410 | 2,057,741 | 27,949 | 1,230,291 |
| 78-05 | Total | 153,203 | 39,136,349 | 1,193,786 | | 67,027,997 | 1,551,264 | 84,235,663 |
| 78-05 | Average | 5,472 | 1,397,727 | 42,635 | 0.0855 | 2,393,857 | 55,402 | 3,008,417 |
| 78-89 | Total | 70,403 | 24,380,328 | 679,106 | | 34,271,189 | 868,251 | 46,703,316 |
| 78-89 | Average | 5,087 | 2,032,444 | 58,758 | 0.0437 | 2,864,259 | 73,883 | 3,891,943 |

NOTE: Average Annual Concentrations are Flow Weighted. Highlighted cells represent actual measurements.

Date: 23-Sep-09

**Table B-1**

# Lower Gooseberry Reservoir (without Narrows) Eutrophication Study

## Phosphorus Content and Probability of Eutrophication

| Year | Contents of Lower Gooseberry Reservoir Jun - Sep Average | Contents of Lower Gooseberry Reservoir Jun - Sep Average (V) | Surface Area at Volume of Lower Gooseberry | Surface Area at Volume of Lower Gooseberry (A) | Mean Lake Depth of Lower Gooseberry (z) | Reservoir Outflow of Lower Gooseberry | Reservoir Outflow of Lower Gooseberry ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus In Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table B-3)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | m³ | Acres | m² | m | AF | m³/yr | yr | g/yr | g/m²/yr | | mg/L | | | |
| 1978 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 17,434 | 21,504,647 | 0.0122 | 302,199 | 1.3032 | 7.2632 | 0.0129 | 0.7225 | 0.2651 | 0.2349 |
| 1979 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 11,916 | 14,698,255 | 0.0178 | 205,774 | 0.8874 | 5.7919 | 0.0127 | 0.7509 | 0.2737 | 0.2263 |
| 1980 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 18,480 | 22,794,877 | 0.0115 | 321,960 | 1.3884 | 7.5393 | 0.0130 | 0.7114 | 0.2617 | 0.2383 |
| 1981 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,213 | 11,364,134 | 0.0230 | 158,027 | 0.6815 | 4.9578 | 0.0125 | 0.7785 | 0.2819 | 0.2181 |
| 1982 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 17,761 | 21,907,998 | 0.0119 | 309,348 | 1.3341 | 7.3639 | 0.0130 | 0.7140 | 0.2625 | 0.2375 |
| 1983 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 27,101 | 33,428,785 | 0.0078 | 480,423 | 2.0718 | 9.5436 | 0.0134 | 0.6646 | 0.2470 | 0.2530 |
| 1984 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 28,114 | 34,678,310 | 0.0075 | 492,606 | 2.1243 | 9.6854 | 0.0132 | 0.6814 | 0.2523 | 0.2477 |
| 1985 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 20,049 | 24,730,221 | 0.0106 | 352,931 | 1.5220 | 7.9584 | 0.0132 | 0.6907 | 0.2552 | 0.2448 |
| 1986 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 24,531 | 30,258,719 | 0.0086 | 427,730 | 1.8446 | 8.9124 | 0.0131 | 0.6956 | 0.2568 | 0.2432 |
| 1987 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,305 | 10,244,126 | 0.0255 | 152,240 | 0.6565 | 4.8500 | 0.0132 | 0.6831 | 0.2528 | 0.2472 |
| 1988 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,310 | 11,483,783 | 0.0228 | 163,479 | 0.7050 | 5.0578 | 0.0128 | 0.7414 | 0.2709 | 0.2291 |
| 1989 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,566 | 10,566,067 | 0.0247 | 155,114 | 0.6689 | 4.9037 | 0.0131 | 0.6998 | 0.2581 | 0.2419 |
| 1990 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,076 | 9,961,394 | 0.0263 | 160,072 | 0.6903 | 4.9955 | 0.0142 | 0.5648 | 0.2140 | 0.2860 |
| 1991 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 11,713 | 14,447,767 | 0.0181 | 220,820 | 0.9523 | 6.0377 | 0.0138 | 0.6153 | 0.2309 | 0.2691 |
| 1992 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 5,383 | 6,640,025 | 0.0394 | 103,879 | 0.4480 | 3.8723 | 0.0136 | 0.6400 | 0.2390 | 0.2610 |
| 1993 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 17,148 | 21,151,903 | 0.0124 | 292,061 | 1.2595 | 7.1187 | 0.0127 | 0.7511 | 0.2738 | 0.2262 |
| 1994 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,072 | 11,190,534 | 0.0234 | 167,509 | 0.7224 | 5.1309 | 0.0134 | 0.6655 | 0.2472 | 0.2528 |
| 1995 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 22,629 | 27,913,165 | 0.0094 | 378,073 | 1.6304 | 8.2876 | 0.0126 | 0.7671 | 0.2785 | 0.2215 |
| 1996 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 14,470 | 17,848,682 | 0.0147 | 239,442 | 1.0326 | 6.3326 | 0.0123 | 0.8060 | 0.2899 | 0.2101 |
| 1997 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 21,674 | 26,734,361 | 0.0098 | 372,462 | 1.6062 | 8.2149 | 0.0129 | 0.7247 | 0.2658 | 0.2342 |
| 1998 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 16,463 | 20,307,011 | 0.0129 | 265,639 | 1.1456 | 6.7320 | 0.0120 | 0.8384 | 0.2991 | 0.2009 |
| 1999 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 13,687 | 16,882,895 | 0.0155 | 294,312 | 1.2692 | 7.1509 | 0.0157 | 0.4003 | 0.1556 | 0.3444 |
| 2000 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,060 | 11,175,441 | 0.0234 | 155,265 | 0.6696 | 4.9066 | 0.0125 | 0.7811 | 0.2827 | 0.2173 |
| 2001 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,040 | 11,151,311 | 0.0235 | 150,707 | 0.6499 | 4.8212 | 0.0121 | 0.8241 | 0.2951 | 0.2049 |
| 2002 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 6,161 | 7,599,584 | 0.0344 | 109,219 | 0.4710 | 3.9883 | 0.0126 | 0.7581 | 0.2759 | 0.2241 |
| 2003 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,742 | 12,016,064 | 0.0218 | 177,900 | 0.7672 | 5.3160 | 0.0133 | 0.6774 | 0.2510 | 0.2490 |
| 2004 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,115 | 10,009,749 | 0.0261 | 153,150 | 0.6605 | 4.8671 | 0.0136 | 0.6400 | 0.2390 | 0.2610 |
| 2005 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 17,298 | 21,337,016 | 0.0123 | 318,582 | 1.3739 | 7.4926 | 0.0137 | 0.6277 | 0.2350 | 0.2650 |
| Average | 212 | 261,500 | 57 | 231,886 | 1.1277 | 14,304 | 17,643,815 | 0.0181 | 252,890 | 1.0906 | 6.3962 | 0.0131 | 0.7006 | | 0.2425 |

* Table B-3 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Table B-2

# Scofield Reservoir (without Narrows) Eutrophication Study

## Phosphorus Content and Probability of Eutrophication

| Year | Contents of Scofield Reservoir Jun - Sep Average | Contents of Scofield Reservoir Jun - Sep Average (V) | Surface Area at Volume of Scofield | Surface Area of Scofield (A) | Mean Lake Depth of Scofield (z) | Reservoir Outflow of Scofield | Reservoir Outflow of Scofield ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus In Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table B-3)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | $m^3$ | Acres | $m^2$ | m | AF | $m^3/yr$ | yr | kg/yr | $g/m^2/yr$ | | mg/L | | | |
| 1978 | 53,241 | 65,671,688 | 2,530 | 10,240,284 | 6.4131 | 35,827 | 44,192,210 | 1.4860 | 4,160,196 | 0.4063 | 1.3133 | 0.0319 | -0.7707 | 0.2796 | 0.7796 |
| 1979 | 58,459 | 72,108,232 | 2,606 | 10,546,854 | 6.8369 | 45,190 | 55,741,368 | 1.2936 | 4,103,569 | 0.3891 | 1.2329 | 0.0284 | -0.5773 | 0.2183 | 0.7183 |
| 1980 | 61,625 | 76,014,344 | 2,651 | 10,729,108 | 7.0849 | 71,195 | 87,818,352 | 0.8656 | 5,639,686 | 0.5256 | 1.4413 | 0.0286 | -0.5890 | 0.2222 | 0.7222 |
| 1981 | 42,591 | 52,535,532 | 2,355 | 9,530,608 | 5.5123 | 42,659 | 52,619,407 | 0.9984 | 1,670,914 | 0.1753 | 0.8752 | 0.0169 | 0.2735 | 0.1077 | 0.3923 |
| 1982 | 62,436 | 77,014,326 | 2,662 | 10,771,813 | 7.1496 | 73,962 | 91,231,704 | 0.8442 | 14,122,801 | 1.3111 | 2.4561 | 0.0504 | -1.5252 | 0.4364 | 0.9364 |
| 1983 | 63,257 | 78,026,300 | 2,672 | 10,813,018 | 7.2160 | 148,143 | 182,732,293 | 0.4270 | 8,296,241 | 0.7672 | 1.7816 | 0.0258 | -0.4195 | 0.1626 | 0.6626 |
| 1984 | 64,040 | 78,992,354 | 2,683 | 10,855,898 | 7.2764 | 152,686 | 188,336,828 | 0.4194 | 10,906,614 | 1.0047 | 2.0780 | 0.0309 | -0.7206 | 0.2645 | 0.7645 |
| 1985 | 56,155 | 69,266,709 | 2,573 | 10,411,750 | 6.6527 | 92,353 | 113,916,223 | 0.6080 | 7,355,074 | 0.7064 | 1.7802 | 0.0310 | -0.7239 | 0.2655 | 0.7655 |
| 1986 | 60,699 | 74,871,744 | 2,638 | 10,675,734 | 7.0133 | 108,623 | 133,984,988 | 0.5588 | 7,875,349 | 0.7377 | 1.7703 | 0.0295 | -0.6444 | 0.2405 | 0.7405 |
| 1987 | 49,714 | 61,322,242 | 2,481 | 10,039,217 | 6.1083 | 37,075 | 45,731,605 | 1.3409 | 2,043,871 | 0.2036 | 0.8997 | 0.0203 | -0.0210 | 0.0086 | 0.5086 |
| 1988 | 42,050 | 51,868,298 | 2,339 | 9,464,806 | 5.4801 | 38,435 | 47,409,150 | 1.0941 | 2,903,804 | 0.3068 | 1.2211 | 0.0262 | -0.4472 | 0.1727 | 0.6727 |
| 1989 | 23,196 | 28,612,273 | 1,824 | 7,380,780 | 3.8766 | 40,203 | 49,589,958 | 0.5770 | 1,753,174 | 0.2375 | 1.2877 | 0.0203 | -0.0232 | 0.0095 | 0.5095 |
| 1990 | 16,533 | 20,392,855 | 1,552 | 6,282,745 | 3.2459 | 30,041 | 37,055,243 | 0.5503 | 1,733,187 | 0.2759 | 1.5614 | 0.0252 | -0.3788 | 0.1476 | 0.6476 |
| 1991 | 22,262 | 27,460,012 | 1,781 | 7,206,771 | 3.8103 | 34,843 | 42,978,457 | 0.6389 | 3,522,747 | 0.4888 | 1.9900 | 0.0361 | -0.9745 | 0.3351 | 0.8351 |
| 1992 | 8,066 | 9,948,765 | 1,106 | 4,476,220 | 2.2226 | 19,815 | 24,441,044 | 0.4071 | 1,037,946 | 0.2319 | 1.7618 | 0.0247 | -0.2506 | 0.1370 | 0.6370 |
| 1993 | 49,108 | 60,574,047 | 2,467 | 9,984,989 | 6.0665 | 31,531 | 38,893,661 | 1.5574 | 5,181,866 | 0.5190 | 1.5674 | 0.0387 | -1.0908 | 0.3622 | 0.8622 |
| 1994 | 26,076 | 32,164,224 | 1,911 | 7,733,967 | 4.1588 | 44,217 | 54,540,601 | 0.5897 | 2,012,720 | 0.2602 | 1.3038 | 0.0209 | -0.0697 | 0.0278 | 0.5278 |
| 1995 | 57,259 | 70,628,702 | 2,590 | 10,479,974 | 6.7394 | 52,788 | 65,113,259 | 1.0847 | 4,732,124 | 0.4515 | 1.3573 | 0.0294 | -0.6360 | 0.2377 | 0.7377 |
| 1996 | 59,249 | 73,082,643 | 2,618 | 10,596,338 | 6.8970 | 51,003 | 62,911,547 | 1.1617 | 4,229,869 | 0.3992 | 1.2452 | 0.0235 | -0.5248 | 0.2002 | 0.7002 |
| 1997 | 61,439 | 75,784,131 | 2,648 | 10,717,928 | 7.0708 | 77,474 | 95,563,869 | 0.7930 | 6,345,169 | 0.5920 | 1.5477 | 0.0298 | -0.6590 | 0.2452 | 0.7452 |
| 1998 | 60,768 | 74,956,433 | 2,639 | 10,680,375 | 7.0181 | 64,886 | 80,036,229 | 0.9365 | 4,630,803 | 0.4336 | 1.2940 | 0.0262 | -0.4433 | 0.1713 | 0.6713 |
| 1999 | 60,060 | 74,083,582 | 2,629 | 10,641,031 | 6.9621 | 47,941 | 59,135,096 | 1.2528 | 4,080,204 | 0.3834 | 1.2093 | 0.0274 | -0.5219 | 0.1992 | 0.6992 |
| 2000 | 39,648 | 48,905,604 | 2,296 | 9,291,865 | 5.2633 | 45,426 | 56,032,108 | 0.8728 | 2,250,104 | 0.2422 | 1.0878 | 0.0206 | -0.0488 | 0.0195 | 0.5195 |
| 2001 | 36,458 | 44,970,755 | 2,228 | 9,016,956 | 4.9874 | 35,437 | 43,710,992 | 1.0288 | 2,629,306 | 0.2916 | 1.2527 | 0.0263 | -0.4510 | 0.1741 | 0.6741 |
| 2002 | 26,285 | 32,421,676 | 1,963 | 7,942,298 | 4.0822 | 31,210 | 38,497,045 | 0.8422 | 2,131,358 | 0.2684 | 1.3422 | 0.0260 | -0.4325 | 0.1673 | 0.6673 |
| 2003 | 35,648 | 43,971,758 | 2,201 | 8,909,004 | 4.9357 | 36,594 | 45,138,570 | 0.9742 | 2,167,523 | 0.2433 | 1.1329 | 0.0228 | -0.2184 | 0.0863 | 0.5863 |
| 2004 | 24,758 | 30,538,544 | 1,888 | 7,641,494 | 3.9964 | 34,158 | 42,133,065 | 0.7248 | 2,059,837 | 0.2696 | 1.3627 | 0.0246 | -0.3416 | 0.1336 | 0.6336 |
| 2005 | 63,365 | 78,160,427 | 2,674 | 10,820,592 | 7.2233 | 27,549 | 33,981,891 | 2.3001 | 4,579,309 | 0.4232 | 1.2542 | 0.0347 | -0.9094 | 0.3184 | 0.8184 |
| | | | | | | | | | | | | | | | |
| Average | 45,873 | 56,583,864 | 2,329 | 9,424,372 | 5.7607 | 55,402 | 68,338,095 | 0.9367 | 4,434,120 | 0.4480 | 1.4431 | 0.0279 | -0.5086 | 0 | 0.6834 |

* Table B-3 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Date: September 25, 2006

Table C-1

**Flow and Phosphorus Routing WITH Proposed Narrows Project**

# Narrows Reservoir Operation

| Year Month | (Frenzen-Noble) Natural Flow-Cottonwood Creek Near Fairview: Flow Acre-Feet | Concentration mg/l | Weight grams | (Frenzen-Noble) Other Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Total Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | Narrows Reservoir – Diversion by Cottonwood-Gooseberry: Flow Acre-Feet | Concentration mg/l | Weight grams | Reservoir Evaporation Acre-Feet | Project Irrigation Delivery: Acre-Feet | mg/l | grams | (CALC.) Phosphorus Uptake grams | End of Month: Contents Total Acre-Feet | Phosphorus mg/l Table D-1 | Phosphorus grams | (Frenzen-Noble) Stream Flow below Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | 4377 | 0.0121 | 63,300 | | | | | | |
| Oct | 96 | 0.0209 | 2,475 | 8 | 0.0209 | 200 | 104 | 0.0209 | 2,679 | 17 | 0.0121 | 254 | 12 | 123 | 0.0121 | 1,838 | 1,606 | 3,956 | 0.0121 | 58,812 | 272 | 0.0121 | 4,056 | 63 | 0.0209 | 1,630 |
| Nov | 104 | 0.0198 | 2,540 | 8 | 0.0198 | 206 | 112 | 0.0198 | 2,746 | 18 | 0.0121 | 269 | 9 | 119 | 0.0121 | 1,778 | 1,197 | 3,843 | 0.0121 | 57,425 | 59 | 0.0121 | 888 | 68 | 0.0198 | 1,630 |
| Dec | 87 | 0.0187 | 2,007 | 7 | 0.0187 | 163 | 94 | 0.0187 | 2,169 | 16 | 0.0121 | 240 | 0 | 123 | 0.0121 | 1,838 | 764 | 3,733 | 0.0121 | 55,807 | 61 | 0.0121 | 917 | 88 | 0.0187 | 2,028 |
| 1978 Jan | 84 | 0.0176 | 1,824 | 7 | 0.0176 | 148 | 91 | 0.0176 | 1,971 | 17 | 0.0121 | 256 | 0 | 123 | 0.0121 | 1,838 | 613 | 3,634 | 0.0121 | 54,355 | 61 | 0.0121 | 917 | 82 | 0.0176 | 1,781 |
| Feb | 83 | 0.0165 | 1,689 | 7 | 0.0165 | 137 | 90 | 0.0165 | 1,826 | 16 | 0.0121 | 239 | 0 | 111 | 0.0121 | 1,659 | 485 | 3,535 | 0.0121 | 52,769 | 55 | 0.0121 | 828 | 73 | 0.0165 | 1,491 |
| Mar | 103 | 0.0154 | 1,957 | 8 | 0.0154 | 158 | 111 | 0.0154 | 2,115 | 21 | 0.0121 | 314 | 5 | 123 | 0.0121 | 1,838 | 451 | 3,438 | 0.0121 | 51,264 | 61 | 0.0121 | 917 | 101 | 0.0154 | 1,915 |
| Apr | 582 | 0.0143 | 10,266 | 47 | 0.0143 | 832 | 629 | 0.0143 | 11,097 | 114 | 0.0121 | 1,703 | 0 | 0 | 0.0121 | 0 | 1,697 | 3,893 | 0.0121 | 58,178 | 59 | 0.0121 | 888 | 515 | 0.0143 | 9,082 |
| May | 4,143 | 0.0131 | 66,946 | 336 | 0.0131 | 5,423 | 4,479 | 0.0131 | 72,368 | 715 | 0.0121 | 10,683 | 66 | 0 | 0.0121 | 0 | 4,419 | 7,329 | 0.0121 | 108,019 | 361 | 0.0121 | 5,400 | 2,718 | 0.0131 | 43,894 |
| Jun | 5,070 | 0.0141 | 88,178 | 411 | 0.0141 | 7,142 | 5,481 | 0.0141 | 95,321 | 799 | 0.0121 | 11,939 | 137 | 537 | 0.0121 | 8,021 | 15,475 | 11,178 | 0.0121 | 167,018 | 59 | 0.0121 | 888 | 2,159 | 0.0141 | 44,495 |
| Jul | 649 | 0.0110 | 8,806 | 53 | 0.0110 | 713 | 702 | 0.0110 | 9,519 | 101 | 0.0121 | 1,509 | 102 | 1,892 | 0.0121 | 28,270 | 2,052 | 9,023 | 0.0121 | 143,790 | 61 | 0.0121 | 917 | 313 | 0.0110 | 4,233 |
| Aug | 378 | 0.0176 | 8,206 | 31 | 0.0176 | 665 | 409 | 0.0176 | 8,871 | 60 | 0.0121 | 897 | 138 | 1,913 | 0.0121 | 28,581 | 5,119 | 7,840 | 0.0121 | 117,147 | 61 | 0.0121 | 917 | 197 | 0.0176 | 4,283 |
| Sep | 171 | 0.0240 | 5,062 | 14 | 0.0240 | 410 | 185 | 0.0240 | 5,472 | 28 | 0.0121 | 418 | 102 | 336 | 0.0121 | 5,022 | 4,252 | 7,500 | 0.0121 | 112,060 | 59 | 0.0121 | 888 | 95 | 0.0240 | 2,795 |
| WY Total/Average | 11,550 | 0.0140 | 199,955 | 936 | 0.0140 | 16,196 | 12,486 | 0.0140 | 216,151 | 1,924 | 0.0121 | 28,748 | 705 | 5,400 | 0.0121 | 80,682 | 40,132 | 5,781 | 0.0121 | 86,378 | 1,235 | 0.0121 | 18,430 | 6,872 | 0.0143 | 119,397 |
| Oct | 34 | 0.0209 | 877 | 3 | 0.0209 | 71 | 37 | 0.0209 | 948 | 6 | 0.0094 | 70 | 12 | 219 | 0.0094 | 2,510 | 25,596 | 7,169 | 0.0094 | 83,494 | 51 | 0.0094 | 712 | 9 | 0.0209 | 236 |
| Nov | 153 | 0.0198 | 3,737 | 12 | 0.0198 | 303 | 165 | 0.0198 | 4,039 | 42 | 0.0094 | 487 | 13 | 119 | 0.0094 | 1,380 | 2,293 | 7,129 | 0.0094 | 82,684 | 59 | 0.0094 | 689 | 138 | 0.0198 | 3,363 |
| Dec | 97 | 0.0187 | 2,237 | 8 | 0.0187 | 181 | 105 | 0.0187 | 2,419 | 28 | 0.0094 | 325 | 0 | 123 | 0.0094 | 1,427 | 1,292 | 7,021 | 0.0094 | 81,437 | 61 | 0.0094 | 712 | 96 | 0.0187 | 2,215 |
| 1979 Jan | 93 | 0.0176 | 2,019 | 8 | 0.0176 | 164 | 101 | 0.0176 | 2,183 | 28 | 0.0094 | 329 | 0 | 123 | 0.0094 | 1,427 | 1,016 | 6,902 | 0.0094 | 80,140 | 61 | 0.0094 | 712 | 99 | 0.0176 | 2,159 |
| Feb | 88 | 0.0165 | 1,791 | 7 | 0.0165 | 145 | 95 | 0.0165 | 1,936 | 25 | 0.0094 | 290 | 0 | 111 | 0.0094 | 1,287 | 833 | 6,813 | 0.0094 | 79,023 | 55 | 0.0094 | 643 | 86 | 0.0165 | 1,748 |
| Mar | 99 | 0.0154 | 1,881 | 8 | 0.0154 | 152 | 107 | 0.0154 | 2,033 | 28 | 0.0094 | 325 | 0 | 123 | 0.0094 | 1,427 | 792 | 6,709 | 0.0094 | 77,801 | 61 | 0.0094 | 712 | 93 | 0.0154 | 1,760 |
| Apr | 294 | 0.0143 | 5,186 | 24 | 0.0143 | 420 | 318 | 0.0143 | 5,606 | 76 | 0.0094 | 882 | 0 | 0 | 0.0094 | 0 | 1,920 | 6,890 | 0.0094 | 79,916 | 59 | 0.0094 | 689 | 234 | 0.0143 | 4,133 |
| May | 4,186 | 0.0131 | 67,640 | 339 | 0.0131 | 5,479 | 4,525 | 0.0131 | 73,119 | 1,006 | 0.0094 | 11,669 | 100 | 0 | 0.0094 | 0 | 21,893 | 9,939 | 0.0094 | 115,283 | 361 | 0.0094 | 4,192 | 2,761 | 0.0131 | 44,613 |
| Jun | 2,250 | 0.0141 | 39,237 | 183 | 0.0141 | 3,178 | 2,439 | 0.0141 | 42,415 | 489 | 0.0094 | 5,677 | 177 | 523 | 0.0094 | 6,066 | 16,180 | 11,179 | 0.0094 | 129,660 | 59 | 0.0094 | 689 | 1,100 | 0.0141 | 19,136 |
| Jul | 471 | 0.0110 | 6,391 | 38 | 0.0110 | 518 | 509 | 0.0110 | 6,908 | 99 | 0.0094 | 1,157 | 201 | 1,825 | 0.0094 | 21,172 | 3,736 | 9,453 | 0.0094 | 109,643 | 61 | 0.0094 | 712 | 198 | 0.0110 | 2,684 |
| Aug | 247 | 0.0176 | 5,362 | 20 | 0.0176 | 434 | 267 | 0.0176 | 5,797 | 52 | 0.0094 | 603 | 183 | 1,883 | 0.0094 | 21,844 | 4,301 | 7,568 | 0.0094 | 87,776 | 61 | 0.0094 | 712 | 112 | 0.0176 | 2,433 |
| Sep | 177 | 0.0240 | 4,056 | 11 | 0.0240 | 325 | 148 | 0.0240 | 4,384 | 32 | 0.0094 | 371 | 99 | 351 | 0.0094 | 4,069 | 3,814 | 7,175 | 0.0094 | 83,210 | 59 | 0.0094 | 689 | 84 | 0.0240 | 2,454 |
| WY Total/Average | 8,233 | 0.0140 | 142,415 | 683 | 0.0140 | 11,571 | 8,916 | 0.0140 | 151,786 | 1,910 | 0.0094 | 22,154 | 808 | 5,400 | 0.0094 | 62,637 | 83,979 | 7,820 | 0.0094 | 90,702 | 1,022 | 0.0094 | 11,862 | 5,010 | 0.0141 | 86,970 |
| Oct | 139 | 0.0209 | 3,583 | 11 | 0.0209 | 290 | 150 | 0.0209 | 3,874 | 22 | 0.0121 | 328 | 50 | 123 | 0.0121 | 1,832 | -21,231 | 7,066 | 0.0121 | 105,251 | 61 | 0.0121 | 914 | 161 | 0.0209 | 3,597 |
| Nov | 120 | 0.0198 | 2,931 | 10 | 0.0198 | 237 | 130 | 0.0198 | 3,168 | 19 | 0.0121 | 282 | 15 | 119 | 0.0121 | 1,772 | 1,454 | 6,986 | 0.0121 | 104,035 | 59 | 0.0121 | 886 | 90 | 0.0198 | 2,201 |
| Dec | 116 | 0.0187 | 2,676 | 9 | 0.0187 | 217 | 125 | 0.0187 | 2,892 | 21 | 0.0121 | 313 | 0 | 123 | 0.0121 | 1,832 | 1,025 | 6,906 | 0.0121 | 102,874 | 61 | 0.0121 | 914 | 111 | 0.0187 | 2,553 |
| 1980 Jan | 104 | 0.0176 | 2,258 | 8 | 0.0176 | 183 | 112 | 0.0176 | 2,441 | 21 | 0.0121 | 313 | 0 | 123 | 0.0121 | 1,832 | 787 | 6,813 | 0.0121 | 101,450 | 61 | 0.0121 | 914 | 134 | 0.0176 | 2,883 |
| Feb | 99 | 0.0165 | 2,015 | 8 | 0.0165 | 163 | 107 | 0.0165 | 2,178 | 19 | 0.0121 | 283 | 0 | 111 | 0.0121 | 1,653 | 565 | 6,730 | 0.0121 | 100,232 | 55 | 0.0121 | 826 | 113 | 0.0165 | 2,299 |
| Mar | 112 | 0.0154 | 2,128 | 9 | 0.0154 | 172 | 121 | 0.0154 | 2,300 | 21 | 0.0121 | 313 | 0 | 123 | 0.0121 | 1,832 | 497 | 6,650 | 0.0121 | 99,027 | 61 | 0.0121 | 914 | 113 | 0.0154 | 2,187 |
| Apr | 530 | 0.0143 | 9,349 | 43 | 0.0143 | 757 | 573 | 0.0143 | 10,106 | 91 | 0.0121 | 1,355 | 9 | 0 | 0.0121 | 0 | 1,575 | 7,071 | 0.0121 | 105,319 | 59 | 0.0121 | 884 | 464 | 0.0143 | 8,180 |
| May | 4,179 | 0.0131 | 67,527 | 339 | 0.0131 | 5,470 | 4,517 | 0.0131 | 72,997 | 640 | 0.0121 | 9,530 | 111 | 0 | 0.0121 | 0 | 7,782 | 10,478 | 0.0121 | 156,022 | 361 | 0.0121 | 5,381 | 2,753 | 0.0131 | 44,477 |
| Jun | 5,391 | 0.0141 | 93,761 | 437 | 0.0141 | 7,595 | 5,828 | 0.0141 | 101,356 | 753 | 0.0121 | 11,213 | 194 | 364 | 0.0121 | 5,419 | 17,322 | 14,965 | 0.0121 | 222,540 | 59 | 0.0121 | 884 | 2,725 | 0.0141 | 47,399 |
| Jul | 727 | 0.0110 | 9,864 | 59 | 0.0110 | 799 | 786 | 0.0110 | 10,663 | 101 | 0.0121 | 1,504 | 247 | 1,827 | 0.0121 | 27,203 | 2,636 | 13,495 | 0.0121 | 200,944 | 61 | 0.0121 | 914 | 365 | 0.0110 | 4,956 |
| Aug | 302 | 0.0176 | 6,556 | 24 | 0.0176 | 531 | 326 | 0.0176 | 7,087 | 42 | 0.0121 | 625 | 202 | 1,799 | 0.0121 | 26,792 | 5,239 | 11,717 | 0.0121 | 174,466 | 61 | 0.0121 | 914 | 148 | 0.0176 | 3,209 |
| Sep | 235 | 0.0240 | 6,957 | 19 | 0.0240 | 564 | 254 | 0.0240 | 7,520 | 33 | 0.0121 | 497 | 139 | 688 | 0.0121 | 10,242 | 5,811 | 11,051 | 0.0121 | 164,557 | 59 | 0.0121 | 884 | 475 | 0.0240 | 3,600 |
| WY Total/Average | 12,054 | 0.0141 | 209,605 | 976 | 0.0141 | 16,979 | 13,030 | 0.0141 | 226,583 | 1,780 | 0.0121 | 26,520 | 968 | 5,400 | 0.0121 | 80,410 | 23,057 | 9,180 | 0.0121 | 136,395 | 1,033 | 0.0121 | 15,225 | 7,233 | 0.0142 | 125,437 |
| Oct | 196 | 0.0209 | 5,053 | 16 | 0.0209 | 409 | 212 | 0.0209 | 5,462 | 53 | 0.0076 | 518 | 71 | 123 | 0.0076 | 1,158 | 84,617 | 10,953 | 0.0076 | 103,148 | 61 | 0.0076 | 578 | 132 | 0.0209 | 3,922 |
| Nov | 165 | 0.0198 | 4,030 | 13 | 0.0198 | 326 | 178 | 0.0198 | 4,356 | 50 | 0.0076 | 471 | 21 | 119 | 0.0076 | 1,121 | 2,873 | 10,882 | 0.0076 | 102,482 | 59 | 0.0076 | 559 | 154 | 0.0198 | 3,753 |
| Dec | 138 | 0.0187 | 3,183 | 11 | 0.0187 | 258 | 149 | 0.0187 | 3,441 | 42 | 0.0076 | 396 | 0 | 123 | 0.0076 | 1,158 | 2,036 | 10,800 | 0.0076 | 101,755 | 61 | 0.0076 | 578 | 130 | 0.0187 | 2,993 |
| 1981 Jan | 113 | 0.0176 | 2,453 | 9 | 0.0176 | 199 | 122 | 0.0176 | 2,652 | 40 | 0.0076 | 377 | 0 | 123 | 0.0076 | 1,158 | 1,501 | 10,702 | 0.0076 | 100,792 | 61 | 0.0076 | 578 | 144 | 0.0176 | 3,123 |
| Feb | 106 | 0.0165 | 2,157 | 9 | 0.0165 | 175 | 115 | 0.0165 | 2,332 | 36 | 0.0076 | 339 | 0 | 111 | 0.0076 | 1,045 | 1,253 | 10,615 | 0.0076 | 99,968 | 55 | 0.0076 | 522 | 126 | 0.0165 | 2,572 |
| Mar | 162 | 0.0154 | 3,077 | 13 | 0.0154 | 249 | 175 | 0.0154 | 3,327 | 56 | 0.0076 | 527 | 0 | 123 | 0.0076 | 1,158 | 1,677 | 10,549 | 0.0076 | 99,350 | 61 | 0.0076 | 578 | 108 | 0.0154 | 3,759 |
| Apr | 891 | 0.0143 | 15,716 | 72 | 0.0143 | 1,273 | 963 | 0.0143 | 16,989 | 268 | 0.0076 | 2,524 | 0 | 0 | 0.0076 | 0 | 7,919 | 11,183 | 0.0076 | 105,337 | 59 | 0.0076 | 559 | 813 | 0.0143 | 14,373 |
| May | 2,753 | 0.0131 | 44,485 | 223 | 0.0131 | 3,603 | 2,976 | 0.0131 | 48,088 | 649 | 0.0076 | 6,112 | 160 | 0 | 0.0076 | 0 | 21,567 | 12,991 | 0.0076 | 122,343 | 361 | 0.0076 | 3,403 | 1,323 | 0.0131 | 21,378 |
| Jun | 1,214 | 0.0100 | 14,975 | 98 | 0.0100 | 1,213 | 1,312 | 0.0100 | 16,187 | 283 | 0.0076 | 2,665 | 215 | 420 | 0.0076 | 3,941 | 5,858 | 13,125 | 0.0076 | 123,607 | 59 | 0.0076 | 559 | 564 | 0.0100 | 6,958 |
| Jul | 361 | 0.0110 | 4,898 | 29 | 0.0110 | 397 | 390 | 0.0110 | 5,295 | 78 | 0.0076 | 735 | 228 | 1,042 | 0.0076 | 18,291 | 3,752 | 11,207 | 0.0076 | 105,546 | 61 | 0.0076 | 578 | 125 | 0.0110 | 3,093 |
| Aug | 189 | 0.0176 | 4,103 | 15 | 0.0176 | 332 | 204 | 0.0176 | 4,435 | 42 | 0.0076 | 396 | 177 | 2,113 | 0.0076 | 19,898 | 4,177 | 9,019 | 0.0076 | 84,932 | 61 | 0.0076 | 578 | 75 | 0.0176 | 1,631 |
| Sep | 149 | 0.0240 | 4,411 | 12 | 0.0240 | 357 | 161 | 0.0240 | 4,768 | 18 | 0.0076 | 258 | 114 | 3 | 0.0076 | 24 | 4,325 | 8,396 | 0.0076 | 84,433 | 59 | 0.0075 | 559 | 90 | 0.0240 | 2,602 |
| WY Total/Average | 8,437 | 0.0137 | 156,542 | 671 | 0.0137 | 8,792 | 8,958 | 0.0137 | 117,333 | 1,657 | 0.0076 | 15,617 | 984 | 5,400 | 0.0076 | 50,833 | 121,558 | 10,917 | 0.0076 | 102,808 | 1,023 | 0.0076 | 9,631 | 3,892 | 0.0145 | 68,766 |

Date: September 25, 2006

Table C-1

## Flow and Phosphorus Routing WITH Proposed Narrows Project

# Narrows Reservoir Operation

| | (Franson-Noble) | | | | | | (CALC) | | | Narrows Reservoir | | | | | | | | | | | (Franson-Noble) | | | (CALC) Lands Gains Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Natural Flow-Gooseberry Creek Near Fairview | | | Other Inflows at Narrows Reservoir | | | Total Inflow at Narrows Reservoir | | | Diversion by Cottonwood-Gooseberry | | | Reservoir Evaporation | Project Irrigation Delivery | | | (CALC) Phosphorus Uptake | End of Month | | | Stream Flow below Narrows Reservoir | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| Year Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Acre-Feet | Flow Acre-Feet | mg/l | grams | grams | Content Total Acre-Feet | Phosphorus mg/l Table D-1 | Phosphorus grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | | | | | | | | | | | | | | | | | | [illegible] | 0.0121 | 63,900 | | | | | | |
| Oct | 209 | 0.0209 | 5,285 | 17 | 0.0209 | 428 | 222 | 0.0209 | 5,713 | 64 | 0.0113 | 611 | 60 | 123 | 0.0113 | 1,707 | 16,527 | 8,806 | 0.0113 | 123,499 | 61 | 0.0113 | 852 | 159 | 0.0209 | 4,109 |
| Nov | 147 | 0.0198 | 3,350 | 12 | 0.0198 | 293 | 159 | 0.0198 | 3,581 | 33 | 0.0113 | 458 | 18 | 119 | 0.0113 | 1,652 | 1,920 | 8,828 | 0.0113 | 122,529 | 59 | 0.0113 | 824 | 129 | 0.0198 | 3,153 |
| Dec | 101 | 0.0187 | 2,330 | 8 | 0.0187 | 185 | 109 | 0.0187 | 2,516 | 24 | 0.0113 | 333 | 0 | 123 | 0.0113 | 1,707 | 1,003 | 8,729 | 0.0113 | 121,149 | 61 | 0.0113 | 852 | 108 | 0.0187 | 2,502 |
| 1982 Jan | 80 | 0.0176 | 1,737 | 6 | 0.0176 | 141 | 86 | 0.0176 | 1,877 | 18 | 0.0113 | 250 | 0 | 123 | 0.0113 | 1,707 | 677 | 8,613 | 0.0113 | 119,540 | 61 | 0.0113 | 852 | 72 | 0.0176 | 1,563 |
| Feb | 76 | 0.0165 | 1,547 | 6 | 0.0165 | 125 | 82 | 0.0165 | 1,672 | 16 | 0.0113 | 222 | 0 | 111 | 0.0113 | 1,541 | 552 | 8,515 | 0.0113 | 118,148 | 55 | 0.0113 | 769 | 57 | 0.0165 | 1,157 |
| Mar | 102 | 0.0154 | 1,938 | 8 | 0.0154 | 157 | 110 | 0.0154 | 2,095 | 24 | 0.0113 | 333 | 0 | 123 | 0.0113 | 1,707 | 564 | 8,415 | 0.0113 | 116,787 | 61 | 0.0113 | 852 | 99 | 0.0154 | 1,876 |
| Apr | 664 | 0.0143 | 11,712 | 54 | 0.0143 | 949 | 718 | 0.0143 | 12,661 | 152 | 0.0113 | 2,119 | 0 | 0 | 0.0113 | 0 | 2,699 | 8,921 | 0.0113 | 123,814 | 59 | 0.0113 | 824 | 594 | 0.0143 | 10,481 |
| May | 5,440 | 0.0131 | 88,000 | 441 | 0.0131 | 7,128 | 5,887 | 0.0131 | 95,128 | 1,150 | 0.0113 | 15,960 | 134 | 0 | 0.0113 | 0 | 15,286 | 13,163 | 0.0113 | 192,681 | 361 | 0.0113 | 5,015 | 4,023 | 0.0131 | 65,004 |
| Jun | 3,227 | 0.0141 | 56,125 | 264 | 0.0141 | 4,546 | 3,488 | 0.0141 | 60,671 | 591 | 0.0113 | 8,202 | 217 | 604 | 0.0113 | 8,385 | 15,274 | 15,179 | 0.0113 | 210,665 | 59 | 0.0113 | 824 | 1,603 | 0.0141 | 27,873 |
| Jul | 788 | 0.0110 | 10,692 | 64 | 0.0110 | 866 | 852 | 0.0110 | 11,558 | 146 | 0.0113 | 2,026 | 249 | 1,749 | 0.0113 | 24,274 | 3,193 | 13,825 | 0.0113 | 191,875 | 61 | 0.0113 | 852 | 404 | 0.0110 | 5,486 |
| Aug | 360 | 0.0176 | 7,815 | 29 | 0.0176 | 633 | 389 | 0.0176 | 8,448 | 67 | 0.0113 | 930 | 205 | 1,837 | 0.0113 | 25,501 | 3,590 | 12,043 | 0.0113 | 167,145 | 61 | 0.0113 | 852 | 186 | 0.0176 | 4,034 |
| Sep | 357 | 0.0240 | 10,569 | 29 | 0.0240 | 856 | 386 | 0.0240 | 11,425 | 65 | 0.0113 | 902 | 142 | 488 | 0.0113 | 6,769 | 8,040 | 11,675 | 0.0113 | 162,034 | 59 | 0.0113 | 824 | 177 | 0.0240 | 5,242 |
| WY Total/Average | 11,553 | 0.0141 | 201,339 | 936 | 0.0141 | 16,308 | 12,489 | 0.0141 | 217,647 | 2,330 | 0.0113 | 32,337 | 1,026 | 5,400 | 0.0113 | 74,950 | 18,560 | 10,567 | 0.0113 | 146,655 | 1,023 | 0.0113 | 14,194 | 7,802 | 0.0141 | 132,269 |
| Oct | 453 | 0.0209 | 11,678 | 37 | 0.0209 | 946 | 490 | 0.0209 | 12,624 | 37 | 0.0113 | 517 | 74 | 123 | 0.0113 | 1,718 | 3,703 | 11,870 | 0.0113 | 165,802 | 61 | 0.0113 | 857 | 377 | 0.0209 | 9,727 |
| Nov | 322 | 0.0198 | 7,854 | 26 | 0.0198 | 637 | 348 | 0.0198 | 8,501 | 33 | 0.0113 | 433 | 22 | 119 | 0.0113 | 1,662 | 2,340 | 11,986 | 0.0113 | 167,433 | 59 | 0.0113 | 830 | 374 | 0.0198 | 9,132 |
| Dec | 268 | 0.0187 | 6,182 | 22 | 0.0187 | 501 | 290 | 0.0187 | 6,682 | 23 | 0.0113 | 307 | 0 | 123 | 0.0113 | 1,718 | 2,606 | 12,070 | 0.0113 | 168,597 | 61 | 0.0113 | 857 | 232 | 0.0187 | 5,358 |
| 1983 Jan | 167 | 0.0176 | 3,623 | 14 | 0.0176 | 296 | 181 | 0.0176 | 3,519 | 19 | 0.0113 | 269 | 0 | 123 | 0.0113 | 1,718 | 1,297 | 12,067 | 0.0113 | 168,277 | 61 | 0.0113 | 857 | 205 | 0.0176 | 5,160 |
| Feb | 149 | 0.0165 | 3,035 | 12 | 0.0165 | 240 | 161 | 0.0165 | 3,276 | 17 | 0.0113 | 237 | 0 | 111 | 0.0113 | 1,551 | 1,028 | 12,024 | 0.0113 | 167,965 | 55 | 0.0113 | 774 | 230 | 0.0165 | 4,680 |
| Mar | 213 | 0.0154 | 4,046 | 17 | 0.0154 | 328 | 230 | 0.0154 | 4,374 | 22 | 0.0113 | 307 | 0 | 123 | 0.0113 | 1,718 | 1,457 | 12,068 | 0.0113 | 168,298 | 61 | 0.0113 | 857 | 283 | 0.0154 | 5,377 |
| Apr | 350 | 0.0143 | 6,174 | 28 | 0.0143 | 500 | 378 | 0.0143 | 6,674 | 29 | 0.0113 | 409 | 0 | 0 | 0.0113 | 0 | 1,389 | 12,339 | 0.0113 | 172,349 | 59 | 0.0113 | 830 | 289 | 0.0143 | 5,091 |
| May | 2,903 | 0.0131 | 47,846 | 249 | 0.0131 | 3,876 | 3,231 | 0.0131 | 51,721 | 209 | 0.0113 | 2,856 | 172 | 0 | 0.0113 | 0 | 9,408 | 14,803 | 0.0113 | 206,779 | 361 | 0.0113 | 5,066 | 1,532 | 0.0131 | 24,758 |
| Jun | 9,328 | 0.0141 | 162,234 | 756 | 0.0141 | 13,141 | 10,084 | 0.0141 | 175,375 | 638 | 0.0113 | 8,912 | 235 | 779 | 0.0113 | 11,079 | 17,393 | 17,000 | 0.0113 | 237,468 | 6,034 | 0.0113 | 84,299 | 4,704 | 0.0141 | 82,664 |
| Jul | 1,841 | 0.0100 | 22,709 | 149 | 0.0100 | 1,839 | 1,990 | 0.0100 | 24,548 | 132 | 0.0113 | 1,849 | 267 | 1,708 | 0.0113 | 23,836 | 471 | 16,822 | 0.0113 | 234,984 | 61 | 0.0113 | 857 | 1,092 | 0.0100 | 13,468 |
| Aug | 548 | 0.0176 | 11,897 | 44 | 0.0176 | 964 | 592 | 0.0176 | 12,860 | 39 | 0.0113 | 545 | 232 | 1,189 | 0.0113 | 16,617 | 7,827 | 15,891 | 0.0113 | 221,996 | 61 | 0.0113 | 857 | 308 | 0.0176 | 6,678 |
| Sep | 389 | 0.0240 | 11,812 | 32 | 0.0240 | 957 | 421 | 0.0240 | 12,769 | 37 | 0.0113 | 517 | 171 | 801 | 0.0113 | 11,195 | 8,832 | 15,268 | 0.0113 | 213,254 | 59 | 0.0113 | 830 | 195 | 0.0240 | 5,767 |
| WY Total/Average | 16,929 | 0.0143 | 299,099 | 1,377 | 0.0143 | 24,227 | 18,326 | 0.0143 | 323,327 | 1,216 | 0.0113 | 16,990 | 1,172 | 5,400 | 0.0113 | 75,434 | 81,363 | 13,680 | 0.0113 | 191,098 | 6,898 | 0.0113 | 97,746 | 9,941 | 0.0146 | 178,654 |
| Oct | 361 | 0.0209 | 9,307 | 29 | 0.0209 | 754 | 390 | 0.0209 | 10,060 | 62 | 0.0092 | 703 | 89 | 123 | 0.0092 | 1,394 | 46,912 | 15,320 | 0.0092 | 173,594 | 61 | 0.0092 | 699 | 296 | 0.0209 | 7,625 |
| Nov | 262 | 0.0198 | 6,399 | 21 | 0.0198 | 518 | 283 | 0.0198 | 6,917 | 52 | 0.0092 | 589 | 26 | 119 | 0.0092 | 1,348 | 4,004 | 15,343 | 0.0092 | 173,894 | 59 | 0.0092 | 673 | 289 | 0.0198 | 7,053 |
| Dec | 313 | 0.0187 | 7,220 | 25 | 0.0187 | 583 | 338 | 0.0187 | 7,803 | 55 | 0.0092 | 623 | 8 | 123 | 0.0092 | 1,394 | 3,971 | 15,440 | 0.0092 | 173,013 | 61 | 0.0092 | 695 | 269 | 0.0187 | 6,197 |
| 1984 Jan | 192 | 0.0176 | 4,168 | 16 | 0.0176 | 338 | 208 | 0.0176 | 4,506 | 48 | 0.0092 | 544 | 0 | 123 | 0.0092 | 1,394 | 2,154 | 15,421 | 0.0092 | 174,734 | 61 | 0.0092 | 695 | 321 | 0.0176 | 6,978 |
| Feb | 171 | 0.0165 | 3,480 | 14 | 0.0165 | 282 | 185 | 0.0165 | 3,762 | 42 | 0.0092 | 476 | 0 | 111 | 0.0092 | 1,258 | 1,568 | 15,398 | 0.0092 | 174,467 | 55 | 0.0092 | 628 | 281 | 0.0165 | 5,723 |
| Mar | 197 | 0.0154 | 3,742 | 16 | 0.0154 | 303 | 213 | 0.0154 | 4,045 | 42 | 0.0092 | 476 | 0 | 123 | 0.0092 | 1,394 | 1,632 | 15,384 | 0.0092 | 174,314 | 61 | 0.0092 | 695 | 256 | 0.0154 | 4,864 |
| Apr | 380 | 0.0143 | 6,703 | 31 | 0.0143 | 543 | 411 | 0.0143 | 7,246 | 66 | 0.0092 | 748 | 0 | 0 | 0.0092 | 0 | 3,591 | 15,670 | 0.0092 | 177,548 | 59 | 0.0092 | 673 | 318 | 0.0143 | 5,612 |
| May | 7,142 | 0.0131 | 115,405 | 579 | 0.0131 | 9,348 | 7,721 | 0.0131 | 124,753 | 1,215 | 0.0092 | 13,707 | 201 | 0 | 0.0092 | 0 | 39,355 | 17,000 | 0.0092 | 192,622 | 4,974 | 0.0092 | 56,358 | 5,724 | 0.0131 | 92,500 |
| Jun | 6,656 | 0.0141 | 115,762 | 539 | 0.0141 | 9,377 | 7,195 | 0.0141 | 125,139 | 956 | 0.0092 | 10,832 | 256 | 14 | 0.0092 | 157 | 46,510 | 17,000 | 0.0092 | 192,622 | 5,970 | 0.0092 | 67,640 | 3,181 | 0.0141 | 55,801 |
| Jul | 1,002 | 0.0110 | 13,590 | 81 | 0.0110 | 1,101 | 1,083 | 0.0110 | 14,697 | 147 | 0.0092 | 1,666 | 267 | 2,094 | 0.0092 | 23,984 | 5,447 | 15,606 | 0.0092 | 176,807 | 61 | 0.0092 | 695 | 544 | 0.0110 | 7,379 |
| Aug | 443 | 0.0176 | 9,617 | 36 | 0.0176 | 779 | 479 | 0.0176 | 10,396 | 65 | 0.0092 | 736 | 222 | 1,794 | 0.0092 | 20,328 | 7,434 | 13,944 | 0.0092 | 157,959 | 61 | 0.0092 | 695 | 240 | 0.0176 | 5,213 |
| Sep | 304 | 0.0240 | 9,000 | 25 | 0.0240 | 729 | 329 | 0.0240 | 9,728 | 44 | 0.0092 | 498 | 157 | 866 | 0.0092 | 9,816 | 7,783 | 13,142 | 0.0092 | 148,913 | 59 | 0.0092 | 673 | 154 | 0.0240 | 4,570 |
| WY Total/Average | 17,423 | 0.0142 | 304,399 | 1,411 | 0.0142 | 24,656 | 18,834 | 0.0142 | 329,055 | 2,704 | 0.0092 | 31,558 | 1,216 | 5,400 | 0.0092 | 61,180 | 169,716 | 15,390 | 0.0092 | 174,374 | 11,945 | 0.0092 | 130,818 | 12,034 | 0.0143 | 212,517 |
| Oct | 333 | 0.0209 | 8,585 | 27 | 0.0209 | 695 | 360 | 0.0209 | 9,280 | 71 | 0.0093 | 817 | 80 | 123 | 0.0093 | 1,415 | 3,744 | 13,167 | 0.0093 | 151,310 | 61 | 0.0093 | 700 | 272 | 0.0208 | 7,015 |
| Nov | 209 | 0.0198 | 5,837 | 19 | 0.0198 | 473 | 228 | 0.0198 | 6,510 | 58 | 0.0093 | 667 | 24 | 119 | 0.0093 | 1,369 | 3,609 | 13,165 | 0.0093 | 151,491 | 59 | 0.0093 | 684 | 238 | 0.0198 | 6,292 |
| Dec | 268 | 0.0187 | 6,182 | 22 | 0.0187 | 501 | 290 | 0.0187 | 6,682 | 58 | 0.0093 | 667 | 0 | 123 | 0.0093 | 1,415 | 3,349 | 13,212 | 0.0093 | 152,076 | 61 | 0.0093 | 706 | 232 | 0.0187 | 5,358 |
| 1985 Jan | 182 | 0.0176 | 3,951 | 15 | 0.0176 | 320 | 197 | 0.0176 | 4,271 | 55 | 0.0093 | 633 | 0 | 123 | 0.0093 | 1,415 | 2,009 | 13,170 | 0.0093 | 151,545 | 61 | 0.0093 | 706 | 298 | 0.0176 | 6,475 |
| Feb | 146 | 0.0165 | 2,971 | 12 | 0.0165 | 241 | 158 | 0.0165 | 3,212 | 43 | 0.0093 | 495 | 0 | 111 | 0.0093 | 1,277 | 1,396 | 13,118 | 0.0093 | 150,954 | 55 | 0.0093 | 638 | 223 | 0.0165 | 4,542 |
| Mar | 176 | 0.0154 | 3,343 | 14 | 0.0154 | 271 | 190 | 0.0154 | 3,614 | 46 | 0.0093 | 529 | 0 | 123 | 0.0093 | 1,415 | 1,425 | 13,078 | 0.0093 | 150,489 | 61 | 0.0093 | 706 | 222 | 0.0154 | 4,212 |
| Apr | 1,675 | 0.0143 | 29,545 | 136 | 0.0143 | 2,393 | 1,811 | 0.0143 | 31,938 | 379 | 0.0093 | 4,361 | 0 | 0 | 0.0093 | 0 | 11,603 | 14,450 | 0.0093 | 166,280 | 59 | 0.0093 | 684 | 1,578 | 0.0143 | 27,840 |
| May | 6,282 | 0.0131 | 101,509 | 509 | 0.0131 | 8,222 | 6,791 | 0.0131 | 109,731 | 1,303 | 0.0093 | 14,994 | 191 | 0 | 0.0093 | 0 | 33,789 | 17,000 | 0.0093 | 195,620 | 2,747 | 0.0093 | 31,609 | 4,062 | 0.0131 | 78,566 |
| Jun | 1,733 | 0.0141 | 30,141 | 140 | 0.0141 | 2,441 | 1,873 | 0.0141 | 32,582 | 303 | 0.0093 | 3,475 | 236 | 14 | 0.0093 | 159 | 13,067 | 17,000 | 0.0093 | 195,620 | 1,902 | 0.0093 | 14,969 | 829 | 0.0141 | 14,412 |
| Jul | 655 | 0.0110 | 8,914 | 53 | 0.0110 | 722 | 710 | 0.0110 | 9,636 | 115 | 0.0093 | 1,323 | 267 | 1,468 | 0.0093 | 16,891 | 4,534 | 15,799 | 0.0093 | 181,802 | 61 | 0.0093 | 706 | 319 | 0.0110 | 4,323 |
| Aug | 311 | 0.0176 | 6,752 | 25 | 0.0176 | 547 | 336 | 0.0176 | 7,299 | 55 | 0.0093 | 633 | 224 | 1,815 | 0.0093 | 20,884 | 6,003 | 13,983 | 0.0093 | 160,875 | 61 | 0.0093 | 706 | 153 | 0.0176 | 3,317 |
| Sep | 218 | 0.0240 | 6,454 | 18 | 0.0240 | 523 | 236 | 0.0240 | 6,976 | 40 | 0.0093 | 460 | 158 | 1,332 | 0.0093 | 15,990 | 6,070 | 12,578 | 0.0093 | 144,738 | 59 | 0.0093 | 684 | 118 | 0.0240 | 3,503 |
| WY Total/Average | 13,320 | 0.0142 | 218,184 | 990 | 0.0142 | 17,349 | 13,210 | 0.0142 | 231,333 | 2,525 | 0.0093 | 29,053 | 1,199 | 5,400 | 0.0093 | 62,142 | 91,003 | 14,143 | 0.0093 | 162,746 | 4,631 | 0.0093 | 53,316 | 9,364 | 0.0144 | 165,857 |

Date: September 25, 2006

## Table C-1

## Flow and Phosphorus Routing WITH Proposed Narrows Project

# Narrows Reservoir Operation

| | | (Franson-Noble) | | | | | | (CALC) | | | Narrows Reservoir | | | | | | | | | | | (Franson-Noble) | | | (CALC) Reach Gain Between | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Flow-Gooseberry Creek Near Fairview | | | Other Inflow at Narrows Reservoir | | | Total Inflow to Narrows Reservoir | | | Diversion by Cottonwood-Gooseberry | | | Reservoir Evaporation | Project Irrigation Delivery | | | (CALC) Phosphorus Uptake | End of Month | | | Stream Flow below Narrows Reservoir | | | Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
| | | | | | | | | | | | | | | | | | | | Contents | Phosphorus | | | | | | | |
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Acre-Feet | Acre-Feet | mg/l | grams | grams | Total Acre-Feet | mg/l Table D-1 | grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | | | | | | | | | | | | | | | | | | | 4277 | 0.0121 | 63,300 | | | | | | |
| | Oct | 231 | 0.0209 | 3,955 | 19 | 0.0209 | 482 | 250 | 0.0209 | 6,438 | 46 | 0.0098 | 553 | 78 | 121 | 0.0098 | 1,485 | -2,711 | 12,519 | 0.0098 | 151,098 | 61 | 0.0098 | 741 | 182 | 0.0209 | 4,699 |
| | Nov | 202 | 0.0198 | 4,933 | 16 | 0.0198 | 400 | 218 | 0.0198 | 5,333 | 45 | 0.0098 | 543 | 23 | 119 | 0.0098 | 1,456 | 2,973 | 12,491 | 0.0098 | 150,761 | 59 | 0.0098 | 717 | 207 | 0.0198 | 5,047 |
| | Dec | 196 | 0.0187 | 4,321 | 16 | 0.0187 | 366 | 212 | 0.0187 | 4,887 | 41 | 0.0098 | 495 | 0 | 123 | 0.0098 | 1,485 | 2,330 | 12,478 | 0.0098 | 150,598 | 61 | 0.0098 | 741 | 176 | 0.0187 | 4,063 |
| 1986 | Jan | 150 | 0.0176 | 3,256 | 12 | 0.0176 | 264 | 162 | 0.0176 | 3,520 | 41 | 0.0098 | 495 | 0 | 123 | 0.0098 | 1,485 | 1,563 | 12,416 | 0.0098 | 149,833 | 61 | 0.0098 | 741 | 227 | 0.0176 | 4,925 |
| | Feb | 151 | 0.0165 | 3,073 | 12 | 0.0165 | 249 | 163 | 0.0165 | 3,322 | 42 | 0.0098 | 507 | 0 | 111 | 0.0098 | 1,340 | 1,352 | 12,369 | 0.0098 | 149,290 | 55 | 0.0098 | 669 | 236 | 0.0165 | 4,799 |
| | Mar | 243 | 0.0154 | 4,616 | 20 | 0.0154 | 374 | 263 | 0.0154 | 4,990 | 63 | 0.0098 | 760 | 0 | 123 | 0.0098 | 1,485 | 1,819 | 12,384 | 0.0098 | 149,474 | 61 | 0.0098 | 741 | 333 | 0.0154 | 6,332 |
| | Apr | 1,050 | 0.0143 | 18,521 | 83 | 0.0143 | 1,500 | 1,133 | 0.0143 | 20,021 | 224 | 0.0098 | 2,704 | 0 | 0 | 0.0098 | 0 | 8,323 | 13,236 | 0.0098 | 159,753 | 59 | 0.0098 | 717 | 909 | 0.0143 | 17,091 |
| | May | 6,624 | 0.0131 | 107,035 | 537 | 0.0131 | 8,670 | 7,161 | 0.0131 | 115,705 | 1,315 | 0.0098 | 15,871 | 190 | 0 | 0.0098 | 0 | 31,457 | 17,000 | 0.0098 | 205,181 | 1,901 | 0.0098 | 22,949 | 5,204 | 0.0131 | 84,097 |
| | Jun | 5,312 | 0.0141 | 92,387 | 430 | 0.0141 | 7,483 | 5,742 | 0.0141 | 99,871 | 896 | 0.0098 | 10,814 | 256 | 14 | 0.0098 | 167 | 33,050 | 17,000 | 0.0098 | 203,181 | 4,577 | 0.0098 | 55,239 | 2,684 | 0.0141 | 46,676 |
| | Jul | 644 | 0.0110 | 8,738 | 52 | 0.0110 | 708 | 696 | 0.0110 | 9,446 | 107 | 0.0098 | 1,291 | 267 | 1,784 | 0.0098 | 21,528 | 4,363 | 15,477 | 0.0098 | 186,803 | 61 | 0.0098 | 741 | 311 | 0.0119 | 4,218 |
| | Aug | 324 | 0.0176 | 7,034 | 26 | 0.0176 | 570 | 350 | 0.0176 | 7,604 | 55 | 0.0098 | 664 | 321 | 1,865 | 0.0098 | 22,511 | 6,081 | 13,625 | 0.0098 | 164,450 | 61 | 0.0098 | 741 | 163 | 0.0176 | 3,533 |
| | Sep | 252 | 0.0240 | 7,460 | 20 | 0.0240 | 604 | 272 | 0.0240 | 8,064 | 43 | 0.0098 | 519 | 155 | 1,015 | 0.0098 | 12,254 | 8,646 | 12,625 | 0.0098 | 152,378 | 59 | 0.0098 | 717 | 133 | 0.0240 | 3,925 |
| WY Total/Average | | 15,379 | 0.0141 | 257,531 | 1,246 | 0.0141 | 21,670 | 16,625 | 0.0141 | 289,201 | 2,918 | 0.0098 | 35,219 | 1,179 | 5,400 | 0.0098 | 65,175 | 95,308 | 13,615 | 0.0098 | 164,567 | 7,080 | 0.0098 | 85,452 | 10,824 | 0.0142 | 189,404 |
| | Oct | 296 | 0.0209 | 7,621 | 24 | 0.0209 | 618 | 320 | 0.0209 | 8,249 | 111 | 0.0075 | 1,023 | 78 | 123 | 0.0075 | 1,132 | 82,211 | 12,572 | 0.0075 | 115,696 | 61 | 0.0075 | 505 | 239 | 0.0209 | 6,162 |
| | Nov | 231 | 0.0198 | 5,642 | 19 | 0.0198 | 457 | 250 | 0.0198 | 6,099 | 99 | 0.0075 | 911 | 23 | 119 | 0.0075 | 1,095 | 4,011 | 12,521 | 0.0075 | 113,232 | 59 | 0.0075 | 547 | 247 | 0.0198 | 6,040 |
| | Dec | 170 | 0.0187 | 3,921 | 14 | 0.0187 | 316 | 184 | 0.0187 | 4,239 | 67 | 0.0075 | 617 | 0 | 123 | 0.0075 | 1,132 | 2,548 | 12,453 | 0.0075 | 114,610 | 61 | 0.0075 | 565 | 154 | 0.0187 | 3,558 |
| 1987 | Jan | 89 | 0.0176 | 1,932 | 7 | 0.0176 | 137 | 96 | 0.0176 | 2,089 | 37 | 0.0075 | 341 | 6 | 123 | 0.0075 | 1,132 | 1,209 | 12,328 | 0.0075 | 113,456 | 61 | 0.0075 | 565 | 91 | 0.0176 | 1,971 |
| | Feb | 81 | 0.0165 | 1,640 | 7 | 0.0165 | 154 | 88 | 0.0165 | 1,782 | 31 | 0.0075 | 285 | 0 | 111 | 0.0075 | 1,022 | 976 | 12,218 | 0.0075 | 112,447 | 55 | 0.0075 | 510 | 69 | 0.0165 | 1,413 |
| | Mar | 109 | 0.0154 | 2,071 | 9 | 0.0154 | 168 | 118 | 0.0154 | 2,238 | 45 | 0.0075 | 414 | 0 | 123 | 0.0075 | 1,132 | 1,154 | 12,107 | 0.0075 | 111,420 | 61 | 0.0075 | 565 | 110 | 0.0154 | 2,093 |
| | Apr | 1,083 | 0.0143 | 19,103 | 88 | 0.0143 | 1,547 | 1,171 | 0.0143 | 20,650 | 433 | 0.0075 | 3,985 | 6 | 0 | 0.0075 | 0 | 9,876 | 12,785 | 0.0075 | 117,663 | 59 | 0.0075 | 547 | 1,002 | 0.0143 | 17,679 |
| | May | 2,577 | 0.0131 | 41,641 | 209 | 0.0131 | 3,371 | 2,786 | 0.0131 | 45,014 | 783 | 0.0075 | 7,206 | 176 | 0 | 0.0075 | 0 | 20,997 | 14,251 | 0.0075 | 131,149 | 361 | 0.0075 | 3,326 | 1,147 | 0.0131 | 18,535 |
| | Jun | 757 | 0.0141 | 13,156 | 61 | 0.0141 | 1,066 | 818 | 0.0141 | 14,222 | 227 | 0.0075 | 2,089 | 229 | 850 | 0.0075 | 7,821 | 5,812 | 13,701 | 0.0075 | 126,112 | 59 | 0.0075 | 547 | 324 | 0.0141 | 5,630 |
| | Jul | 395 | 0.0110 | 5,373 | 32 | 0.0110 | 435 | 428 | 0.0110 | 5,808 | 115 | 0.0075 | 1,058 | 233 | 1,795 | 0.0075 | 16,527 | 4,015 | 11,926 | 0.0075 | 109,755 | 61 | 0.0075 | 565 | 148 | 0.0110 | 2,007 |
| | Aug | 215 | 0.0176 | 4,683 | 17 | 0.0176 | 375 | 232 | 0.0176 | 5,046 | 64 | 0.0075 | 589 | 183 | 2,030 | 0.0075 | 18,680 | 4,611 | 9,818 | 0.0075 | 90,356 | 61 | 0.0075 | 565 | 91 | 0.0176 | 1,967 |
| | Sep | 152 | 0.0240 | 4,500 | 12 | 0.0240 | 364 | 164 | 0.0240 | 4,864 | 51 | 0.0075 | 469 | 122 | 3 | 0.0075 | 24 | 8,474 | 9,747 | 0.0075 | 89,707 | 59 | 0.0075 | 547 | 91 | 0.0240 | 2,663 |
| WY Total/Average | | 6,156 | 0.0147 | 111,239 | 499 | 0.0147 | 9,011 | 6,655 | 0.0147 | 120,310 | 2,063 | 0.0073 | 18,985 | 1,047 | 5,400 | 0.0075 | 49,697 | 104,887 | 12,203 | 0.0075 | 112,301 | 1,023 | 0.0075 | 9,412 | 3,713 | 0.0152 | 60,741 |
| | Oct | 149 | 0.0209 | 3,712 | 12 | 0.0209 | 301 | 156 | 0.0209 | 4,013 | 47 | 0.0079 | 461 | 64 | 123 | 0.0079 | 1,206 | -2,740 | 9,607 | 0.0079 | 94,192 | 61 | 0.0079 | 603 | 105 | 0.0209 | 2,716 |
| | Nov | 126 | 0.0198 | 3,027 | 10 | 0.0198 | 249 | 136 | 0.0198 | 3,327 | 42 | 0.0079 | 415 | 19 | 119 | 0.0079 | 1,167 | 2,115 | 9,504 | 0.0079 | 93,182 | 59 | 0.0079 | 582 | 99 | 0.0198 | 2,413 |
| | Dec | 99 | 0.0187 | 2,224 | 8 | 0.0187 | 185 | 107 | 0.0187 | 2,409 | 37 | 0.0079 | 363 | 0 | 123 | 0.0079 | 1,206 | 1,019 | 9,390 | 0.0079 | 92,061 | 61 | 0.0079 | 602 | 89 | 0.0187 | 2,260 |
| 1988 | Jan | 102 | 0.0176 | 2,214 | 8 | 0.0176 | 179 | 110 | 0.0176 | 2,394 | 41 | 0.0079 | 402 | 0 | 123 | 0.0079 | 1,206 | 1,313 | 9,275 | 0.0079 | 90,933 | 61 | 0.0079 | 602 | 119 | 0.0176 | 2,578 |
| | Feb | 98 | 0.0165 | 1,995 | 8 | 0.0165 | 162 | 106 | 0.0165 | 2,156 | 39 | 0.0079 | 382 | 0 | 111 | 0.0079 | 1,088 | 1,117 | 9,175 | 0.0079 | 89,957 | 55 | 0.0079 | 544 | 109 | 0.0165 | 2,220 |
| | Mar | 125 | 0.0154 | 2,374 | 10 | 0.0154 | 192 | 135 | 0.0154 | 2,567 | 49 | 0.0079 | 482 | 0 | 123 | 0.0079 | 1,206 | 1,242 | 9,077 | 0.0079 | 88,994 | 61 | 0.0079 | 602 | 136 | 0.0154 | 2,581 |
| | Apr | 564 | 0.0143 | 9,948 | 46 | 0.0143 | 806 | 610 | 0.0143 | 10,754 | 199 | 0.0079 | 1,951 | 8 | 0 | 0.0079 | 0 | 4,777 | 9,428 | 0.0079 | 92,438 | 59 | 0.0079 | 582 | 496 | 0.0143 | 8,754 |
| | May | 3,714 | 0.0131 | 60,013 | 301 | 0.0131 | 4,861 | 4,015 | 0.0131 | 64,875 | 1,132 | 0.0079 | 11,098 | 140 | 0 | 0.0079 | 0 | 26,888 | 11,810 | 0.0079 | 115,783 | 361 | 0.0079 | 3,543 | 2,287 | 0.0131 | 36,955 |
| | Jun | 958 | 0.0141 | 16,682 | 78 | 0.0141 | 1,350 | 1,036 | 0.0141 | 18,011 | 263 | 0.0079 | 2,578 | 201 | 657 | 0.0079 | 6,438 | 9,832 | 11,665 | 0.0079 | 114,364 | 59 | 0.0079 | 582 | 421 | 0.0141 | 7,431 |
| | Jul | 358 | 0.0110 | 4,857 | 29 | 0.0110 | 393 | 387 | 0.0110 | 5,251 | 95 | 0.0079 | 907 | 208 | 1,804 | 0.0079 | 17,691 | 3,498 | 9,806 | 0.0079 | 96,921 | 61 | 0.0079 | 602 | 123 | 0.0110 | 1,669 |
| | Aug | 209 | 0.0176 | 4,537 | 17 | 0.0176 | 368 | 226 | 0.0176 | 4,905 | 56 | 0.0079 | 549 | 161 | 2,214 | 0.0079 | 21,709 | 4,267 | 7,619 | 0.0079 | 74,700 | 61 | 0.0079 | 602 | 87 | 0.0176 | 1,890 |
| | Sep | 142 | 0.0240 | 4,204 | 12 | 0.0240 | 341 | 154 | 0.0240 | 4,544 | 43 | 0.0079 | 422 | 99 | 3 | 0.0079 | 25 | 4,014 | 7,564 | 0.0079 | 74,200 | 59 | 0.0079 | 582 | 86 | 0.0240 | 2,561 |
| WY Total/Average | | 6,639 | 0.0142 | 115,879 | 538 | 0.0142 | 9,386 | 7,177 | 0.0142 | 125,265 | 2,040 | 0.0079 | 20,060 | 853 | 5,400 | 0.0079 | 52,942 | 57,802 | 9,500 | 0.0079 | 93,146 | 1,023 | 0.0079 | 10,027 | 4,173 | 0.0144 | 74,032 |
| | Oct | 153 | 0.0209 | 3,944 | 12 | 0.0209 | 319 | 165 | 0.0209 | 4,264 | 49 | 0.0078 | 471 | 53 | 123 | 0.0078 | 1,181 | 4,696 | 7,446 | 0.0078 | 71,526 | 61 | 0.0078 | 589 | 115 | 0.0209 | 2,955 |
| | Nov | 167 | 0.0198 | 4,059 | 14 | 0.0198 | 330 | 181 | 0.0198 | 4,409 | 59 | 0.0078 | 567 | 15 | 119 | 0.0078 | 1,143 | 2,822 | 7,376 | 0.0078 | 70,833 | 59 | 0.0078 | 570 | 156 | 0.0198 | 3,822 |
| | Dec | 150 | 0.0187 | 3,460 | 12 | 0.0187 | 280 | 162 | 0.0187 | 3,740 | 53 | 0.0078 | 509 | 0 | 123 | 0.0078 | 1,181 | 2,187 | 7,300 | 0.0078 | 70,121 | 61 | 0.0078 | 589 | 139 | 0.0187 | 3,203 |
| 1989 | Jan | 121 | 0.0176 | 2,627 | 10 | 0.0176 | 213 | 131 | 0.0176 | 2,840 | 51 | 0.0078 | 490 | 0 | 123 | 0.0078 | 1,181 | 1,383 | 7,196 | 0.0078 | 69,106 | 61 | 0.0078 | 589 | 161 | 0.0176 | 3,500 |
| | Feb | 101 | 0.0165 | 2,056 | 8 | 0.0165 | 167 | 109 | 0.0165 | 2,222 | 39 | 0.0078 | 375 | 0 | 111 | 0.0078 | 1,066 | 1,174 | 7,100 | 0.0078 | 68,182 | 55 | 0.0078 | 532 | 116 | 0.0165 | 2,353 |
| | Mar | 166 | 0.0154 | 3,153 | 13 | 0.0154 | 255 | 179 | 0.0154 | 3,409 | 67 | 0.0078 | 643 | 0 | 123 | 0.0078 | 1,181 | 1,685 | 7,028 | 0.0078 | 67,491 | 61 | 0.0078 | 589 | 206 | 0.0154 | 3,903 |
| | Apr | 1,312 | 0.0143 | 23,142 | 106 | 0.0143 | 1,875 | 1,418 | 0.0143 | 25,017 | 462 | 0.0078 | 4,437 | 0 | 0 | 0.0078 | 0 | 11,396 | 7,924 | 0.0078 | 76,104 | 59 | 0.0078 | 570 | 1,224 | 0.0143 | 21,585 |
| | May | 2,470 | 0.0131 | 39,912 | 200 | 0.0131 | 3,233 | 2,670 | 0.0131 | 43,145 | 649 | 0.0078 | 6,233 | 122 | 0 | 0.0078 | 0 | 18,674 | 9,462 | 0.0078 | 90,872 | 361 | 0.0078 | 3,471 | 1,039 | 0.0131 | 16,788 |
| | Jun | 763 | 0.0141 | 13,270 | 62 | 0.0141 | 1,075 | 825 | 0.0141 | 14,345 | 203 | 0.0078 | 1,940 | 170 | 735 | 0.0078 | 7,055 | 8,059 | 9,121 | 0.0078 | 87,593 | 59 | 0.0078 | 570 | 327 | 0.0141 | 5,681 |
| | Jul | 368 | 0.0110 | 4,993 | 29 | 0.0110 | 393 | 397 | 0.0110 | 5,387 | 92 | 0.0078 | 884 | 173 | 1,738 | 0.0078 | 16,881 | 3,224 | 7,433 | 0.0078 | 71,402 | 61 | 0.0078 | 589 | 131 | 0.0110 | 1,777 |
| | Aug | 180 | 0.0176 | 3,908 | 15 | 0.0176 | 317 | 195 | 0.0176 | 4,224 | 46 | 0.0078 | 442 | 128 | 2,187 | 0.0078 | 20,960 | 3,584 | 5,211 | 0.0078 | 50,045 | 61 | 0.0078 | 586 | 68 | 0.0176 | 1,487 |
| | Sep | 161 | 0.0240 | 4,766 | 13 | 0.0240 | 386 | 174 | 0.0240 | 5,152 | 47 | 0.0078 | 451 | 72 | 3 | 0.0078 | 25 | 6,173 | 4,787 | 0.0078 | 45,976 | 476 | 0.0078 | 4,572 | 94 | 0.0240 | 2,782 |
| WY Total/Average | | 6,112 | 0.0145 | 109,310 | 494 | 0.0145 | 8,843 | 6,606 | 0.0145 | 118,153 | 1,816 | 0.0078 | 17,440 | 733 | 5,400 | 0.0078 | 51,860 | 61,251 | 7,282 | 0.0078 | 69,937 | 1,439 | 0.0078 | 13,824 | 3,378 | 0.0120 | 60,848 |

Table C-1

Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Narrows Reservoir Operation

| | (Fanton-Noble) Natural Flow-Gooseberry Creek Near Fairview | | | (Fanton-Noble) Other Inflow at Narrows Reservoir | | | (CALC.) Total Inflow at Narrows Reservoir | | | Diversion by Cottonwood-Gooseberry | | | Reservoir Evaporation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Acre-Feet |
| Oct | 132 | 0.0209 | 3,401 | 11 | 0.0209 | 275 | 143 | 0.0209 | 3,676 | 59 | 0.0101 | 738 | 36 |
| Nov | 230 | 0.0198 | 5,628 | 19 | 0.0198 | 456 | 249 | 0.0198 | 6,084 | 72 | 0.0101 | 888 | 10 |
| Dec | 114 | 0.0187 | 2,632 | 9 | 0.0187 | 213 | 123 | 0.0187 | 2,845 | 64 | 0.0101 | 792 | 0 |
| 1990 Jan | 101 | 0.0176 | 2,185 | 8 | 0.0176 | 177 | 109 | 0.0176 | 2,361 | 62 | 0.0101 | 730 | 0 |
| Feb | 97 | 0.0165 | 1,970 | 8 | 0.0165 | 160 | 105 | 0.0165 | 2,130 | 46 | 0.0101 | 394 | 0 |
| Mar | 128 | 0.0154 | 2,424 | 10 | 0.0154 | 196 | 138 | 0.0154 | 2,621 | 82 | 0.0101 | 1,016 | 0 |
| Apr | 1,120 | 0.0143 | 19,751 | 91 | 0.0143 | 1,600 | 1,210 | 0.0143 | 21,351 | 551 | 0.0101 | 6,902 | 0 |
| May | 2,564 | 0.0131 | 41,432 | 208 | 0.0131 | 3,356 | 2,772 | 0.0131 | 44,787 | 787 | 0.0101 | 9,772 | 79 |
| Jun | 913 | 0.0230 | 25,895 | 74 | 0.0230 | 2,098 | 987 | 0.0230 | 27,993 | 244 | 0.0101 | 3,034 | 121 |
| Jul | 401 | 0.0110 | 5,439 | 33 | 0.0110 | 441 | 433 | 0.0110 | 5,879 | 112 | 0.0101 | 1,392 | 125 |
| Aug | 174 | 0.0280 | 6,020 | 14 | 0.0280 | 488 | 188 | 0.0280 | 6,507 | 56 | 0.0101 | 693 | 88 |
| Sep | 127 | 0.0240 | 3,747 | 10 | 0.0240 | 303 | 137 | 0.0240 | 4,050 | 57 | 0.0101 | 706 | 59 |
| WY Total/Average | 6,109 | 0.0160 | 120,524 | 494 | 0.0160 | 9,762 | 6,594 | 0.0160 | 130,286 | 2,204 | 0.0101 | 27,336 | 518 |
| Oct | 151 | 0.0209 | 3,878 | 12 | 0.0209 | 314 | 163 | 0.0209 | 4,192 | 70 | 0.0105 | 909 | 28 |
| Nov | 144 | 0.0198 | 3,508 | 12 | 0.0198 | 284 | 155 | 0.0198 | 3,793 | 165 | 0.0105 | 2,152 | 8 |
| Dec | 120 | 0.0187 | 2,760 | 10 | 0.0187 | 224 | 129 | 0.0187 | 2,984 | 66 | 0.0105 | 862 | 9 |
| 1991 Jan | 106 | 0.0176 | 2,298 | 9 | 0.0176 | 186 | 114 | 0.0176 | 2,485 | 64 | 0.0105 | 834 | 0 |
| Feb | 104 | 0.0165 | 2,116 | 8 | 0.0165 | 171 | 112 | 0.0165 | 2,288 | 64 | 0.0105 | 829 | 0 |
| Mar | 125 | 0.0154 | 2,383 | 10 | 0.0154 | 193 | 136 | 0.0154 | 2,576 | 77 | 0.0105 | 1,003 | 0 |
| Apr | 504 | 0.0143 | 8,889 | 41 | 0.0143 | 720 | 545 | 0.0143 | 9,609 | 660 | 0.0105 | 8,583 | 0 |
| May | 3,864 | 0.0131 | 62,444 | 313 | 0.0131 | 5,058 | 4,177 | 0.0131 | 67,502 | 1,220 | 0.0105 | 15,865 | 43 |
| Jun | 2,537 | 0.0190 | 59,463 | 206 | 0.0190 | 4,816 | 2,743 | 0.0190 | 64,279 | 448 | 0.0105 | 5,833 | 101 |
| Jul | 567 | 0.0110 | 7,688 | 46 | 0.0110 | 623 | 613 | 0.0110 | 8,311 | 185 | 0.0105 | 2,405 | 120 |
| Aug | 296 | 0.0050 | 1,824 | 24 | 0.0050 | 148 | 320 | 0.0050 | 1,971 | 77 | 0.0105 | 1,003 | 90 |
| Sep | 249 | 0.0240 | 7,374 | 20 | 0.0240 | 597 | 269 | 0.0240 | 7,972 | 62 | 0.0105 | 813 | 42 |
| WY Total/Average | 8,766 | 0.0152 | 164,627 | 710 | 0.0152 | 13,335 | 9,476 | 0.0152 | 177,962 | 3,159 | 0.0105 | 41,091 | 444 |
| Oct | 154 | 0.0400 | 7,619 | 13 | 0.0400 | 617 | 167 | 0.0400 | 8,236 | 24 | 0.0099 | 298 | 33 |
| Nov | 145 | 0.0198 | 3,534 | 12 | 0.0198 | 286 | 156 | 0.0198 | 3,820 | 14 | 0.0099 | 166 | 6 |
| Dec | 124 | 0.0187 | 2,854 | 10 | 0.0187 | 231 | 134 | 0.0187 | 3,085 | 21 | 0.0099 | 258 | 0 |
| 1992 Jan | 90 | 0.0176 | 1,951 | 7 | 0.0176 | 158 | 97 | 0.0176 | 2,109 | 21 | 0.0099 | 261 | 0 |
| Feb | 82 | 0.0165 | 1,660 | 7 | 0.0165 | 134 | 88 | 0.0165 | 1,795 | 20 | 0.0099 | 250 | 0 |
| Mar | 141 | 0.0154 | 2,682 | 11 | 0.0154 | 217 | 153 | 0.0154 | 2,900 | 23 | 0.0099 | 285 | 0 |
| Apr | 741 | 0.0143 | 13,071 | 60 | 0.0143 | 1,059 | 801 | 0.0143 | 14,130 | 38 | 0.0099 | 471 | 0 |
| May | 1,705 | 0.0131 | 27,544 | 138 | 0.0131 | 2,231 | 1,843 | 0.0131 | 29,775 | 641 | 0.0099 | 7,862 | 56 |
| Jun | 654 | 0.0090 | 7,255 | 53 | 0.0090 | 588 | 706 | 0.0090 | 7,842 | 421 | 0.0099 | 5,159 | 82 |
| Jul | 263 | 0.0110 | 3,568 | 21 | 0.0110 | 289 | 284 | 0.0110 | 3,857 | 82 | 0.0099 | 1,002 | 77 |
| Aug | 138 | 0.0210 | 3,515 | 11 | 0.0210 | 283 | 147 | 0.0210 | 3,797 | 46 | 0.0099 | 563 | 57 |
| Sep | 118 | 0.0240 | 3,488 | 10 | 0.0240 | 283 | 127 | 0.0240 | 3,771 | 40 | 0.0099 | 492 | 38 |
| WY Total/Average | 4,353 | 0.0147 | 78,739 | 352 | 0.0147 | 6,378 | 4,705 | 0.0147 | 85,117 | 1,392 | 0.0099 | 17,067 | 338 |
| Oct | 235 | 0.0209 | 6,063 | 19 | 0.0209 | 491 | 254 | 0.0209 | 6,554 | 193 | 0.0119 | 2,879 | 30 |
| Nov | 176 | 0.0198 | 4,305 | 14 | 0.0198 | 349 | 191 | 0.0198 | 4,654 | 201 | 0.0119 | 2,989 | 6 |
| Dec | 160 | 0.0187 | 3,689 | 13 | 0.0187 | 299 | 173 | 0.0187 | 3,987 | 174 | 0.0119 | 2,563 | 0 |
| 1993 Jan | 127 | 0.0176 | 2,755 | 10 | 0.0176 | 223 | 137 | 0.0176 | 2,978 | 128 | 0.0119 | 1,879 | 0 |
| Feb | 127 | 0.0165 | 2,575 | 10 | 0.0165 | 209 | 137 | 0.0165 | 2,784 | 104 | 0.0119 | 1,534 | 0 |
| Mar | 234 | 0.0154 | 4,454 | 19 | 0.0154 | 361 | 253 | 0.0154 | 4,814 | 223 | 0.0119 | 3,260 | 0 |
| Apr | 993 | 0.0143 | 17,518 | 80 | 0.0143 | 1,419 | 1,074 | 0.0143 | 18,937 | 1,085 | 0.0119 | 15,938 | 0 |
| May | 5,968 | 0.0131 | 96,436 | 483 | 0.0131 | 7,811 | 6,451 | 0.0131 | 104,247 | 1,118 | 0.0119 | 16,401 | 39 |
| Jun | 2,602 | 0.0150 | 48,137 | 211 | 0.0150 | 3,899 | 2,812 | 0.0150 | 52,036 | 421 | 0.0119 | 6,185 | 133 |
| Jul | 632 | 0.0110 | 8,575 | 51 | 0.0110 | 695 | 683 | 0.0110 | 9,270 | 200 | 0.0119 | 2,938 | 164 |
| Aug | 305 | 0.0050 | 1,883 | 25 | 0.0050 | 153 | 330 | 0.0050 | 2,036 | 106 | 0.0119 | 1,558 | 123 |
| Sep | 226 | 0.0240 | 6,685 | 18 | 0.0240 | 541 | 244 | 0.0240 | 7,225 | 124 | 0.0119 | 1,819 | 68 |
| WY Total/Average | 11,785 | 0.0140 | 203,073 | 955 | 0.0140 | 16,449 | 12,740 | 0.0140 | 219,524 | 4,079 | 0.0119 | 59,932 | 555 |

| | Narrows Reservoir Project Irrigation Delivery | | | (CALC.) Phosphorus Uptake | End of Month Contents | Phosphorus | | (Fanton-Noble) Stream Flow below Narrows Reservoir | | | (CALC.) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year Month | Acre-Feet | mg/l | grams | grams | Total Acre-Feet | mg/l Table D-1 | grams | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | Concentration mg/l | Weight grams |
| | | | | | 4271 | 0.0121 | 63,900 | | | | | | |
| Oct | 123 | 0.0101 | 1,527 | -13,109 | 4,651 | 0.0101 | 57,735 | 61 | 0.0101 | 762 | 95 | 0.0209 | 2,460 |
| Nov | 119 | 0.0101 | 1,477 | 3,118 | 4,640 | 0.0101 | 57,598 | 59 | 0.0101 | 737 | 245 | 0.0198 | 5,992 |
| Dec | 123 | 0.0101 | 1,527 | 1,314 | 4,515 | 0.0101 | 56,048 | 61 | 0.0101 | 762 | 110 | 0.0187 | 2,534 |
| 1990 Jan | 123 | 0.0101 | 1,527 | 1,011 | 4,377 | 0.0101 | 54,340 | 61 | 0.0101 | 762 | 117 | 0.0176 | 2,542 |
| Feb | 111 | 0.0101 | 1,378 | 831 | 4,268 | 0.0101 | 52,979 | 55 | 0.0101 | 688 | 106 | 0.0165 | 2,161 |
| Mar | 123 | 0.0101 | 1,527 | 908 | 4,170 | 0.0101 | 51,787 | 61 | 0.0101 | 762 | 141 | 0.0154 | 2,676 |
| Apr | 0 | 0.0101 | 0 | 6,324 | 4,730 | 0.0101 | 58,715 | 59 | 0.0101 | 737 | 1,037 | 0.0143 | 18,296 |
| May | 0 | 0.0101 | 0 | 11,354 | 6,274 | 0.0101 | 77,890 | 361 | 0.0101 | 4,486 | 1,134 | 0.0131 | 18,317 |
| Jun | 657 | 0.0101 | 8,152 | 17,252 | 6,179 | 0.0101 | 76,708 | 59 | 0.0101 | 737 | 404 | 0.0230 | 11,464 |
| Jul | 1,647 | 0.0101 | 20,447 | 2,053 | 4,667 | 0.0101 | 57,933 | 61 | 0.0101 | 762 | 131 | 0.0110 | 2,055 |
| Aug | 0 | 0.0101 | 0 | 5,234 | 4,123 | 0.0101 | 51,184 | 590 | 0.0101 | 7,329 | 64 | 0.0280 | 2,226 |
| Sep | 0 | 0.0101 | 0 | 3,080 | 3,715 | 0.0101 | 46,119 | 429 | 0.0101 | 5,331 | 80 | 0.0240 | 2,361 |
| | | | | | | | | 429 | | | | | |
| WY Total/Average | 3,026 | 0.0101 | 37,562 | 43,370 | 4,690 | 0.0101 | 58,220 | 1,922 | 0.0101 | 23,857 | 3,685 | 0.0161 | 73,083 |
| Oct | 123 | 0.0105 | 1,600 | 241 | 3,379 | 0.0105 | 43,952 | 277 | 0.0105 | 3,608 | 112 | 0.0209 | 2,879 |
| Nov | 119 | 0.0105 | 1,548 | 1,873 | 3,183 | 0.0105 | 41,399 | 59 | 0.0105 | 773 | 124 | 0.0198 | 3,033 |
| Dec | 123 | 0.0105 | 1,600 | 1,301 | 3,061 | 0.0105 | 39,822 | 61 | 0.0105 | 798 | 114 | 0.0187 | 2,636 |
| 1991 Jan | 123 | 0.0105 | 1,600 | 996 | 2,927 | 0.0105 | 38,078 | 61 | 0.0105 | 798 | 129 | 0.0176 | 2,798 |
| Feb | 111 | 0.0105 | 1,444 | 826 | 2,809 | 0.0105 | 36,545 | 55 | 0.0105 | 721 | 123 | 0.0165 | 2,508 |
| Mar | 123 | 0.0105 | 1,600 | 812 | 2,684 | 0.0105 | 34,909 | 61 | 0.0105 | 798 | 137 | 0.0154 | 2,607 |
| Apr | 0 | 0.0105 | 0 | 2,523 | 2,509 | 0.0105 | 32,640 | 59 | 0.0105 | 773 | 438 | 0.0143 | 7,730 |
| May | 0 | 0.0105 | 0 | 13,744 | 5,061 | 0.0105 | 65,832 | 361 | 0.0105 | 4,703 | 2,438 | 0.0131 | 39,387 |
| Jun | 735 | 0.0105 | 9,558 | 29,915 | 6,461 | 0.0105 | 84,035 | 59 | 0.0105 | 773 | 1,246 | 0.0190 | 29,200 |
| Jul | 1,756 | 0.0105 | 22,865 | 3,034 | 4,939 | 0.0105 | 64,244 | 61 | 0.0105 | 798 | 260 | 0.0110 | 3,525 |
| Aug | 2,163 | 0.0105 | 28,138 | 1,017 | 2,847 | 0.0105 | 37,029 | 61 | 0.0105 | 798 | 144 | 0.0050 | 885 |
| Sep | 3 | 0.0105 | 34 | 3,018 | 2,949 | 0.0105 | 38,304 | 59 | 0.0105 | 773 | 131 | 0.0240 | 3,884 |
| WY Total/Average | 3,400 | 0.0105 | 78,244 | 58,267 | 3,387 | 0.0105 | 46,404 | 1,229 | 0.0105 | 16,113 | 5,396 | 0.0152 | 101,171 |
| Oct | 123 | 0.0099 | 1,508 | 8,682 | 2,616 | 0.0099 | 32,097 | 327 | 0.0099 | 4,015 | 119 | 0.0400 | 5,882 |
| Nov | 119 | 0.0099 | 1,459 | 1,976 | 2,577 | 0.0099 | 31,587 | 59 | 0.0099 | 728 | 126 | 0.0198 | 3,068 |
| Dec | 123 | 0.0099 | 1,508 | 1,445 | 2,505 | 0.0099 | 30,707 | 61 | 0.0099 | 752 | 118 | 0.0187 | 2,711 |
| 1992 Jan | 19 | 0.0099 | 236 | 918 | 2,500 | 0.0099 | 30,648 | 61 | 0.0099 | 752 | 93 | 0.0176 | 2,018 |
| Feb | 12 | 0.0099 | 153 | 716 | 2,500 | 0.0099 | 30,648 | 55 | 0.0099 | 689 | 70 | 0.0165 | 1,426 |
| Mar | 68 | 0.0099 | 834 | 1,028 | 2,500 | 0.0099 | 30,648 | 61 | 0.0099 | 752 | 163 | 0.0154 | 3,104 |
| Apr | 0 | 0.0099 | 0 | 4,310 | 3,203 | 0.0099 | 39,270 | 59 | 0.0099 | 728 | 669 | 0.0143 | 11,799 |
| May | 0 | 0.0099 | 0 | 7,868 | 3,988 | 0.0099 | 48,883 | 361 | 0.0099 | 4,430 | 272 | 0.0131 | 4,391 |
| Jun | 611 | 0.0099 | 7,490 | 186 | 3,521 | 0.0099 | 43,164 | 59 | 0.0099 | 728 | 270 | 0.0090 | 2,994 |
| Jul | 0 | 0.0099 | 0 | 1,310 | 2,921 | 0.0099 | 35,909 | 726 | 0.0099 | 8,906 | 61 | 0.0110 | 833 |
| Aug | 0 | 0.0099 | 0 | 2,695 | 2,510 | 0.0099 | 30,767 | 435 | 0.0099 | 5,381 | 39 | 0.0210 | 1,016 |
| Sep | 0 | 0.0099 | 0 | 2,672 | 2,500 | 0.0099 | 30,646 | 59 | 0.0099 | 728 | 76 | 0.0240 | 2,254 |
| WY Total/Average | 1,076 | 0.0099 | 13,196 | 33,806 | 2,820 | 0.0099 | 34,573 | 2,347 | 0.0099 | 28,770 | 2,072 | 0.0162 | 41,296 |
| Oct | 0 | 0.0119 | 0 | -2,970 | 2,477 | 0.0119 | 36,398 | 61 | 0.0119 | 902 | 186 | 0.0209 | 4,795 |
| Nov | 0 | 0.0119 | 0 | 1,940 | 2,399 | 0.0119 | 35,250 | 59 | 0.0119 | 873 | 170 | 0.0198 | 4,145 |
| Dec | 0 | 0.0119 | 0 | 1,448 | 2,336 | 0.0119 | 34,320 | 61 | 0.0119 | 902 | 146 | 0.0187 | 3,377 |
| 1993 Jan | 0 | 0.0119 | 0 | 967 | 2,284 | 0.0119 | 33,560 | 61 | 0.0119 | 902 | 176 | 0.0176 | 3,822 |
| Feb | 0 | 0.0119 | 0 | 779 | 2,261 | 0.0119 | 33,221 | 55 | 0.0119 | 815 | 177 | 0.0165 | 3,596 |
| Mar | 0 | 0.0119 | 0 | 1,091 | 2,231 | 0.0119 | 32,783 | 61 | 0.0119 | 902 | 318 | 0.0154 | 6,046 |
| Apr | 0 | 0.0119 | 0 | 3,167 | 2,161 | 0.0119 | 31,746 | 59 | 0.0119 | 873 | 914 | 0.0143 | 16,123 |
| May | 0 | 0.0119 | 0 | 10,036 | 7,095 | 0.0119 | 104,247 | 361 | 0.0119 | 5,310 | 4,547 | 0.0131 | 73,473 |
| Jun | 735 | 0.0119 | 10,791 | 12,695 | 8,558 | 0.0119 | 125,739 | 59 | 0.0119 | 873 | 1,279 | 0.0150 | 23,671 |
| Jul | 1,758 | 0.0119 | 25,825 | 1,642 | 7,058 | 0.0119 | 103,701 | 61 | 0.0119 | 902 | 302 | 0.0110 | 4,104 |
| Aug | 2,187 | 0.0119 | 32,074 | -1,614 | 4,915 | 0.0119 | 72,216 | 61 | 0.0119 | 902 | 150 | 0.0050 | 924 |
| Sep | 1 | 0.0119 | 18 | 4,646 | 4,905 | 0.0119 | 72,067 | 59 | 0.0119 | 873 | 121 | 0.0240 | 3,595 |
| WY Total/Average | 4,681 | 0.0119 | 68,731 | 34,413 | 4,037 | 0.0120 | 59,605 | 1,023 | 0.0119 | 15,026 | 8,487 | 0.0141 | 147,672 |

Table C-1 Date: September 25, 2006

**Flow and Phosphorus Routing WITH Proposed Narrows Project**

## Narrows Reservoir Operation

| Year | Month | (Fransen-Noble) Natural Flow-Gooseberry Creek Near Fairview: Flow Acre-Feet | Concentration mg/l | Weight grams | Other Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC) Total Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | Narrows Reservoir — Diversion by Cottonwood-Gooseberry: Flow Acre-Feet | Concentration mg/l | Weight grams | Reservoir Evaporation Acre-Feet | Project Irrigation Delivery Acre-Feet | mg/l | grams | (CALC) Phosphorus Uptake grams | End of Month Contents Total Acre-Feet | Phosphorus mg/l Table D-1 | Phosphorus grams | (Fransen-Noble) Stream Flow below Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | 4297 | 0.0121 | 63,500 | | | | | | |
| | Oct | 182 | 0.0209 | 4,708 | 15 | 0.0209 | 381 | 197 | 0.0209 | 5,089 | 27 | 0.0089 | 295 | 30 | 123 | 0.0089 | 1,358 | 21,242 | 4,855 | 0.0089 | 53,384 | 61 | 0.0089 | 677 | 140 | 0.0209 | 3,607 |
| | Nov | 142 | 0.0198 | 3,470 | 12 | 0.0198 | 281 | 154 | 0.0198 | 3,751 | 17 | 0.0089 | 189 | 11 | 119 | 0.0089 | 1,311 | 2,173 | 4,893 | 0.0089 | 53,004 | 59 | 0.0089 | 656 | 122 | 0.0198 | 2,979 |
| | Dec | 134 | 0.0187 | 3,083 | 11 | 0.0187 | 250 | 144 | 0.0187 | 3,333 | 16 | 0.0089 | 174 | 0 | 123 | 0.0089 | 1,355 | 3,728 | 4,747 | 0.0089 | 52,390 | 61 | 0.0089 | 677 | 125 | 0.0187 | 2,898 |
| 1994 | Jan | 99 | 0.0176 | 2,140 | 8 | 0.0176 | 173 | 107 | 0.0176 | 2,314 | 20 | 0.0089 | 223 | 0 | 123 | 0.0089 | 1,358 | 1,177 | 4,640 | 0.0089 | 51,308 | 61 | 0.0089 | 677 | 113 | 0.0176 | 2,443 |
| | Feb | 94 | 0.0165 | 1,908 | 8 | 0.0165 | 155 | 101 | 0.0165 | 2,062 | 23 | 0.0089 | 252 | 0 | 111 | 0.0089 | 1,225 | 944 | 4,563 | 0.0089 | 50,337 | 55 | 0.0089 | 612 | 99 | 0.0165 | 2,017 |
| | Mar | 129 | 0.0154 | 2,445 | 10 | 0.0154 | 196 | 139 | 0.0154 | 2,644 | 38 | 0.0089 | 421 | 0 | 123 | 0.0089 | 1,358 | 1,108 | 4,477 | 0.0089 | 49,417 | 61 | 0.0089 | 677 | 143 | 0.0154 | 2,711 |
| | Apr | 652 | 0.0143 | 11,496 | 53 | 0.0143 | 931 | 705 | 0.0143 | 12,427 | 99 | 0.0089 | 1,086 | 0 | 0 | 0.0089 | 0 | 4,652 | 5,024 | 0.0089 | 55,447 | 59 | 0.0089 | 656 | 582 | 0.0143 | 10,266 |
| | May | 3,411 | 0.0131 | 55,114 | 276 | 0.0131 | 4,464 | 3,687 | 0.0131 | 59,579 | 1,019 | 0.0089 | 11,504 | 83 | 0 | 0.0089 | 0 | 19,800 | 7,188 | 0.0089 | 79,326 | 361 | 0.0089 | 3,986 | 1,983 | 0.0131 | 32,037 |
| | Jun | 938 | 0.0141 | 16,282 | 76 | 0.0141 | 1,319 | 1,012 | 0.0141 | 17,601 | 401 | 0.0089 | 4,422 | 138 | 735 | 0.0089 | 8,108 | 7,936 | 6,870 | 0.0089 | 75,817 | 59 | 0.0089 | 656 | 416 | 0.0141 | 7,239 |
| | Jul | 294 | 0.0190 | 6,881 | 24 | 0.0190 | 557 | 317 | 0.0190 | 7,438 | 86 | 0.0089 | 946 | 137 | 1,758 | 0.0089 | 19,399 | 3,446 | 3,145 | 0.0089 | 36,786 | 61 | 0.0089 | 677 | 81 | 0.0190 | 1,908 |
| | Aug | 208 | 0.0220 | 5,381 | 17 | 0.0220 | 452 | 222 | 0.0220 | 6,033 | 41 | 0.0089 | 450 | 94 | 2,183 | 0.0089 | 24,094 | 4,611 | 2,985 | 0.0089 | 32,936 | 61 | 0.0089 | 677 | 85 | 0.0220 | 2,303 |
| | Sep | 162 | 0.0240 | 4,787 | 13 | 0.0240 | 388 | 175 | 0.0240 | 5,174 | 26 | 0.0089 | 291 | 44 | 3 | 0.0089 | 39 | 3,733 | 3,031 | 0.0089 | 33,453 | 59 | 0.0089 | 656 | 95 | 0.0240 | 2,799 |
| WY Total/Average | | 6,839 | 0.0149 | 117,895 | 522 | 0.0148 | 9,550 | 6,961 | 0.0148 | 127,445 | 1,872 | 0.0089 | 20,656 | 540 | 5,400 | 0.0089 | 59,509 | 74,518 | 4,882 | 0.0089 | 53,656 | 1,023 | 0.0089 | 11,287 | 3,983 | 0.0149 | 73,197 |
| | Oct | 217 | 0.0209 | 5,587 | 18 | 0.0209 | 453 | 234 | 0.0209 | 6,040 | 76 | 0.0136 | 1,283 | 44 | 123 | 0.0136 | 2,067 | -14,992 | 2,981 | 0.0136 | 50,103 | 61 | 0.0136 | 1,032 | 170 | 0.0209 | 4,378 |
| | Nov | 148 | 0.0198 | 3,617 | 12 | 0.0198 | 293 | 160 | 0.0198 | 3,910 | 64 | 0.0136 | 1,068 | 7 | 119 | 0.0136 | 2,000 | 1,335 | 2,892 | 0.0136 | 48,612 | 59 | 0.0136 | 998 | 130 | 0.0198 | 3,183 |
| | Dec | 154 | 0.0187 | 3,550 | 12 | 0.0187 | 282 | 166 | 0.0187 | 3,838 | 62 | 0.0136 | 1,050 | 0 | 123 | 0.0136 | 2,067 | 1,041 | 2,812 | 0.0136 | 47,260 | 61 | 0.0136 | 1,032 | 142 | 0.0187 | 3,266 |
| 1995 | Jan | 121 | 0.0176 | 2,628 | 10 | 0.0176 | 233 | 131 | 0.0176 | 2,861 | 49 | 0.0136 | 822 | 0 | 123 | 0.0136 | 2,067 | 641 | 2,709 | 0.0136 | 45,538 | 61 | 0.0136 | 1,032 | 163 | 0.0176 | 3,537 |
| | Feb | 113 | 0.0165 | 2,298 | 9 | 0.0165 | 186 | 122 | 0.0165 | 2,484 | 44 | 0.0136 | 733 | 0 | 111 | 0.0136 | 1,866 | 433 | 2,621 | 0.0136 | 44,060 | 55 | 0.0136 | 932 | 144 | 0.0165 | 2,939 |
| | Mar | 196 | 0.0154 | 3,723 | 16 | 0.0154 | 302 | 212 | 0.0154 | 4,024 | 60 | 0.0136 | 1,007 | 0 | 123 | 0.0136 | 2,067 | 463 | 2,589 | 0.0136 | 43,515 | 61 | 0.0136 | 1,032 | 254 | 0.0154 | 4,832 |
| | Apr | 570 | 0.0143 | 10,046 | 46 | 0.0143 | 814 | 616 | 0.0143 | 10,860 | 292 | 0.0136 | 4,906 | 0 | 0 | 0.0136 | 0 | 313 | 2,853 | 0.0136 | 47,956 | 59 | 0.0136 | 998 | 502 | 0.0143 | 8,855 |
| | May | 4,413 | 0.0131 | 71,304 | 357 | 0.0131 | 5,776 | 4,770 | 0.0131 | 77,080 | 1,129 | 0.0136 | 18,968 | 50 | 0 | 0.0136 | 0 | 2,253 | 6,083 | 0.0136 | 102,247 | 361 | 0.0136 | 6,074 | 2,987 | 0.0131 | 48,272 |
| | Jun | 6,590 | 0.0141 | 114,608 | 534 | 0.0141 | 9,283 | 7,123 | 0.0141 | 123,891 | 253 | 0.0136 | 4,245 | 118 | 751 | 0.0136 | 12,347 | 6,150 | 12,042 | 0.0136 | 202,397 | 59 | 0.0136 | 998 | 3,348 | 0.0141 | 58,195 |
| | Jul | 1,329 | 0.0050 | 8,197 | 108 | 0.0050 | 664 | 1,437 | 0.0050 | 8,861 | 77 | 0.0136 | 1,293 | 211 | 1,756 | 0.0136 | 29,548 | -11,706 | 11,369 | 0.0136 | 191,064 | 61 | 0.0136 | 1,032 | 758 | 0.0050 | 4,674 |
| | Aug | 513 | 0.0176 | 11,127 | 42 | 0.0176 | 901 | 554 | 0.0176 | 12,028 | 65 | 0.0136 | 1,101 | 179 | 2,183 | 0.0136 | 36,693 | 5,727 | 9,433 | 0.0136 | 158,577 | 61 | 0.0136 | 1,032 | 285 | 0.0176 | 6,183 |
| | Sep | 284 | 0.0240 | 8,398 | 23 | 0.0240 | 680 | 307 | 0.0240 | 9,078 | 60 | 0.0136 | 1,004 | 118 | 3 | 0.0136 | 44 | 5,916 | 9,501 | 0.0136 | 159,699 | 59 | 0.0136 | 998 | 146 | 0.0240 | 4,313 |
| WY Total/Average | | 14,646 | 0.0136 | 245,082 | 1,186 | 0.0136 | 19,852 | 15,832 | 0.0136 | 264,934 | 2,230 | 0.0136 | 37,481 | 709 | 5,600 | 0.0136 | 90,763 | -6,746 | 5,637 | 0.0136 | 95,088 | 1,023 | 0.0136 | 17,190 | 9,027 | 0.0119 | 152,628 |
| | Oct | 179 | 0.0050 | 1,106 | 15 | 0.0050 | 90 | 194 | 0.0050 | 1,195 | 37 | 0.0095 | 438 | 63 | 123 | 0.0095 | 1,443 | 47,922 | 9,410 | 0.0095 | 110,371 | 61 | 0.0095 | 720 | 137 | 0.0050 | 845 |
| | Nov | 162 | 0.0198 | 3,960 | 13 | 0.0198 | 321 | 175 | 0.0198 | 4,281 | 26 | 0.0095 | 306 | 18 | 119 | 0.0095 | 1,396 | 2,441 | 9,363 | 0.0095 | 109,814 | 59 | 0.0095 | 697 | 150 | 0.0198 | 3,663 |
| | Dec | 140 | 0.0187 | 3,225 | 11 | 0.0187 | 261 | 151 | 0.0187 | 3,486 | 28 | 0.0095 | 328 | 0 | 123 | 0.0095 | 1,443 | 1,714 | 9,302 | 0.0095 | 109,096 | 61 | 0.0095 | 720 | 130 | 0.0187 | 3,007 |
| 1996 | Jan | 92 | 0.0176 | 1,990 | 7 | 0.0176 | 161 | 99 | 0.0176 | 2,151 | 28 | 0.0095 | 328 | 0 | 123 | 0.0095 | 1,443 | 989 | 9,188 | 0.0095 | 107,768 | 61 | 0.0095 | 720 | 97 | 0.0176 | 2,106 |
| | Feb | 99 | 0.0165 | 2,021 | 8 | 0.0165 | 164 | 107 | 0.0165 | 2,185 | 25 | 0.0095 | 298 | 0 | 111 | 0.0095 | 1,302 | 936 | 9,104 | 0.0095 | 106,777 | 55 | 0.0095 | 650 | 112 | 0.0165 | 2,282 |
| | Mar | 140 | 0.0154 | 2,668 | 11 | 0.0154 | 216 | 152 | 0.0154 | 2,884 | 46 | 0.0095 | 544 | 0 | 123 | 0.0095 | 1,443 | 1,103 | 9,028 | 0.0095 | 105,852 | 61 | 0.0095 | 720 | 162 | 0.0154 | 3,080 |
| | Apr | 427 | 0.0143 | 7,531 | 35 | 0.0143 | 610 | 462 | 0.0143 | 8,140 | 94 | 0.0095 | 1,104 | 0 | 0 | 0.0095 | 0 | 2,728 | 9,333 | 0.0095 | 109,464 | 59 | 0.0095 | 697 | 393 | 0.0143 | 6,928 |
| | May | 5,177 | 0.0131 | 83,647 | 419 | 0.0131 | 6,775 | 5,596 | 0.0131 | 90,422 | 756 | 0.0095 | 8,867 | 137 | 0 | 0.0095 | 0 | 16,421 | 13,672 | 0.0095 | 160,359 | 361 | 0.0095 | 4,239 | 3,753 | 0.0131 | 60,649 |
| | Jun | 2,465 | 0.0120 | 36,492 | 200 | 0.0120 | 2,956 | 2,665 | 0.0120 | 39,448 | 1,165 | 0.0095 | 13,666 | 223 | 735 | 0.0095 | 8,616 | 10,807 | 14,133 | 0.0095 | 166,021 | 58 | 0.0095 | 697 | 1,209 | 0.0120 | 17,891 |
| | Jul | 519 | 0.0110 | 7,037 | 42 | 0.0110 | 570 | 561 | 0.0110 | 7,607 | 242 | 0.0095 | 2,833 | 238 | 1,756 | 0.0095 | 20,616 | 3,826 | 12,417 | 0.0095 | 145,633 | 61 | 0.0095 | 720 | 228 | 0.0110 | 3,099 |
| | Aug | 206 | 0.0250 | 6,344 | 17 | 0.0250 | 514 | 222 | 0.0250 | 6,858 | 88 | 0.0095 | 1,034 | 391 | 2,183 | 0.0095 | 25,605 | 6,485 | 10,116 | 0.0095 | 118,647 | 61 | 0.0095 | 720 | 55 | 0.0250 | 2,019 |
| | Sep | 142 | 0.0240 | 4,200 | 11 | 0.0240 | 340 | 153 | 0.0240 | 4,540 | 45 | 0.0095 | 525 | 125 | 3 | 0.0095 | 30 | 4,205 | 10,038 | 0.0095 | 117,731 | 59 | 0.0095 | 697 | 86 | 0.0240 | 2,553 |
| WY Total/Average | | 9,748 | 0.0133 | 160,221 | 790 | 0.0133 | 12,978 | 10,537 | 0.0133 | 173,199 | 2,581 | 0.0095 | 30,269 | 997 | 5,600 | 0.0095 | 63,335 | 109,567 | 10,427 | 0.0096 | 122,294 | 1,023 | 0.0095 | 11,995 | 6,513 | 0.0135 | 108,202 |
| | Oct | 144 | 0.0209 | 3,722 | 12 | 0.0209 | 301 | 156 | 0.0209 | 4,023 | 37 | 0.0112 | 515 | 66 | 123 | 0.0112 | 1,705 | -18,629 | 9,906 | 0.0112 | 137,312 | 61 | 0.0112 | 851 | 106 | 0.0209 | 2,742 |
| | Nov | 167 | 0.0198 | 4,090 | 14 | 0.0198 | 331 | 181 | 0.0198 | 4,422 | 38 | 0.0112 | 526 | 19 | 119 | 0.0112 | 1,649 | 2,178 | 9,852 | 0.0112 | 136,557 | 59 | 0.0112 | 823 | 157 | 0.0198 | 3,845 |
| | Dec | 147 | 0.0187 | 3,396 | 12 | 0.0187 | 275 | 159 | 0.0187 | 3,671 | 32 | 0.0112 | 445 | 0 | 123 | 0.0112 | 1,705 | 1,465 | 9,795 | 0.0112 | 135,763 | 61 | 0.0112 | 851 | 136 | 0.0187 | 3,143 |
| 1997 | Jan | 116 | 0.0176 | 2,520 | 9 | 0.0176 | 204 | 125 | 0.0176 | 2,724 | 21 | 0.0112 | 295 | 0 | 123 | 0.0112 | 1,705 | 985 | 9,714 | 0.0112 | 134,651 | 61 | 0.0112 | 851 | 152 | 0.0176 | 3,295 |
| | Feb | 114 | 0.0165 | 2,317 | 9 | 0.0165 | 188 | 123 | 0.0165 | 2,505 | 25 | 0.0112 | 341 | 0 | 111 | 0.0112 | 1,539 | 799 | 9,646 | 0.0112 | 133,709 | 55 | 0.0112 | 768 | 147 | 0.0165 | 2,983 |
| | Mar | 166 | 0.0154 | 3,153 | 13 | 0.0154 | 255 | 179 | 0.0154 | 3,407 | 34 | 0.0112 | 470 | 0 | 123 | 0.0112 | 1,705 | 901 | 9,608 | 0.0112 | 133,169 | 61 | 0.0112 | 851 | 204 | 0.0154 | 3,883 |
| | Apr | 634 | 0.0143 | 11,190 | 51 | 0.0143 | 906 | 686 | 0.0143 | 12,096 | 93 | 0.0112 | 1,283 | 0 | 0 | 0.0112 | 0 | 2,591 | 10,141 | 0.0112 | 140,568 | 59 | 0.0112 | 823 | 565 | 0.0143 | 9,968 |
| | May | 7,428 | 0.0131 | 120,020 | 602 | 0.0131 | 9,722 | 8,029 | 0.0131 | 129,742 | 1,089 | 0.0112 | 15,089 | 148 | 0 | 0.0112 | 0 | 20,507 | 16,572 | 0.0112 | 229,705 | 361 | 0.0112 | 5,009 | 6,011 | 0.0131 | 97,123 |
| | Jun | 3,025 | 0.0141 | 52,608 | 245 | 0.0141 | 4,261 | 3,270 | 0.0141 | 56,869 | 343 | 0.0112 | 4,756 | 252 | 735 | 0.0112 | 10,182 | 15,039 | 17,000 | 0.0112 | 235,635 | 1,512 | 0.0112 | 20,961 | 1,499 | 0.0141 | 26,064 |
| | Jul | 543 | 0.0110 | 7,361 | 44 | 0.0110 | 596 | 586 | 0.0110 | 7,957 | 69 | 0.0112 | 961 | 267 | 1,759 | 0.0112 | 24,364 | 3,526 | 15,431 | 0.0112 | 213,891 | 61 | 0.0112 | 851 | 244 | 0.0110 | 3,311 |
| | Aug | 248 | 0.0176 | 5,394 | 20 | 0.0176 | 437 | 269 | 0.0176 | 5,830 | 28 | 0.0112 | 385 | 220 | 2,183 | 0.0112 | 30,239 | 5,102 | 13,207 | 0.0112 | 183,064 | 61 | 0.0112 | 851 | 113 | 0.0176 | 2,448 |
| | Sep | 255 | 0.0240 | 7,542 | 21 | 0.0240 | 611 | 275 | 0.0240 | 8,153 | 25 | 0.0112 | 342 | 132 | 3 | 0.0112 | 36 | 6,637 | 13,244 | 0.0112 | 183,578 | 59 | 0.0112 | 823 | 134 | 0.0240 | 3,955 |
| WY Total/Average | | 12,987 | 0.0139 | 221,312 | 1,052 | 0.0139 | 18,088 | 14,039 | 0.0139 | 241,400 | 1,833 | 0.0112 | 25,409 | 1,124 | 5,300 | 0.0112 | 78,849 | 40,981 | 12,010 | 0.0112 | 166,407 | 2,476 | 0.0112 | 34,311 | 9,467 | 0.0139 | 162,760 |

Date September 25, 2006

Table C-1

Flow and Phosphorus Routing WITH Proposed Narrows Project

## Narrows Reservoir Operation

| Year Month | (Fremont-Noble) Natural Flow-Gooseberry Creek Near Fairview: Flow Acre-Feet | Concentration mg/l | Weight grams | (Fremont-Noble) Other Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Total Inflow at Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | Narrows Reservoir — Diversion by Cottonwood-Gooseberry: Flow Acre-Feet | Concentration mg/l | Weight grams | Reservoir Evaporation: Acre-Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct | 210 | 0.0209 | 5,404 | 17 | 0.0209 | 438 | 227 | 0.0209 | 5,841 | 19 | 0.0089 | 207 | 41 |
| Nov | 170 | 0.0198 | 4,146 | 14 | 0.0198 | 336 | 183 | 0.0198 | 4,481 | 25 | 0.0089 | 270 | 24 |
| Dec | 168 | 0.0187 | 3,875 | 14 | 0.0187 | 314 | 182 | 0.0187 | 4,188 | 22 | 0.0089 | 243 | 0 |
| 1998 Jan | 130 | 0.0176 | 2,813 | 10 | 0.0176 | 228 | 140 | 0.0176 | 3,041 | 21 | 0.0089 | 233 | 0 |
| Feb | 140 | 0.0165 | 2,851 | 11 | 0.0165 | 231 | 151 | 0.0165 | 3,082 | 20 | 0.0089 | 225 | 0 |
| Mar | 204 | 0.0154 | 3,867 | 16 | 0.0154 | 313 | 220 | 0.0154 | 4,181 | 29 | 0.0089 | 321 | 0 |
| Apr | 642 | 0.0143 | 11,328 | 52 | 0.0143 | 918 | 694 | 0.0143 | 12,245 | 97 | 0.0089 | 1,064 | 0 |
| May | 4,626 | 0.0131 | 74,747 | 373 | 0.0131 | 6,034 | 5,000 | 0.0131 | 80,801 | 1,091 | 0.0089 | 11,991 | 183 |
| Jun | 2,818 | 0.0100 | 34,765 | 228 | 0.0100 | 2,816 | 3,047 | 0.0100 | 37,581 | 370 | 0.0089 | 4,063 | 253 |
| Jul | 759 | 0.0110 | 10,293 | 61 | 0.0110 | 834 | 820 | 0.0110 | 11,127 | 64 | 0.0089 | 699 | 307 |
| Aug | 337 | 0.0176 | 7,323 | 27 | 0.0176 | 593 | 365 | 0.0176 | 7,916 | 30 | 0.0089 | 325 | 232 |
| Sep | 240 | 0.0150 | 4,440 | 19 | 0.0150 | 360 | 260 | 0.0150 | 4,807 | 32 | 0.0089 | 353 | 134 |
| WY Total/Average | 10,443 | 0.0129 | 165,857 | 846 | 0.0129 | 13,434 | 11,289 | 0.0129 | 179,291 | 1,810 | 0.0089 | 19,900 | 1,186 |
| Oct | 197 | 0.0209 | 5,084 | 16 | 0.0209 | 412 | 213 | 0.0209 | 5,495 | 33 | 0.0108 | 447 | 82 |
| Nov | 167 | 0.0198 | 4,079 | 14 | 0.0198 | 330 | 181 | 0.0198 | 4,410 | 29 | 0.0108 | 386 | 24 |
| Dec | 85 | 0.0187 | 1,966 | 7 | 0.0187 | 159 | 92 | 0.0187 | 2,125 | 28 | 0.0108 | 373 | 0 |
| 1999 Jan | 67 | 0.0176 | 1,458 | 5 | 0.0176 | 118 | 73 | 0.0176 | 1,576 | 27 | 0.0108 | 359 | 0 |
| Feb | 85 | 0.0165 | 1,737 | 7 | 0.0165 | 141 | 93 | 0.0165 | 1,877 | 30 | 0.0108 | 403 | 0 |
| Mar | 127 | 0.0154 | 2,413 | 10 | 0.0154 | 195 | 137 | 0.0154 | 2,609 | 41 | 0.0108 | 546 | 0 |
| Apr | 339 | 0.0143 | 5,977 | 27 | 0.0143 | 484 | 366 | 0.0143 | 6,461 | 105 | 0.0108 | 1,393 | 0 |
| May | 3,776 | 0.0131 | 61,012 | 306 | 0.0131 | 4,942 | 4,082 | 0.0131 | 65,954 | 634 | 0.0108 | 8,400 | 180 |
| Jun | 2,882 | 0.0230 | 81,749 | 233 | 0.0230 | 6,621 | 3,115 | 0.0230 | 88,371 | 367 | 0.0108 | 4,851 | 287 |
| Jul | 619 | 0.0110 | 8,385 | 50 | 0.0110 | 679 | 668 | 0.0110 | 9,064 | 102 | 0.0108 | 1,361 | 287 |
| Aug | 436 | 0.0250 | 12,823 | 34 | 0.0250 | 1,039 | 469 | 0.0250 | 13,851 | 45 | 0.0108 | 603 | 223 |
| Sep | 293 | 0.0240 | 8,678 | 24 | 0.0240 | 703 | 317 | 0.0240 | 9,383 | 32 | 0.0108 | 424 | 133 |
| WY Total/Average | 9,052 | 0.0175 | 195,339 | 733 | 0.0175 | 15,826 | 9,785 | 0.0175 | 211,185 | 1,471 | 0.0108 | 19,650 | 1,174 |
| Oct | 138 | 0.0209 | 4,077 | 11 | 0.0209 | 330 | 151 | 0.0209 | 4,408 | 41 | 0.0073 | 369 | 82 |
| Nov | 139 | 0.0198 | 3,394 | 11 | 0.0198 | 275 | 150 | 0.0198 | 3,669 | 38 | 0.0073 | 343 | 24 |
| Dec | 94 | 0.0187 | 2,159 | 8 | 0.0187 | 175 | 101 | 0.0187 | 2,334 | 19 | 0.0073 | 167 | 0 |
| 2000 Jan | 82 | 0.0176 | 1,790 | 7 | 0.0176 | 145 | 89 | 0.0176 | 1,935 | 11 | 0.0073 | 97 | 0 |
| Feb | 80 | 0.0165 | 1,633 | 7 | 0.0165 | 132 | 87 | 0.0165 | 1,767 | 17 | 0.0073 | 156 | 0 |
| Mar | 123 | 0.0154 | 2,331 | 10 | 0.0154 | 189 | 133 | 0.0154 | 2,520 | 29 | 0.0073 | 263 | 0 |
| Apr | 821 | 0.0143 | 14,484 | 67 | 0.0143 | 1,173 | 888 | 0.0143 | 15,657 | 66 | 0.0073 | 598 | 0 |
| May | 3,179 | 0.0131 | 51,363 | 257 | 0.0131 | 4,160 | 3,436 | 0.0131 | 55,524 | 711 | 0.0073 | 6,425 | 184 |
| Jun | 1,040 | 0.0100 | 12,825 | 84 | 0.0100 | 1,039 | 1,124 | 0.0100 | 13,864 | 513 | 0.0073 | 4,631 | 245 |
| Jul | 322 | 0.0116 | 4,364 | 26 | 0.0110 | 353 | 348 | 0.0110 | 4,717 | 106 | 0.0073 | 953 | 231 |
| Aug | 198 | 0.0180 | 4,360 | 16 | 0.0180 | 353 | 212 | 0.0180 | 4,712 | 77 | 0.0073 | 694 | 203 |
| Sep | 156 | 0.0240 | 4,429 | 13 | 0.0240 | 359 | 162 | 0.0240 | 4,787 | 32 | 0.0073 | 482 | 153 |
| WY Total/Average | 6,373 | 0.0136 | 107,211 | 517 | 0.0136 | 8,684 | 6,900 | 0.0136 | 115,895 | 1,681 | 0.0073 | 15,177 | 1,124 |
| Oct | 153 | 0.0209 | 3,946 | 12 | 0.0209 | 320 | 166 | 0.0209 | 4,277 | 49 | 0.0074 | 443 | 71 |
| Nov | 127 | 0.0198 | 3,099 | 10 | 0.0198 | 250 | 137 | 0.0198 | 3,343 | 45 | 0.0074 | 410 | 33 |
| Dec | 39 | 0.0187 | 887 | 3 | 0.0187 | 72 | 42 | 0.0187 | 959 | 35 | 0.0074 | 314 | 0 |
| 2001 Jan | 46 | 0.0176 | 996 | 4 | 0.0176 | 81 | 50 | 0.0176 | 1,077 | 30 | 0.0074 | 276 | 0 |
| Feb | 58 | 0.0165 | 1,183 | 5 | 0.0165 | 96 | 63 | 0.0165 | 1,279 | 27 | 0.0074 | 244 | 0 |
| Mar | 131 | 0.0154 | 2,494 | 11 | 0.0154 | 202 | 142 | 0.0154 | 2,696 | 46 | 0.0074 | 422 | 0 |
| Apr | 907 | 0.0143 | 15,999 | 73 | 0.0143 | 1,296 | 981 | 0.0143 | 17,295 | 308 | 0.0074 | 2,798 | 0 |
| May | 3,624 | 0.0131 | 58,565 | 294 | 0.0131 | 4,744 | 3,918 | 0.0131 | 63,309 | 879 | 0.0074 | 7,983 | 158 |
| Jun | 696 | 0.0100 | 8,584 | 56 | 0.0100 | 695 | 752 | 0.0100 | 9,279 | 212 | 0.0074 | 1,926 | 221 |
| Jul | 277 | 0.0110 | 3,757 | 22 | 0.0110 | 304 | 299 | 0.0110 | 4,061 | 67 | 0.0074 | 610 | 225 |
| Aug | 184 | 0.0100 | 2,271 | 15 | 0.0100 | 184 | 199 | 0.0100 | 2,455 | 42 | 0.0074 | 382 | 177 |
| Sep | 110 | 0.0240 | 3,261 | 9 | 0.0240 | 264 | 119 | 0.0240 | 3,527 | 39 | 0.0074 | 353 | 113 |
| WY Total/Average | 6,353 | 0.0134 | 105,050 | 515 | 0.0134 | 8,509 | 6,867 | 0.0134 | 113,559 | 1,780 | 0.0074 | 16,161 | 988 |

| Year Month | Narrows Reservoir — Project Irrigation Delivery: Acre-Feet | mg/l | grams | (CALC.) Phosphorus Uptake grams | End of Month: Content Total Acre-Feet | Phosphorus mg/l Table D-1 | Phosphorus grams | (Fremont-Noble) Stream Flow below Narrows Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir: Flow Acre-Feet | Concentration mg/l | Weight grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 477 | 0.0121 | 63,500 | | | | | | |
| Oct | 123 | 0.0089 | 1,358 | 43,179 | 13,187 | 0.0089 | 145,086 | 61 | 0.0089 | 673 | 164 | 0.0209 | 4,213 |
| Nov | 119 | 0.0089 | 1,309 | 2,724 | 13,143 | 0.0089 | 144,326 | 59 | 0.0089 | 653 | 161 | 0.0198 | 3,922 |
| Dec | 123 | 0.0089 | 1,353 | 2,192 | 13,119 | 0.0089 | 144,254 | 61 | 0.0089 | 675 | 153 | 0.0187 | 3,525 |
| 1998 Jan | 123 | 0.0089 | 1,353 | 1,501 | 13,053 | 0.0089 | 143,531 | 61 | 0.0089 | 675 | 182 | 0.0176 | 3,952 |
| Feb | 111 | 0.0089 | 1,221 | 1,417 | 13,017 | 0.0089 | 143,141 | 55 | 0.0089 | 608 | 209 | 0.0165 | 4,251 |
| Mar | 123 | 0.0089 | 1,353 | 1,761 | 13,024 | 0.0089 | 143,213 | 61 | 0.0089 | 675 | 265 | 0.0154 | 5,072 |
| Apr | 0 | 0.0089 | 0 | 4,611 | 13,562 | 0.0089 | 149,130 | 59 | 0.0089 | 653 | 573 | 0.0143 | 10,102 |
| May | 0 | 0.0089 | 0 | 27,831 | 16,936 | 0.0089 | 186,235 | 361 | 0.0089 | 3,974 | 3,201 | 0.0131 | 51,724 |
| Jun | 737 | 0.0089 | 8,078 | 6,884 | 17,000 | 0.0089 | 186,934 | 1,624 | 0.0089 | 17,856 | 1,392 | 0.0100 | 17,166 |
| Jul | 1,758 | 0.0089 | 19,328 | 5,043 | 15,671 | 0.0089 | 172,316 | 61 | 0.0089 | 673 | 385 | 0.0110 | 5,226 |
| Aug | 2,183 | 0.0089 | 24,003 | 6,353 | 13,539 | 0.0089 | 148,875 | 61 | 0.0089 | 673 | 171 | 0.0176 | 3,703 |
| Sep | 3 | 0.0089 | 29 | 3,046 | 13,550 | 0.0089 | 149,001 | 59 | 0.0089 | 653 | 128 | 0.0150 | 2,359 |
| WY Total/Average | 5,400 | 0.0089 | 59,379 | 106,181 | 14,067 | 0.0089 | 154,680 | 2,587 | 0.0089 | 28,449 | 6,984 | 0.0134 | 115,222 |
| Oct | 123 | 0.0108 | 1,642 | -38,127 | 13,464 | 0.0108 | 179,719 | 61 | 0.0108 | 819 | 151 | 0.0209 | 3,936 |
| Nov | 119 | 0.0108 | 1,588 | 2,320 | 13,413 | 0.0108 | 179,047 | 59 | 0.0108 | 793 | 157 | 0.0198 | 3,830 |
| Dec | 123 | 0.0108 | 1,642 | 895 | 13,293 | 0.0108 | 177,443 | 61 | 0.0108 | 819 | 87 | 0.0187 | 2,002 |
| 1999 Jan | 123 | 0.0108 | 1,642 | 807 | 13,155 | 0.0108 | 175,593 | 61 | 0.0108 | 819 | 42 | 0.0176 | 913 |
| Feb | 111 | 0.0108 | 1,482 | 686 | 13,050 | 0.0108 | 174,197 | 55 | 0.0108 | 740 | 79 | 0.0165 | 1,607 |
| Mar | 123 | 0.0108 | 1,642 | 776 | 12,962 | 0.0108 | 173,023 | 61 | 0.0108 | 819 | 149 | 0.0154 | 2,657 |
| Apr | 0 | 0.0108 | 0 | 1,572 | 13,165 | 0.0108 | 175,724 | 59 | 0.0108 | 793 | 278 | 0.0143 | 4,896 |
| May | 0 | 0.0108 | 0 | 15,099 | 16,007 | 0.0108 | 214,495 | 361 | 0.0108 | 4,824 | 2,349 | 0.0131 | 37,951 |
| Jun | 733 | 0.0108 | 9,806 | 50,095 | 17,000 | 0.0108 | 226,919 | 839 | 0.0108 | 11,193 | 1,424 | 0.0230 | 40,410 |
| Jul | 1,758 | 0.0108 | 23,462 | 3,705 | 15,460 | 0.0108 | 206,631 | 61 | 0.0108 | 819 | 293 | 0.0110 | 3,980 |
| Aug | 2,193 | 0.0108 | 29,149 | 10,608 | 13,419 | 0.0108 | 179,122 | 61 | 0.0108 | 819 | 222 | 0.0250 | 6,859 |
| Sep | 3 | 0.0108 | 33 | 7,107 | 13,489 | 0.0108 | 180,054 | 59 | 0.0108 | 793 | 139 | 0.0240 | 4,431 |
| WY Total/Average | 5,400 | 0.0108 | 72,080 | 64,366 | 13,597 | 0.0108 | 186,831 | 1,802 | 0.0108 | 24,054 | 5,372 | 0.0171 | 113,431 |
| Oct | 120 | 0.0073 | 1,111 | 41,833 | 13,353 | 0.0073 | 120,595 | 64 | 0.0073 | 554 | 164 | 0.0209 | 3,054 |
| Nov | 118 | 0.0073 | 1,075 | 2,538 | 13,263 | 0.0073 | 119,780 | 59 | 0.0073 | 536 | 118 | 0.0198 | 2,872 |
| Dec | 123 | 0.0073 | 1,111 | 1,620 | 13,161 | 0.0073 | 118,862 | 64 | 0.0073 | 554 | 92 | 0.0187 | 2,137 |
| 2000 Jan | 123 | 0.0073 | 1,111 | 1,110 | 13,053 | 0.0073 | 117,904 | 61 | 0.0073 | 554 | 76 | 0.0176 | 1,617 |
| Feb | 111 | 0.0073 | 1,002 | 993 | 12,958 | 0.0073 | 117,029 | 55 | 0.0073 | 501 | 61 | 0.0165 | 1,266 |
| Mar | 123 | 0.0073 | 1,111 | 1,232 | 12,878 | 0.0073 | 116,300 | 61 | 0.0073 | 554 | 132 | 0.0154 | 2,520 |
| Apr | 0 | 0.0073 | 0 | 7,641 | 13,640 | 0.0073 | 123,182 | 59 | 0.0073 | 536 | 797 | 0.0143 | 13,172 |
| May | 0 | 0.0073 | 0 | 38,334 | 15,819 | 0.0073 | 142,862 | 364 | 0.0073 | 3,264 | 1,716 | 0.0131 | 28,229 |
| Jun | 733 | 0.0073 | 6,636 | 5,926 | 15,291 | 0.0073 | 138,099 | 59 | 0.0073 | 536 | 470 | 0.0100 | 5,790 |
| Jul | 1,758 | 0.0073 | 15,874 | 3,440 | 13,563 | 0.0073 | 122,487 | 61 | 0.0073 | 554 | 100 | 0.0110 | 1,353 |
| Aug | 2,183 | 0.0073 | 19,715 | 4,626 | 11,251 | 0.0073 | 101,616 | 61 | 0.0073 | 554 | 79 | 0.0180 | 1,750 |
| Sep | 3 | 0.0073 | 23 | 4,548 | 11,162 | 0.0073 | 100,807 | 59 | 0.0073 | 536 | 89 | 0.0240 | 2,669 |
| WY Total/Average | 5,400 | 0.0073 | 48,508 | 123,961 | 13,291 | 0.0073 | 120,035 | 1,023 | 0.0073 | 9,236 | 3,846 | 0.0141 | 66,621 |
| Oct | 123 | 0.0074 | 1,117 | 2,853 | 11,026 | 0.0074 | 100,115 | 61 | 0.0074 | 557 | 114 | 0.0209 | 2,946 |
| Nov | 119 | 0.0074 | 1,081 | 2,287 | 10,916 | 0.0074 | 99,136 | 59 | 0.0074 | 539 | 105 | 0.0198 | 2,448 |
| Dec | 123 | 0.0074 | 1,117 | 582 | 10,739 | 0.0074 | 97,525 | 61 | 0.0074 | 557 | 69 | 0.0187 | 1,182 |
| 2001 Jan | 123 | 0.0074 | 1,117 | 626 | 10,573 | 0.0074 | 96,025 | 61 | 0.0074 | 557 | -6 | 0.0176 | -123 |
| Feb | 111 | 0.0074 | 1,008 | 708 | 10,443 | 0.0074 | 94,840 | 55 | 0.0074 | 503 | 14 | 0.0165 | 286 |
| Mar | 123 | 0.0074 | 1,117 | 1,409 | 10,354 | 0.0074 | 94,033 | 61 | 0.0074 | 557 | 147 | 0.0154 | 2,791 |
| Apr | 0 | 0.0074 | 0 | 8,371 | 10,967 | 0.0074 | 99,601 | 59 | 0.0074 | 539 | 830 | 0.0143 | 14,646 |
| May | 0 | 0.0074 | 0 | 29,157 | 13,487 | 0.0074 | 122,487 | 361 | 0.0074 | 3,282 | 2,193 | 0.0131 | 35,497 |
| Jun | 733 | 0.0074 | 6,672 | 4,453 | 13,012 | 0.0074 | 118,171 | 59 | 0.0074 | 539 | 292 | 0.0100 | 3,398 |
| Jul | 1,758 | 0.0074 | 15,963 | 3,187 | 11,200 | 0.0074 | 101,715 | 61 | 0.0074 | 557 | 70 | 0.0110 | 958 |
| Aug | 2,183 | 0.0074 | 19,826 | 2,254 | 8,938 | 0.0074 | 81,156 | 61 | 0.0074 | 557 | 71 | 0.0100 | 876 |
| Sep | 3 | 0.0074 | 24 | 3,473 | 9,841 | 0.0074 | 80,292 | 59 | 0.0074 | 539 | 73 | 0.0240 | 2,160 |
| WY Total/Average | 5,400 | 0.0074 | 49,041 | 59,562 | 10,874 | 0.0074 | 98,758 | 1,023 | 0.0074 | 9,208 | 3,993 | 0.0128 | 67,233 |

Table C-1

Date: September 25, 2006

# Flow and Phosphorus Routing WITH Proposed Narrows Project

## Narrows Reservoir Operation

| Year | Month | (Franson-Noble) Natural Flow-Gooseberry Creek Near Fairview Flow Acre-Feet | Concentration mg/l | Weight grams | Other Inflow at Narrows Reservoir Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Total Inflow at Narrows Reservoir Flow Acre-Feet | Concentration mg/l | Weight grams | Narrows Reservoir: Diversion by Cottonwood-Gooseberry Flow Acre-Feet | Concentration mg/l | Weight grams | Reservoir Evaporation Acre-Feet | Project Irrigation Delivery Acre-Feet | mg/l | grams | (CALC.) Phosphorus Uptake grams | End of Month Contents Total Acre-Feet | Phosphorus mg/l Table D-1 | Phosphorus grams | (Franson-Noble) Stream Flow below Narrows Reservoir Flow Acre-Feet | Concentration mg/l | Weight grams | (CALC.) Reach Gains Between Narrows Reservoir Site and Lower Gooseberry Reservoir Flow Acre-Feet | Concentration mg/l | Weight grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | 8677 | 0.0121 | 63,900 | | | | | | |
| | Oct | 92 | 0.0209 | 2,384 | 7 | 0.0209 | 193 | 100 | 0.0209 | 2,577 | 28 | 0.0066 | 226 | 40 | 121 | 0.0066 | 1,005 | 10,273 | 8,601 | 0.0066 | 70,863 | 61 | 0.0066 | 502 | 61 | 0.0209 | 1,580 |
| | Nov | 121 | 0.0198 | 2,953 | 10 | 0.0198 | 239 | 131 | 0.0198 | 3,192 | 23 | 0.0066 | 187 | 17 | 110 | 0.0066 | 871 | 2,265 | 8,582 | 0.0066 | 70,145 | 59 | 0.0066 | 486 | 92 | 0.0198 | 2,236 |
| | Dec | 79 | 0.0187 | 1,834 | 6 | 0.0187 | 149 | 86 | 0.0187 | 1,982 | 7 | 0.0066 | 55 | 0 | 123 | 0.0066 | 1,005 | 1,280 | 8,476 | 0.0066 | 69,285 | 61 | 0.0066 | 502 | 82 | 0.0187 | 1,897 |
| 2002 | Jan | 56 | 0.0176 | 1,209 | 4 | 0.0176 | 98 | 60 | 0.0176 | 1,307 | 2 | 0.0066 | 13 | 0 | 123 | 0.0066 | 1,005 | 815 | 8,351 | 0.0066 | 68,257 | 61 | 0.0066 | 502 | 16 | 0.0176 | 354 |
| | Feb | 46 | 0.0165 | 936 | 4 | 0.0165 | 76 | 50 | 0.0165 | 1,012 | 6 | 0.0066 | 49 | 0 | 111 | 0.0066 | 907 | 606 | 8,228 | 0.0066 | 67,254 | 55 | 0.0066 | 453 | -14 | 0.0165 | -292 |
| | Mar | 58 | 0.0154 | 1,097 | 5 | 0.0154 | 89 | 62 | 0.0154 | 1,186 | 29 | 0.0066 | 236 | 0 | 123 | 0.0066 | 1,005 | 676 | 8,077 | 0.0066 | 66,021 | 61 | 0.0066 | 502 | 25 | 0.0154 | 474 |
| | Apr | 740 | 0.0143 | 13,057 | 60 | 0.0143 | 1,058 | 800 | 0.0143 | 14,115 | 179 | 0.0066 | 1,466 | 0 | 0 | 0.0066 | 0 | 7,574 | 8,638 | 0.0066 | 70,610 | 59 | 0.0066 | 486 | 668 | 0.0143 | 11,784 |
| | May | 2,448 | 0.0131 | 39,554 | 198 | 0.0131 | 3204 | 2,646 | 0.0131 | 42,757 | 625 | 0.0066 | 5,107 | 131 | 0 | 0.0066 | 0 | 22,198 | 10,168 | 0.0066 | 83,109 | 361 | 0.0066 | 2,954 | 1,017 | 0.0131 | 16,433 |
| | Jun | 505 | 0.0141 | 8,741 | 41 | 0.0141 | 708 | 547 | 0.0141 | 9,449 | 99 | 0.0066 | 811 | 180 | 731 | 0.0066 | 6,003 | 6,480 | 9,638 | 0.0066 | 78,777 | 59 | 0.0066 | 486 | 192 | 0.0141 | 3,351 |
| | Jul | 232 | 0.0110 | 3,149 | 19 | 0.0110 | 255 | 251 | 0.0110 | 3,404 | 36 | 0.0066 | 293 | 198 | 1,758 | 0.0066 | 14,367 | 2,826 | 7,853 | 0.0066 | 64,190 | 61 | 0.0066 | 502 | 41 | 0.0110 | 559 |
| | Aug | 114 | 0.0176 | 2,464 | 9 | 0.0176 | 200 | 123 | 0.0176 | 2,664 | 27 | 0.0066 | 223 | 138 | 2,187 | 0.0066 | 17,844 | 3,755 | 5,570 | 0.0066 | 45,530 | 61 | 0.0066 | 502 | 25 | 0.0176 | 539 |
| | Sep | 104 | 0.0240 | 3,080 | 8 | 0.0240 | 249 | 112 | 0.0240 | 3,329 | 18 | 0.0066 | 149 | 76 | 3 | 0.0066 | 21 | 3,024 | 5,526 | 0.0066 | 45,170 | 59 | 0.0066 | 486 | 70 | 0.0240 | 2,093 |
| WY Total/Average | | 4,593 | 0.0142 | 80,458 | 372 | 0.0142 | 6517 | 4,965 | 0.0142 | 86,975 | 1,079 | 0.0066 | 8,818 | 778 | 5,400 | 0.0066 | 44,119 | 60,780 | 8,148 | 0.0066 | 66,601 | 1,023 | 0.0066 | 8,360 | 2,371 | 0.0146 | 40,985 |
| | Oct | 60 | 0.0209 | 1,538 | 3 | 0.0209 | 125 | 64 | 0.0209 | 1,663 | 58 | 0.0072 | 509 | 40 | 123 | 0.0072 | 1,087 | 12,237 | 5,308 | 0.0072 | 46,931 | 61 | 0.0072 | 543 | 180 | 0.0209 | 4,631 |
| | Nov | 53 | 0.0198 | 1,293 | 4 | 0.0198 | 105 | 57 | 0.0198 | 1,398 | 49 | 0.0072 | 422 | 11 | 119 | 0.0072 | 1,052 | 903 | 5,128 | 0.0072 | 45,337 | 59 | 0.0072 | 525 | 115 | 0.0198 | 2,814 |
| | Dec | 14 | 0.0187 | 323 | 1 | 0.0187 | 26 | 15 | 0.0187 | 349 | 14 | 0.0072 | 124 | 0 | 123 | 0.0072 | 1,087 | 215 | 4,945 | 0.0072 | 43,717 | 61 | 0.0072 | 543 | 26 | 0.0187 | 592 |
| 2003 | Jan | 45 | 0.0176 | 968 | 4 | 0.0176 | 78 | 48 | 0.0176 | 1,046 | 3 | 0.0072 | 30 | 0 | 123 | 0.0072 | 1,087 | 620 | 4,805 | 0.0072 | 42,483 | 61 | 0.0072 | 543 | 9 | 0.0176 | 194 |
| | Feb | 52 | 0.0165 | 1,055 | 4 | 0.0165 | 85 | 56 | 0.0165 | 1,141 | 13 | 0.0072 | 111 | 8 | 111 | 0.0072 | 981 | 645 | 4,682 | 0.0072 | 41,396 | 55 | 0.0072 | 490 | 54 | 0.0165 | 1,089 |
| | Mar | 60 | 0.0154 | 1,140 | 5 | 0.0154 | 92 | 65 | 0.0154 | 1,232 | 40 | 0.0072 | 353 | 0 | 123 | 0.0072 | 1,087 | 659 | 4,502 | 0.0072 | 39,806 | 61 | 0.0072 | 543 | 130 | 0.0154 | 2,478 |
| | Apr | 374 | 0.0143 | 6,597 | 30 | 0.0143 | 534 | 404 | 0.0143 | 7,131 | 374 | 0.0072 | 3,303 | 0 | 0 | 0.0072 | 0 | 3,557 | 4,474 | 0.0072 | 39,553 | 59 | 0.0072 | 525 | 712 | 0.0143 | 12,556 |
| | May | 2,638 | 0.0131 | 42,626 | 214 | 0.0131 | 3453 | 2,852 | 0.0131 | 46,079 | 1,302 | 0.0072 | 11,508 | 75 | 0 | 0.0072 | 0 | 21,350 | 5,889 | 0.0072 | 52,052 | 61 | 0.0072 | 543 | 4,355 | 0.0131 | 70,367 |
| | Jun | 704 | 0.0180 | 15,625 | 57 | 0.0180 | 1,263 | 761 | 0.0180 | 16,888 | 207 | 0.0072 | 1,828 | 115 | 731 | 0.0072 | 6,495 | 11,181 | 5,532 | 0.0072 | 48,912 | 59 | 0.0072 | 525 | 1,165 | 0.0180 | 25,817 |
| | Jul | 169 | 0.0173 | 3,613 | 14 | 0.0173 | 293 | 183 | 0.0173 | 3,906 | 75 | 0.0072 | 665 | 118 | 1,519 | 0.0072 | 13,540 | 3,295 | 3,707 | 0.0072 | 32,777 | 61 | 0.0072 | 543 | 243 | 0.0173 | 5,229 |
| | Aug | 125 | 0.0160 | 2,473 | 10 | 0.0160 | 200 | 135 | 0.0160 | 2,673 | 57 | 0.0072 | 502 | 70 | 1,155 | 0.0072 | 10,208 | 2,095 | 2,500 | 0.0072 | 22,102 | 61 | 0.0072 | 543 | 155 | 0.0160 | 3,071 |
| | Sep | 61 | 0.0240 | 1,815 | 5 | 0.0240 | 147 | 66 | 0.0240 | 1,963 | 38 | 0.0072 | 337 | 36 | 0 | 0.0072 | 0 | 1,709 | 2,431 | 0.0072 | 21,494 | 59 | 0.0072 | 525 | 139 | 0.0240 | 4,124 |
| WY Total/Average | | 4,355 | 0.0147 | 79,067 | 351 | 0.0147 | 6,404 | 4,707 | 0.0147 | 85,471 | 2,248 | 0.0072 | 19,870 | 483 | 4,569 | 0.0072 | 39,820 | 44,261 | 4,402 | 0.0072 | 39,715 | 723 | 0.0072 | 6,389 | 7,282 | 0.0147 | 132,940 |
| | Oct | 37 | 0.0209 | 954 | 3 | 0.0209 | 77 | 40 | 0.0209 | 1,031 | 57 | 0.0107 | 486 | 19 | 0 | 0.0107 | 0 | -9,882 | 2,354 | 0.0107 | 31,110 | 61 | 0.0107 | 811 | 113 | 0.0209 | 2,905 |
| | Nov | 75 | 0.0198 | 1,836 | 6 | 0.0198 | 149 | 81 | 0.0198 | 1,985 | 50 | 0.0107 | 403 | 6 | 0 | 0.0107 | 0 | 984 | 2,319 | 0.0107 | 30,923 | 59 | 0.0107 | 785 | 122 | 0.0198 | 2,983 |
| | Dec | 53 | 0.0187 | 1,186 | 4 | 0.0187 | 96 | 56 | 0.0187 | 1,282 | 9 | 0.0107 | 119 | 0 | 0 | 0.0107 | 0 | 347 | 2,325 | 0.0107 | 30,727 | 61 | 0.0107 | 811 | 86 | 0.0187 | 1,994 |
| 2004 | Jan | 60 | 0.0176 | 1,312 | 5 | 0.0176 | 106 | 65 | 0.0176 | 1,419 | 2 | 0.0107 | 28 | 0 | 0 | 0.0107 | 0 | 333 | 2,320 | 0.0107 | 30,712 | 61 | 0.0107 | 811 | 73 | 0.0176 | 1,582 |
| | Feb | 62 | 0.0165 | 1,257 | 5 | 0.0165 | 102 | 67 | 0.0165 | 1,359 | 8 | 0.0107 | 106 | 0 | 0 | 0.0107 | 0 | 476 | 2,330 | 0.0107 | 30,795 | 55 | 0.0107 | 733 | 86 | 0.0165 | 1,749 |
| | Mar | 87 | 0.0154 | 1,644 | 7 | 0.0154 | 133 | 94 | 0.0154 | 1,777 | 39 | 0.0107 | 509 | 0 | 0 | 0.0107 | 0 | 541 | 2,323 | 0.0107 | 30,712 | 61 | 0.0107 | 811 | 198 | 0.0154 | 3,760 |
| | Apr | 674 | 0.0143 | 11,894 | 55 | 0.0143 | 963 | 729 | 0.0143 | 12,858 | 238 | 0.0107 | 3,156 | 0 | 0 | 0.0107 | 0 | 3,205 | 2,754 | 0.0107 | 36,406 | 59 | 0.0107 | 785 | 1,193 | 0.0143 | 21,050 |
| | May | 1,854 | 0.0131 | 29,956 | 150 | 0.0131 | 2426 | 2,004 | 0.0131 | 32,382 | 832 | 0.0107 | 10,994 | 49 | 0 | 0.0107 | 0 | 6,536 | 3,816 | 0.0107 | 50,446 | 61 | 0.0107 | 811 | 2,558 | 0.0131 | 41,332 |
| | Jun | 377 | 0.0195 | 9,096 | 31 | 0.0195 | 738 | 408 | 0.0195 | 9,833 | 132 | 0.0107 | 1,746 | 99 | 731 | 0.0107 | 9,916 | 5,443 | 3,710 | 0.0107 | 49,555 | 59 | 0.0107 | 785 | 840 | 0.0195 | 20,203 |
| | Jul | 169 | 0.0173 | 3,609 | 14 | 0.0173 | 292 | 183 | 0.0173 | 3,900 | 48 | 0.0107 | 635 | 71 | 722 | 0.0107 | 9,545 | 2,418 | 2,500 | 0.0107 | 33,045 | 61 | 0.0107 | 811 | 190 | 0.0173 | 4,058 |
| | Aug | 111 | 0.0211 | 2,890 | 9 | 0.0211 | 234 | 120 | 0.0211 | 3,124 | 36 | 0.0107 | 479 | 49 | 0 | 0.0107 | 0 | 2,190 | 2,473 | 0.0107 | 32,689 | 61 | 0.0107 | 813 | 81 | 0.0211 | 2,137 |
| | Sep | 52 | 0.0240 | 1,512 | 4 | 0.0240 | 136 | 53 | 0.0240 | 1,676 | 24 | 0.0107 | 322 | 37 | 0 | 0.0107 | 0 | 1,421 | 2,409 | 0.0107 | 31,859 | 59 | 0.0107 | 785 | 105 | 0.0240 | 3,098 |
| WY Total/Average | | 3,610 | 0.0151 | 67,100 | 292 | 0.0151 | 5,440 | 3,903 | 0.0151 | 72,866 | 1,486 | 0.0107 | 18,984 | 319 | 1,857 | 0.0107 | 19,259 | 14,470 | 2,597 | 0.0107 | 34,335 | 723 | 0.0107 | 9,557 | 5,648 | 0.0151 | 105,903 |
| | Oct | 84 | 0.0209 | 2,154 | 7 | 0.0209 | 174 | 90 | 0.0209 | 2,329 | 55 | 0.0115 | 778 | 19 | 0 | 0.0115 | 0 | -1,000 | 2,382 | 0.0115 | 33,519 | 61 | 0.0115 | 870 | 196 | 0.0209 | 5,059 |
| | Nov | 57 | 0.0198 | 1,442 | 5 | 0.0198 | 137 | 73 | 0.0198 | 1,779 | 45 | 0.0115 | 645 | 5 | 0 | 0.0115 | 0 | 824 | 2,326 | 0.0115 | 32,983 | 59 | 0.0115 | 842 | 177 | 0.0198 | 4,356 |
| | Dec | 52 | 0.0187 | 1,193 | 4 | 0.0187 | 97 | 56 | 0.0187 | 1,290 | 13 | 0.0115 | 190 | 0 | 0 | 0.0115 | 0 | 497 | 2,307 | 0.0115 | 32,715 | 61 | 0.0115 | 870 | 96 | 0.0187 | 2,207 |
| 2005 | Jan | 61 | 0.0176 | 1,321 | 5 | 0.0176 | 107 | 66 | 0.0176 | 1,428 | 3 | 0.0115 | 45 | 0 | 0 | 0.0115 | 0 | 495 | 2,308 | 0.0115 | 32,732 | 61 | 0.0115 | 870 | 77 | 0.0176 | 1,664 |
| | Feb | 61 | 0.0165 | 1,251 | 5 | 0.0165 | 101 | 66 | 0.0165 | 1,353 | 12 | 0.0115 | 179 | 5 | 0 | 0.0115 | 0 | 410 | 2,307 | 0.0115 | 32,719 | 55 | 0.0115 | 786 | 93 | 0.0165 | 1,896 |
| | Mar | 66 | 0.0154 | 1,251 | 5 | 0.0154 | 101 | 71 | 0.0154 | 1,352 | 57 | 0.0115 | 815 | 0 | 0 | 0.0115 | 0 | 343 | 2,256 | 0.0115 | 32,043 | 61 | 0.0115 | 870 | 192 | 0.0154 | 3,602 |
| | Apr | 356 | 0.0143 | 6,279 | 29 | 0.0143 | 509 | 385 | 0.0143 | 6,788 | 356 | 0.0115 | 5,093 | 0 | 0 | 0.0115 | 0 | 1,330 | 2,229 | 0.0115 | 31,605 | 59 | 0.0115 | 842 | 317 | 0.0143 | 14,430 |
| | May | 4,223 | 0.0131 | 68,233 | 342 | 0.0131 | 5527 | 4,565 | 0.0131 | 73,762 | 1,241 | 0.0115 | 17,606 | 40 | 0 | 0.0115 | 0 | 9,396 | 5,150 | 0.0115 | 73,043 | 361 | 0.0115 | 5,122 | 3,000 | 0.0131 | 50,493 |
| | Jun | 2,544 | 0.0195 | 61,179 | 206 | 0.0195 | 4,956 | 2,750 | 0.0195 | 66,135 | 197 | 0.0115 | 2,796 | 101 | 731 | 0.0115 | 10,418 | 23,383 | 6,606 | 0.0115 | 96,526 | 59 | 0.0115 | 842 | 2,122 | 0.0195 | 51,046 |
| | Jul | 310 | 0.0100 | 3,822 | 25 | 0.0100 | 310 | 335 | 0.0100 | 4,131 | 72 | 0.0115 | 1,017 | 156 | 1,758 | 0.0115 | 24,922 | 1,307 | 5,115 | 0.0115 | 72,535 | 61 | 0.0115 | 870 | 468 | 0.0100 | 5,743 |
| | Aug | 191 | 0.0100 | 2,360 | 15 | 0.0100 | 191 | 207 | 0.0100 | 2,551 | 54 | 0.0115 | 768 | 93 | 2,183 | 0.0115 | 30,960 | 937 | 2,930 | 0.0115 | 41,550 | 61 | 0.0115 | 870 | 298 | 0.0100 | 3,679 |
| | Sep | 124 | 0.0100 | 1,533 | 10 | 0.0100 | 124 | 134 | 0.0100 | 1,657 | 36 | 0.0115 | 515 | 43 | 3 | 0.0115 | 37 | 368 | 2,923 | 0.0115 | 41,446 | 59 | 0.0115 | 842 | 187 | 0.0100 | 2,301 |
| WY Total/Average | | 8,136 | 0.0152 | 152,220 | 659 | 0.0152 | 12330 | 8,798 | 0.0152 | 164,550 | 2,143 | 0.0115 | 30,396 | 440 | 4,678 | 0.0115 | 66,345 | 43,700 | 3,252 | 0.0115 | 46,118 | 1,023 | 0.0115 | 14,504 | 10,644 | 0.0152 | 191,356 |
| 78-05 | Total | 258,421 | | 4,547,412 | 20,932 | | 368,329 | 279,358 | | 4,915,741 | 57,951 | | 702,749 | 23,596 | 178,087 | | 1,643,864 | 1,853,052 | | | 2,914,558 | 61,082 | | 738,330 | 179,105 | | 3,188,314 |
| 78-05 | Average | 9,230 | 0.0143 | 162,408 | 748 | 0.0143 | 13,155 | 9,977 | 0.0143 | 175,562 | 2,070 | 0.0091 | 25,098 | 843 | 4,072 | 0.0097 | 58,709 | 66,180 | 8,889 | 0.0095 | 104,092 | 2,182 | 0.0095 | 26,370 | 6,397 | 0.0144 | 113,875 |
| 78-89 | Total | 130,677 | | 2,281,550 | 10,584 | | 184,705 | 141,261 | | 2,466,344 | 24,936 | | 294,550 | 11,892 | 64,801 | | 767,964 | 951,612 | 170,085 | | 1,531,192 | 19,083 | | 470,141 | 84,475 | | 1,493,899 |
| | Average | 10,890 | 0.0142 | 190,129 | 882 | 0.0142 | 15,400 | 11,772 | 0.0142 | 205,529 | 2,080 | 0.0096 | 24,546 | 991 | 5,400 | 0.0096 | 63,997 | 79,301 | 10,840 | 0.0095 | 127,599 | 3,257 | 0.0098 | 39,179 | 7,040 | 0.0143 | 124,491 |

NOTE: Average Annual Concentrations are Flow Weighted

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 2 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 335 | 0.0138 | 5,696 | 335 | 0.0123 | 5,093 | | | 603 | 335 | 0.0123 | 5,093 |
| | Nov | 127 | 0.0162 | 2,538 | 127 | 0.0123 | 1,928 | | | 610 | 127 | 0.0123 | 1,928 |
| | Dec | 149 | 0.0160 | 2,946 | 149 | 0.0123 | 2,268 | | | 678 | 149 | 0.0123 | 2,268 |
| 1978 | Jan | 142 | 0.0152 | 2,658 | 142 | 0.0123 | 2,150 | | | 508 | 142 | 0.0123 | 2,150 |
| | Feb | 129 | 0.0146 | 2,320 | 129 | 0.0123 | 1,955 | | | 365 | 129 | 0.0123 | 1,955 |
| | Mar | 162 | 0.0142 | 2,829 | 162 | 0.0123 | 2,461 | | | 368 | 162 | 0.0123 | 2,461 |
| | Apr | 574 | 0.0141 | 9,969 | 574 | 0.0123 | 8,721 | | | 1,248 | 574 | 0.0123 | 8,721 |
| | May | 3,078 | 0.0130 | 49,293 | 3,078 | 0.0123 | 46,741 | | | 2,552 | 3,078 | 0.0123 | 46,741 |
| | Jun | 2,618 | 0.0141 | 45,383 | 2,618 | 0.0123 | 39,754 | | | 5,628 | 2,618 | 0.0123 | 39,754 |
| | Jul | 375 | 0.0112 | 5,170 | 375 | 0.0123 | 5,692 | | | -522 | 375 | 0.0123 | 5,692 |
| | Aug | 259 | 0.0163 | 5,202 | 259 | 0.0123 | 3,930 | | | 1,272 | 259 | 0.0123 | 3,930 |
| | Sep | 159 | 0.0195 | 3,823 | 159 | 0.0123 | 2,408 | | | 1,415 | 159 | 0.0123 | 2,408 |
| WY | Total | 8,106 | 0.0138 | 137,827 | 8,106 | 0.0123 | 123,101 | | | 14,726 | 8,106 | 0.0123 | 123,101 |
| | Oct | 71 | 0.0109 | 950 | 71 | 0.0117 | 1,022 | | | -72 | 71 | 0.0117 | 1,022 |
| | Nov | 197 | 0.0167 | 4,050 | 197 | 0.0117 | 2,851 | | | 1,199 | 197 | 0.0117 | 2,851 |
| | Dec | 158 | 0.0151 | 2,930 | 158 | 0.0117 | 2,279 | | | 650 | 158 | 0.0117 | 2,279 |
| 1979 | Jan | 161 | 0.0145 | 2,871 | 161 | 0.0117 | 2,327 | | | 544 | 161 | 0.0117 | 2,327 |
| | Feb | 141 | 0.0137 | 2,391 | 141 | 0.0117 | 2,045 | | | 346 | 141 | 0.0117 | 2,045 |
| | Mar | 154 | 0.0130 | 2,478 | 154 | 0.0117 | 2,234 | | | 245 | 154 | 0.0117 | 2,234 |
| | Apr | 294 | 0.0133 | 4,820 | 294 | 0.0117 | 4,248 | | | 572 | 294 | 0.0117 | 4,248 |
| | May | 3,122 | 0.0127 | 48,805 | 3,122 | 0.0117 | 45,178 | | | 3,626 | 3,122 | 0.0117 | 45,178 |
| | Jun | 1,160 | 0.0139 | 19,825 | 1,160 | 0.0117 | 16,780 | | | 3,045 | 1,160 | 0.0117 | 16,780 |
| | Jul | 259 | 0.0106 | 3,396 | 259 | 0.0117 | 3,751 | | | -354 | 259 | 0.0117 | 3,751 |
| | Aug | 173 | 0.0147 | 3,143 | 173 | 0.0117 | 2,509 | | | 635 | 173 | 0.0117 | 2,509 |
| | Sep | 143 | 0.0179 | 3,173 | 143 | 0.0117 | 2,074 | | | 1,099 | 143 | 0.0117 | 2,074 |
| WY | Total | 6,033 | 0.0133 | 98,832 | 6,033 | 0.0117 | 87,297 | | | 11,535 | 6,033 | 0.0117 | 87,297 |
| | Oct | 162 | 0.0176 | 3,511 | 162 | 0.0124 | 2,485 | | | 1,026 | 162 | 0.0124 | 2,485 |
| | Nov | 150 | 0.0167 | 3,089 | 150 | 0.0124 | 2,295 | | | 795 | 150 | 0.0124 | 2,295 |
| | Dec | 172 | 0.0163 | 3,465 | 172 | 0.0124 | 2,637 | | | 829 | 172 | 0.0124 | 2,637 |
| 1980 | Jan | 185 | 0.0158 | 3,597 | 185 | 0.0124 | 2,835 | | | 761 | 185 | 0.0124 | 2,835 |
| | Feb | 168 | 0.0150 | 3,125 | 168 | 0.0124 | 2,582 | | | 543 | 168 | 0.0124 | 2,582 |
| | Mar | 176 | 0.0142 | 3,097 | 176 | 0.0124 | 2,703 | | | 394 | 176 | 0.0124 | 2,703 |
| | Apr | 523 | 0.0140 | 9,070 | 523 | 0.0124 | 8,025 | | | 1,045 | 523 | 0.0124 | 8,025 |
| | May | 3,114 | 0.0130 | 49,858 | 3,114 | 0.0124 | 47,737 | | | 2,121 | 3,114 | 0.0124 | 47,737 |
| | Jun | 2,785 | 0.0141 | 48,284 | 2,785 | 0.0124 | 42,691 | | | 5,593 | 2,785 | 0.0124 | 42,691 |
| | Jul | 426 | 0.0112 | 5,868 | 426 | 0.0124 | 6,538 | | | -670 | 426 | 0.0124 | 6,538 |
| | Aug | 209 | 0.0160 | 4,117 | 209 | 0.0124 | 3,203 | | | 914 | 209 | 0.0124 | 3,203 |
| | Sep | 184 | 0.0202 | 4,584 | 184 | 0.0124 | 2,826 | | | 1,758 | 184 | 0.0124 | 2,826 |
| WY | Total | 8,255 | 0.0139 | 141,665 | 8,255 | 0.0124 | 126,557 | | | 15,108 | 8,255 | 0.0124 | 126,557 |

**Table C-2**

Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/L | Weight grams | Flow Acre-Feet | mg/L Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams/Wk | Flow Acre-Feet | mg/L Table D-2 | Weight grams |
| | Oct | 214 | 0.0171 | 4,500 | 214 | 0.0113 | 2,984 | | | 1,516 | 214 | 0.0113 | 2,984 |
| | Nov | 213 | 0.0164 | 4,312 | 213 | 0.0113 | 2,977 | | | 1,334 | 213 | 0.0113 | 2,977 |
| | Dec | 191 | 0.0151 | 3,573 | 191 | 0.0113 | 2,672 | | | 901 | 191 | 0.0113 | 2,672 |
| 1981 | Jan | 205 | 0.0146 | 3,701 | 205 | 0.0113 | 2,868 | | | 833 | 205 | 0.0113 | 2,868 |
| | Feb | 182 | 0.0138 | 3,095 | 182 | 0.0113 | 2,541 | | | 554 | 182 | 0.0113 | 2,541 |
| | Mar | 259 | 0.0136 | 4,337 | 259 | 0.0113 | 3,623 | | | 714 | 259 | 0.0113 | 3,623 |
| | Apr | 874 | 0.0138 | 14,932 | 874 | 0.0113 | 12,217 | | | 2,715 | 874 | 0.0113 | 12,217 |
| | May | 1,684 | 0.0119 | 24,781 | 1,684 | 0.0113 | 23,539 | | | 1,242 | 1,684 | 0.0113 | 23,539 |
| | Jun | 620 | 0.0098 | 7,475 | 620 | 0.0113 | 8,665 | | | -1,190 | 620 | 0.0113 | 8,665 |
| | Jul | 186 | 0.0099 | 2,271 | 186 | 0.0113 | 2,601 | | | -330 | 186 | 0.0113 | 2,601 |
| | Aug | 136 | 0.0131 | 2,200 | 136 | 0.0113 | 1,902 | | | 298 | 136 | 0.0113 | 1,902 |
| | Sep | 149 | 0.0175 | 3,222 | 149 | 0.0113 | 2,087 | | | 1,135 | 149 | 0.0113 | 2,087 |
| WY | Total | 4,914 | 0.0129 | 78,397 | 4,914 | 0.0113 | 68,677 | | | 9,720 | 4,914 | 0.0113 | 68,677 |
| | Oct | 221 | 0.0182 | 4,961 | 221 | 0.0123 | 3,358 | | | 1,603 | 221 | 0.0123 | 3,358 |
| | Nov | 188 | 0.0171 | 3,977 | 188 | 0.0123 | 2,867 | | | 1,110 | 188 | 0.0123 | 2,867 |
| | Dec | 161 | 0.0159 | 3,154 | 161 | 0.0123 | 2,452 | | | 703 | 161 | 0.0123 | 2,452 |
| 1982 | Jan | 133 | 0.0147 | 2,405 | 133 | 0.0123 | 2,021 | | | 383 | 133 | 0.0123 | 2,021 |
| | Feb | 112 | 0.0139 | 1,926 | 112 | 0.0123 | 1,708 | | | 219 | 112 | 0.0123 | 1,708 |
| | Mar | 160 | 0.0138 | 2,727 | 160 | 0.0123 | 2,435 | | | 292 | 160 | 0.0123 | 2,435 |
| | Apr | 654 | 0.0140 | 11,306 | 654 | 0.0123 | 9,941 | | | 1,365 | 654 | 0.0123 | 9,941 |
| | May | 4,384 | 0.0129 | 70,020 | 4,384 | 0.0123 | 66,681 | | | 3,339 | 4,384 | 0.0123 | 66,681 |
| | Jun | 1,662 | 0.0140 | 28,697 | 1,662 | 0.0123 | 25,278 | | | 3,420 | 1,662 | 0.0123 | 25,278 |
| | Jul | 466 | 0.0110 | 6,336 | 466 | 0.0123 | 7,081 | | | -745 | 466 | 0.0123 | 7,081 |
| | Aug | 247 | 0.0160 | 4,886 | 247 | 0.0123 | 3,760 | | | 1,126 | 247 | 0.0123 | 3,760 |
| | Sep | 236 | 0.0208 | 6,067 | 236 | 0.0123 | 3,597 | | | 2,470 | 236 | 0.0123 | 3,597 |
| WY | Total | 8,625 | 0.0138 | 146,463 | 8,625 | 0.0123 | 131,177 | | | 15,286 | 8,625 | 0.0123 | 131,177 |
| | Oct | 439 | 0.0196 | 10,584 | 439 | 0.0122 | 6,590 | | | 3,994 | 439 | 0.0122 | 6,590 |
| | Nov | 433 | 0.0186 | 9,962 | 433 | 0.0122 | 6,509 | | | 3,453 | 433 | 0.0122 | 6,509 |
| | Dec | 294 | 0.0172 | 6,216 | 294 | 0.0122 | 4,412 | | | 1,804 | 294 | 0.0122 | 4,412 |
| 1983 | Jan | 327 | 0.0164 | 6,621 | 327 | 0.0122 | 4,910 | | | 1,711 | 327 | 0.0122 | 4,910 |
| | Feb | 285 | 0.0155 | 5,454 | 285 | 0.0122 | 4,287 | | | 1,167 | 285 | 0.0122 | 4,287 |
| | Mar | 344 | 0.0147 | 6,228 | 344 | 0.0122 | 5,170 | | | 1,059 | 344 | 0.0122 | 5,170 |
| | Apr | 348 | 0.0138 | 5,921 | 348 | 0.0122 | 5,228 | | | 693 | 348 | 0.0122 | 5,228 |
| | May | 1,894 | 0.0128 | 29,806 | 1,894 | 0.0122 | 28,445 | | | 1,361 | 1,894 | 0.0122 | 28,445 |
| | Jun | 10,799 | 0.0125 | 167,154 | 10,799 | 0.0122 | 162,219 | | | 4,936 | 10,799 | 0.0122 | 162,219 |
| | Jul | 1,153 | 0.0101 | 14,326 | 1,153 | 0.0122 | 17,324 | | | -2,999 | 1,153 | 0.0122 | 17,324 |
| | Aug | 369 | 0.0166 | 7,535 | 369 | 0.0122 | 5,543 | | | 1,992 | 369 | 0.0122 | 5,543 |
| | Sep | 254 | 0.0210 | 6,593 | 254 | 0.0122 | 3,817 | | | 2,776 | 254 | 0.0122 | 3,817 |
| WY | Total | 16,939 | 0.0132 | 276,400 | 16,939 | 0.0122 | 254,453 | | | 21,947 | 16,939 | 0.0122 | 254,453 |

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 357 | 0.0189 | 8,320 | 357 | 0.0110 | 4,851 | | | 3,470 | 357 | 0.0110 | 4,851 |
| | Nov | 348 | 0.0180 | 7,726 | 348 | 0.0110 | 4,729 | | | 2,997 | 348 | 0.0110 | 4,729 |
| | Dec | 330 | 0.0169 | 6,892 | 330 | 0.0110 | 4,482 | | | 2,410 | 330 | 0.0110 | 4,482 |
| 1984 | Jan | 383 | 0.0163 | 7,674 | 383 | 0.0110 | 5,199 | | | 2,474 | 383 | 0.0110 | 5,199 |
| | Feb | 337 | 0.0153 | 6,350 | 337 | 0.0110 | 4,571 | | | 1,779 | 337 | 0.0110 | 4,571 |
| | Mar | 317 | 0.0142 | 5,559 | 317 | 0.0110 | 4,311 | | | 1,248 | 317 | 0.0110 | 4,311 |
| | Apr | 378 | 0.0135 | 6,286 | 378 | 0.0110 | 5,129 | | | 1,157 | 378 | 0.0110 | 5,129 |
| | May | 10,698 | 0.0113 | 148,858 | 10,698 | 0.0110 | 145,302 | | | 3,557 | 10,698 | 0.0110 | 145,302 |
| | Jun | 9,350 | 0.0110 | 126,440 | 9,350 | 0.0110 | 126,995 | | | -554 | 9,350 | 0.0110 | 126,995 |
| | Jul | 605 | 0.0108 | 8,074 | 605 | 0.0110 | 8,220 | | | -145 | 605 | 0.0110 | 8,220 |
| | Aug | 301 | 0.0159 | 5,908 | 301 | 0.0110 | 4,095 | | | 1,813 | 301 | 0.0110 | 4,095 |
| | Sep | 214 | 0.0199 | 5,243 | 214 | 0.0110 | 2,903 | | | 2,340 | 214 | 0.0110 | 2,903 |
| WY | Total | 23,619 | 0.0118 | 343,332 | 23,619 | 0.0110 | 320,787 | | | 22,545 | 23,619 | 0.0110 | 320,787 |
| | Oct | 333 | 0.0188 | 7,719 | 333 | 0.0116 | 4,784 | | | 2,936 | 333 | 0.0116 | 4,784 |
| | Nov | 317 | 0.0178 | 6,976 | 317 | 0.0116 | 4,549 | | | 2,427 | 317 | 0.0116 | 4,549 |
| | Dec | 294 | 0.0167 | 6,064 | 294 | 0.0116 | 4,213 | | | 1,851 | 294 | 0.0116 | 4,213 |
| 1985 | Jan | 360 | 0.0162 | 7,181 | 360 | 0.0116 | 5,160 | | | 2,021 | 360 | 0.0116 | 5,160 |
| | Feb | 279 | 0.0151 | 5,180 | 279 | 0.0116 | 3,997 | | | 1,183 | 279 | 0.0116 | 3,997 |
| | Mar | 283 | 0.0141 | 4,918 | 283 | 0.0116 | 4,062 | | | 856 | 283 | 0.0116 | 4,062 |
| | Apr | 1,638 | 0.0141 | 28,523 | 1,638 | 0.0116 | 23,497 | | | 5,026 | 1,638 | 0.0116 | 23,497 |
| | May | 7,609 | 0.0117 | 110,175 | 7,609 | 0.0116 | 109,172 | | | 1,004 | 7,609 | 0.0116 | 109,172 |
| | Jun | 2,130 | 0.0112 | 29,392 | 2,130 | 0.0116 | 30,567 | | | -1,175 | 2,130 | 0.0116 | 30,567 |
| | Jul | 380 | 0.0107 | 5,032 | 380 | 0.0116 | 5,454 | | | -423 | 380 | 0.0116 | 5,454 |
| | Aug | 214 | 0.0152 | 4,024 | 214 | 0.0116 | 3,073 | | | 951 | 214 | 0.0116 | 3,073 |
| | Sep | 178 | 0.0191 | 4,187 | 178 | 0.0116 | 2,550 | | | 1,637 | 178 | 0.0116 | 2,550 |
| WY | Total | 14,015 | 0.0127 | 219,372 | 14,015 | 0.0116 | 201,079 | | | 18,294 | 14,015 | 0.0116 | 201,079 |
| | Oct | 244 | 0.0181 | 5,440 | 244 | 0.0115 | 3,459 | | | 1,981 | 244 | 0.0115 | 3,459 |
| | Nov | 266 | 0.0176 | 5,764 | 266 | 0.0115 | 3,777 | | | 1,987 | 266 | 0.0115 | 3,777 |
| | Dec | 238 | 0.0164 | 4,803 | 238 | 0.0115 | 3,372 | | | 1,432 | 238 | 0.0115 | 3,372 |
| 1986 | Jan | 288 | 0.0159 | 5,666 | 288 | 0.0115 | 4,092 | | | 1,574 | 288 | 0.0115 | 4,092 |
| | Feb | 291 | 0.0152 | 5,468 | 291 | 0.0115 | 4,134 | | | 1,333 | 291 | 0.0115 | 4,134 |
| | Mar | 395 | 0.0145 | 7,072 | 395 | 0.0115 | 5,603 | | | 1,469 | 395 | 0.0115 | 5,603 |
| | Apr | 1,028 | 0.0140 | 17,808 | 1,028 | 0.0115 | 14,599 | | | 3,209 | 1,028 | 0.0115 | 14,599 |
| | May | 7,106 | 0.0122 | 107,046 | 7,106 | 0.0115 | 100,880 | | | 6,166 | 7,106 | 0.0115 | 100,880 |
| | Jun | 7,260 | 0.0114 | 101,915 | 7,260 | 0.0115 | 103,075 | | | -1,160 | 7,260 | 0.0115 | 103,075 |
| | Jul | 372 | 0.0108 | 4,958 | 372 | 0.0115 | 5,284 | | | -326 | 372 | 0.0115 | 5,284 |
| | Aug | 224 | 0.0155 | 4,274 | 224 | 0.0115 | 3,182 | | | 1,092 | 224 | 0.0115 | 3,182 |
| | Sep | 192 | 0.0196 | 4,642 | 192 | 0.0115 | 2,726 | | | 1,916 | 192 | 0.0115 | 2,726 |
| WY | Total | 17,904 | 0.0124 | 274,856 | 17,904 | 0.0115 | 254,184 | | | 20,673 | 17,904 | 0.0115 | 254,184 |

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project

# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 300 | 0.0182 | 6,727 | 300 | 0.0118 | 4,375 | | | 2,352 | 300 | 0.0118 | 4,375 |
| | Nov | 307 | 0.0174 | 6,586 | 307 | 0.0118 | 4,466 | | | 2,120 | 307 | 0.0118 | 4,466 |
| | Dec | 216 | 0.0155 | 4,122 | 216 | 0.0118 | 3,140 | | | 983 | 216 | 0.0118 | 3,140 |
| 1987 | Jan | 152 | 0.0135 | 2,536 | 152 | 0.0118 | 2,216 | | | 320 | 152 | 0.0118 | 2,216 |
| | Feb | 125 | 0.0125 | 1,923 | 125 | 0.0118 | 1,819 | | | 105 | 125 | 0.0118 | 1,819 |
| | Mar | 172 | 0.0126 | 2,658 | 172 | 0.0118 | 2,498 | | | 160 | 172 | 0.0118 | 2,498 |
| | Apr | 1,062 | 0.0139 | 18,226 | 1,062 | 0.0118 | 15,460 | | | 2,765 | 1,062 | 0.0118 | 15,460 |
| | May | 1,509 | 0.0117 | 21,864 | 1,509 | 0.0118 | 21,969 | | | -105 | 1,509 | 0.0118 | 21,969 |
| | Jun | 383 | 0.0131 | 6,176 | 383 | 0.0118 | 5,579 | | | 598 | 383 | 0.0118 | 5,579 |
| | Jul | 209 | 0.0100 | 2,572 | 209 | 0.0118 | 3,048 | | | -476 | 209 | 0.0118 | 3,048 |
| | Aug | 152 | 0.0135 | 2,531 | 152 | 0.0118 | 2,213 | | | 318 | 152 | 0.0118 | 2,213 |
| | Sep | 150 | 0.0175 | 3,231 | 150 | 0.0118 | 2,186 | | | 1,046 | 150 | 0.0118 | 2,186 |
| WY | Total | 4,736 | 0.0135 | 79,153 | 4,736 | 0.0118 | 68,968 | | | 10,186 | 4,736 | 0.0118 | 68,968 |
| | Oct | 167 | 0.0161 | 3,317 | 167 | 0.0115 | 2,367 | | | 950 | 167 | 0.0115 | 2,367 |
| | Nov | 158 | 0.0153 | 2,995 | 158 | 0.0115 | 2,246 | | | 749 | 158 | 0.0115 | 2,246 |
| | Dec | 159 | 0.0146 | 2,862 | 159 | 0.0115 | 2,263 | | | 599 | 159 | 0.0115 | 2,263 |
| 1988 | Jan | 180 | 0.0143 | 3,180 | 180 | 0.0115 | 2,557 | | | 622 | 180 | 0.0115 | 2,557 |
| | Feb | 165 | 0.0136 | 2,763 | 165 | 0.0115 | 2,336 | | | 428 | 165 | 0.0115 | 2,336 |
| | Mar | 197 | 0.0131 | 3,183 | 197 | 0.0115 | 2,801 | | | 382 | 197 | 0.0115 | 2,801 |
| | Apr | 556 | 0.0136 | 9,337 | 556 | 0.0115 | 7,890 | | | 1,447 | 556 | 0.0115 | 7,890 |
| | May | 2,649 | 0.0124 | 40,501 | 2,649 | 0.0115 | 37,603 | | | 2,898 | 2,649 | 0.0115 | 37,603 |
| | Jun | 487 | 0.0133 | 8,016 | 487 | 0.0115 | 6,911 | | | 1,104 | 487 | 0.0115 | 6,911 |
| | Jul | 184 | 0.0100 | 2,271 | 184 | 0.0115 | 2,618 | | | -347 | 184 | 0.0115 | 2,618 |
| | Aug | 148 | 0.0136 | 2,492 | 148 | 0.0115 | 2,108 | | | 384 | 148 | 0.0115 | 2,108 |
| | Sep | 146 | 0.0175 | 3,143 | 146 | 0.0115 | 2,071 | | | 1,072 | 146 | 0.0115 | 2,071 |
| WY | Total | 5,196 | 0.0131 | 84,059 | 5,196 | 0.0115 | 73,770 | | | 10,289 | 5,196 | 0.0115 | 73,770 |
| | Oct | 176 | 0.0163 | 3,544 | 176 | 0.0114 | 2,480 | | | 1,064 | 176 | 0.0114 | 2,480 |
| | Nov | 216 | 0.0165 | 4,392 | 216 | 0.0114 | 3,042 | | | 1,350 | 216 | 0.0114 | 3,042 |
| | Dec | 200 | 0.0154 | 3,792 | 200 | 0.0114 | 2,821 | | | 971 | 200 | 0.0114 | 2,821 |
| 1989 | Jan | 223 | 0.0149 | 4,089 | 223 | 0.0114 | 3,136 | | | 953 | 223 | 0.0114 | 3,136 |
| | Feb | 171 | 0.0137 | 2,890 | 171 | 0.0114 | 2,413 | | | 476 | 171 | 0.0114 | 2,413 |
| | Mar | 267 | 0.0136 | 4,494 | 267 | 0.0114 | 3,761 | | | 733 | 267 | 0.0114 | 3,761 |
| | Apr | 1,283 | 0.0140 | 22,156 | 1,283 | 0.0114 | 18,081 | | | 4,075 | 1,283 | 0.0114 | 18,081 |
| | May | 1,400 | 0.0117 | 20,258 | 1,400 | 0.0114 | 19,732 | | | 526 | 1,400 | 0.0114 | 19,732 |
| | Jun | 387 | 0.0131 | 6,261 | 387 | 0.0114 | 5,448 | | | 813 | 387 | 0.0114 | 5,448 |
| | Jul | 192 | 0.0100 | 2,367 | 192 | 0.0114 | 2,711 | | | -344 | 192 | 0.0114 | 2,711 |
| | Aug | 130 | 0.0130 | 2,075 | 130 | 0.0114 | 1,829 | | | 246 | 130 | 0.0114 | 1,829 |
| | Sep | 570 | 0.0105 | 7,354 | 570 | 0.0114 | 8,033 | | | -679 | 570 | 0.0114 | 8,033 |
| WY | Total | 5,215 | 0.0130 | 83,672 | 5,215 | 0.0114 | 73,488 | | | 10,184 | 5,215 | 0.0114 | 73,488 |

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 157 | 0.0167 | 3,222 | 157 | 0.0123 | 2,377 | | | 845 | 157 | 0.0123 | 2,377 |
| | Nov | 305 | 0.0179 | 6,730 | 305 | 0.0123 | 4,620 | | | 2,110 | 305 | 0.0123 | 4,620 |
| | Dec | 171 | 0.0156 | 3,296 | 171 | 0.0123 | 2,596 | | | 700 | 171 | 0.0123 | 2,596 |
| 1990 | Jan | 178 | 0.0150 | 3,304 | 178 | 0.0123 | 2,706 | | | 599 | 178 | 0.0123 | 2,706 |
| | Feb | 162 | 0.0143 | 2,849 | 162 | 0.0123 | 2,450 | | | 399 | 162 | 0.0123 | 2,450 |
| | Mar | 202 | 0.0138 | 3,438 | 202 | 0.0123 | 3,066 | | | 372 | 202 | 0.0123 | 3,066 |
| | Apr | 1,097 | 0.0141 | 19,034 | 1,097 | 0.0123 | 16,624 | | | 2,410 | 1,097 | 0.0123 | 16,624 |
| | May | 1,495 | 0.0124 | 22,803 | 1,495 | 0.0123 | 22,661 | | | 142 | 1,495 | 0.0123 | 22,661 |
| | Jun | 463 | 0.0213 | 12,202 | 463 | 0.0123 | 7,026 | | | 5,176 | 463 | 0.0123 | 7,026 |
| | Jul | 213 | 0.0107 | 2,817 | 213 | 0.0123 | 3,226 | | | -409 | 213 | 0.0123 | 3,226 |
| | Aug | 655 | 0.0118 | 9,555 | 655 | 0.0123 | 9,926 | | | -371 | 655 | 0.0123 | 9,926 |
| | Sep | 509 | 0.0122 | 7,694 | 509 | 0.0123 | 7,719 | | | -25 | 509 | 0.0123 | 7,719 |
| WY | Total | 5,607 | 0.0140 | 96,944 | 5,607 | 0.0123 | 84,996 | | | 11,948 | 5,607 | 0.0123 | 84,996 |
| | Oct | 389 | 0.0135 | 6,487 | 389 | 0.0126 | 6,066 | | | 421 | 389 | 0.0126 | 6,066 |
| | Nov | 184 | 0.0168 | 3,805 | 184 | 0.0126 | 2,862 | | | 943 | 184 | 0.0126 | 2,862 |
| | Dec | 176 | 0.0159 | 3,435 | 176 | 0.0126 | 2,739 | | | 696 | 176 | 0.0126 | 2,739 |
| 1991 | Jan | 190 | 0.0153 | 3,596 | 190 | 0.0126 | 2,967 | | | 630 | 190 | 0.0126 | 2,967 |
| | Feb | 179 | 0.0147 | 3,229 | 179 | 0.0126 | 2,786 | | | 443 | 179 | 0.0126 | 2,786 |
| | Mar | 199 | 0.0139 | 3,406 | 199 | 0.0126 | 3,097 | | | 309 | 199 | 0.0126 | 3,097 |
| | Apr | 498 | 0.0139 | 8,502 | 498 | 0.0126 | 7,759 | | | 743 | 498 | 0.0126 | 7,759 |
| | May | 2,799 | 0.0128 | 44,088 | 2,799 | 0.0126 | 43,640 | | | 448 | 2,799 | 0.0126 | 43,640 |
| | Jun | 1,305 | 0.0186 | 29,973 | 1,305 | 0.0126 | 20,353 | | | 9,620 | 1,305 | 0.0126 | 20,353 |
| | Jul | 321 | 0.0109 | 4,323 | 321 | 0.0126 | 5,008 | | | -684 | 321 | 0.0126 | 5,008 |
| | Aug | 205 | 0.0067 | 1,684 | 205 | 0.0126 | 3,195 | | | -1,511 | 205 | 0.0126 | 3,195 |
| | Sep | 191 | 0.0198 | 4,657 | 191 | 0.0126 | 2,972 | | | 1,685 | 191 | 0.0126 | 2,972 |
| WY | Total | 6,634 | 0.0143 | 117,184 | 6,634 | 0.0126 | 103,443 | | | 13,742 | 6,634 | 0.0126 | 103,443 |
| | Oct | 443 | 0.0178 | 9,697 | 443 | 0.0112 | 6,118 | | | 3,579 | 443 | 0.0112 | 6,118 |
| | Nov | 185 | 0.0166 | 3,796 | 185 | 0.0112 | 2,557 | | | 1,239 | 185 | 0.0112 | 2,557 |
| | Dec | 179 | 0.0157 | 3,463 | 179 | 0.0112 | 2,472 | | | 991 | 179 | 0.0112 | 2,472 |
| 1992 | Jan | 154 | 0.0146 | 2,771 | 154 | 0.0112 | 2,133 | | | 638 | 154 | 0.0112 | 2,133 |
| | Feb | 125 | 0.0136 | 2,105 | 125 | 0.0112 | 1,734 | | | 371 | 125 | 0.0112 | 1,734 |
| | Mar | 225 | 0.0139 | 3,857 | 225 | 0.0112 | 3,107 | | | 750 | 225 | 0.0112 | 3,107 |
| | Apr | 728 | 0.0139 | 12,526 | 728 | 0.0112 | 10,065 | | | 2,461 | 728 | 0.0112 | 10,065 |
| | May | 633 | 0.0113 | 8,821 | 633 | 0.0112 | 8,750 | | | 71 | 633 | 0.0112 | 8,750 |
| | Jun | 329 | 0.0092 | 3,723 | 329 | 0.0112 | 4,549 | | | -826 | 329 | 0.0112 | 4,549 |
| | Jul | 787 | 0.0100 | 9,733 | 787 | 0.0112 | 10,882 | | | -1,149 | 787 | 0.0112 | 10,882 |
| | Aug | 495 | 0.0108 | 6,598 | 495 | 0.0112 | 6,834 | | | -237 | 495 | 0.0112 | 6,834 |
| | Sep | 136 | 0.0178 | 2,983 | 136 | 0.0112 | 1,873 | | | 1,109 | 136 | 0.0112 | 1,873 |
| WY | Total | 4,419 | 0.0129 | 70,072 | 4,419 | 0.0112 | 61,075 | | | 8,997 | 4,419 | 0.0112 | 61,075 |

**Table C-2**

Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project

# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 247 | 0.0187 | 5,697 | 247 | 0.0125 | 3,805 | | | 1,893 | 247 | 0.0125 | 3,805 |
| | Nov | 229 | 0.0178 | 5,018 | 229 | 0.0125 | 3,524 | | | 1,494 | 229 | 0.0125 | 3,524 |
| | Dec | 208 | 0.0167 | 4,279 | 208 | 0.0125 | 3,195 | | | 1,083 | 208 | 0.0125 | 3,195 |
| 1993 | Jan | 237 | 0.0161 | 4,724 | 237 | 0.0125 | 3,652 | | | 1,073 | 237 | 0.0125 | 3,652 |
| | Feb | 232 | 0.0154 | 4,410 | 232 | 0.0125 | 3,570 | | | 841 | 232 | 0.0125 | 3,570 |
| | Mar | 380 | 0.0148 | 6,948 | 380 | 0.0125 | 5,839 | | | 1,109 | 380 | 0.0125 | 5,839 |
| | Apr | 973 | 0.0142 | 16,996 | 973 | 0.0125 | 14,971 | | | 2,025 | 973 | 0.0125 | 14,971 |
| | May | 4,908 | 0.0130 | 78,783 | 4,908 | 0.0125 | 75,486 | | | 3,297 | 4,908 | 0.0125 | 75,486 |
| | Jun | 1,339 | 0.0149 | 24,544 | 1,339 | 0.0125 | 20,589 | | | 3,955 | 1,339 | 0.0125 | 20,589 |
| | Jul | 364 | 0.0112 | 5,006 | 364 | 0.0125 | 5,596 | | | -590 | 364 | 0.0125 | 5,596 |
| | Aug | 211 | 0.0070 | 1,826 | 211 | 0.0125 | 3,248 | | | -1,422 | 211 | 0.0125 | 3,248 |
| | Sep | 181 | 0.0200 | 4,468 | 181 | 0.0125 | 2,781 | | | 1,687 | 181 | 0.0125 | 2,781 |
| WY | Total | 9,510 | 0.0139 | 162,698 | 9,510 | 0.0125 | 146,254 | | | 16,444 | 9,510 | 0.0125 | 146,254 |
| | Oct | 201 | 0.0173 | 4,284 | 201 | 0.0119 | 2,966 | | | 1,318 | 201 | 0.0119 | 2,966 |
| | Nov | 181 | 0.0162 | 3,634 | 181 | 0.0119 | 2,672 | | | 961 | 181 | 0.0119 | 2,672 |
| | Dec | 187 | 0.0155 | 3,571 | 187 | 0.0119 | 2,753 | | | 818 | 187 | 0.0119 | 2,753 |
| 1994 | Jan | 174 | 0.0145 | 3,120 | 174 | 0.0119 | 2,563 | | | 557 | 174 | 0.0119 | 2,563 |
| | Feb | 154 | 0.0138 | 2,625 | 154 | 0.0119 | 2,274 | | | 350 | 154 | 0.0119 | 2,274 |
| | Mar | 204 | 0.0135 | 3,388 | 204 | 0.0119 | 3,008 | | | 381 | 204 | 0.0119 | 3,008 |
| | Apr | 641 | 0.0138 | 10,921 | 641 | 0.0119 | 9,452 | | | 1,469 | 641 | 0.0119 | 9,452 |
| | May | 2,344 | 0.0125 | 36,026 | 2,344 | 0.0119 | 34,545 | | | 1,481 | 2,344 | 0.0119 | 34,545 |
| | Jun | 476 | 0.0135 | 7,895 | 476 | 0.0119 | 7,010 | | | 885 | 476 | 0.0119 | 7,010 |
| | Jul | 143 | 0.0147 | 2,585 | 143 | 0.0119 | 2,104 | | | 481 | 143 | 0.0119 | 2,104 |
| | Aug | 146 | 0.0165 | 2,981 | 146 | 0.0119 | 2,155 | | | 825 | 146 | 0.0119 | 2,155 |
| | Sep | 154 | 0.0182 | 3,454 | 154 | 0.0119 | 2,269 | | | 1,186 | 154 | 0.0119 | 2,269 |
| WY | Total | 5,006 | 0.0137 | 84,484 | 5,006 | 0.0119 | 73,772 | | | 10,712 | 5,006 | 0.0119 | 73,772 |
| | Oct | 231 | 0.0190 | 5,410 | 231 | 0.0124 | 3,522 | | | 1,887 | 231 | 0.0124 | 3,522 |
| | Nov | 190 | 0.0179 | 4,182 | 190 | 0.0124 | 2,891 | | | 1,291 | 190 | 0.0124 | 2,891 |
| | Dec | 203 | 0.0172 | 4,298 | 203 | 0.0124 | 3,093 | | | 1,206 | 203 | 0.0124 | 3,093 |
| 1995 | Jan | 224 | 0.0165 | 4,569 | 224 | 0.0124 | 3,417 | | | 1,151 | 224 | 0.0124 | 3,417 |
| | Feb | 200 | 0.0157 | 3,871 | 200 | 0.0124 | 3,045 | | | 826 | 200 | 0.0124 | 3,045 |
| | Mar | 316 | 0.0151 | 5,864 | 316 | 0.0124 | 4,811 | | | 1,053 | 316 | 0.0124 | 4,811 |
| | Apr | 561 | 0.0142 | 9,853 | 561 | 0.0124 | 8,553 | | | 1,300 | 561 | 0.0124 | 8,553 |
| | May | 3,349 | 0.0132 | 54,346 | 3,349 | 0.0124 | 51,018 | | | 3,328 | 3,349 | 0.0124 | 51,018 |
| | Jun | 3,405 | 0.0141 | 59,193 | 3,405 | 0.0124 | 51,882 | | | 7,311 | 3,405 | 0.0124 | 51,882 |
| | Jul | 819 | 0.0056 | 5,706 | 819 | 0.0124 | 12,481 | | | -6,775 | 819 | 0.0124 | 12,481 |
| | Aug | 346 | 0.0169 | 7,215 | 346 | 0.0124 | 5,274 | | | 1,940 | 346 | 0.0124 | 5,274 |
| | Sep | 205 | 0.0210 | 5,312 | 205 | 0.0124 | 3,125 | | | 2,187 | 205 | 0.0124 | 3,125 |
| WY | Total | 10,050 | 0.0137 | 169,818 | 10,050 | 0.0124 | 153,111 | | | 16,706 | 10,050 | 0.0124 | 153,111 |

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 198 | 0.0064 | 1,565 | 198 | 0.0116 | 2,828 | | | -1,263 | 198 | 0.0116 | 2,828 |
| | Nov | 209 | 0.0169 | 4,360 | 209 | 0.0116 | 2,985 | | | 1,375 | 209 | 0.0116 | 2,985 |
| | Dec | 192 | 0.0158 | 3,727 | 192 | 0.0116 | 2,734 | | | 993 | 192 | 0.0116 | 2,734 |
| 1996 | Jan | 158 | 0.0145 | 2,826 | 158 | 0.0116 | 2,258 | | | 568 | 158 | 0.0116 | 2,258 |
| | Feb | 168 | 0.0142 | 2,932 | 168 | 0.0116 | 2,389 | | | 543 | 168 | 0.0116 | 2,389 |
| | Mar | 224 | 0.0138 | 3,800 | 224 | 0.0116 | 3,187 | | | 613 | 224 | 0.0116 | 3,187 |
| | Apr | 423 | 0.0136 | 7,104 | 423 | 0.0116 | 6,026 | | | 1,078 | 423 | 0.0116 | 6,026 |
| | May | 4,115 | 0.0128 | 64,887 | 4,115 | 0.0116 | 58,663 | | | 6,225 | 4,115 | 0.0116 | 58,663 |
| | Jun | 1,268 | 0.0119 | 18,588 | 1,268 | 0.0116 | 18,079 | | | 509 | 1,268 | 0.0116 | 18,079 |
| | Jul | 290 | 0.0107 | 3,819 | 290 | 0.0116 | 4,131 | | | -312 | 290 | 0.0116 | 4,131 |
| | Aug | 146 | 0.0185 | 3,339 | 146 | 0.0116 | 2,086 | | | 1,253 | 146 | 0.0116 | 2,086 |
| | Sep | 146 | 0.0181 | 3,250 | 146 | 0.0116 | 2,076 | | | 1,173 | 146 | 0.0116 | 2,076 |
| WY | Total | 7,536 | 0.0129 | 120,197 | 7,536 | 0.0116 | 107,443 | | | 12,754 | 7,536 | 0.0116 | 107,443 |
| | Oct | 168 | 0.0174 | 3,593 | 168 | 0.0122 | 2,516 | | | 1,077 | 168 | 0.0122 | 2,516 |
| | Nov | 217 | 0.0175 | 4,668 | 217 | 0.0122 | 3,252 | | | 1,416 | 217 | 0.0122 | 3,252 |
| | Dec | 198 | 0.0164 | 3,994 | 198 | 0.0122 | 2,964 | | | 1,030 | 198 | 0.0122 | 2,964 |
| 1997 | Jan | 213 | 0.0158 | 4,146 | 213 | 0.0122 | 3,197 | | | 949 | 213 | 0.0122 | 3,197 |
| | Feb | 202 | 0.0151 | 3,752 | 202 | 0.0122 | 3,030 | | | 722 | 202 | 0.0122 | 3,030 |
| | Mar | 266 | 0.0144 | 4,734 | 266 | 0.0122 | 3,987 | | | 747 | 266 | 0.0122 | 3,987 |
| | Apr | 624 | 0.0140 | 10,791 | 624 | 0.0122 | 9,366 | | | 1,425 | 624 | 0.0122 | 9,366 |
| | May | 6,372 | 0.0130 | 102,132 | 6,372 | 0.0122 | 95,566 | | | 6,566 | 6,372 | 0.0122 | 95,566 |
| | Jun | 3,011 | 0.0127 | 47,026 | 3,011 | 0.0122 | 45,157 | | | 1,869 | 3,011 | 0.0122 | 45,157 |
| | Jul | 305 | 0.0110 | 4,162 | 305 | 0.0122 | 4,580 | | | -419 | 305 | 0.0122 | 4,580 |
| | Aug | 174 | 0.0154 | 3,298 | 174 | 0.0122 | 2,611 | | | 687 | 174 | 0.0122 | 2,611 |
| | Sep | 193 | 0.0201 | 4,778 | 193 | 0.0122 | 2,894 | | | 1,884 | 193 | 0.0122 | 2,894 |
| WY | Total | 11,943 | 0.0134 | 197,074 | 11,943 | 0.0122 | 179,121 | | | 17,953 | 11,943 | 0.0122 | 179,121 |
| | Oct | 225 | 0.0176 | 4,892 | 225 | 0.0110 | 3,059 | | | 1,833 | 225 | 0.0110 | 3,059 |
| | Nov | 220 | 0.0169 | 4,575 | 220 | 0.0110 | 2,992 | | | 1,584 | 220 | 0.0110 | 2,992 |
| | Dec | 214 | 0.0159 | 4,200 | 214 | 0.0110 | 2,913 | | | 1,287 | 214 | 0.0110 | 2,913 |
| 1998 | Jan | 243 | 0.0154 | 4,627 | 243 | 0.0110 | 3,311 | | | 1,317 | 243 | 0.0110 | 3,311 |
| | Feb | 264 | 0.0149 | 4,861 | 264 | 0.0110 | 3,594 | | | 1,266 | 264 | 0.0110 | 3,594 |
| | Mar | 328 | 0.0142 | 5,747 | 328 | 0.0110 | 4,466 | | | 1,281 | 328 | 0.0110 | 4,466 |
| | Apr | 632 | 0.0138 | 10,755 | 632 | 0.0110 | 8,596 | | | 2,159 | 632 | 0.0110 | 8,596 |
| | May | 3,562 | 0.0127 | 55,698 | 3,562 | 0.0110 | 48,446 | | | 7,252 | 3,562 | 0.0110 | 48,446 |
| | Jun | 3,016 | 0.0094 | 35,023 | 3,016 | 0.0110 | 41,010 | | | -5,987 | 3,016 | 0.0110 | 41,010 |
| | Jul | 447 | 0.0107 | 5,901 | 447 | 0.0110 | 6,073 | | | -172 | 447 | 0.0110 | 6,073 |
| | Aug | 232 | 0.0153 | 4,380 | 232 | 0.0110 | 3,155 | | | 1,224 | 232 | 0.0110 | 3,155 |
| | Sep | 187 | 0.0131 | 3,013 | 187 | 0.0110 | 2,542 | | | 471 | 187 | 0.0110 | 2,542 |
| WY | Total | 9,571 | 0.0122 | 143,671 | 9,571 | 0.0110 | 130,157 | | | 13,514 | 9,571 | 0.0110 | 130,157 |

**Table C-2**

Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 214 | 0.0180 | 4,756 | 214 | 0.0137 | 3,615 | | | 1,141 | 214 | 0.0137 | 3,615 |
| | Nov | 216 | 0.0173 | 4,623 | 216 | 0.0137 | 3,651 | | | 972 | 216 | 0.0137 | 3,651 |
| | Dec | 148 | 0.0154 | 2,821 | 148 | 0.0137 | 2,502 | | | 319 | 148 | 0.0137 | 2,502 |
| 1999 | Jan | 103 | 0.0136 | 1,732 | 103 | 0.0137 | 1,746 | | | -14 | 103 | 0.0137 | 1,746 |
| | Feb | 134 | 0.0142 | 2,347 | 134 | 0.0137 | 2,269 | | | 77 | 134 | 0.0137 | 2,269 |
| | Mar | 201 | 0.0140 | 3,477 | 201 | 0.0137 | 3,399 | | | 78 | 201 | 0.0137 | 3,399 |
| | Apr | 337 | 0.0137 | 5,689 | 337 | 0.0137 | 5,691 | | | -1 | 337 | 0.0137 | 5,691 |
| | May | 2,710 | 0.0128 | 42,775 | 2,710 | 0.0137 | 45,763 | | | -2,988 | 2,710 | 0.0137 | 45,763 |
| | Jun | 2,263 | 0.0185 | 51,605 | 2,263 | 0.0137 | 38,215 | | | 13,389 | 2,263 | 0.0137 | 38,215 |
| | Jul | 355 | 0.0110 | 4,799 | 355 | 0.0137 | 5,989 | | | -1,190 | 355 | 0.0137 | 5,989 |
| | Aug | 283 | 0.0219 | 7,658 | 283 | 0.0137 | 4,782 | | | 2,877 | 283 | 0.0137 | 4,782 |
| | Sep | 209 | 0.0203 | 5,224 | 209 | 0.0137 | 3,530 | | | 1,693 | 209 | 0.0137 | 3,530 |
| WY | Total | 7,175 | 0.0155 | 137,504 | 7,175 | 0.0137 | 121,152 | | | 16,352 | 7,175 | 0.0137 | 121,152 |
| | Oct | 180 | 0.0163 | 3,608 | 180 | 0.0111 | 2,460 | | | 1,148 | 180 | 0.0111 | 2,460 |
| | Nov | 177 | 0.0156 | 3,408 | 177 | 0.0111 | 2,421 | | | 987 | 177 | 0.0111 | 2,421 |
| | Dec | 155 | 0.0142 | 2,711 | 155 | 0.0111 | 2,119 | | | 592 | 155 | 0.0111 | 2,119 |
| 2000 | Jan | 138 | 0.0130 | 2,211 | 138 | 0.0111 | 1,884 | | | 327 | 138 | 0.0111 | 1,884 |
| | Feb | 123 | 0.0123 | 1,867 | 123 | 0.0111 | 1,676 | | | 190 | 123 | 0.0111 | 1,676 |
| | Mar | 194 | 0.0128 | 3,075 | 194 | 0.0111 | 2,655 | | | 420 | 194 | 0.0111 | 2,655 |
| | Apr | 806 | 0.0138 | 13,708 | 806 | 0.0111 | 11,028 | | | 2,680 | 806 | 0.0111 | 11,028 |
| | May | 2,111 | 0.0121 | 31,540 | 2,111 | 0.0111 | 28,883 | | | 2,657 | 2,111 | 0.0111 | 28,883 |
| | Jun | 529 | 0.0097 | 6,332 | 529 | 0.0111 | 7,241 | | | -908 | 529 | 0.0111 | 7,241 |
| | Jul | 161 | 0.0096 | 1,907 | 161 | 0.0111 | 2,204 | | | -297 | 161 | 0.0111 | 2,204 |
| | Aug | 140 | 0.0133 | 2,304 | 140 | 0.0111 | 1,918 | | | 386 | 140 | 0.0111 | 1,918 |
| | Sep | 149 | 0.0173 | 3,185 | 149 | 0.0111 | 2,037 | | | 1,149 | 149 | 0.0111 | 2,037 |
| WY | Total | 4,863 | 0.0126 | 75,857 | 4,863 | 0.0111 | 66,525 | | | 9,332 | 4,863 | 0.0111 | 66,525 |
| | Oct | 176 | 0.0162 | 3,505 | 176 | 0.0110 | 2,375 | | | 1,130 | 176 | 0.0110 | 2,375 |
| | Nov | 160 | 0.0152 | 2,988 | 160 | 0.0110 | 2,158 | | | 830 | 160 | 0.0110 | 2,158 |
| | Dec | 111 | 0.0124 | 1,699 | 111 | 0.0110 | 1,499 | | | 200 | 111 | 0.0110 | 1,499 |
| 2001 | Jan | 56 | 0.0063 | 433 | 56 | 0.0110 | 752 | | | -319 | 56 | 0.0110 | 752 |
| | Feb | 70 | 0.0093 | 798 | 70 | 0.0110 | 945 | | | -147 | 70 | 0.0110 | 945 |
| | Mar | 208 | 0.0130 | 3,349 | 208 | 0.0110 | 2,816 | | | 533 | 208 | 0.0110 | 2,816 |
| | Apr | 890 | 0.0138 | 15,186 | 890 | 0.0110 | 12,026 | | | 3,160 | 890 | 0.0110 | 12,026 |
| | May | 2,558 | 0.0123 | 38,779 | 2,558 | 0.0110 | 34,577 | | | 4,203 | 2,558 | 0.0110 | 34,577 |
| | Jun | 351 | 0.0096 | 4,138 | 351 | 0.0110 | 4,746 | | | -608 | 351 | 0.0110 | 4,746 |
| | Jul | 132 | 0.0093 | 1,514 | 132 | 0.0110 | 1,782 | | | -269 | 132 | 0.0110 | 1,782 |
| | Aug | 132 | 0.0088 | 1,434 | 132 | 0.0110 | 1,790 | | | -356 | 132 | 0.0110 | 1,790 |
| | Sep | 132 | 0.0165 | 2,699 | 132 | 0.0110 | 1,789 | | | 910 | 132 | 0.0110 | 1,789 |
| WY | Total | 4,976 | 0.0125 | 76,521 | 4,976 | 0.0110 | 67,253 | | | 9,268 | 4,976 | 0.0110 | 67,253 |

**Table C-2** Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 122 | 0.0137 | 2,070 | 122 | 0.0105 | 1,576 | | | 495 | 122 | 0.0105 | 1,576 |
| | Nov | 152 | 0.0146 | 2,742 | 152 | 0.0105 | 1,957 | | | 785 | 152 | 0.0105 | 1,957 |
| | Dec | 144 | 0.0135 | 2,398 | 144 | 0.0105 | 1,851 | | | 547 | 144 | 0.0105 | 1,851 |
| 2002 | Jan | 78 | 0.0089 | 855 | 78 | 0.0105 | 1,001 | | | -146 | 78 | 0.0105 | 1,001 |
| | Feb | 41 | 0.0032 | 162 | 41 | 0.0105 | 530 | | | -368 | 41 | 0.0105 | 530 |
| | Mar | 86 | 0.0092 | 973 | 86 | 0.0105 | 1,111 | | | -138 | 86 | 0.0105 | 1,111 |
| | Apr | 727 | 0.0137 | 12,270 | 727 | 0.0105 | 9,379 | | | 2,891 | 727 | 0.0105 | 9,379 |
| | May | 1,378 | 0.0114 | 19,387 | 1,378 | 0.0105 | 17,770 | | | 1,617 | 1,378 | 0.0105 | 17,770 |
| | Jun | 251 | 0.0123 | 3,817 | 251 | 0.0105 | 3,235 | | | 582 | 251 | 0.0105 | 3,235 |
| | Jul | 103 | 0.0084 | 1,061 | 103 | 0.0105 | 1,323 | | | -262 | 103 | 0.0105 | 1,323 |
| | Aug | 86 | 0.0098 | 1,041 | 86 | 0.0105 | 1,112 | | | -71 | 86 | 0.0105 | 1,112 |
| | Sep | 130 | 0.0160 | 2,569 | 130 | 0.0105 | 1,673 | | | 896 | 130 | 0.0105 | 1,673 |
| WY | Total | 3,298 | 0.0121 | 49,344 | 3,298 | 0.0105 | 42,518 | | | 6,827 | 3,298 | 0.0105 | 42,518 |
| | Oct | 241 | 0.0174 | 5,173 | 241 | 0.0126 | 3,739 | | | 1,434 | 241 | 0.0126 | 3,739 |
| | Nov | 175 | 0.0155 | 3,339 | 175 | 0.0126 | 2,709 | | | 630 | 175 | 0.0126 | 2,709 |
| | Dec | 87 | 0.0106 | 1,135 | 87 | 0.0126 | 1,351 | | | -216 | 87 | 0.0126 | 1,351 |
| 2003 | Jan | 70 | 0.0085 | 736 | 70 | 0.0126 | 1,091 | | | -354 | 70 | 0.0126 | 1,091 |
| | Feb | 109 | 0.0118 | 1,579 | 109 | 0.0126 | 1,691 | | | -111 | 109 | 0.0126 | 1,691 |
| | Mar | 192 | 0.0128 | 3,021 | 192 | 0.0126 | 2,976 | | | 44 | 192 | 0.0126 | 2,976 |
| | Apr | 771 | 0.0138 | 13,081 | 771 | 0.0126 | 11,966 | | | 1,115 | 771 | 0.0126 | 11,966 |
| | May | 4,416 | 0.0130 | 70,909 | 4,416 | 0.0126 | 68,517 | | | 2,393 | 4,416 | 0.0126 | 68,517 |
| | Jun | 1,222 | 0.0175 | 26,342 | 1,222 | 0.0126 | 18,962 | | | 7,380 | 1,222 | 0.0126 | 18,962 |
| | Jul | 306 | 0.0153 | 5,771 | 306 | 0.0126 | 4,754 | | | 1,017 | 306 | 0.0126 | 4,754 |
| | Aug | 216 | 0.0135 | 3,593 | 216 | 0.0126 | 3,350 | | | 243 | 216 | 0.0126 | 3,350 |
| | Sep | 199 | 0.0190 | 4,649 | 199 | 0.0126 | 3,083 | | | 1,566 | 199 | 0.0126 | 3,083 |
| WY | Total | 8,004 | 0.0141 | 139,329 | 8,004 | 0.0126 | 124,188 | | | 15,141 | 8,004 | 0.0126 | 124,188 |
| | Oct | 176 | 0.0174 | 3,777 | 176 | 0.0130 | 2,834 | | | 943 | 176 | 0.0130 | 2,834 |
| | Nov | 182 | 0.0168 | 3,768 | 182 | 0.0130 | 2,916 | | | 852 | 182 | 0.0130 | 2,916 |
| | Dec | 148 | 0.0154 | 2,806 | 148 | 0.0130 | 2,375 | | | 431 | 148 | 0.0130 | 2,375 |
| 2004 | Jan | 134 | 0.0145 | 2,393 | 134 | 0.0130 | 2,157 | | | 237 | 134 | 0.0130 | 2,157 |
| | Feb | 141 | 0.0142 | 2,482 | 141 | 0.0130 | 2,271 | | | 211 | 141 | 0.0130 | 2,271 |
| | Mar | 260 | 0.0143 | 4,579 | 260 | 0.0130 | 4,173 | | | 407 | 260 | 0.0130 | 4,173 |
| | Apr | 1,253 | 0.0141 | 21,835 | 1,253 | 0.0130 | 20,126 | | | 1,709 | 1,253 | 0.0130 | 20,126 |
| | May | 2,619 | 0.0130 | 42,144 | 2,619 | 0.0130 | 42,079 | | | 65 | 2,619 | 0.0130 | 42,079 |
| | Jun | 899 | 0.0189 | 20,988 | 899 | 0.0130 | 14,448 | | | 6,540 | 899 | 0.0130 | 14,448 |
| | Jul | 252 | 0.0157 | 4,869 | 252 | 0.0130 | 4,041 | | | 828 | 252 | 0.0130 | 4,041 |
| | Aug | 143 | 0.0166 | 2,932 | 143 | 0.0130 | 2,295 | | | 637 | 143 | 0.0130 | 2,295 |
| | Sep | 164 | 0.0192 | 3,883 | 164 | 0.0130 | 2,635 | | | 1,248 | 164 | 0.0130 | 2,635 |
| WY | Total | 6,371 | 0.0148 | 116,456 | 6,371 | 0.0130 | 102,350 | | | 14,106 | 6,371 | 0.0130 | 102,350 |

**Table C-2**

Date: September 25, 2006

## Flow and Phosphorus Routing WITH Proposed Narrows Project
# Lower Gooseberry Reservoir Operation

| | | Net Inflow to Lower Gooseberry Reservoir | | | (EST.) Stream Flow Gooseberry Creek below Lower Gooseberry Reservoir | | | Lower Gooseberry Reservoir Phosphorus Uptake | | | (CALC) Stream Flow-Gooseberry Creek Near Scofield | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | Flow Acre-Feet | Concentration mg/l | Weight grams | Flow Acre-Feet | mg/l Table 5 | Weight grams | Flow Acre-Feet | Concentration mg/l | (CALC) grams | Flow Acre-Feet | mg/l Table D-2 | Weight grams |
| | Oct | 258 | 0.0187 | 5,930 | 258 | 0.0129 | 4,113 | | | 1,817 | 258 | 0.0129 | 4,113 |
| | Nov | 197 | 0.0173 | 4,197 | 197 | 0.0129 | 3,141 | | | 1,056 | 197 | 0.0129 | 3,141 |
| | Dec | 157 | 0.0159 | 3,078 | 157 | 0.0129 | 2,508 | | | 570 | 157 | 0.0129 | 2,508 |
| 2004 | Jan | 138 | 0.0149 | 2,534 | 138 | 0.0129 | 2,203 | | | 331 | 138 | 0.0129 | 2,203 |
| | Feb | 148 | 0.0146 | 2,672 | 148 | 0.0129 | 2,364 | | | 308 | 148 | 0.0129 | 2,364 |
| | Mar | 251 | 0.0144 | 4,473 | 251 | 0.0129 | 4,008 | | | 465 | 251 | 0.0129 | 4,008 |
| | Apr | 876 | 0.0141 | 15,253 | 876 | 0.0129 | 13,991 | | | 1,262 | 876 | 0.0129 | 13,991 |
| | May | 6,327 | 0.0130 | 101,530 | 6,327 | 0.0129 | 101,016 | | | 513 | 6,327 | 0.0129 | 101,016 |
| | Jun | 2,182 | 0.0193 | 51,889 | 2,182 | 0.0129 | 34,829 | | | 17,059 | 2,182 | 0.0129 | 34,829 |
| | Jul | 527 | 0.0102 | 6,616 | 527 | 0.0129 | 8,416 | | | -1,800 | 527 | 0.0129 | 8,416 |
| | Aug | 359 | 0.0103 | 4,546 | 359 | 0.0129 | 5,737 | | | -1,191 | 359 | 0.0129 | 5,737 |
| | Sep | 246 | 0.0104 | 3,143 | 246 | 0.0129 | 3,926 | | | -783 | 246 | 0.0129 | 3,926 |
| WY | Total | 11,666 | 0.0143 | 205,859 | 11,666 | 0.0129 | 186,252 | | | 19,608 | 11,666 | 0.0129 | 186,252 |
| 78-05 | Total | 240,187 | | 3,927,044 | 240,187 | | 3,533,147 | | | 393,897 | 240,187 | | 3,533,147 |
| 78-05 | Average | 8,578 | 0.0133 | 140,252 | 8,578 | 0.0119 | 126,184 | | | 14,068 | 8,578 | 0.0119 | 126,184 |
| 78-89 | Total | 123,558 | | 1,964,030 | 123,558 | | 1,783,537 | | | 180,493 | 123,558 | | 1,783,537 |
| 78-89 | Average | 10,296 | 0.0129 | 163,669 | 10,296 | 0.0117 | 148,628 | | | 15,041 | 10,296 | 0.0117 | 148,628 |

NOTE: Average Annual Concentrations are Flow Weighted

Date: September 25, 2006

Table C-3
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
## Scofield Reservoir Operation

| Year | Month | (CALC) Stream Flow-Gooseberry Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calibrated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 335 | 0.0123 | 5,093 | 178 | 0.0897 | 19,701 | 513 | 0.0392 | 24,794 | 359 | 0.0700 | 30,998 |
| | Nov | 127 | 0.0123 | 1,926 | 209 | 0.0422 | 10,874 | 336 | 0.0300 | 12,802 | 368 | 0.0670 | 30,413 |
| | Dec | 149 | 0.0123 | 2,268 | 321 | 0.0312 | 12,344 | 470 | 0.0252 | 14,612 | 391 | 0.0700 | 33,761 |
| 1979 | Jan | 143 | 0.0123 | 2,150 | 338 | 0.0184 | 7,682 | 480 | 0.0166 | 9,832 | 393 | 0.0380 | 18,374 |
| | Feb | 129 | 0.0123 | 1,957 | 329 | 0.0304 | 12,337 | 458 | 0.0253 | 14,292 | 359 | 0.0700 | 31,388 |
| | Mar | 162 | 0.0123 | 2,461 | 889 | 0.0337 | 36,923 | 1,051 | 0.0304 | 39,384 | 511 | 0.0600 | 30,423 |
| | Apr | 574 | 0.0123 | 8,721 | 2,030 | 0.0330 | 82,675 | 2,694 | 0.0283 | 91,396 | 910 | 0.1000 | 112,243 |
| | May | 3,078 | 0.0123 | 46,741 | 14,480 | 0.0913 | 1,631,591 | 17,558 | 0.0775 | 1,678,332 | 4,521 | 0.1320 | 736,112 |
| | Jun | 3,018 | 0.0124 | 39,754 | 9,310 | 0.0312 | 358,298 | 11,928 | 0.0271 | 398,052 | 3,032 | 0.0770 | 332,342 |
| | Jul | 375 | 0.0123 | 5,692 | 1,236 | 0.0470 | 71,633 | 1,611 | 0.0389 | 77,325 | 727 | 0.0420 | 37,663 |
| | Aug | 259 | 0.0123 | 3,930 | 414 | 0.0320 | 16,045 | 673 | 0.0248 | 20,374 | 487 | 0.0700 | 42,030 |
| | Sep | 159 | 0.0123 | 2,408 | 383 | 0.0621 | 29,342 | 542 | 0.0475 | 31,750 | 423 | 0.0310 | 16,137 |
| WY Total/Average | | 8,700 | 0.0123 | 121,101 | 30,117 | 0.0616 | 2,290,044 | 38,223 | 0.0512 | 2,413,149 | 13,106 | 0.0906 | 1,464,329 |
| | Oct | 71 | 0.0117 | 1,022 | 348 | 0.0594 | 25,508 | 419 | 0.0514 | 26,537 | 371 | 0.0730 | 32,034 |
| | Nov | 197 | 0.0117 | 2,851 | 394 | 0.0427 | 16,493 | 591 | 0.0310 | 19,294 | 407 | 0.0670 | 33,636 |
| | Dec | 158 | 0.0117 | 2,279 | 220 | 0.0347 | 9,411 | 378 | 0.0251 | 11,690 | 372 | 0.0700 | 32,120 |
| 1979 | Jan | 161 | 0.0117 | 2,327 | 33 | 0.0376 | 1,590 | 194 | 0.0161 | 3,857 | 334 | 0.0380 | 15,655 |
| | Feb | 143 | 0.0117 | 2,045 | 55 | 0.0580 | 4,004 | 196 | 0.0252 | 6,109 | 331 | 0.0700 | 28,925 |
| | Mar | 154 | 0.0117 | 2,234 | 348 | 0.0420 | 12,889 | 402 | 0.0304 | 15,083 | 379 | 0.0890 | 37,301 |
| | Apr | 294 | 0.0117 | 4,248 | 1,814 | 0.0316 | 47,269 | 1,908 | 0.0277 | 71,517 | 634 | 0.1000 | 78,203 |
| | May | 3,122 | 0.0117 | 45,178 | 14,350 | 0.0809 | 1,608,169 | 17,472 | 0.0768 | 1,656,347 | 4,455 | 0.1320 | 725,366 |
| | Jun | 1,160 | 0.0117 | 18,780 | 5,010 | 0.0491 | 230,508 | 6,170 | 0.0351 | 267,288 | 1,919 | 0.0720 | 170,420 |
| | Jul | 239 | 0.0113 | 3,251 | 1,091 | 0.0440 | 57,013 | 1,310 | 0.0376 | 60,263 | 628 | 0.0420 | 33,335 |
| | Aug | 173 | 0.0113 | 2,399 | 407 | 0.0285 | 14,150 | 576 | 0.0234 | 16,459 | 441 | 0.0700 | 37,093 |
| | Sep | 143 | 0.0117 | 2,074 | 249 | 0.0230 | 7,986 | 392 | 0.0267 | 10,049 | 382 | 0.0310 | 14,645 |
| WY Total/Average | | 6,022 | 0.0117 | 87,291 | 23,485 | 0.0731 | 2,055,817 | 29,518 | 0.0580 | 2,143,114 | 10,654 | 0.0943 | 1,234,640 |
| | Oct | 102 | 0.0124 | 2,493 | 272 | 0.0890 | 30,079 | 434 | 0.0609 | 32,553 | 194 | 0.0300 | 15,751 |
| | Nov | 150 | 0.0124 | 2,295 | 345 | 0.0390 | 16,577 | 495 | 0.0309 | 18,872 | 200 | 0.0670 | 16,329 |
| | Dec | 172 | 0.0124 | 2,637 | 379 | 0.0314 | 14,670 | 551 | 0.0258 | 17,306 | 172 | 0.0700 | 14,853 |
| 1980 | Jan | 185 | 0.0124 | 2,835 | 370 | 0.0189 | 8,603 | 555 | 0.0167 | 11,438 | 120 | 0.0380 | 5,627 |
| | Feb | 168 | 0.0124 | 2,592 | 365 | 0.0310 | 14,221 | 533 | 0.0256 | 16,813 | 224 | 0.0700 | 18,341 |
| | Mar | 176 | 0.0124 | 2,303 | 381 | 0.0300 | 18,467 | 557 | 0.0310 | 21,310 | 272 | 0.0800 | 26,841 |
| | Apr | 523 | 0.0124 | 8,025 | 3,614 | 0.0297 | 132,470 | 4,137 | 0.0275 | 140,524 | 1,032 | 0.1000 | 127,040 |
| | May | 3,114 | 0.0124 | 47,717 | 22,640 | 0.0829 | 2,316,280 | 25,754 | 0.0744 | 2,364,017 | 4,330 | 0.1320 | 705,053 |
| | Jun | 2,785 | 0.0124 | 42,605 | 11,970 | 0.0413 | 608,510 | 14,755 | 0.0357 | 649,356 | 3,330 | 0.0720 | 475,089 |
| | Jul | 436 | 0.0124 | 6,658 | 1,618 | 0.0240 | 48,793 | 2,054 | 0.0220 | 55,323 | 900 | 0.0420 | 46,620 |
| | Aug | 209 | 0.0124 | 3,201 | 648 | 0.0270 | 21,583 | 857 | 0.0234 | 24,784 | 379 | 0.0990 | 32,724 |
| | Sep | 184 | 0.0124 | 2,820 | 592 | 0.1500 | 108,152 | 776 | 0.1180 | 112,979 | 337 | 0.0310 | 10,651 |
| WY Total/Average | | 8,233 | 0.0124 | 126,557 | 45,186 | 0.0627 | 3,328,264 | 53,441 | 0.0546 | 3,495,303 | 13,419 | 0.0900 | 1,495,598 |
| | Oct | 216 | 0.0113 | 2,984 | 130 | 0.0730 | 31,748 | 344 | 0.0507 | 34,732 | 246 | 0.0900 | 28,702 |
| | Nov | 213 | 0.0113 | 2,977 | 445 | 0.0329 | 18,077 | 658 | 0.0259 | 21,054 | 276 | 0.0500 | 17,445 |
| | Dec | 191 | 0.0113 | 2,672 | 689 | 0.0289 | 24,906 | 880 | 0.0234 | 27,578 | 273 | 0.0700 | 23,372 |
| 1981 | Jan | 205 | 0.0113 | 2,866 | 481 | 0.0324 | 15,239 | 586 | 0.0250 | 18,107 | 223 | 0.0500 | 13,753 |
| | Feb | 182 | 0.0113 | 2,541 | 568 | 0.0295 | 20,684 | 750 | 0.0251 | 23,222 | 179 | 0.0700 | 17,036 |
| | Mar | 239 | 0.0113 | 3,623 | 783 | 0.0373 | 34,544 | 1,022 | 0.0307 | 37,968 | 297 | 0.0650 | 23,110 |
| | Apr | 874 | 0.0113 | 12,217 | 2,510 | 0.0357 | 110,623 | 3,384 | 0.0294 | 122,832 | 502 | 0.0750 | 52,084 |
| | May | 1,684 | 0.0113 | 23,370 | 3,770 | 0.1091 | 465,498 | 5,454 | 0.0737 | 489,855 | 606 | 0.0700 | 60,096 |
| | Jun | 620 | 0.0113 | 8,697 | 2,690 | 0.0483 | 160,297 | 3,310 | 0.0414 | 168,962 | 463 | 0.0350 | 19,989 |
| | Jul | 186 | 0.0113 | 2,604 | 528 | 0.0226 | 14,698 | 714 | 0.0196 | 17,299 | 231 | 0.0400 | 10,411 |
| | Aug | 130 | 0.0113 | 1,905 | 289 | -0.0013 | -442 | 419 | 0.0028 | 1,460 | 236 | 0.1400 | 40,734 |
| | Sep | 149 | 0.0113 | 2,087 | 397 | 0.0087 | 4,245 | 546 | 0.0094 | 6,332 | 217 | 0.0350 | 9,355 |
| WY Total/Average | | 4,914 | 0.0113 | 68,677 | 13,214 | 0.0551 | 919,923 | 18,448 | 0.0434 | 988,601 | 3,993 | 0.0647 | 319,067 |

| Year | Month | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Contents: Total Acre-Feet | mg/l Table D-1 | Weight Grams | Flow River Below Scofield Dam: Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 8,414 | 0.0358 | 271,823 | | |
| | Oct | 37 | 0.0350 | 1,587 | 338 | 0.0612 | 24,032 | 1,227 | 81,411 | 192 | 35,654 | 8,335 | 0.0358 | 368,311 | 118 | 49,270 |
| | Nov | 41 | 0.0190 | 971 | -311 | 0.0465 | -17,885 | 434 | 26,302 | 55 | 9,600 | 8,340 | 0.0358 | 368,530 | 379 | 16,482 |
| | Dec | 34 | 0.0500 | 3,321 | -863 | 0.0494 | -51,449 | 251 | 20,230 | 0 | 4,037 | 8,325 | 0.0358 | 357,893 | 389 | 16,261 |
| 1979 | Jan | 59 | 0.0500 | 3,364 | -871 | 0.0225 | -19,379 | 356 | 12,195 | 0 | -3,517 | 8,313 | 0.0358 | 367,233 | 388 | 16,261 |
| | Feb | 53 | 0.0500 | 3,201 | -585 | 0.0455 | -32,833 | 315 | 16,307 | 0 | 4,409 | 8,295 | 0.0358 | 366,535 | 338 | 14,713 |
| | Mar | 119 | 0.0500 | 7,319 | 848 | 0.0403 | 48,312 | 2,526 | 145,439 | 0 | 33,847 | 10,666 | 0.0358 | 471,209 | 116 | 6,849 |
| | Apr | 134 | 0.0600 | 24,743 | 2,096 | 0.0443 | 114,958 | 5,944 | 343,327 | 0 | 80,535 | 16,610 | 0.0358 | 733,967 | 0 | 0 |
| | May | 2,284 | 0.1020 | 287,347 | -8,575 | 0.0807 | -235,858 | 25,787 | 2,445,933 | 591 | 1,509,014 | 37,799 | 0.0358 | 1,670,260 | 0 | 0 |
| | Jun | 1,604 | 0.0420 | 85,601 | -551 | 0.0329 | -14,238 | 17,012 | 802,037 | 1,040 | 96,001 | 45,296 | 0.0358 | 2,001,661 | 642 | 374,057 |
| | Jul | 239 | 0.0300 | 8,707 | -1,055 | 0.0345 | -44,915 | 1,518 | 76,776 | 1,167 | 63,043 | 34,256 | 0.0358 | 1,513,644 | 1,160 | 502,730 |
| | Aug | 106 | 0.0750 | 9,788 | -953 | 0.0401 | -47,357 | 312 | 25,035 | 922 | 51,081 | 24,994 | 0.0358 | 1,104,466 | 890 | 382,232 |
| | Sep | 71 | 0.0500 | 4,359 | -958 | 0.0386 | -45,627 | 76 | -8,615 | 615 | 10,371 | 19,857 | 0.0358 | 877,440 | 602 | 201,368 |
| WY Total/Average | | 3,491 | 0.0951 | 450,401 | -4,661 | 0.0500 | -322,353 | 51,862 | 4,005,622 | 4,505 | 1,916,801 | 19,257 | 0.0358 | 830,945 | 33,827 | 1,583,166 |
| | Oct | 41 | 0.0250 | 1,269 | -34 | 0.0607 | -4,022 | 774 | 56,406 | 230 | 120,504 | 19,101 | 0.0324 | 753,682 | 240 | 49,570 |
| | Nov | 62 | 0.0190 | 1,466 | -204 | 0.0414 | -10,981 | 1,179 | 65,337 | 94 | 21,741 | 19,976 | 0.0324 | 798,364 | 238 | 8,712 |
| | Dec | 44 | 0.0500 | 2,794 | 635 | 0.0471 | 36,864 | 1,429 | 83,277 | 5 | 26,270 | 21,161 | 0.0324 | 845,916 | 284 | 9,754 |
| 1979 | Jan | 23 | 0.0500 | 1,440 | 1,122 | 0.0307 | 42,521 | 1,671 | 63,474 | 3 | -3,399 | 22,849 | 0.0324 | 903,434 | 146 | 7,350 |
| | Feb | 34 | 0.0000 | 1,482 | 854 | 0.0533 | 35,503 | 1,409 | 91,418 | 0 | 35,479 | 23,635 | 0.0324 | 944,822 | 434 | 15,050 |
| | Mar | 47 | 0.0500 | 2,884 | 859 | 0.0535 | 55,352 | 1,666 | 110,630 | 5 | 44,035 | 28,117 | 0.0324 | 1,024,030 | 144 | 7,350 |
| | Apr | 187 | 0.0000 | 13,898 | 785 | 0.0474 | 45,447 | 3,112 | 189,285 | 0 | 64,897 | 23,135 | 0.0324 | 924,853 | 596 | 201,016 |
| | May | 2,348 | 0.1020 | 383,625 | -1,569 | 0.0805 | -155,956 | 22,606 | 2,506,643 | 755 | 1,654,077 | 44,858 | 0.0324 | 1,793,506 | 98 | 3,913 |
| | Jun | 879 | 0.0500 | 54,204 | 3,019 | 0.0290 | 101,688 | 13,986 | 733,609 | 1,110 | 218,887 | 44,559 | 0.0324 | 1,795,502 | 1,116 | 526,704 |
| | Jul | 182 | 0.0520 | 11,663 | -1,106 | 0.0364 | -49,571 | 1,014 | 55,869 | 1,126 | 84,054 | 34,422 | 0.0324 | 1,370,056 | 895 | 396,761 |
| | Aug | 81 | 0.0750 | 7,450 | -124 | 0.0423 | -6,436 | 373 | 53,665 | 824 | 33,724 | 27,033 | 0.0320 | 1,060,655 | 708 | 297,342 |
| | Sep | 59 | 0.0500 | 3,264 | -1,075 | 0.0350 | -35,228 | -247 | -7,300 | 636 | 27,990 | 19,335 | 0.0324 | 772,952 | 601 | 272,497 |
| WY Total/Average | | 3,568 | 0.0807 | 244,940 | 3,323 | 0.0548 | 237,434 | 49,975 | 4,804,315 | 4,503 | 2,382,315 | 21,979 | 0.0324 | 1,083,948 | 45,136 | 1,908,517 |
| | Oct | 56 | 0.0350 | 2,400 | 559 | 0.0573 | 39,005 | 1,257 | 92,706 | 289 | -294 | 18,098 | 0.0345 | 730,777 | 246 | 33,075 |
| | Nov | 60 | 0.0190 | 1,418 | 238 | 0.0379 | 11,148 | 993 | 47,984 | 82 | 5,159 | 18,592 | 0.0345 | 791,433 | 401 | 13,959 |
| | Dec | 66 | 0.0500 | 4,053 | 407 | 0.0363 | 18,227 | 1,196 | 54,626 | 2 | 1,763 | 19,545 | 0.0345 | 823,860 | 426 | 18,696 |
| 1980 | Jan | 61 | 0.0500 | 3,097 | 1,356 | 0.0228 | 37,636 | 2,070 | 58,072 | 3 | -29,740 | 21,013 | 0.0345 | 895,015 | 446 | 18,591 |
| | Feb | 63 | 0.1000 | 3,865 | 819 | 0.0387 | 39,079 | 1,639 | 79,085 | 0 | 9,369 | 22,283 | 0.0342 | 948,907 | 371 | 13,803 |
| | Mar | 66 | 0.0500 | 4,067 | 1,307 | 0.0462 | 78,565 | 2,200 | 130,782 | 6 | 33,047 | 23,642 | 0.0339 | 1,006,484 | 409 | 16,224 |
| | Apr | 408 | 0.0000 | 34,503 | -409 | 0.0413 | -20,803 | 5,277 | 283,524 | 5 | 59,637 | 23,223 | 0.0345 | 988,855 | 806 | 344,909 |
| | May | 3,190 | 0.1020 | 401,220 | -3,488 | 0.0778 | 328,620 | 30,785 | 3,231,620 | 753 | 1,950,548 | 53,300 | 0.0342 | 2,206,904 | 0 | 0 |
| | Jun | 1,134 | 0.0500 | 28,573 | -4,082 | 0.0106 | -47,917 | 25,147 | 1,098,354 | 1,169 | 247,699 | 56,833 | 0.0345 | 2,419,503 | 9,600 | 793,283 |
| | Jul | 201 | 0.0500 | 17,951 | 619 | 0.0274 | 35,932 | 3,866 | 340,812 | 1,242 | 29,088 | 47,957 | 0.0342 | 2,082,424 | 1,160 | 488,662 |
| | Aug | 149 | 0.0750 | 10,977 | -394 | 0.0373 | -18,042 | 960 | 50,443 | 1,035 | 35,622 | 37,892 | 0.0342 | 1,603,744 | 800 | 427,381 |
| | Sep | 109 | 0.0800 | 12,758 | 427 | 0.0824 | 43,279 | 1,804 | 204,118 | 736 | 154,834 | 35,222 | 0.0342 | 1,530,041 | 896 | 143,686 |
| WY Total/Average | | 6,728 | 0.0454 | 524,607 | 1,633 | -0.0083 | -17,340 | 75,330 | 5,460,912 | 5,251 | 2,522,039 | 31,440 | 0.0345 | 1,139,310 | 52,145 | 3,210,779 |
| | Oct | 92 | 0.0350 | 3,980 | -340 | 0.0771 | -24,024 | 840 | 54,399 | 377 | 753,799 | 38,344 | 0.0182 | 783,834 | 180 | 25,627 |
| | Nov | 80 | 0.0250 | 2,475 | 141 | 0.0318 | 5,400 | 1,157 | 46,142 | 116 | 22,286 | 35,133 | 0.0187 | 800,093 | 29 | 6,789 |
| | Dec | 108 | 0.0500 | 6,283 | 8 | 0.0164 | 275 | 1,261 | 57,709 | 0 | 28,987 | 36,687 | 0.0183 | 821,632 | 382 | 4,991 |
| 1981 | Jan | 67 | 0.0500 | 4,141 | 210 | 0.0511 | 8,505 | 1,086 | 44,567 | 0 | 19,829 | 38,007 | 0.0185 | 879,577 | 387 | 4,991 |
| | Feb | 83 | 0.0950 | 3,206 | 222 | 0.0316 | 9,609 | 1,235 | 53,273 | 0 | 30,090 | 37,843 | 0.0185 | 861,803 | 239 | 8,331 |
| | Mar | 116 | 0.0500 | 7,183 | 275 | 0.0416 | 14,089 | 1,688 | 38,350 | 0 | 49,904 | 39,486 | 0.0181 | 880,092 | 440 | 10,153 |
| | Apr | 439 | 0.0700 | 16,240 | -412 | 0.0520 | -12,557 | 4,974 | 178,610 | 0 | 85,837 | 41,850 | 0.0182 | 955,319 | 1,208 | 27,353 |
| | May | 899 | 0.0870 | 80,835 | 1,300 | 0.0607 | 112,354 | 8,459 | 748,320 | 859 | 576,121 | 40,601 | 0.0182 | 924,611 | 892 | 203,906 |
| | Jun | 467 | 0.0300 | 17,268 | -1,248 | 0.0340 | -53,122 | 2,994 | 153,117 | 1,075 | 109,417 | 32,951 | 0.0185 | 773,171 | 898 | 195,141 |
| | Jul | 106 | 0.0300 | 3,922 | -187 | 0.0220 | -5,200 | 844 | 25,416 | 1,055 | 31,113 | 23,528 | 0.0185 | 535,804 | 1,027 | 333,679 |
| | Aug | 58 | 0.2200 | 15,647 | 976 | 0.0594 | 67,838 | 1,628 | 125,680 | 784 | 108,214 | 15,614 | 0.0185 | 358,521 | 636 | 107,693 |
| | Sep | 67 | 0.0400 | 3,329 | -323 | 0.0147 | -5,857 | 506 | 9,657 | 480 | 6,716 | 11,566 | 0.0181 | 320,109 | 547 | 66,618 |
| WY Total/Average | | 2,490 | 0.0562 | 172,591 | 871 | 0.1094 | 117,438 | 25,806 | 1,597,247 | 6,782 | 1,819,923 | 32,386 | 0.0181 | 717,526 | 43,659 | 971,487 |

Date September 25, 2006

Table C-3
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
# Scofield Reservoir Operation

| Year | Month | (CALC) Stream Flow-Gooseberry Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Data for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 127 | 0.0123 | 3,358 | 460 | 0.0811 | 46,161 | 681 | 0.0615 | 51,829 | 297 | 0.0700 | 23,644 |
| | Nov | 168 | 0.0123 | 2,867 | 403 | 0.0608 | 30,267 | 595 | 0.0317 | 23,133 | 232 | 0.0300 | 8,723 |
| | Dec | 161 | 0.0123 | 2,452 | 419 | 0.0519 | 26,839 | 580 | 0.0409 | 29,291 | 342 | 0.0350 | 14,923 |
| 1983 | Jan | 133 | 0.0123 | 2,021 | 355 | 0.0182 | 7,959 | 488 | 0.0166 | 9,977 | 211 | 0.0500 | 13,013 |
| | Feb | 112 | 0.0123 | 1,700 | 315 | 0.0297 | 11,537 | 427 | 0.0251 | 13,245 | 234 | 0.0500 | 14,432 |
| | Mar | 160 | 0.0123 | 2,415 | 401 | 0.0370 | 18,333 | 561 | 0.0306 | 21,158 | 405 | 0.0600 | 29,965 |
| | Apr | 654 | 0.0123 | 9,941 | 2,560 | 0.0323 | 101,878 | 3,214 | 0.0282 | 111,819 | 1,080 | 0.4000 | 532,867 |
| | May | 4,184 | 0.0123 | 66,681 | 14,600 | 0.2314 | 4,144,893 | 18,784 | 0.1818 | 4,211,574 | 3,260 | 0.2600 | 1,061,564 |
| | Jun | 1,663 | 0.0123 | 25,278 | 5,440 | 0.0761 | 504,216 | 7,102 | 0.0604 | 529,494 | 3,580 | 0.1470 | 645,509 |
| | Jul | 468 | 0.0123 | 7,083 | 1,420 | 0.0611 | 107,058 | 1,886 | 0.0491 | 114,138 | 1,250 | 0.0700 | 107,930 |
| | Aug | 247 | 0.0123 | 3,760 | 712 | 0.1450 | 127,364 | 958 | 0.1108 | 131,364 | 503 | 0.1500 | 93,067 |
| | Sep | 236 | 0.0123 | 3,597 | 642 | 0.1670 | 132,645 | 878 | 0.1257 | 136,241 | 473 | 0.1000 | 58,344 |
| WY Total/Average | | 8,623 | 0.0123 | 131,177 | 27,527 | 0.1547 | 5,251,347 | 36,152 | 0.1207 | 5,382,774 | 11,767 | 0.2025 | 2,432,985 |
| | Oct | 439 | 0.0122 | 6,585 | 810 | 0.1098 | 107,684 | 1,249 | 0.0745 | 114,278 | 912 | 0.2400 | 198,724 |
| | Nov | 437 | 0.0122 | 6,580 | 1,019 | 0.0402 | 50,614 | 1,452 | 0.0319 | 57,123 | 408 | 0.0670 | 33,719 |
| | Dec | 294 | 0.0122 | 4,432 | 510 | 0.0401 | 25,081 | 804 | 0.0275 | 30,393 | 276 | 0.0700 | 23,833 |
| 1984 | Jan | 327 | 0.0122 | 4,910 | 557 | 0.0150 | 13,226 | 884 | 0.0166 | 18,136 | 394 | 0.0300 | 15,530 |
| | Feb | 285 | 0.0122 | 4,287 | 491 | 0.0510 | 25,308 | 776 | 0.0259 | 28,792 | 343 | 0.0700 | 29,601 |
| | Mar | 344 | 0.0122 | 5,175 | 679 | 0.0420 | 35,198 | 1,023 | 0.0320 | 40,368 | 476 | 0.0800 | 46,973 |
| | Apr | 348 | 0.0122 | 5,228 | 1,457 | 0.0349 | 37,148 | 1,805 | 0.0291 | 42,377 | 728 | 0.1000 | 89,759 |
| | May | 1,894 | 0.0122 | 28,443 | 14,200 | 0.0843 | 1,474,675 | 16,094 | 0.0758 | 1,502,120 | 4,000 | 0.1120 | 748,977 |
| | Jun | 10,799 | 0.0122 | 162,219 | 29,310 | 0.0600 | 1,011,066 | 40,109 | 0.0237 | 1,172,225 | 7,090 | 0.0720 | 709,602 |
| | Jul | 1,159 | 0.0122 | 17,324 | 3,150 | 0.0501 | 196,679 | 4,325 | 0.0401 | 214,003 | 1,980 | 0.0400 | 97,914 |
| | Aug | 369 | 0.0122 | 5,543 | 1,449 | 0.0257 | 46,774 | 1,818 | 0.0233 | 52,317 | 897 | 0.0700 | 77,431 |
| | Sep | 258 | 0.0122 | 3,817 | 1,005 | 0.0240 | 29,591 | 1,253 | 0.0216 | 33,408 | 780 | 0.0400 | 38,314 |
| WY Total/Average | | 16,859 | 0.0122 | 254,453 | 54,758 | 0.0455 | 3,069,079 | 71,677 | 0.0736 | 3,323,533 | 19,375 | 0.0860 | 2,102,063 |
| | Oct | 357 | 0.0110 | 4,851 | 806 | 0.0866 | 86,119 | 1,163 | 0.0624 | 90,970 | 601 | 0.0700 | 51,897 |
| | Nov | 348 | 0.0110 | 4,729 | 680 | 0.0418 | 35,026 | 1,028 | 0.0313 | 39,755 | 349 | 0.0670 | 45,371 |
| | Dec | 330 | 0.0110 | 4,482 | 628 | 0.0353 | 27,374 | 959 | 0.0278 | 31,837 | 554 | 0.0700 | 47,810 |
| 1985 | Jan | 353 | 0.0110 | 5,199 | 619 | 0.0194 | 14,809 | 1,002 | 0.0162 | 20,004 | 524 | 0.0350 | 24,381 |
| | Feb | 337 | 0.0110 | 4,571 | 716 | 0.0320 | 28,231 | 1,053 | 0.0251 | 32,802 | 529 | 0.0700 | 45,590 |
| | Mar | 317 | 0.0110 | 4,311 | 743 | 0.0399 | 36,323 | 1,060 | 0.0311 | 40,634 | 379 | 0.0600 | 37,130 |
| | Apr | 378 | 0.0110 | 5,129 | 2,217 | 0.0301 | 82,436 | 2,595 | 0.0274 | 87,554 | 1,300 | 0.1000 | 160,554 |
| | May | 10,098 | 0.0110 | 143,902 | 27,130 | 0.0914 | 3,058,098 | 37,828 | 0.0687 | 3,204,340 | 8,706 | 0.1320 | 1,416,519 |
| | Jun | 8,350 | 0.0110 | 126,995 | 12,110 | 0.0311 | 464,700 | 21,460 | 0.0224 | 591,755 | 5,790 | 0.0720 | 511,935 |
| | Jul | 605 | 0.0110 | 8,220 | 2,550 | 0.0417 | 137,380 | 3,155 | 0.0374 | 145,600 | 1,600 | 0.0420 | 85,890 |
| | Aug | 301 | 0.0110 | 4,095 | 1,026 | 0.0266 | 33,667 | 1,327 | 0.0231 | 37,762 | 986 | 0.0700 | 85,151 |
| | Sep | 214 | 0.0110 | 2,903 | 811 | 0.0352 | 35,206 | 1,025 | 0.0463 | 61,110 | 638 | 0.0310 | 24,014 |
| WY Total/Average | | 23,419 | 0.0110 | 320,787 | 50,036 | 0.0660 | 4,062,335 | 73,455 | 0.0482 | 4,383,121 | 22,107 | 0.0928 | 2,532,870 |
| | Oct | 373 | 0.0116 | 4,784 | 935 | 0.0794 | 91,919 | 1,272 | 0.0610 | 96,697 | 370 | 0.0700 | 64,031 |
| | Nov | 317 | 0.0116 | 4,549 | 852 | 0.0383 | 40,070 | 1,169 | 0.0308 | 44,619 | 583 | 0.0670 | 40,347 |
| | Dec | 294 | 0.0116 | 4,213 | 718 | 0.0227 | 20,914 | 1,016 | 0.0266 | 23,007 | 331 | 0.0300 | 41,029 |
| 1986 | Jan | 350 | 0.0116 | 5,160 | 500 | 0.0195 | 13,433 | 920 | 0.0164 | 18,612 | 515 | 0.0300 | 19,057 |
| | Feb | 279 | 0.0116 | 3,997 | 339 | 0.0344 | 16,728 | 425 | 0.0254 | 19,757 | 425 | 0.0700 | 36,524 |
| | Mar | 287 | 0.0116 | 4,052 | 994 | 0.0665 | 42,163 | 1,237 | 0.0306 | 48,902 | 595 | 0.0800 | 38,214 |
| | Apr | 1,638 | 0.0116 | 23,497 | 5,560 | 0.0317 | 228,655 | 7,198 | 0.0284 | 252,113 | 2,420 | 0.1000 | 298,504 |
| | May | 7,600 | 0.0116 | 109,172 | 13,200 | 0.1387 | 2,603,268 | 20,809 | 0.1052 | 2,712,440 | 5,414 | 0.1300 | 867,513 |
| | Jun | 2,136 | 0.0116 | 30,567 | 2,920 | 0.0250 | 93,274 | 5,050 | 0.0197 | 123,841 | 2,710 | 0.0100 | 33,428 |
| | Jul | 380 | 0.0116 | 5,454 | 1,100 | 0.0485 | 66,155 | 1,486 | 0.0351 | 71,502 | 1,042 | 0.0420 | 53,979 |
| | Aug | 214 | 0.0116 | 3,073 | 376 | -0.0012 | -418 | 790 | 0.0022 | 2,255 | 621 | 0.0100 | 7,808 |
| | Sep | 176 | 0.0116 | 2,556 | 533 | 0.0240 | 15,806 | 713 | 0.0209 | 18,306 | 716 | 0.0100 | 8,669 |
| WY Total/Average | | 14,013 | 0.0116 | 201,079 | 28,368 | 0.0653 | 3,228,298 | 42,381 | 0.0658 | 3,430,347 | 16,377 | 0.0766 | 1,548,602 |

| Year | Month | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Volume Acre-Feet | Conc mg/l | Weight Grams | Price River Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 8,419 | 0.0318 | 271,325 | | |
| | Oct | 88 | 0.0350 | 3,799 | 979 | 0.0570 | 68,849 | 2,045 | 149,924 | 242 | -411,705 | 14,717 | 0.0575 | 1,043,287 | 53 | 47,642 |
| | Nov | 73 | 0.0300 | 2,690 | 533 | 0.0276 | 18,814 | 1,439 | 58,561 | 74 | -47,119 | 15,792 | 0.0575 | 1,119,590 | 300 | 21,269 |
| | Dec | 67 | 0.0300 | 2,472 | 387 | 0.0419 | 20,020 | 1,216 | 66,709 | 0 | -23,760 | 16,768 | 0.0575 | 1,188,805 | 300 | 21,269 |
| 1983 | Jan | 55 | 0.0500 | 3,388 | 1,319 | 0.0283 | 46,806 | 2,003 | 73,184 | 0 | -75,195 | 18,563 | 0.0575 | 1,315,915 | 300 | 21,269 |
| | Feb | 49 | 0.0500 | 3,005 | 979 | 0.0348 | 42,044 | 1,689 | 72,727 | 0 | -47,038 | 19,950 | 0.0575 | 1,414,411 | 300 | 21,269 |
| | Mar | 65 | 0.0500 | 4,000 | 848 | 0.0500 | 52,487 | 1,875 | 117,692 | 0 | -15,910 | 21,525 | 0.0575 | 1,526,083 | 300 | 21,269 |
| | Apr | 406 | 0.0600 | 30,042 | 994 | 0.1068 | 130,851 | 5,694 | 805,159 | 0 | 401,541 | 26,919 | 0.0575 | 1,908,470 | 300 | 21,269 |
| | May | 2,523 | 0.1500 | 466,903 | 12,792 | 0.1738 | 2,742,246 | 39,359 | 9,302,286 | 734 | 8,503,313 | 65,524 | 0.0575 | 4,645,443 | 0 | 0 |
| | Jun | 1,084 | 0.0600 | 80,199 | 12,204 | 0.0724 | 1,089,516 | 23,950 | 2,344,718 | 1,241 | 734,782 | 65,940 | 0.0575 | 4,675,576 | 2263 | 1,579,801 |
| | Jul | 277 | 0.1550 | 52,879 | 2,913 | 0.0571 | 198,075 | 6,225 | 473,023 | 1,298 | 123,702 | 57,728 | 0.0575 | 4,092,530 | 1681 | 932,560 |
| | Aug | 114 | 0.0300 | 1,632 | 247 | 0.1005 | 30,613 | 1,643 | 256,395 | 1,092 | 203,113 | 49,161 | 0.0575 | 3,486,790 | 886 | 659,084 |
| | Sep | 123 | 0.1000 | 15,442 | 385 | 0.1000 | 47,461 | 1,861 | 257,948 | 795 | 181,846 | 44,250 | 0.0575 | 3,137,171 | 866 | 433,237 |
| WY Total/Average | | 4,845 | 0.1093 | 666,484 | 34,515 | 0.1054 | 4,487,381 | 98,559 | 13,569,624 | 5,491 | 7,130,148 | 34,739 | 0.0575 | 2,462,846 | 33,200 | 1,771,711 |
| | Oct | 189 | 0.0350 | 7,756 | 323 | 0.1060 | 42,207 | 2,303 | 352,948 | 409 | 1,043,182 | 48,392 | 0.0271 | 1,519,750 | 415 | 27,220 |
| | Nov | 187 | 0.0190 | 4,389 | 724 | 0.0354 | 31,435 | 2,772 | 126,685 | 121 | 17,940 | 47,794 | 0.0271 | 1,508,606 | 366 | 8,977 |
| | Dec | 122 | 0.0500 | 7,519 | -24 | 0.0351 | -1,069 | 1,278 | 60,703 | 0 | 17,930 | 48,338 | 0.0271 | 1,618,375 | 366 | 22,903 |
| 1984 | Jan | 108 | 0.0500 | 6,673 | 557 | 0.0260 | 17,678 | 1,949 | 60,017 | 0 | -5,224 | 49,369 | 0.0271 | 1,652,788 | 421 | 30,836 |
| | Feb | 95 | 0.0500 | 5,874 | 1,057 | 0.0385 | 50,407 | 2,271 | 119,690 | 0 | 14,643 | 51,607 | 0.0271 | 1,700,079 | 402 | 27,896 |
| | Mar | 128 | 0.0500 | 7,922 | 820 | 0.0448 | 45,461 | 2,453 | 140,041 | 0 | 28,809 | 52,337 | 0.0271 | 1,752,275 | 421 | 30,836 |
| | Apr | 229 | 0.0600 | 16,923 | 1,096 | 0.0664 | 89,100 | 4,457 | 260,397 | 0 | 117,107 | 52,049 | 0.0271 | 1,742,567 | 4742 | 118,796 |
| | May | 2,040 | 0.1020 | 256,652 | 3,899 | 0.0411 | 192,547 | 26,620 | 2,051,294 | 939 | 2,092,165 | 73,500 | 0.0271 | 2,460,915 | 4200 | 160,881 |
| | Jun | 4,341 | 0.0430 | 231,962 | 22,223 | 0.0318 | 871,640 | 75,861 | 3,033,934 | 1,296 | 326,175 | 73,500 | 0.0271 | 2,460,815 | 25507 | 2,460,780 |
| | Jul | 508 | 0.0520 | 42,920 | 9,464 | 0.0364 | 424,879 | 16,345 | 775,833 | 1,339 | 273,774 | 66,815 | 0.0271 | 2,210,213 | 2380 | 752,641 |
| | Aug | 252 | 0.0730 | 21,379 | 635 | 0.0379 | 29,455 | 3,557 | 162,558 | 1,166 | 100,184 | 58,834 | 0.0271 | 1,959,757 | 965 | 332,662 |
| | Sep | 175 | 0.0750 | 15,784 | 875 | 0.0297 | 32,099 | 3,090 | 119,625 | 853 | 44,449 | 48,208 | 0.0271 | 1,616,650 | 1282 | 412,430 |
| WY Total/Average | | 8,326 | 0.0988 | 667,145 | 42,371 | 0.0389 | 2,030,806 | 142,240 | 8,103,640 | 6,104 | 7,201,321 | 55,489 | 0.0271 | 1,857,791 | 132,107 | 4,423,006 |
| | Oct | 157 | 0.0400 | 7,735 | 1,153 | 0.0579 | 82,151 | 3,073 | 232,749 | 420 | -111,045 | 18,421 | 0.0314 | 1,488,189 | 1282 | 484,292 |
| | Nov | 132 | 0.0190 | 3,087 | 2,351 | 0.0386 | 110,065 | 3,910 | 198,278 | 115 | 49,532 | 41,375 | 0.0314 | 1,600,450 | 385 | 14,465 |
| | Dec | 130 | 0.0500 | 7,998 | 1,336 | 0.0401 | 66,131 | 2,978 | 153,812 | 0 | 34,817 | 44,353 | 0.0314 | 1,715,645 | 0 | 0 |
| 1985 | Jan | 121 | 0.0500 | 7,452 | 555 | 0.0254 | 17,396 | 2,202 | 69,413 | 0 | -15,757 | 46,555 | 0.0314 | 1,800,813 | 0 | 0 |
| | Feb | 125 | 0.0500 | 7,721 | -199 | 0.0403 | -9,831 | 1,513 | 76,362 | 0 | 19,073 | 48,068 | 0.0314 | 1,859,324 | 0 | 0 |
| | Mar | 128 | 0.0500 | 7,922 | 2,834 | 0.0468 | 140,502 | 4,203 | 246,254 | 0 | 83,059 | 51,210 | 0.0314 | 1,986,293 | 321 | 35,026 |
| | Apr | 315 | 0.0600 | 23,291 | -73 | 0.0499 | -4,470 | 4,137 | 266,720 | 0 | 106,709 | 51,065 | 0.0314 | 1,975,234 | 4422 | 173,049 |
| | May | 4,288 | 0.1020 | 539,485 | 12,238 | 0.0807 | 1,218,881 | 63,054 | 6,378,213 | 954 | 3,976,078 | 73,500 | 0.0314 | 2,843,087 | 38005 | 1,534,303 |
| | Jun | 2,168 | 0.0430 | 125,535 | 37,623 | 0.0342 | 1,104,610 | 57,208 | 2,393,502 | 1,204 | 235,670 | 73,500 | 0.0314 | 2,843,087 | 58014 | 2,162,832 |
| | Jul | 448 | 0.0120 | 28,219 | 3,492 | 0.0364 | 264,379 | 11,081 | 521,097 | 1,350 | 144,707 | 66,115 | 0.0314 | 2,557,444 | 17115 | 662,032 |
| | Aug | 184 | 0.0750 | 17,022 | 536 | 0.0417 | 27,549 | 3,033 | 167,468 | 1,137 | 94,098 | 60,206 | 0.0314 | 2,331,187 | 7746 | 299,627 |
| | Sep | 137 | 0.0530 | 8,967 | -412 | 0.0590 | -29,877 | 1,179 | 64,234 | 942 | 33,326 | 52,738 | 0.0314 | 2,039,965 | 7866 | 304,230 |
| WY Total/Average | | 8,514 | 0.0746 | 784,477 | 53,173 | 0.0465 | 2,047,850 | 157,620 | 10,768,324 | 6,117 | 4,656,591 | 53,842 | 0.0314 | 2,080,512 | 147,059 | 5,688,957 |
| | Oct | 154 | 0.0236 | 7,097 | 289 | 0.0581 | 14,521 | 2,392 | 183,246 | 431 | 78,868 | 48,776 | 0.0318 | 1,309,842 | 882 | 236,215 |
| | Nov | 144 | 0.0190 | 3,368 | 348 | 0.0355 | 16,959 | 2,240 | 115,292 | 124 | 70,087 | 49,946 | 0.0318 | 1,358,123 | 89 | 34,930 |
| | Dec | 136 | 0.0500 | 7,999 | 1,681 | 0.0407 | 84,511 | 3,422 | 178,977 | 0 | 43,856 | 53,970 | 0.0319 | 2,061,213 | 92 | 33,049 |
| 1986 | Jan | 110 | 0.0500 | 6,789 | 377 | 0.0252 | 10,716 | 1,920 | 55,171 | 0 | -20,085 | 54,407 | 0.0318 | 2,126,472 | 0 | 0 |
| | Feb | 96 | 0.0500 | 4,685 | 912 | 0.0426 | 48,819 | 2,041 | 108,953 | 0 | 28,953 | 56,538 | 0.0318 | 2,216,471 | 0 | 0 |
| | Mar | 145 | 0.0600 | 8,930 | 832 | 0.0408 | 47,067 | 2,800 | 161,072 | 0 | 31,547 | 58,935 | 0.0318 | 2,295,590 | 782 | 31,649 |
| | Apr | 934 | 0.0600 | 69,156 | 1,009 | 0.0450 | 56,090 | 11,572 | 673,353 | 0 | 220,987 | 62,862 | 0.0318 | 2,502,839 | 4280 | 245,576 |
| | May | 2,377 | 0.1600 | 324,433 | 9,096 | 0.0907 | 1,197,266 | 37,994 | 5,323,494 | 1,517 | 3,852,977 | 73,500 | 0.0318 | 2,881,442 | 2729 | 1,071,008 |
| | Jun | 580 | 0.0100 | 7,160 | 1,336 | 0.0162 | 106,419 | 15,479 | 239,947 | 1,294 | -253,675 | 69,333 | 0.0318 | 2,718,250 | 1056 | 848,719 |
| | Jul | 271 | 0.0520 | 14,377 | 382 | 0.0366 | 17,349 | 3,529 | 156,997 | 1,320 | 86,681 | 60,230 | 0.0318 | 2,362,730 | 1076 | 420,876 |
| | Aug | 111 | 0.0450 | 5,478 | -403 | 0.0090 | -3,624 | 1,082 | 10,514 | 1,105 | 11,395 | 48,107 | 0.0318 | 1,883,943 | 1241 | 475,268 |
| | Sep | 95 | 0.0600 | 6,919 | -320 | 0.0273 | -13,041 | 926 | 18,275 | 789 | 17,617 | 43,670 | 0.0318 | 1,712,908 | 442 | 174,373 |
| WY Total/Average | | 5,289 | 0.1022 | 666,196 | 13,039 | 0.0672 | 1,576,471 | 43,079 | 7,250,616 | 6,089 | 4,184,810 | 56,400 | 0.0318 | 2,230,007 | 86,036 | 5,175,361 |

Date: September 25, 2006

Table C-3
Flow and Phosphorus Routing WITH Proposed Narrows Project
# Scofield Reservoir Operation

| Year Month | (CALC) Stream Flow-Cottonwood Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Gain for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Total Acre-Feet | mg/l Table D-1 | Weight Grams | Price River Below Scofield Dam: Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | 8,414 | 0.0358 | 371,325 | | |
| Oct | 344 | 0.0115 | 3,499 | 654 | 0.0391 | 43,793 | 898 | 0.0607 | 67,253 | 507 | 0.0700 | 43,451 | 114 | 0.0350 | 4,934 | 737 | 0.0579 | 52,662 | 2,252 | 168,230 | 467 | 185,849 | 44,843 | 0.0302 | 1,669,421 | 472 | 25,017 |
| Nov | 266 | 0.0115 | 3,777 | 521 | 0.0403 | 26,522 | 787 | 0.0312 | 30,290 | 475 | 0.0670 | 39,256 | 99 | 0.0190 | 2,324 | 951 | 0.0406 | 47,846 | 2,312 | 119,734 | 121 | 38,157 | 46,734 | 0.0302 | 1,759,822 | 800 | 11,168 |
| Dec | 238 | 0.0115 | 3,372 | 434 | 0.0345 | 18,466 | 872 | 0.0264 | 21,878 | 450 | 0.0700 | 38,853 | 86 | 0.0500 | 5,309 | 798 | 0.0420 | 81,346 | 2,066 | 107,146 | 0 | 32,087 | 48,125 | 0.0302 | 1,791,386 | 655 | 22,493 |
| 1986 Jan | 288 | 0.0115 | 4,092 | 608 | 0.0187 | 14,059 | 896 | 0.0164 | 18,121 | 436 | 0.0300 | 17,984 | 159 | 0.0500 | 6,485 | 768 | 0.0231 | 21,918 | 2,255 | 68,538 | 0 | -19,429 | 49,765 | 0.0302 | 1,852,650 | 669 | 22,995 |
| Feb | 291 | 0.0115 | 4,134 | 397 | 0.0421 | 23,639 | 886 | 0.0253 | 27,773 | 485 | 0.0700 | 41,877 | 105 | 0.0500 | 6,471 | 1,356 | 0.0408 | 68,205 | 2,834 | 144,426 | 0 | 38,914 | 52,299 | 0.0302 | 1,945,994 | 300 | 11,168 |
| Mar | 365 | 0.0115 | 5,003 | 2,097 | 0.0343 | 88,693 | 2,492 | 0.0307 | 94,287 | 923 | 0.0880 | 81,215 | 297 | 0.0500 | 17,730 | 895 | 0.0425 | 46,937 | 4,497 | 240,176 | 0 | 72,772 | 55,875 | 0.0302 | 2,060,111 | 301 | 14,287 |
| Apr | 1,028 | 0.0115 | 14,599 | 6,370 | 0.0301 | 236,691 | 7,398 | 0.0275 | 251,291 | 1,957 | 0.1000 | 241,394 | 500 | 0.0600 | 66,576 | 2,773 | 0.0420 | 143,608 | 11,028 | 782,669 | 0 | 217,848 | 66,096 | 0.0302 | 2,460,628 | 380 | 136,504 |
| May | 7,108 | 0.0115 | 100,880 | 17,510 | 0.1012 | 2,184,930 | 24,618 | 0.0753 | 2,285,818 | 6,055 | 0.1320 | 985,878 | 3,112 | 0.1020 | 391,491 | 8,994 | 0.0804 | 893,015 | 43,777 | 4,356,801 | 1,028 | 2,877,032 | 73,300 | 0.0302 | 2,736,269 | 3248 | 1,204,128 |
| Jun | 7,260 | 0.0115 | 107,078 | 6,640 | 0.0346 | 283,506 | 13,900 | 0.0226 | 386,671 | 3,152 | 0.0720 | 279,933 | 1,544 | 0.0430 | 81,912 | 15,414 | 0.0330 | 626,921 | 34,011 | 1,375,437 | 1,294 | 137,855 | 73,500 | 0.0302 | 2,736,269 | 3271 | 1,217,992 |
| Jul | 372 | 0.0115 | 5,284 | 2,010 | 0.0412 | 102,087 | 2,382 | 0.0365 | 107,371 | 868 | 0.0420 | 45,590 | 318 | 0.0520 | 20,795 | 1,012 | 0.0360 | 45,066 | 4,392 | 218,361 | 1,350 | 97,856 | 64,835 | 0.0302 | 2,413,698 | 1587 | 643,275 |
| Aug | 224 | 0.0115 | 3,182 | 902 | 0.0256 | 28,485 | 1,126 | 0.0228 | 31,667 | 587 | 0.0700 | 48,957 | 199 | 0.0730 | 13,798 | 300 | 0.0385 | 18,547 | 2,233 | 112,969 | 1,130 | 71,905 | 54,164 | 0.0302 | 2,010,437 | 1174 | 438,324 |
| Sep | 192 | 0.0115 | 2,720 | 708 | 0.1143 | 99,726 | 900 | 0.0923 | 102,453 | 509 | 0.0100 | 6,278 | 118 | 0.0700 | 10,153 | 38 | 0.0583 | 2,550 | 1,562 | 121,461 | 817 | 93,704 | 48,085 | 0.0302 | 1,790,112 | 882 | 234,082 |
| WY Total/Average | 17,960 | 0.0115 | 254,744 | 39,051 | 0.0659 | 3,170,695 | 56,955 | 0.0488 | 3,428,876 | 16,342 | 0.0928 | 1,870,647 | 6,937 | 0.0733 | 627,577 | 32,124 | 0.0457 | 1,809,289 | 112,359 | 7,772,391 | 6,146 | 3,864,560 | 56,485 | 0.0302 | 2,102,833 | 103,297 | 3,799,727 |
| Oct | 300 | 0.0118 | 4,325 | 712 | 0.0806 | 70,817 | 1,012 | 0.0602 | 75,191 | 527 | 0.0700 | 45,503 | 127 | 0.0350 | 5,499 | 614 | 0.0572 | 43,703 | 2,281 | 169,896 | 459 | 715,383 | 49,450 | 0.0282 | 1,232,287 | 400 | 12,360 |
| Nov | 307 | 0.0118 | 4,466 | 570 | 0.0407 | 28,612 | 877 | 0.0306 | 33,078 | 488 | 0.0670 | 40,330 | 106 | 0.0190 | 2,495 | -134 | 0.0404 | -6,703 | 1,337 | 69,200 | 124 | 38,587 | 50,683 | 0.0282 | 1,262,500 | 2 | 0 |
| Dec | 210 | 0.0118 | 3,140 | 506 | 0.0314 | 19,353 | 716 | 0.0253 | 22,493 | 449 | 0.0700 | 38,682 | 85 | 0.0500 | 3,242 | 496 | 0.0421 | 25,751 | 1,245 | 92,170 | 0 | 48,695 | 52,407 | 0.0282 | 1,305,975 | 2 | 0 |
| 1987 Jan | 152 | 0.0118 | 2,216 | 444 | 0.0170 | 9,789 | 596 | 0.0163 | 12,005 | 413 | 0.0380 | 19,359 | 66 | 0.0500 | 4,051 | 1,027 | 0.0269 | 34,138 | 2,102 | 69,554 | 0 | 17,169 | 54,510 | 0.0282 | 1,354,360 | 0 | 0 |
| Feb | 125 | 0.0118 | 1,819 | 340 | 0.0294 | 12,315 | 465 | 0.0246 | 14,133 | 387 | 0.0700 | 33,415 | 52 | 0.0500 | 3,193 | 895 | 0.0457 | 50,440 | 1,799 | 101,182 | 0 | 36,333 | 56,309 | 0.0282 | 1,403,187 | 0 | 0 |
| Mar | 172 | 0.0118 | 2,498 | 454 | 0.0308 | 20,387 | 626 | 0.0299 | 23,085 | 421 | 0.0880 | 41,344 | 70 | 0.0500 | 4,342 | 1,272 | 0.0497 | 78,273 | 2,389 | 147,243 | 0 | 67,721 | 58,697 | 0.0282 | 1,462,709 | 2 | 0 |
| Apr | 1,062 | 0.0118 | 15,460 | 2,400 | 0.0357 | 105,667 | 3,462 | 0.0284 | 121,127 | 1,128 | 0.1000 | 139,138 | 432 | 0.0600 | 33,447 | 781 | 0.0435 | 43,872 | 5,825 | 335,584 | 0 | 190,483 | 63,419 | 0.0282 | 1,580,371 | 105 | 27,476 |
| May | 1,509 | 0.0118 | 21,967 | 3,720 | 0.0899 | 414,972 | 5,229 | 0.0677 | 436,681 | 1,679 | 0.0900 | 180,395 | 349 | 0.0600 | 55,453 | 312 | 0.0017 | 29,101 | 8,039 | 707,608 | 1,053 | 532,058 | 67,988 | 0.0282 | 1,587,640 | 750 | 187,769 |
| Jun | 383 | 0.0118 | 5,579 | 915 | 0.0264 | 30,221 | 1,298 | 0.0224 | 35,799 | 862 | 0.0720 | 58,791 | 280 | 0.0600 | 12,356 | 24 | 0.0350 | 1,048 | 2,185 | 107,996 | 1,328 | 84,009 | 56,379 | 0.0282 | 1,404,940 | 768 | 180,358 |
| Jul | 209 | 0.0118 | 3,048 | 481 | 0.0310 | 30,244 | 690 | 0.0391 | 33,292 | 483 | 0.0420 | 25,023 | 104 | 0.0520 | 6,646 | 843 | 0.0368 | 38,252 | 2,120 | 105,242 | 1,339 | 81,299 | 48,020 | 0.0282 | 1,196,651 | 938 | 230,232 |
| Aug | 152 | 0.0118 | 2,211 | 316 | 0.0437 | 17,127 | 470 | 0.0334 | 19,342 | 409 | 0.0700 | 35,315 | 84 | 0.0700 | 3,313 | -226 | 0.0480 | -13,407 | 716 | 40,762 | 1,095 | 54,710 | 41,116 | 0.0282 | 1,024,607 | 850 | 164,096 |
| Sep | 150 | 0.0118 | 2,186 | 256 | 0.0653 | 20,835 | 406 | 0.0457 | 23,021 | 386 | 0.0310 | 14,763 | 51 | 0.0530 | 3,357 | -302 | 0.0181 | -14,205 | 543 | 28,933 | 751 | 32,107 | 36,278 | 0.0282 | 904,029 | 601 | 113,403 |
| WY Total/Average | 4,736 | 0.0118 | 68,968 | 11,112 | 0.0565 | 780,280 | 15,848 | 0.0424 | 849,228 | 7,631 | 0.0740 | 678,254 | 2,127 | 0.0540 | 141,598 | 5,672 | 0.0441 | 308,251 | 31,079 | 1,977,379 | 5,810 | 1,339,559 | 52,513 | 0.0282 | 1,308,805 | 17,023 | 923,895 |
| Oct | 167 | 0.0115 | 2,367 | 342 | 0.0406 | 17,205 | 509 | 0.0312 | 19,572 | 405 | 0.0700 | 34,969 | 62 | 0.0400 | 3,058 | -110 | 0.0464 | -6,298 | 865 | 51,284 | 382 | -271,052 | 35,153 | 0.0271 | 1,174,601 | 400 | 53,764 |
| Nov | 158 | 0.0115 | 2,248 | 371 | 0.0381 | 17,418 | 529 | 0.0301 | 19,660 | 407 | 0.0670 | 33,636 | 62 | 0.0190 | 1,464 | 186 | 0.0436 | 10,013 | 1,185 | 64,772 | 144 | 28,885 | 36,227 | 0.0271 | 1,210,489 | 2 | 0 |
| Dec | 159 | 0.0115 | 2,261 | 332 | 0.0312 | 12,773 | 491 | 0.0248 | 15,036 | 394 | 0.0700 | 34,020 | 55 | 0.0500 | 1,422 | 751 | 0.0451 | 41,783 | 1,691 | 94,261 | 0 | 37,745 | 37,918 | 0.0271 | 1,267,004 | 2 | 0 |
| 1988 Jan | 180 | 0.0115 | 2,557 | 306 | 0.0191 | 7,216 | 486 | 0.0162 | 9,773 | 390 | 0.0380 | 18,421 | 55 | 0.0500 | 1,332 | 958 | 0.0273 | 32,333 | 1,892 | 64,109 | 0 | 985 | 39,810 | 0.0271 | 1,330,228 | 2 | 0 |
| Feb | 165 | 0.0115 | 2,336 | 320 | 0.0317 | 12,528 | 485 | 0.0249 | 14,860 | 393 | 0.0700 | 33,903 | 55 | 0.0500 | 1,393 | 256 | 0.0432 | 14,267 | 1,189 | 66,455 | 0 | 26,742 | 40,999 | 0.0271 | 1,350,941 | 2 | 0 |
| Mar | 197 | 0.0115 | 2,801 | 458 | 0.0384 | 21,668 | 655 | 0.0302 | 24,468 | 438 | 0.0880 | 42,432 | 75 | 0.0500 | 4,611 | 615 | 0.0494 | 49,866 | 1,975 | 121,197 | 0 | 55,192 | 42,974 | 0.0271 | 1,435,943 | 0 | 0 |
| Apr | 556 | 0.0115 | 7,890 | 9,043 | 0.0276 | 307,800 | 9,599 | 0.0267 | 315,790 | 2,300 | 0.1000 | 283,702 | 1,085 | 0.0600 | 80,280 | -8,275 | 0.0417 | -423,727 | 4,749 | 256,035 | 0 | 97,300 | 47,723 | 0.0271 | 1,594,616 | 2 | 0 |
| May | 2,649 | 0.0115 | 37,603 | 4,980 | 0.1702 | 1,045,366 | 7,629 | 0.1151 | 1,082,999 | 2,341 | 0.1320 | 381,163 | 1,107 | 0.1500 | 204,729 | 1,519 | 0.1021 | 191,366 | 12,595 | 1,860,247 | 935 | 1,470,626 | 54,486 | 0.0271 | 1,820,672 | 400 | 163,567 |
| Jun | 487 | 0.0115 | 6,941 | 1,800 | 0.0302 | 66,956 | 2,287 | 0.0262 | 73,867 | 890 | 0.0720 | 79,752 | 328 | 0.0430 | 17,389 | 45 | 0.0351 | 1,966 | 3,558 | 172,971 | 1,175 | 93,383 | 47,700 | 0.0271 | 1,593,832 | 979 | 300,480 |
| Jul | 184 | 0.0115 | 2,618 | 612 | 0.0460 | 34,709 | 796 | 0.0380 | 37,327 | 301 | 0.0420 | 25,953 | 113 | 0.0520 | 7,261 | -557 | 0.0367 | -25,240 | 854 | 45,304 | 1,181 | 56,242 | 36,365 | 0.0271 | 1,215,123 | 1100 | 367,791 |
| Aug | 148 | 0.0115 | 2,108 | 395 | -0.0042 | -2,036 | 543 | 0.0001 | 72 | 424 | 0.0700 | 36,610 | 72 | 0.1000 | 8,886 | -703 | 0.0035 | -31,390 | 270 | 13,978 | 944 | 36,279 | 27,782 | 0.0271 | 928,314 | 793 | 264,500 |
| Sep | 140 | 0.0115 | 2,071 | 454 | 0.0553 | 30,945 | 600 | 0.0445 | 33,017 | 428 | 0.0319 | 16,213 | 72 | 0.0530 | 4,702 | -700 | 0.0389 | -33,354 | 375 | 20,368 | 644 | 28,076 | 23,693 | 0.0271 | 791,752 | 300 | 133,244 |
| WY Total/Average | 5,190 | 0.0115 | 73,770 | 19,443 | 0.0657 | 1,572,650 | 28,609 | 0.0542 | 1,646,420 | 9,310 | 0.0859 | 1,020,807 | 3,141 | 0.0884 | 342,375 | -3,815 | 0.0248 | -178,823 | 31,225 | 2,830,979 | 5,172 | 1,658,967 | 39,236 | 0.0271 | 1,311,046 | 18,435 | 1,284,278 |
| Oct | 178 | 0.0114 | 2,480 | 281 | 0.0885 | 30,837 | 459 | 0.0589 | 33,307 | 397 | 0.0700 | 34,279 | 57 | 0.0400 | 2,813 | -340 | 0.0601 | -25,608 | 567 | 44,850 | 118 | 168,819 | 23,196 | 0.0226 | 646,911 | 148 | 20,661 |
| Nov | 216 | 0.0114 | 3,082 | 252 | 0.0476 | 14,731 | 468 | 0.0308 | 17,773 | 400 | 0.0670 | 33,058 | 59 | 0.0190 | 1,377 | -102 | 0.0440 | -5,537 | 825 | 46,670 | 93 | 28,257 | 23,652 | 0.0226 | 659,648 | 279 | 7,697 |
| Dec | 200 | 0.0114 | 2,821 | 344 | 0.0336 | 14,251 | 544 | 0.0254 | 17,072 | 412 | 0.0700 | 35,574 | 66 | 0.0500 | 4,040 | 354 | 0.0439 | 10,003 | 1,376 | 85,689 | 0 | 42,729 | 25,105 | 0.0226 | 700,150 | 124 | 3,438 |
| 1989 Jan | 223 | 0.0114 | 3,136 | 209 | 0.0209 | 5,378 | 432 | 0.0160 | 8,514 | 334 | 0.0380 | 17,909 | 50 | 0.0500 | 3,086 | 540 | 0.0278 | 18,540 | 1,408 | 48,160 | 0 | 8,939 | 26,386 | 0.0226 | 735,803 | 124 | 3,458 |
| Feb | 171 | 0.0114 | 2,493 | 181 | 0.0372 | 8,314 | 352 | 0.0247 | 10,727 | 367 | 0.0700 | 31,688 | 41 | 0.0500 | 2,528 | 827 | 0.0476 | 49,177 | 1,587 | 94,121 | 0 | 49,574 | 27,871 | 0.0226 | 777,315 | 112 | 3,124 |
| Mar | 267 | 0.0114 | 3,701 | 303 | 0.0565 | 14,144 | 470 | 0.0309 | 17,906 | 358 | 0.0800 | 39,274 | 38 | 0.0500 | 3,563 | 1,947 | 0.0516 | 123,832 | 2,873 | 184,575 | 0 | 104,451 | 30,620 | 0.0226 | 853,981 | 124 | 3,458 |
| Apr | 1,283 | 0.0114 | 18,061 | 2,440 | 0.0380 | 114,388 | 3,723 | 0.0288 | 132,469 | 1,225 | 0.1000 | 151,102 | 304 | 0.0800 | 37,318 | 398 | 0.0432 | 21,177 | 5,850 | 342,065 | 5 | 179,908 | 32,523 | 0.0226 | 907,055 | 847 | 110,079 |
| May | 1,400 | 0.0114 | 19,732 | 4,280 | 0.0112 | 59,232 | 5,680 | 0.0153 | 78,984 | 1,774 | 0.1320 | 288,844 | 800 | 0.1420 | 140,204 | -1,114 | 0.0440 | -60,435 | 7,140 | 447,577 | 817 | 271,233 | 29,071 | 0.0220 | 810,225 | 895 | 273,176 |
| Jun | 387 | 0.0114 | 5,444 | 800 | -0.0024 | -2,389 | 1,187 | 0.0021 | 3,058 | 646 | 0.3200 | 254,987 | 192 | 0.0980 | 22,071 | 343 | 0.0911 | 38,563 | 2,368 | 119,296 | 944 | 279,597 | 22,483 | 0.0226 | 627,016 | 790 | 232,392 |
| Jul | 192 | 0.0114 | 2,711 | 237 | 0.1151 | 33,630 | 429 | 0.0666 | 36,347 | 429 | 0.0930 | 49,213 | 74 | 0.0910 | 8,345 | -1,012 | 0.0677 | -84,494 | -79 | 9,405 | 877 | 35,061 | 12,518 | 0.0226 | 349,128 | 908 | 251,235 |
| Aug | 139 | 0.0114 | 1,829 | 367 | 0.0464 | 20,989 | 497 | 0.0372 | 22,817 | 411 | 0.0180 | 19,265 | 66 | 0.0910 | 7,235 | -32 | 0.0392 | -1,554 | 940 | 47,783 | 574 | 37,562 | 7,800 | 0.0226 | 217,517 | 508 | 141,811 |
| Sep | 170 | 0.0114 | 8,013 | 451 | 0.0174 | 9,604 | 1,021 | 0.0141 | 17,728 | 428 | 0.0340 | 17,950 | 74 | 0.0380 | 3,479 | -743 | 0.0249 | -21,997 | 779 | 17,158 | 349 | 5,165 | 7,800 | 0.0226 | 217,517 | 430 | 11,992 |
| WY Total/Average | 3,213 | 0.0114 | 73,488 | 10,047 | 0.0261 | 323,254 | 15,102 | 0.0211 | 396,741 | 7,275 | 0.1089 | 973,233 | 2,080 | 0.0681 | 226,695 | 1,260 | 0.0522 | 81,688 | 25,842 | 1,648,736 | 3,971 | 1,209,297 | 22,417 | 0.0226 | 623,201 | 37,706 | 1,093,284 |

Date: September 25, 2006

# Table C-3
## Flow and Phosphorus Routing WITH Proposed Narrows Project
## Scofield Reservoir Operation

| Year Month | (CALC) Stream Flow-Gooseberry Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|
| Oct | 157 | 0.0123 | 2,377 | 250 | 0.0070 | 2,162 | 407 | 0.0090 | 4,539 |
| Nov | 202 | 0.0123 | 4,020 | 291 | -0.0143 | -5,209 | 596 | -0.0008 | -590 |
| Dec | 171 | 0.0123 | 2,598 | 304 | 0.0310 | 11,017 | 475 | 0.0243 | 14,213 |
| 1990 Jan | 178 | 0.0123 | 2,706 | 259 | 0.0183 | 5,842 | 438 | 0.0158 | 8,547 |
| Feb | 102 | 0.0123 | 1,450 | 149 | 0.0368 | 6,761 | 311 | 0.0240 | 9,215 |
| Mar | 203 | 0.0123 | 3,060 | 187 | 0.0466 | 10,757 | 389 | 0.0288 | 13,823 |
| Apr | 1,097 | 0.0123 | 16,624 | 3,193 | 0.0326 | 128,449 | 4,290 | 0.0274 | 145,073 |
| May | 1,495 | 0.0123 | 22,661 | 5,452 | 0.0974 | 658,673 | 6,947 | 0.0790 | 677,335 |
| Jun | 463 | 0.0123 | 7,026 | 1,754 | 0.0391 | 82,900 | 2,217 | 0.0256 | 69,926 |
| Jul | 213 | 0.0123 | 3,226 | 727 | 0.0444 | 39,824 | 940 | 0.0371 | 43,051 |
| Aug | 655 | 0.0123 | 9,938 | 358 | 0.0254 | 11,198 | 1,013 | 0.0169 | 21,124 |
| Sep | 509 | 0.0123 | 7,719 | 296 | 0.0570 | 21,049 | 805 | 0.0290 | 28,768 |
| WY Total/Average | 3,607 | 0.0123 | 84,996 | 13,220 | 0.0583 | 930,028 | 18,827 | 0.0466 | 1,605,054 |
| Oct | 389 | 0.0126 | 6,066 | 305 | 0.0620 | 20,907 | 694 | 0.0431 | 36,673 |
| Nov | 184 | 0.0126 | 2,862 | 287 | 0.0356 | 12,604 | 671 | 0.0266 | 15,466 |
| Dec | 176 | 0.0126 | 2,739 | 282 | 0.0321 | 11,140 | 457 | 0.0246 | 13,879 |
| 1991 Jan | 190 | 0.0126 | 2,967 | 362 | 0.0183 | 8,098 | 552 | 0.0162 | 11,065 |
| Feb | 179 | 0.0126 | 2,786 | 377 | 0.0354 | 16,360 | 556 | 0.0265 | 10,794 |
| Mar | 190 | 0.0126 | 3,097 | 430 | 0.0274 | 10,837 | 620 | 0.0290 | 23,934 |
| Apr | 400 | 0.0126 | 3,759 | 1,787 | 0.0231 | 62,624 | 2,288 | 0.0250 | 70,597 |
| May | 2,798 | 0.0126 | 43,640 | 6,625 | 0.2029 | 1,657,836 | 9,424 | 0.1464 | 1,704,475 |
| Jun | 1,309 | 0.0126 | 20,353 | 3,920 | 0.0317 | 153,316 | 5,229 | 0.0509 | 173,667 |
| Jul | 327 | 0.0126 | 5,088 | 1,323 | 0.0490 | 60,876 | 1,644 | 0.0270 | 65,864 |
| Aug | 200 | 0.0126 | 3,195 | 471 | 0.0287 | 16,607 | 676 | 0.0239 | 19,889 |
| Sep | 191 | 0.0126 | 2,972 | 361 | 0.0692 | 30,813 | 552 | 0.0492 | 33,785 |
| WY Total/Average | 6,634 | 0.0126 | 103,443 | 16,330 | 0.1032 | 2,078,837 | 22,962 | 0.0770 | 2,182,300 |
| Oct | 443 | 0.0112 | 8,148 | 67 | 0.2121 | 17,512 | 510 | 0.0377 | 23,669 |
| Nov | 183 | 0.0112 | 2,557 | 434 | 0.0572 | 30,963 | 619 | 0.0308 | 23,510 |
| Dec | 179 | 0.0112 | 2,472 | 344 | 0.0326 | 13,843 | 523 | 0.0253 | 16,319 |
| 1992 Jan | 154 | 0.0112 | 2,135 | 291 | 0.0183 | 6,669 | 440 | 0.0160 | 8,782 |
| Feb | 125 | 0.0112 | 1,784 | 271 | 0.0300 | 10,203 | 395 | 0.0246 | 12,039 |
| Mar | 225 | 0.0112 | 3,107 | 529 | 0.0386 | 25,559 | 759 | 0.0298 | 28,952 |
| Apr | 723 | 0.0112 | 10,061 | 2,118 | 0.0366 | 96,978 | 2,847 | 0.0286 | 101,041 |
| May | 632 | 0.0112 | 8,730 | 1,867 | 0.1093 | 253,773 | 2,500 | 0.0845 | 264,524 |
| Jun | 329 | 0.0112 | 4,549 | 715 | -0.0017 | -1,467 | 1,044 | 0.0024 | 3,082 |
| Jul | 787 | 0.0112 | 10,880 | 425 | 0.0463 | 23,232 | 1,212 | 0.0228 | 34,088 |
| Aug | 607 | 0.0112 | 8,834 | 126 | 0.0097 | 1,504 | 627 | 0.0110 | 8,428 |
| Sep | 146 | 0.0112 | 1,873 | 196 | 0.0465 | 56,041 | 351 | 0.0438 | 17,934 |
| WY Total/Average | 4,439 | 0.0112 | 61,095 | 7,393 | 0.0523 | 477,543 | 11,852 | 0.0370 | 538,448 |
| Oct | 247 | 0.0123 | 3,865 | 224 | 0.1004 | 27,740 | 471 | 0.0542 | 31,554 |
| Nov | 229 | 0.0123 | 3,554 | 232 | 0.0418 | 10,922 | 447 | 0.0265 | 14,496 |
| Dec | 208 | 0.0123 | 3,199 | 245 | 0.0323 | 9,752 | 453 | 0.0232 | 12,949 |
| 1993 Jan | 237 | 0.0123 | 3,852 | 217 | 0.0201 | 5,505 | 454 | 0.0161 | 9,013 |
| Feb | 232 | 0.0123 | 3,530 | 108 | 0.0415 | 7,975 | 338 | 0.0241 | 11,347 |
| Mar | 390 | 0.0123 | 5,839 | 399 | 0.0452 | 22,249 | 729 | 0.0292 | 28,072 |
| Apr | 977 | 0.0123 | 14,971 | 1,391 | 0.0337 | 57,229 | 2,274 | 0.0257 | 72,192 |
| May | 4,908 | 0.0123 | 75,669 | 17,739 | 0.0076 | 2,131,414 | 22,647 | 0.0790 | 2,206,909 |
| Jun | 1,839 | 0.0123 | 28,569 | 4,902 | 0.0217 | 144,392 | 6,281 | 0.0313 | 164,961 |
| Jul | 364 | 0.0123 | 5,596 | 1,123 | 0.0464 | 64,227 | 1,497 | 0.0331 | 60,822 |
| Aug | 211 | 0.0123 | 3,248 | 541 | 0.0504 | 33,632 | 752 | 0.0398 | 36,887 |
| Sep | 191 | 0.0123 | 2,761 | 307 | 0.0458 | 24,890 | 467 | 0.0460 | 27,671 |
| WY Total/Average | 9,510 | 0.0123 | 146,254 | 27,409 | 0.0731 | 2,379,789 | 36,513 | 0.0590 | 2,646,043 |

| Year Month | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|
| Oct | 370 | 0.0700 | 32,761 | 38 | 0.0200 | 1,178 | -475 | 0.0171 | -40,111 |
| Nov | 437 | 0.1300 | 70,061 | 79 | 0.0025 | 243 | -288 | 0.0479 | -16,968 |
| Dec | 369 | 0.0700 | 33,528 | 53 | 0.0500 | 3,260 | -203 | 0.0456 | -11,399 |
| 1990 Jan | 376 | 0.0300 | 13,906 | 47 | 0.0260 | 1,510 | -124 | 0.0231 | -3,549 |
| Feb | 356 | 0.0700 | 30,723 | 35 | 0.0500 | 2,158 | 68 | 0.0490 | 4,123 |
| Mar | 370 | 0.0200 | 11,827 | 41 | 0.0240 | 1,268 | 460 | 0.0278 | 16,087 |
| Apr | 1,277 | 0.1000 | 157,560 | 531 | 0.0600 | 39,412 | 2,495 | 0.0430 | 132,396 |
| May | 2,022 | 0.0430 | 107,236 | 954 | 0.0550 | 65,395 | -1,071 | 0.0619 | -127,544 |
| Jun | 878 | 0.0720 | 77,971 | 317 | 0.0410 | 16,807 | -459 | 0.0352 | -19,932 |
| Jul | 535 | 0.0420 | 27,715 | 135 | 0.0025 | 408 | -311 | 0.0331 | -8,397 |
| Aug | 405 | 0.0700 | 34,956 | 61 | 0.0750 | 5,667 | -453 | 0.0439 | -24,499 |
| Sep | 385 | 0.0510 | 48,717 | 51 | 0.0530 | 3,314 | -215 | 0.0381 | -10,092 |
| WY Total/Average | 7,811 | 0.0636 | 813,112 | 2,332 | 0.0484 | 138,616 | -1,986 | 0.0509 | -110,096 |
| Oct | 390 | 0.0700 | 34,155 | 56 | 0.0750 | 2,458 | -620 | 0.0598 | -46,369 |
| Nov | 374 | 0.0670 | 30,895 | 43 | 0.0190 | 1,066 | -484 | 0.0460 | -25,160 |
| Dec | 385 | 0.0700 | 33,264 | 51 | 0.0500 | 3,149 | -781 | 0.0458 | -44,445 |
| 1991 Jan | 402 | 0.0589 | 18,844 | 60 | 0.0500 | 3,697 | -111 | 0.0272 | -3,727 |
| Feb | 404 | 0.0709 | 34,852 | 61 | 0.0500 | 3,751 | -272 | 0.0444 | -14,929 |
| Mar | 439 | 0.0800 | 41,364 | 69 | 0.0500 | 4,268 | 398 | 0.0500 | 24,424 |
| Apr | 719 | 0.1600 | 48,634 | 231 | 0.0600 | 17,084 | 1,261 | 0.0461 | 71,711 |
| May | 2,718 | 0.0780 | 261,492 | 1,310 | 0.1300 | 210,788 | 1,307 | 0.1127 | 181,622 |
| Jun | 1,799 | 0.0720 | 159,674 | 844 | 0.0410 | 48,149 | 2,117 | 0.0333 | 87,495 |
| Jul | 608 | 0.0420 | 34,091 | 198 | 0.0620 | 15,716 | -1,483 | 0.0303 | -46,239 |
| Aug | 466 | 0.0495 | 28,152 | 91 | 0.0009 | 4,390 | -340 | 0.0318 | -15,351 |
| Sep | 434 | 0.0310 | 16,592 | 77 | 0.0450 | 3,064 | -333 | 0.0390 | -8,796 |
| WY Total/Average | 9,172 | 0.0691 | 792,025 | 3,066 | 0.0847 | 320,314 | 879 | 0.1376 | 142,487 |
| Oct | 358 | 0.0700 | 49,958 | 36 | 0.0030 | 1,872 | -480 | 0.0603 | -31,432 |
| Nov | 435 | 0.0670 | 35,909 | 77 | 0.0130 | 1,816 | 92 | 0.0422 | 4,303 |
| Dec | 405 | 0.0700 | 35,207 | 64 | 0.0500 | 3,939 | -119 | 0.0441 | -6,485 |
| 1992 Jan | 385 | 0.0589 | 28,079 | 51 | 0.0500 | 3,153 | 220 | 0.0278 | 7,539 |
| Feb | 375 | 0.0700 | 32,413 | 46 | 0.0500 | 3,611 | 159 | 0.0467 | 8,227 |
| Mar | 463 | 0.0800 | 45,455 | 92 | 0.0500 | 5,622 | 546 | 0.0480 | 32,281 |
| Apr | 1,009 | 0.1000 | 124,449 | 369 | 0.0600 | 28,691 | -563 | 0.0439 | -30,100 |
| May | 967 | 0.1320 | 157,400 | 505 | 0.1020 | 65,898 | -1,862 | 0.0832 | -197,471 |
| Jun | 540 | 0.0210 | 14,224 | 139 | 0.0200 | 4,460 | -1,850 | 0.0118 | -22,343 |
| Jul | 452 | 0.0420 | 22,376 | 76 | 0.0520 | 4,879 | -406 | 0.0373 | -19,630 |
| Aug | 347 | 0.0710 | 30,248 | 30 | 0.2630 | 9,895 | -277 | 0.0576 | -19,934 |
| Sep | 355 | 0.0300 | 13,909 | 49 | 0.0500 | 2,623 | -7 | 0.0375 | -367 |
| WY Total/Average | 6,092 | 0.0746 | 580,856 | 1,434 | 0.0660 | 113,298 | -3,799 | 0.0440 | -205,305 |
| Oct | 387 | 0.0700 | 35,457 | 51 | 0.0350 | 2,349 | -278 | 0.0609 | -20,581 |
| Nov | 367 | 0.0670 | 30,335 | 41 | 0.0190 | 966 | 544 | 0.0466 | 19,790 |
| Dec | 372 | 0.0700 | 32,079 | 43 | 0.0500 | 2,681 | 139 | 0.0471 | 8,056 |
| 1993 Jan | 356 | 0.0589 | 17,536 | 44 | 0.0500 | 2,766 | 385 | 0.0282 | 13,395 |
| Feb | 366 | 0.0706 | 31,643 | 41 | 0.0500 | 2,514 | 589 | 0.0477 | 34,626 |
| Mar | 444 | 0.0800 | 43,809 | 63 | 0.0500 | 3,895 | 810 | 0.0487 | 35,858 |
| Apr | 737 | 0.1600 | 86,967 | 241 | 0.0600 | 17,846 | 2,614 | 0.0539 | 148,244 |
| May | 5,805 | 0.1320 | 934,999 | 1,899 | 0.1020 | 178,914 | -499 | 0.0804 | -46,428 |
| Jun | 2,033 | 0.0910 | 237,921 | 939 | 0.0420 | 48,652 | 1,873 | 0.0335 | 77,339 |
| Jul | 679 | 0.0420 | 35,124 | 209 | 0.0520 | 13,401 | -689 | 0.0363 | -29,782 |
| Aug | 477 | 0.1590 | 93,624 | 101 | 0.0770 | 8,310 | 491 | 0.0774 | 46,874 |
| Sep | 403 | 0.0310 | 15,429 | 61 | 0.0510 | 3,971 | -332 | 0.0385 | -15,775 |
| WY Total/Average | 12,505 | 0.1041 | 1,604,973 | 4,869 | 0.0811 | 288,604 | 5,501 | 0.0411 | 279,044 |

| Year Month | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Contents: Total Acre-Feet | mg/l (Table D-1) | Weight Grams | Flows from Below Scofield Dam: Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 8,414 | 0.0338 | 171,825 | | |
| Oct | -41 | -1,632 | 183 | -69,245 | 7,579 | 0.0309 | 285,149 | 6 | 0 |
| Nov | 824 | 52,748 | 54 | 23,758 | 6,165 | 0.0305 | 287,000 | 179 | 5,759 |
| Dec | 713 | 39,582 | 0 | 12,743 | 8,687 | 0.0305 | 327,047 | 101 | 7,191 |
| 1990 Jan | 739 | 20,504 | 0 | -7,304 | 9,221 | 0.0305 | 347,174 | 209 | 7,681 |
| Feb | 776 | 46,220 | 0 | 17,243 | 9,940 | 0.0305 | 374,290 | 51 | 1,920 |
| Mar | 1,271 | 43,056 | 0 | -4,803 | 11,033 | 0.0305 | 413,465 | 178 | 6,626 |
| Apr | 8,595 | 474,447 | 0 | 150,859 | 17,435 | 0.0305 | 636,412 | 2100 | 82,641 |
| May | 9,292 | 720,422 | 611 | 433,544 | 17,416 | 0.0305 | 655,722 | 7938 | 287,568 |
| Jun | 2,953 | 144,773 | 741 | 61,512 | 14,481 | 0.0305 | 545,020 | 6187 | 193,783 |
| Jul | 1,396 | 62,374 | 700 | 36,551 | 7,800 | 0.0305 | 293,667 | 7972 | 277,355 |
| Aug | 1,027 | 17,268 | 458 | 15,848 | 7,800 | 0.0305 | 291,667 | 888 | 21,430 |
| Sep | 1,026 | 36,706 | 547 | 11,203 | 7,800 | 0.0305 | 291,667 | 677 | 25,905 |
| WY Total/Average | 27,504 | 1,676,668 | 3,105 | 681,309 | 10,613 | 0.0301 | 799,567 | 24,399 | 918,620 |
| Oct | 517 | 27,986 | 183 | -40,630 | 7,800 | 0.0405 | 390,000 | 60 | 16,384 |
| Nov | 845 | 22,244 | 54 | 3,785 | 8,028 | 0.0405 | 401,419 | 181 | 7,050 |
| Dec | 112 | 6,164 | 0 | 550 | 8,026 | 0.0405 | 401,333 | 114 | 5,700 |
| 1991 Jan | 903 | 29,879 | 0 | -46,278 | 8,977 | 0.0405 | 424,483 | 60 | 21,601 |
| Feb | 748 | 40,468 | 0 | 3,077 | 9,136 | 0.0405 | 456,725 | 111 | 5,557 |
| Mar | 1,513 | 92,990 | 0 | 77,347 | 10,007 | 0.0405 | 330,868 | 49 | 2,000 |
| Apr | 4,494 | 248,016 | 0 | 31,081 | 12,776 | 0.0405 | 688,401 | 1199 | 18,501 |
| May | 14,758 | 2,564,378 | 544 | 1,853,674 | 22,960 | 0.0405 | 1,093,046 | 4809 | 296,418 |
| Jun | 9,933 | 482,986 | 822 | 7,935 | 24,898 | 0.0405 | 1,244,796 | 8298 | 514,209 |
| Jul | 819 | 45,307 | 910 | 51,409 | 15,433 | 0.0405 | 770,866 | 8998 | 484,012 |
| Aug | 896 | 38,881 | 637 | 25,851 | 8,629 | 0.0405 | 411,458 | 7946 | 352,259 |
| Sep | 880 | 46,623 | 560 | 20,870 | 7,800 | 0.0405 | 390,000 | 1340 | 67,177 |
| WY Total/Average | 38,099 | 3,427,124 | 3,518 | 1,734,393 | 12,836 | 0.0405 | 686,801 | 32,325 | 1,616,196 |
| Oct | 224 | 4,779 | 183 | -90,197 | 7,800 | 0.0303 | 281,909 | 239 | 12,682 |
| Nov | 1,213 | 65,347 | 54 | 22,184 | 8,658 | 0.0303 | 324,003 | 301 | 11,265 |
| Dec | 878 | 49,080 | 8 | 10,267 | 9,226 | 0.0303 | 343,268 | 187 | 11,489 |
| 1992 Jan | 1,103 | 37,553 | 0 | -3,709 | 10,022 | 0.0303 | 379,061 | 307 | 11,489 |
| Feb | 786 | 33,498 | 0 | 18,847 | 10,660 | 0.0303 | 398,325 | 496 | 10,779 |
| Mar | 1,662 | 112,396 | 3 | 42,707 | 12,492 | 0.0303 | 467,112 | 40 | 1,497 |
| Apr | 3,681 | 221,701 | 8 | 85,054 | 17,568 | 0.0303 | 507,781 | 2004 | 97,077 |
| May | 2,795 | 298,352 | 580 | 272,350 | 8,998 | 0.0303 | 325,248 | 4889 | 234,540 |
| Jun | 83 | -588 | 554 | 16,235 | 7,800 | 0.0303 | 291,906 | 778 | 20,421 |
| Jul | 1,314 | 42,708 | 525 | 13,635 | 7,800 | 0.0303 | 291,906 | 751 | 29,002 |
| Aug | 730 | 28,549 | 658 | 19,743 | 7,800 | 0.0303 | 291,906 | 492 | 9,827 |
| Sep | 733 | 14,345 | 340 | 18,957 | 7,800 | 0.0303 | 291,906 | 344 | 14,783 |
| WY Total/Average | 15,519 | 1,006,887 | 2,646 | 513,537 | 9,181 | 0.0303 | 351,070 | 11,175 | 465,804 |
| Oct | 437 | 46,679 | 183 | -58,561 | 7,526 | 0.0400 | 390,397 | 62 | 20,833 |
| Nov | 1,194 | 65,556 | 55 | 10,695 | 8,586 | 0.0400 | 429,948 | 282 | 11,456 |
| Dec | 1,023 | 56,302 | 0 | 6,944 | 9,180 | 0.0400 | 467,139 | 288 | 16,518 |
| 1993 Jan | 1,250 | 42,720 | 0 | -19,331 | 10,327 | 0.0400 | 509,933 | 389 | 15,275 |
| Feb | 1,364 | 69,329 | 0 | 12,300 | 11,431 | 0.0400 | 564,657 | 378 | 13,796 |
| Mar | 2,236 | 132,803 | 0 | 33,481 | 13,490 | 0.0400 | 666,194 | 177 | 8,716 |
| Apr | 5,871 | 329,248 | 0 | 43,665 | 19,270 | 0.0400 | 971,491 | 8 | 0 |
| May | 30,913 | 3,480,087 | 644 | 1,985,249 | 49,539 | 0.0400 | 2,440,020 | 8 | 0 |
| Jun | 11,133 | 518,895 | 1,140 | 26,207 | 54,873 | 0.0400 | 2,709,514 | 662 | 229,100 |
| Jul | 1,708 | 88,567 | 1,230 | 64,944 | 44,311 | 0.0400 | 2,187,679 | 1960 | 545,258 |
| Aug | 1,821 | 195,851 | 1,010 | 146,543 | 36,544 | 0.0400 | 1,494,241 | 4078 | 421,347 |
| Sep | 519 | 31,295 | 720 | 16,274 | 30,939 | 0.0400 | 1,337,142 | 3014 | 172,279 |
| WY Total/Average | 59,783 | 5,059,865 | 4,988 | 2,257,359 | 24,739 | 0.0400 | 1,230,519 | 11,577 | 1,550,880 |

Date September 25, 2006

# Table C-3
## Flow and Phosphorus Routing WITH Proposed Narrows Project
## Scofield Reservoir Operation

| Year | Month | (CALC) Stream Flow-Gooseberry Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 203 | 0.0119 | 2,906 | 363 | 0.0897 | 40,152 | 566 | 0.0621 | 43,378 |
| | Nov | 181 | 0.0119 | 2,672 | 211 | 0.0450 | 13,757 | 392 | 0.0319 | 15,430 |
| | Dec | 189 | 0.0119 | 2,753 | 275 | 0.0356 | 12,126 | 462 | 0.0261 | 14,830 |
| 1994 | Jan | 174 | 0.0119 | 2,563 | 325 | 0.0187 | 7,506 | 499 | 0.0164 | 10,069 |
| | Feb | 154 | 0.0119 | 2,274 | 998 | 0.0271 | 33,319 | 1,152 | 0.0250 | 35,593 |
| | Mar | 209 | 0.0119 | 3,008 | 1,536 | 0.0326 | 61,851 | 1,745 | 0.0302 | 64,859 |
| | Apr | 641 | 0.0119 | 9,452 | 2,228 | 0.0131 | 91,004 | 2,869 | 0.0284 | 100,456 |
| | May | 2,344 | 0.0119 | 34,545 | 4,002 | 0.1207 | 635,538 | 6,346 | 0.0856 | 670,083 |
| | Jun | 475 | 0.0119 | 7,010 | 982 | 0.0357 | 40,002 | 1,438 | 0.0255 | 47,013 |
| | Jul | 143 | 0.0119 | 2,104 | 344 | 0.0241 | 10,231 | 487 | 0.0206 | 12,335 |
| | Aug | 146 | 0.0119 | 2,155 | 207 | -0.0058 | -1,473 | 353 | 0.0046 | 682 |
| | Sep | 154 | 0.0119 | 2,209 | 97 | 0.1151 | 13,764 | 251 | 0.0518 | 16,033 |
| WY Total/Average | | 5,009 | [illegible] | 71,339 | 11,509 | [illegible] | [illegible] | 16,334 | [illegible] | 1,030,753 |
| | Oct | 231 | 0.0124 | 3,522 | 236 | 0.1100 | 32,867 | 467 | 0.0632 | 36,390 |
| | Nov | 190 | 0.0124 | 2,891 | 235 | 0.0457 | 13,220 | 426 | 0.0328 | 16,110 |
| | Dec | 203 | 0.0124 | 3,093 | 200 | 0.0468 | 11,771 | 403 | 0.0290 | 14,864 |
| 1995 | Jan | 224 | 0.0124 | 3,417 | 276 | 0.0244 | 8,338 | 501 | 0.0198 | 11,755 |
| | Feb | 200 | 0.0124 | 3,045 | 155 | 0.0527 | 14,496 | 358 | 0.0254 | 17,540 |
| | Mar | 316 | 0.0124 | 4,811 | 1,290 | 0.0359 | 32,983 | 4,511 | 0.0160 | 57,393 |
| | Apr | 562 | 0.0124 | 8,553 | 2,815 | 0.0302 | 105,099 | 3,377 | 0.0273 | 113,652 |

Table C-3
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
## Scofield Reservoir Operation

Date September 25, 2006

| Year | Month | (CALC) Stream Flow-[illegible] Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Total Acre-Feet | mg/l Total P | Weight Grams | Price River Below Scofield Dam: Flow Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | 8,434 | 0.0358 | 371,823 | | |
| | Oct | 225 | 0.0110 | 3,059 | 380 | 0.0816 | 38,361 | 805 | 0.0621 | 61,820 | 489 | 0.0700 | 41,861 | 105 | 0.0350 | 4,518 | 448 | 0.0561 | 32,141 | 1,693 | 190,141 | 421 | 658,248 | 40,091 | 0.0272 | 1,447,802 | 7908 | 268,100 |
| | Nov | 220 | 0.0110 | 2,992 | 501 | 0.0405 | 24,991 | 721 | 0.0315 | 27,982 | 458 | 0.0600 | 33,872 | 90 | 0.0190 | 2,110 | 118 | 0.0413 | 6,017 | 1,388 | 74,007 | 119 | 51,184 | 44,360 | 0.0272 | 1,490,420 | 0 | 0 |
| | Dec | 214 | 0.0110 | 2,913 | 344 | 0.0348 | 15,614 | 559 | 0.0269 | 18,527 | 425 | 0.0700 | 36,729 | 73 | 0.0500 | 4,475 | 99 | 0.0431 | 5,285 | 1,156 | 65,016 | 0 | 26,168 | 45,516 | 0.0272 | 1,539,259 | 0 | 0 |
| 1998 | Jan | 243 | 0.0110 | 3,331 | 331 | 0.0209 | 8,553 | 575 | 0.0167 | 11,864 | 420 | 0.0380 | 19,706 | 70 | 0.0500 | 4,310 | 991 | 0.0268 | 32,782 | 2,059 | 68,666 | 0 | -503 | 47,574 | 0.0272 | 1,598,427 | 0 | 0 |
| | Feb | 264 | 0.0110 | 3,594 | 453 | 0.0347 | 19,401 | 717 | 0.0260 | 22,996 | 453 | 0.0700 | 39,095 | 87 | 0.0500 | 5,359 | -47 | 0.0419 | -2,431 | 1,210 | 65,053 | 0 | 24,163 | 48,785 | 0.0272 | 1,639,097 | 0 | 0 |
| | Mar | 329 | 0.0110 | 4,466 | 696 | 0.0418 | 35,902 | 1,024 | 0.0319 | 40,368 | 526 | 0.0800 | 51,874 | 127 | 0.0500 | 7,815 | 1,080 | 0.0460 | 61,351 | 2,783 | 161,608 | 0 | 68,785 | 50,626 | 0.0272 | 1,700,976 | 807 | 30,144 |
| | Apr | 632 | 0.0110 | 8,596 | 2,020 | 0.0345 | 81,997 | 2,652 | 0.0289 | 94,503 | 916 | 0.1000 | 115,504 | 348 | 0.0600 | 25,758 | 332 | 0.0643 | 29,071 | 4,468 | 264,897 | 0 | 114,733 | 46,879 | 0.0272 | 1,642,273 | 6296 | 208,835 |
| | May | 3,362 | 0.0110 | 45,446 | 11,417 | 0.1014 | 1,428,513 | 14,979 | 0.0799 | 1,476,960 | 4,033 | 0.1320 | 656,385 | 2,020 | 0.1020 | 254,141 | 3,175 | 0.0606 | 115,603 | 24,206 | 2,703,370 | 962 | 1,921,711 | 73,132 | 0.0273 | 2,423,199 | 22 | 772 |
| | Jun | 3,016 | 0.0110 | 41,010 | 6,683 | 0.0300 | 247,256 | 9,698 | 0.0241 | 288,266 | 2,482 | 0.0720 | 218,047 | 1,172 | 0.0430 | 62,162 | 1,868 | 0.0332 | 76,423 | 15,200 | 645,501 | 1,264 | 177,038 | 73,757 | 0.0272 | 2,444,512 | 1332 | 446,250 |
| | Jul | 447 | 0.0110 | 6,073 | 2,609 | 0.0091 | 29,308 | 1,955 | 0.0094 | 23,281 | 1,049 | 0.0210 | 27,195 | 409 | 0.0520 | 26,268 | -908 | 0.0155 | -17,389 | 3,006 | 71,443 | 1,343 | -4,530 | 63,371 | 0.0272 | 2,129,184 | 1188 | 391,101 |
| | Aug | 232 | 0.0110 | 3,153 | 481 | 0.0283 | 24,087 | 923 | 0.0239 | 27,240 | 524 | 0.0700 | 46,138 | 131 | 0.0730 | 12,133 | 1,085 | 0.0391 | 52,163 | 2,674 | 137,895 | 1,132 | 85,739 | 53,489 | 0.0272 | 1,797,158 | 1948 | 394,183 |
| | Sep | 187 | 0.0110 | 2,542 | 447 | 0.1610 | 88,694 | 654 | 0.1167 | 91,236 | 415 | 0.0720 | 42,338 | 88 | 0.0470 | 5,122 | 124 | 0.0672 | 10,230 | 1,390 | 118,946 | 914 | 107,024 | 47,719 | 0.0272 | 1,600,281 | 6297 | 210,219 |
| WY Total/Average | | 9,371 | 0.0110 | 130,157 | 26,371 | 0.0628 | 2,066,789 | 36,342 | 0.0490 | 2,196,947 | 12,237 | 0.0884 | 1,308,543 | 4,721 | 0.0711 | 414,257 | 8,374 | 0.0597 | 601,768 | 81,673 | 4,516,513 | 5,048 | 3,294,678 | 53,191 | 0.0272 | 1,787,132 | 37,686 | 1,839,564 |
| | Oct | 314 | 0.0137 | 3,575 | 433 | 0.0846 | 45,223 | 649 | 0.0631 | 48,848 | 449 | 0.0700 | 38,654 | 63 | 0.0352 | 2,672 | -426 | 0.0686 | -30,837 | 754 | 48,316 | 418 | 20,284 | 43,986 | 0.0277 | 1,470,646 | 3040 | 172,637 |
| | Nov | 316 | 0.0137 | 5,051 | 535 | 0.0371 | 25,255 | 789 | 0.0305 | 28,906 | 487 | 0.0670 | 39,565 | 95 | 0.0196 | 2,253 | 423 | 0.0435 | 21,408 | 1,753 | 91,102 | 119 | 55,229 | 44,442 | 0.0277 | 1,519,740 | 198 | 6,771 |
| | Dec | 444 | 0.0127 | 2,502 | 462 | 0.0280 | 15,967 | 810 | 0.0346 | 18,469 | 416 | 0.0700 | 35,959 | 68 | 0.0500 | 4,178 | 32 | 0.0426 | 2,803 | 1,140 | 61,411 | 0 | 23,233 | 45,283 | 0.0277 | 1,548,446 | 327 | 16,493 |
| 1999 | Jan | 103 | 0.0097 | 1,746 | 429 | 0.0169 | 8,922 | 531 | 0.0153 | 10,068 | 397 | 0.0380 | 18,668 | 57 | 0.0500 | 3,527 | 160 | 0.0279 | 5,442 | 1,196 | 38,210 | 0 | -963 | 46,120 | 0.0277 | 1,577,124 | 327 | 10,498 |
| | Feb | 138 | 0.0137 | 2,209 | 96 | 0.0387 | 4,376 | 231 | 0.0241 | 6,845 | 341 | 0.0700 | 29,412 | 27 | 0.0500 | 1,633 | 475 | 0.0517 | 30,164 | 1,078 | 68,073 | 0 | 33,389 | 46,915 | 0.0277 | 1,609,330 | 277 | 9,470 |
| | Mar | 201 | 0.0137 | 3,399 | 439 | 0.0377 | 20,410 | 646 | 0.0302 | 23,899 | 425 | 0.0800 | 43,343 | 75 | 0.0500 | 4,589 | 2,092 | 0.0493 | 127,634 | 3,236 | 198,584 | 0 | 67,756 | 49,325 | 0.0277 | 1,790,422 | 428 | 14,537 |
| | Apr | 377 | 0.0137 | 5,601 | 1,526 | 0.0505 | 49,951 | 1,460 | 0.0271 | 35,642 | 609 | 0.1096 | 65,391 | 294 | 0.0800 | 15,110 | 882 | 0.0468 | 39,331 | 3,218 | 192,624 | 0 | 82,593 | 50,863 | 0.0277 | 1,792,742 | 980 | 67,309 |
| | May | 2,710 | 0.0137 | 45,753 | 8,329 | 0.1059 | 1,058,287 | 11,033 | 0.0816 | 1,102,050 | 3,144 | 0.1500 | 551,620 | 1,519 | 0.1026 | 192,582 | 3,275 | 0.0606 | 148,211 | 18,086 | 2,153,203 | 851 | 1,546,619 | 67,038 | 0.0277 | 2,292,160 | 982 | 47,255 |
| | Jun | 2,263 | 0.0137 | 38,215 | 4,378 | 0.0304 | 163,969 | 6,641 | 0.0247 | 202,155 | 2,019 | 0.0780 | 174,207 | 833 | 0.0639 | 74,716 | 2,071 | 0.0382 | 95,373 | 11,645 | 362,711 | 1,221 | 207,373 | 64,433 | 0.0277 | 2,201,356 | 1332 | 444,892 |
| | Jul | 355 | 0.0137 | 5,900 | 1,105 | 0.0456 | 62,108 | 1,460 | 0.0378 | 68,094 | 669 | 0.0430 | 35,762 | 215 | 0.0520 | 13,387 | 181 | 0.0363 | 6,772 | 2,315 | 124,359 | 1,288 | 42,468 | 54,232 | 0.0277 | 1,852,850 | 1147 | 397,453 |
| | Aug | 283 | 0.0137 | 4,782 | 539 | 0.0307 | 34,628 | 882 | 0.0280 | 39,421 | 532 | 0.4270 | 214,532 | 180 | 0.0250 | 4,016 | 553 | 0.1160 | 79,462 | 2,057 | 337,429 | 1,072 | 456,764 | 47,352 | 0.0277 | 1,632,927 | 748 | 254,684 |
| | Sep | 309 | 0.0137 | 2,530 | 421 | 0.0700 | 36,318 | 450 | 0.0533 | 39,848 | 461 | 0.0310 | 17,798 | 94 | 0.0530 | 6,157 | 77 | 0.0394 | 3,714 | 1,288 | 67,518 | 788 | 71,103 | 42,701 | 0.0277 | 1,460,233 | 528 | 189,048 |
| WY Total/Average | | 5,279 | 0.0137 | 121,152 | 19,329 | 0.0607 | 1,511,608 | 22,096 | 0.0519 | 1,644,253 | 10,013 | 0.1030 | 1,239,777 | 3,520 | 0.0734 | 337,254 | 9,384 | 0.0596 | 754,609 | 49,614 | 3,936,392 | 5,890 | 2,640,005 | 39,249 | 0.0277 | 1,717,161 | 47,941 | 1,609,613 |
| | Oct | 180 | 0.0111 | 2,460 | 525 | 0.0766 | 66,265 | 706 | 0.0584 | 50,729 | 449 | 0.0700 | 38,761 | 85 | 0.0350 | 3,681 | -1,724 | 0.0586 | -124,643 | -485 | -31,478 | 404 | 117,530 | 35,786 | 0.0215 | 951,060 | 808 | 103,150 |
| | Nov | 177 | 0.0111 | 2,421 | 655 | 0.0336 | 27,485 | 802 | 0.0302 | 29,907 | 465 | 0.0670 | 38,460 | 94 | 0.0190 | 2,207 | -948 | 0.0411 | -47,629 | 425 | 22,951 | 112 | 14,978 | 35,308 | 0.0215 | 938,362 | 798 | 20,976 |
| | Dec | 155 | 0.0111 | 2,119 | 505 | 0.0294 | 18,302 | 660 | 0.0251 | 20,421 | 420 | 0.0700 | 17,157 | 75 | 0.0500 | 4,646 | -38 | 0.0429 | -1,962 | 1,136 | 60,655 | 0 | 30,462 | 36,135 | 0.0215 | 950,334 | 309 | 8,222 |
| 2000 | Jan | 139 | 0.0111 | 1,884 | 563 | 0.0179 | 12,416 | 901 | 0.0165 | 14,309 | 456 | 0.0440 | 20,519 | 79 | 0.0500 | 4,887 | 561 | 0.0264 | 18,395 | 1,783 | 58,101 | 0 | 10,707 | 37,609 | 0.0215 | 999,568 | 309 | 8,223 |
| | Feb | 123 | 0.0111 | 1,676 | 529 | 0.0282 | 18,439 | 652 | 0.0250 | 20,116 | 427 | 0.0750 | 36,893 | 74 | 0.0500 | 4,537 | 934 | 0.0431 | 49,603 | 2,087 | 111,147 | 0 | 15,686 | 39,676 | 0.0215 | 1,054,439 | 26 | 530 |
| | Mar | 194 | 0.0111 | 2,655 | 543 | 0.0336 | 23,213 | 737 | 0.0306 | 27,868 | 850 | 0.0800 | 44,420 | 85 | 0.0500 | 5,276 | 418 | 0.0484 | 24,986 | 1,692 | 102,574 | 0 | 17,613 | 41,367 | 0.0215 | 1,099,490 | 0 | 0 |
| | Apr | 809 | 0.0111 | 11,028 | 2,406 | 0.0352 | 104,564 | 3,212 | 0.0292 | 115,592 | 1,095 | 0.1000 | 135,016 | 134 | 0.0600 | 12,108 | -270 | 0.0430 | -12,449 | 4,490 | 269,267 | 0 | 148,926 | 44,603 | 0.0215 | 1,190,715 | 104 | 28,013 |
| | May | 2,111 | 0.0111 | 28,883 | 4,610 | 0.1201 | 683,091 | 6,721 | 0.0859 | 711,973 | 2,126 | 0.1320 | 346,089 | 990 | 0.1020 | 124,612 | 1,163 | 0.0812 | 116,494 | 10,990 | 1,290,169 | 917 | 1,011,215 | 47,098 | 0.0215 | 1,251,658 | 1798 | 207,011 |
| | Jun | 539 | 0.0111 | 7,341 | 1,325 | 0.0623 | 102,077 | 1,836 | 0.0478 | 109,318 | 778 | 0.0370 | 39,517 | 203 | 0.0490 | 12,034 | 222 | 0.0392 | 10,747 | 3,117 | 168,236 | 1,429 | 110,356 | 39,671 | 0.0215 | 1,054,224 | 945 | 250,215 |
| | Jul | 161 | 0.0111 | 2,204 | 517 | 0.0457 | 29,193 | 679 | 0.0375 | 31,397 | 466 | 0.0420 | 24,154 | 95 | 0.0520 | 6,069 | 84 | 0.0380 | 3,815 | 1,323 | 65,436 | 1,118 | 39,841 | 29,613 | 0.0215 | 787,010 | 1088 | 272,909 |
| | Aug | 140 | 0.0111 | 1,918 | 349 | 0.0247 | 10,532 | 485 | 0.0208 | 12,450 | 408 | 0.0210 | 10,512 | 62 | 0.0340 | 2,603 | -405 | 0.0212 | -10,615 | 549 | 14,953 | 869 | 23,452 | 21,485 | 0.0215 | 570,994 | 780 | 207,516 |
| | Sep | 148 | 0.0111 | 2,017 | 385 | 0.0091 | 25,882 | 504 | 0.0449 | 27,919 | 408 | 0.0310 | 15,405 | 61 | 0.0530 | 4,003 | -333 | 0.0985 | -11,047 | 737 | 36,342 | 599 | 11,949 | 20,013 | 0.0215 | 531,881 | 1025 | 45,511 |
| WY Total/Average | | 4,863 | 0.0111 | 66,525 | 12,830 | 0.0697 | 1,105,459 | 17,713 | 0.0536 | 1,171,087 | 7,935 | 0.0800 | 782,971 | 2,107 | 0.0701 | 207,302 | [illegible] | [illegible] | [illegible] | 27,651 | 2,177,323 | 3,114 | 1,899,449 | 37,714 | 0.0215 | [illegible] | [illegible] | 1,207,299 |
| | Oct | 176 | 0.0130 | 2,315 | 395 | 0.0767 | 38,700 | 570 | 0.0584 | 41,075 | 419 | 0.0700 | 36,194 | 64 | 0.0350 | 2,008 | 269 | 0.0582 | 19,624 | 1,328 | 99,891 | 255 | -121,181 | 20,349 | 0.0291 | 731,329 | 504 | 23,620 |
| | Nov | 160 | 0.0110 | 2,158 | 403 | 0.0408 | 20,391 | 604 | 0.0300 | 22,549 | 422 | 0.0670 | 34,093 | 71 | 0.0190 | 1,662 | 469 | 0.0427 | 24,705 | 1,371 | 83,815 | 37 | 20,167 | 21,296 | 0.0291 | 763,797 | 529 | 10,781 |
| | Dec | 111 | 0.0110 | 1,499 | 340 | 0.0271 | 11,552 | 430 | 0.0232 | 13,051 | 394 | 0.0700 | 12,282 | 45 | 0.0500 | 2,764 | -78 | 0.0468 | -4,505 | 796 | 43,511 | 0 | 14,068 | 21,780 | 0.0291 | 781,243 | 329 | 11,096 |
| 2001 | Jan | 56 | 0.0110 | 752 | 227 | 0.0170 | 4,758 | 283 | 0.0158 | 5,307 | 341 | 0.0300 | 33,093 | 27 | 0.0500 | 1,639 | 2,787 | 0.0391 | 83,626 | 3,037 | 111,855 | 0 | 3,691 | 24,313 | 0.0291 | 870,249 | 309 | 11,606 |
| | Feb | 70 | 0.0115 | 945 | 305 | 0.0271 | 19,230 | 375 | 0.0241 | 11,163 | 365 | 0.0700 | 31,468 | 40 | 0.0500 | 2,434 | 369 | 0.0479 | 21,799 | 1,149 | 66,904 | 0 | 22,697 | 25,389 | 0.0291 | 570,455 | 278 | 10,822 |
| | Mar | 206 | 0.0115 | 2,816 | 457 | 0.0395 | 22,252 | 660 | 0.0305 | 25,078 | 434 | 0.0800 | 42,831 | 77 | 0.0500 | 4,703 | 1,092 | 0.0492 | 54,645 | 5,239 | 137,127 | 0 | 56,871 | 27,622 | 0.0291 | 990,761 | 0 | 0 |
| | Apr | 890 | 0.0110 | 12,026 | 1,859 | 0.0377 | 86,532 | 2,799 | 0.0290 | 98,378 | 971 | 0.1000 | 119,790 | 267 | 0.0600 | 27,376 | 786 | 0.0441 | 42,405 | 4,874 | 288,153 | 0 | 113,335 | 32,466 | 0.0291 | 1,162,745 | 80 | 2,645 |
| | May | 2,558 | 0.0110 | 34,377 | 5,381 | 0.1066 | 800,667 | 7,941 | 0.0852 | 835,044 | 2,419 | 0.1320 | 396,695 | 1,158 | 0.1020 | 145,009 | 306 | 0.0813 | 30,567 | 11,640 | 1,387,745 | 610 | 998,523 | 28,645 | 0.0292 | 1,380,157 | 434 | 164,778 |
| | Jun | 351 | 0.0110 | 4,746 | 1,259 | 0.0305 | 47,285 | 1,610 | 0.0262 | 52,125 | 319 | 0.0720 | 62,474 | 229 | 0.0379 | 10,440 | -204 | 0.0357 | -8,979 | 2,350 | 117,065 | 1,037 | 70,686 | 31,495 | 0.0291 | 1,127,592 | 804 | 365,697 |
| | Jul | 132 | 0.0110 | 1,782 | 459 | 0.0492 | 35,980 | 590 | 0.0381 | 27,702 | 446 | 0.0420 | 21,128 | 84 | 0.0520 | 3,383 | 220 | 0.0371 | 20,443 | 1,348 | 46,778 | 1,058 | 34,847 | 33,103 | 0.0291 | 828,678 | 682 | 310,725 |
| | Aug | 132 | 0.0110 | 1,790 | 306 | 0.0596 | 13,045 | 439 | 0.0511 | 18,825 | 401 | 0.0700 | 34,903 | 58 | 0.1020 | 4,531 | 1,100 | 0.0469 | 83,728 | 1,996 | 113,881 | 777 | 73,833 | 16,964 | 0.0291 | 608,498 | 730 | 264,027 |
| | Sep | 132 | 0.0110 | 1,789 | 213 | 0.0842 | 18,842 | 345 | 0.0438 | 18,633 | 367 | 0.0310 | 14,022 | 31 | 0.0530 | 2,072 | 54 | 0.0376 | 1,403 | 828 | 59,710 | 300 | 27,935 | 18,186 | 0.0291 | 472,606 | 498 | 147,097 |
| | | | | | | | | | | | | | | | | | | 0.0000 | 0 | | | | | | | | | |
| WY Total/Average | | 4,998 | 0.0110 | 67,253 | 11,659 | 0.0765 | 1,097,944 | 16,653 | 0.0568 | 1,167,257 | 7,861 | 0.0897 | 865,221 | 2,207 | 0.0759 | 232,153 | 6,503 | 0.0416 | 338,599 | 33,157 | 2,581,180 | 4,358 | 1,340,168 | 24,727 | 0.0291 | 980,936 | 15,437 | 1,274,087 |

Date: September 25, 2006

# Table C-3
## Flow and Phosphorus Routing WITH Proposed Narrows Project
## Scofield Reservoir Operation

| Year | Month | (CALC) Stream Flow-Cranberry Creek Near Scofield: Flow Acre-Feet | Concentration mg/l | Weight Grams | (Calculated) Gains for Fish Creek Above Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 122 | 0.0105 | 1,576 | 311 | 0.0714 | 29,238 | 454 | 0.0530 | 30,854 |
| | Nov | 152 | 0.0105 | 1,957 | 245 | 0.0431 | 13,014 | 397 | 0.0306 | 14,971 |
| | Dec | 144 | 0.0105 | 1,851 | 166 | 0.0310 | 1,572 | 309 | 0.0247 | 9,424 |
| 2002 | Jan | 78 | 0.0105 | 1,004 | 189 | 0.0192 | 4,570 | 267 | 0.0160 | 5,271 |
| | Feb | 41 | 0.0105 | 530 | 162 | 0.0272 | 5,440 | 203 | 0.0238 | 5,970 |
| | Mar | 86 | 0.0105 | 1,111 | 350 | 0.0329 | 14,218 | 437 | 0.0283 | 15,329 |
| | Apr | 727 | 0.0105 | 9,379 | 1,764 | 0.0892 | 78,766 | 2,492 | 0.0287 | 88,145 |
| | May | 1,378 | 0.0105 | 17,770 | 3,836 | 0.1102 | 521,626 | 5,215 | 0.0839 | 539,377 |
| | Jun | 251 | 0.0105 | 3,233 | 1,111 | 0.0085 | 11,638 | 1,362 | 0.0089 | 14,869 |
| | Jul | 103 | 0.0105 | 1,323 | 286 | 0.0474 | 16,735 | 389 | 0.0377 | 18,057 |
| | Aug | 86 | 0.0105 | 1,112 | 173 | 0.0607 | 12,963 | 259 | 0.0440 | 14,074 |
| | Sep | 130 | 0.0105 | 1,673 | 277 | 0.0088 | 2,879 | 407 | 0.0091 | 4,552 |
| WY Total/Average | | 1,299 | 0.0105 | 42,518 | 8,891 | 0.0655 | 718,375 | 12,189 | 0.0506 | 760,892 |
| | Oct | 341 | 0.0126 | 4,759 | 262 | 0.0368 | 11,869 | 503 | 0.0232 | 15,628 |
| | Nov | 172 | 0.0126 | 2,909 | 418 | 0.0739 | 38,129 | 593 | 0.0559 | 40,848 |
| | Dec | 87 | 0.0126 | 1,354 | 357 | 0.0259 | 11,411 | 445 | 0.0233 | 12,761 |
| 2003 | Jan | 70 | 0.0126 | 1,091 | 413 | 0.0096 | 4,474 | 483 | 0.0100 | 5,565 |
| | Feb | 109 | 0.0126 | 1,691 | 267 | 0.0293 | 9,627 | 376 | 0.0244 | 11,318 |
| | Mar | 192 | 0.0126 | 2,970 | 393 | 0.0357 | 17,331 | 585 | 0.0281 | 20,307 |
| | Apr | 771 | 0.0126 | 11,966 | 1,609 | 0.0322 | 63,965 | 2,380 | 0.0259 | 75,931 |
| | May | 4,416 | 0.0126 | 68,517 | 6,371 | 0.0513 | 403,045 | 10,787 | 0.0354 | 471,562 |
| | Jun | 1,323 | 0.0126 | 18,962 | 2,160 | 0.0074 | 19,966 | 3,482 | 0.0093 | 38,928 |
| | Jul | 306 | 0.0126 | 4,754 | 584 | 0.0441 | 31,871 | 893 | 0.0333 | 36,624 |
| | Aug | 216 | 0.0126 | 3,350 | 292 | 0.0074 | 2,663 | 508 | 0.0096 | 6,014 |
| | Sep | 199 | 0.0126 | 3,083 | 215 | 0.0075 | 1,977 | 414 | 0.0099 | 5,060 |
| WY Total/Average | | 8,004 | 0.0126 | 124,188 | 13,363 | 0.0774 | 616,757 | 21,367 | 0.0281 | 740,945 |
| | Oct | 176 | 0.0130 | 2,834 | 213 | 0.0080 | 2,109 | 390 | 0.0103 | 4,943 |
| | Nov | 182 | 0.0130 | 2,916 | 262 | 0.0398 | 12,894 | 444 | 0.0289 | 15,811 |
| | Dec | 144 | 0.0130 | 2,375 | 226 | 0.0317 | 8,845 | 371 | 0.0243 | 11,220 |
| 2004 | Jan | 154 | 0.0130 | 2,157 | 219 | 0.0186 | 5,042 | 354 | 0.0165 | 7,199 |
| | Feb | 141 | 0.0130 | 2,271 | 166 | 0.0339 | 7,784 | 328 | 0.0249 | 10,055 |
| | Mar | 260 | 0.0130 | 4,173 | 493 | 0.0384 | 23,453 | 755 | 0.0297 | 27,625 |
| | Apr | 1,251 | 0.0130 | 20,126 | 4,419 | 0.0311 | 169,361 | 5,670 | 0.0271 | 189,487 |
| | May | 2,619 | 0.0130 | 42,079 | 4,859 | 0.1081 | 648,290 | 7,480 | 0.0748 | 691,365 |
| | Jun | 899 | 0.0130 | 14,449 | 738 | 0.0422 | 29,323 | 1,637 | 0.0217 | 43,773 |
| | Jul | 252 | 0.0130 | 4,041 | 363 | 0.0495 | 22,120 | 614 | 0.0345 | 26,162 |
| | Aug | 143 | 0.0130 | 2,295 | 121 | 0.0051 | 769 | 264 | 0.0094 | 3,064 |
| | Sep | 164 | 0.0130 | 2,635 | 142 | 0.0702 | 12,308 | 306 | 0.0395 | 14,943 |
| WY Total/Average | | 6,371 | 0.0130 | 102,350 | 12,253 | 0.0624 | 943,295 | 18,624 | 0.0455 | 1,045,644 |
| | Oct | 258 | 0.0129 | 3,113 | 342 | 0.0075 | 3,170 | 600 | 0.0098 | 7,283 |
| | Nov | 197 | 0.0129 | 3,141 | 249 | 0.0398 | 12,239 | 446 | 0.0279 | 15,380 |
| | Dec | 157 | 0.0129 | 2,506 | 234 | 0.0078 | 2,257 | 391 | 0.0099 | 4,764 |
| 2005 | Jan | 138 | 0.0129 | 2,209 | 225 | 0.0186 | 5,144 | 363 | 0.0164 | 7,353 |
| | Feb | 148 | 0.0129 | 2,364 | 195 | 0.0335 | 8,066 | 343 | 0.0247 | 10,430 |
| | Mar | 251 | 0.0129 | 4,008 | 281 | 0.0418 | 14,484 | 532 | 0.0282 | 18,492 |
| | Apr | 876 | 0.0129 | 13,991 | 1,806 | 0.0303 | 67,506 | 2,682 | 0.0246 | 81,497 |
| | May | 6,327 | 0.0129 | 101,016 | 16,656 | 0.0874 | 1,795,500 | 22,983 | 0.0669 | 1,896,516 |
| | Jun | 2,182 | 0.0129 | 34,829 | 6,730 | 0.0298 | 247,488 | 8,913 | 0.0257 | 282,317 |
| | Jul | 527 | 0.0129 | 8,416 | 910 | 0.0071 | 7,919 | 1,437 | 0.0092 | 16,334 |
| | Aug | 359 | 0.0129 | 5,737 | 507 | 0.0067 | 4,210 | 866 | 0.0093 | 9,947 |
| | Sep | 246 | 0.0129 | 3,926 | 357 | 0.0071 | 3,114 | 603 | 0.0095 | 7,040 |
| WY Total/Average | | 11,666 | 0.0129 | 186,252 | 28,498 | 0.0618 | 2,171,300 | 40,164 | 0.0476 | 2,357,554 |
| 78-05 | Total | 240,187 | | 3,518,147 | 648,615 | | 54,269,545 | 888,802 | | 57,792,692 |
| 78-05 | Average | 8,578 | 0.0119 | 126,184 | 23,165 | 0.0078 | 1,937,841 | 31,743 | 0.0527 | 2,064,025 |
| 78-80 | Total | 123,558 | | 1,783,517 | 350,614 | | 30,072,685 | 474,172 | | 31,856,202 |
| 78-89 | Average | 10,296 | 0.0117 | 148,628 | 29,218 | 0.0605 | 2,506,055 | 39,514 | 0.0542 | 2,654,684 |

| Year | Month | Stream Flow-Mud Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow Acre-Feet | Concentration mg/l | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | 387 | 0.0706 | 35,393 | 52 | 0.0350 | 2,237 | 417 | 0.0601 | 30,484 |
| | Nov | 383 | 0.0670 | 31,623 | 49 | 0.0190 | 1,160 | 1,270 | 0.0452 | 70,811 |
| | Dec | 359 | 0.0768 | 30,987 | 37 | 0.0500 | 2,261 | 209 | 0.0486 | 12,536 |
| 2002 | Jan | 346 | 0.0380 | 16,224 | 10 | 0.0560 | 1,850 | 143 | 0.0298 | 17,652 |
| | Feb | 331 | 0.0700 | 28,620 | 22 | 0.0500 | 1,349 | 3,379 | 0.0534 | 222,527 |
| | Mar | 375 | 0.0800 | 37,059 | 46 | 0.0500 | 2,609 | 1,255 | 0.0537 | 83,148 |
| | Apr | 909 | 0.1000 | 112,105 | 194 | 0.0600 | 24,686 | 249 | 0.0443 | 13,641 |
| | May | 1,680 | 0.1320 | 273,505 | 750 | 0.1020 | 94,332 | 498 | 0.0816 | 41,122 |
| | Jun | 645 | 0.0300 | 23,875 | 191 | 0.0570 | 13,443 | 109 | 0.0185 | 8,414 |
| | Jul | 492 | 0.0420 | 20,838 | 90 | 0.0520 | 3,852 | -712 | 0.0367 | -34,923 |
| | Aug | 352 | 0.0100 | 4,343 | 33 | 0.0750 | 3,051 | 1,272 | 0.0266 | 41,690 |
| | Sep | 382 | 0.0310 | 14,604 | 49 | 0.0530 | 3,209 | 1,206 | 0.0240 | 32,180 |
| WY Total/Average | | 6,551 | 0.0776 | 627,159 | 1,452 | 0.0757 | 154,222 | 9,026 | 0.0451 | 535,567 |
| | Oct | 387 | 0 | 33,104 | 50 | 0 | 2,154 | 457 | 0.0461 | 24,854 |
| | Nov | 402 | 0 | 33,257 | 60 | 0 | 1,410 | 632 | 0.0602 | 47,010 |
| | Dec | 370 | 0 | 31,082 | 43 | 0 | 2,644 | 1,801 | 0.0472 | 110,189 |
| 2003 | Jan | 387 | 0 | 18,435 | 52 | 0 | 3,197 | 1,518 | 0.0247 | 45,430 |
| | Feb | 366 | 0 | 31,624 | 41 | 0 | 3,536 | 819 | 0.0477 | 48,219 |
| | Mar | 329 | 0 | 39,614 | 37 | 0 | 3,610 | 2,167 | 0.0539 | 130,190 |
| | Apr | 707 | 0 | 44,628 | 257 | 0 | 19,825 | 590 | 0.0496 | 33,189 |
| | May | 2,770 | 0 | 180,953 | 1,330 | 0 | 168,349 | -2,193 | 0.0554 | -149,773 |
| | Jun | 1,079 | 0 | 43,307 | 425 | 0 | 12,599 | 3,078 | 0.0113 | 42,154 |
| | Jul | 482 | 0 | 24,308 | 103 | 0 | 6,636 | 88 | 0.0368 | 3,994 |
| | Aug | 399 | 0 | 4,930 | 58 | 0 | 1,389 | -170 | 0.0139 | -2,913 |
| | Sep | 370 | 0 | 14,750 | 43 | 0 | 1,701 | 663 | 0.0221 | 18,077 |
| WY Total/Average | | 8,176 | 0 | 780,449 | 2,529 | 0 | 230,846 | 9,718 | 0.0309 | 370,569 |
| | Oct | 360 | 0 | 31,062 | 17 | 0 | 1,603 | 299 | 0.0406 | 15,105 |
| | Nov | 381 | 0 | 31,464 | 49 | 0 | 1,425 | 595 | 0.0454 | 33,327 |
| | Dec | 365 | 0 | 37,563 | 40 | 0 | 2,475 | 252 | 0.0478 | 14,853 |
| 2004 | Jan | 365 | 0 | 12,080 | 86 | 0 | 2,450 | 637 | 0.0263 | 22,510 |
| | Feb | 360 | 0 | 31,054 | 37 | 0 | 2,286 | 923 | 0.0485 | 55,207 |
| | Mar | 444 | 0 | 42,301 | 83 | 0 | 4,091 | 995 | 0.0487 | 59,784 |
| | Apr | 1,524 | 0 | 187,955 | 886 | 0 | 49,255 | -1,963 | 0.0425 | -102,964 |
| | May | 2,020 | 0 | 330,161 | 918 | 0 | 117,907 | -708 | 0.0813 | -70,565 |
| | Jun | 867 | 0 | 32,078 | 203 | 0 | 72,015 | 254 | 0.0274 | 8,594 |
| | Jul | 432 | 0 | 22,838 | 70 | 0 | 4,868 | -342 | 0.0372 | -15,667 |
| | Aug | 331 | 0 | 4,328 | 32 | 0 | 1,750 | -491 | 0.0116 | -7,051 |
| | Sep | 349 | 0 | 13,353 | 11 | 0 | 2,097 | -736 | 0.0159 | -11,643 |
| WY Total/Average | | 7,624 | 0 | 776,242 | 2,231 | 0 | 262,948 | 199 | 0.0060 | 1,478 |
| | Oct | 408 | 0 | 32,286 | 64 | 0 | 3,743 | 561 | 0.0350 | 24,179 |
| | Nov | 376 | 0 | 31,108 | 30 | 0 | 1,081 | 874 | 0.0457 | 49,336 |
| | Dec | 368 | 0 | 31,768 | 42 | 0 | 2,563 | 685 | 0.0404 | 34,140 |
| 2005 | Jan | 300 | 0 | 17,170 | 41 | 0 | 2,508 | 1,285 | 0.0286 | 45,308 |
| | Feb | 362 | 0 | 31,247 | 78 | 0 | 2,393 | 582 | 0.0482 | 34,635 |
| | Mar | 391 | 0 | 38,539 | 54 | 0 | 3,315 | 1,160 | 0.0522 | 74,650 |
| | Apr | 828 | 0 | 102,112 | 290 | 0 | 21,420 | 1,845 | 0.0442 | 100,491 |
| | May | 5,527 | 0 | 499,949 | 2,827 | 0 | 355,642 | -1,801 | 0.0734 | -140,422 |
| | Jun | 2,595 | 0 | 190,661 | 1,244 | 0 | 80,372 | -240 | 0.0331 | -9,823 |
| | Jul | 624 | 0 | 7,691 | 100 | 0 | 4,429 | -277 | 0.0107 | -3,672 |
| | Aug | 480 | 0 | 5,995 | 123 | 0 | 1,299 | 397 | 0.0100 | 4,891 |
| | Sep | 422 | 0 | 3,200 | 71 | 0 | 878 | 139 | 0.0100 | 1,757 |
| WY Total/Average | | 12,754 | 0 | 1,436,514 | 5,080 | 0 | 464,256 | 5,509 | 0.0517 | 215,431 |
| 78-05 | Total | 310,060 | | 35,425,594 | 114,608 | | 10,483,772 | 262,562 | | 17,519,833 |
| 78-05 | Average | 11,074 | 0.0929 | 1,265,300 | 4,093 | 0.0342 | 374,420 | 9,377 | 0.0541 | 625,708 |
| 78-80 | Total | 153,418 | | 18,697,996 | 60,202 | | 5,646,739 | 185,535 | | 13,177,944 |
| 78-89 | Average | 12,785 | 0.0988 | 1,558,166 | 5,017 | 0.0760 | 470,562 | 15,461 | 0.0576 | 1,098,162 |

| Year | Month | (CALC) Total Inflow Above Scofield Reservoir: Flow Acre-Feet | Weight Grams | Scofield Reservoir: Evaporation Acre-Feet | Phosphorus Uptake Grams | End of Month Content: Total Acre-Feet | mg/l Table D-3 | Weight Grams | Price River Below Scofield Dam: Acre-Feet | Weight Grams |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 8,414 | 0.0358 | 371,825 | | |
| | Oct | 1,310 | 97,348 | 228 | 22,373 | 10,360 | 0.0315 | 455,443 | 883 | 141,934 |
| | Nov | 2,098 | 118,564 | 63 | 40,337 | 11,887 | 0.0312 | 456,837 | 708 | 27,232 |
| | Dec | 914 | 55,208 | 0 | 20,083 | 12,491 | 0.0312 | 480,073 | 325 | 11,890 |
| 2002 | Jan | 987 | 35,989 | 0 | -1,956 | 13,160 | 0.0312 | 506,152 | 310 | 11,899 |
| | Feb | 3,935 | 258,466 | 0 | 106,675 | 16,839 | 0.0312 | 647,174 | 370 | 10,739 |
| | Mar | 2,112 | 138,326 | 0 | 57,139 | 18,742 | 0.0312 | 720,369 | 290 | 8,051 |
| | Apr | 3,983 | 238,577 | 0 | 83,508 | 21,712 | 0.0312 | 834,474 | 972 | 18,903 |
| | May | 8,053 | 948,356 | 583 | 665,097 | 16,784 | 0.0312 | 645,027 | 12299 | 472,705 |
| | Jun | 2,507 | 80,603 | 728 | -10,099 | 11,168 | 0.0312 | 429,205 | 7458 | 286,524 |
| | Jul | 99 | 8,724 | 630 | 28,752 | 9,457 | 0.0312 | 363,451 | 1190 | 43,724 |
| | Aug | 1,917 | 63,156 | 506 | 8,727 | 8,479 | 0.0312 | 325,852 | 2398 | 93,010 |
| | Sep | 2,044 | 54,525 | 362 | -10,108 | 8,810 | 0.0312 | 338,615 | 1380 | 51,867 |
| WY Total/Average | | 30,018 | 2,077,837 | 3,794 | 1,012,532 | 13,341 | 0.0312 | 512,746 | 31,210 | 1,199,996 |
| | Oct | 1,273 | 73,741 | 199 | 88,599 | 9790 | 0.0257 | 308,064 | 359 | 17,649 |
| | Nov | 1,687 | 122,524 | 60 | 71,010 | 11058 | 0.0257 | 350,080 | 290 | 9,478 |
| | Dec | 2,749 | 157,576 | 0 | 70,272 | 13506 | 0.0257 | 427,590 | 309 | 9,794 |
| 2003 | Jan | 2,440 | 72,771 | 0 | -4,521 | 15664 | 0.0257 | 496,562 | 252 | 8,280 |
| | Feb | 1,602 | 93,667 | 0 | 42,950 | 17124 | 0.0257 | 543,733 | 112 | 3,540 |
| | Mar | 2,410 | 233,521 | 0 | 105,038 | 20580 | 0.0257 | 651,836 | 12 | 380 |
| | Apr | 3,994 | 222,772 | 0 | 88,556 | 24509 | 0.0257 | 775,942 | 318 | 10,110 |
| | May | 12,702 | 941,071 | 725 | 561,807 | 32256 | 0.0257 | 1,030,576 | 4272 | 134,531 |
| | Jun | 7,963 | 106,986 | 988 | -114,590 | 30681 | 0.0257 | 971,308 | 8553 | 270,783 |
| | Jul | 1,566 | 72,233 | 1008 | 34,566 | 21159 | 0.0257 | 669,898 | 10081 | 319,137 |
| | Aug | 795 | 13,410 | 745 | 11,832 | 12986 | 0.0257 | 411,122 | 8223 | 260,354 |
| | Sep | 1,468 | 80,727 | 445 | 6,359 | 10416 | 0.0257 | 325,768 | 3613 | 114,381 |
| WY Total/Average | | 41,790 | 2,132,259 | 4166 | 982,539 | 18,311 | 0.0257 | 579,712 | 36594 | 1,158,567 |
| | Oct | 1,086 | 52,712 | 212 | -64,058 | 9958 | 0.0321 | 389,811 | 1494 | 56,728 |
| | Nov | 1,469 | 83,737 | 61 | 26,057 | 10925 | 0.0321 | 432,072 | 339 | 13,419 |
| | Dec | 1,031 | 60,098 | 0 | 19,311 | 11647 | 0.0321 | 460,616 | 309 | 12,235 |
| 2004 | Jan | 1,375 | 49,248 | 0 | -5,904 | 12732 | 0.0321 | 503,536 | 309 | 12,235 |
| | Feb | 1,647 | 98,602 | 0 | 33,408 | 14020 | 0.0321 | 554,460 | 359 | 14,208 |
| | Mar | 2,375 | 116,301 | 0 | 46,273 | 16298 | 0.0321 | 644,486 | 0 | 0 |
| | Apr | 5,890 | 321,733 | 0 | 90,543 | 19198 | 0.0321 | 757,174 | 2704 | 110,501 |
| | May | 9,750 | 1,068,928 | 646 | 708,106 | 20671 | 0.0321 | 817,323 | 7831 | 309,714 |
| | Jun | 2,760 | 96,648 | 897 | 19,181 | 15937 | 0.0321 | 630,270 | 5689 | 264,513 |
| | Jul | 780 | 37,720 | 740 | 36,340 | 9476 | 0.0321 | 374,672 | 6503 | 257,178 |
| | Aug | 158 | 2,089 | 501 | 15,725 | 7899 | 0.0321 | 308,480 | 1329 | 52,537 |
| | Sep | 411 | 18,728 | 349 | 15,458 | 7902 | 0.0321 | 308,480 | 82 | 3,290 |
| WY Total/Average | | 28,677 | 2,026,319 | 3315 | 941,064 | 13,046 | 0.0321 | 515,963 | 27979 | 1,106,537 |
| | Oct | 1,633 | 69,451 | 185 | -49,497 | 8551 | 0.0375 | 394,339 | 717 | 33,129 |
| | Nov | 1,743 | 90,904 | 37 | 15,353 | 10118 | 0.0375 | 467,378 | 102 | 4,712 |
| | Dec | 1,486 | 73,234 | 0 | 4,384 | 11489 | 0.0375 | 530,169 | 132 | 6,097 |
| 2005 | Jan | 2,055 | 72,139 | 0 | -22,659 | 13350 | 0.0375 | 617,378 | 168 | 7,781 |
| | Feb | 1,325 | 78,674 | 0 | 17,498 | 14514 | 0.0375 | 670,904 | 167 | 7,739 |
| | Mar | 2,136 | 134,995 | 0 | 35,275 | 16643 | 0.0375 | 769,348 | 6 | 276 |
| | Apr | 5,645 | 305,550 | 0 | 37,124 | 22450 | 0.0375 | 1,037,775 | 0 | 0 |
| | May | 29,836 | 3,011,703 | 695 | 1,664,596 | 51565 | 0.0375 | 2,383,563 | 23 | 1,259 |
| | Jun | 12,516 | 569,127 | 1158 | -44,094 | 59559 | 0.0375 | 2,753,135 | 3366 | 155,488 |
| | Jul | 1,903 | 24,782 | 1259 | -7,767 | 51845 | 0.0375 | 2,396,567 | 8418 | 389,118 |
| | Aug | 1,834 | 22,133 | 1059 | -14,631 | 45810 | 0.0375 | 2,117,556 | 6831 | 315,774 |
| | Sep | 1,233 | 19,040 | 778 | -6,313 | 40166 | 0.0375 | 1,853,829 | 6120 | 282,881 |
| WY Total/Average | | 63,427 | 4,473,773 | 5189 | 1,722,135 | 28,834 | 0.0375 | 1,332,846 | 26053 | 1,204,290 |
| 78-05 | Total | 1,576,039 | 121,221,894 | 136,471 | 66,364,800 | 897,578 | | 45,328,736 | 1,408,583 | 53,373,090 |
| 78-05 | Average | 56,287 | 4,329,353 | 4,874 | 2,370,171 | 32,056 | 0.0303 | 1,637,455 | 50,307 | 1,906,182 |
| 78-80 | Total | 873,327 | 69,378,832 | 64,623 | 38,642,165 | 481,620 | | 17,983,208 | 909,318 | 30,889,004 |
| 78-89 | Average | 72,777 | 5,781,573 | 5,385 | 3,220,364 | 40,135 | 0.0301 | 1,498,771 | 87,443 | 2,574,107 |

NOTE: Average Annual Concentrations are Flow Weighted

Table D-1

# Narrows Reservoir Eutrophication Study

## Phosphorus Content and Probability of Eutrophication

| Year | Contents of Narrows Reservoir Jun - Sep Average | Contents of Narrows Reservoir Jun - Sep Average (V) | Surface Area at Volume of Narrows | Surface Area at Volume of Narrows (A) | Mean Lake Depth of Narrows (z) | Reservoir Outflow of Narrows | Reservoir Outflow of Narrows ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus In Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table D-4)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | $m^3$ | Acres | $m^2$ | m | AF | $m^3/yr$ | yr | g/yr | $g/m^2/yr$ | | mg/l | | | |
| 1978 | 9,035 | 11,144,901 | 395 | 1,596,776 | 6.9796 | 8,557 | 10,555,205 | 1.0559 | 216,151 | 0.1354 | 0.6540 | 0.0121 | 0.8280 | 0.2962 | 0.2038 |
| 1979 | 8,831 | 10,893,126 | 387 | 1,566,665 | 6.9531 | 8,333 | 10,278,292 | 1.0598 | 151,786 | 0.0969 | 0.5383 | 0.0094 | 1.2462 | 0.3935 | 0.1065 |
| 1980 | 12,802 | 15,790,962 | 513 | 2,076,384 | 7.6050 | 8,206 | 10,121,767 | 1.5601 | 226,583 | 0.1091 | 0.5476 | 0.0121 | 0.8337 | 0.2978 | 0.2022 |
| 1981 | 10,579 | 13,049,278 | 446 | 1,803,098 | 7.2371 | 8,060 | 9,941,549 | 1.3126 | 117,333 | 0.0651 | 0.4158 | 0.0076 | 1.5902 | 0.4441 | 0.0559 |
| 1982 | 13,181 | 16,258,230 | 524 | 2,120,215 | 7.6682 | 8,753 | 10,796,826 | 1.5058 | 217,647 | 0.1027 | 0.5257 | 0.0113 | 0.9499 | 0.3289 | 0.1711 |
| 1983 | 16,245 | 20,037,941 | 601 | 2,432,199 | 8.2386 | 13,614 | 16,792,106 | 1.1933 | 323,327 | 0.1329 | 0.5868 | 0.0113 | 0.9392 | 0.3262 | 0.1738 |
| 1984 | 14,922 | 18,405,964 | 569 | 2,301,895 | 7.9960 | 19,739 | 24,348,370 | 0.7559 | 329,055 | 0.1429 | 0.6234 | 0.0092 | 1.2848 | 0.4005 | 0.0995 |
| 1985 | 14,839 | 18,304,135 | 566 | 2,291,449 | 7.9880 | 12,576 | 15,512,420 | 1.1800 | 231,533 | 0.1010 | 0.5084 | 0.0093 | 1.2593 | 0.3959 | 0.1041 |
| 1986 | 14,682 | 18,109,984 | 562 | 2,275,837 | 7.9575 | 15,398 | 18,993,322 | 0.9535 | 289,201 | 0.1271 | 0.5833 | 0.0098 | 1.1805 | 0.3810 | 0.1190 |
| 1987 | 11,299 | 13,936,763 | 468 | 1,895,742 | 7.3516 | 8,486 | 10,467,016 | 1.3315 | 120,310 | 0.0635 | 0.4060 | 0.0075 | 1.6283 | 0.4483 | 0.0517 |
| 1988 | 9,185 | 11,328,997 | 399 | 1,615,056 | 7.0146 | 8,463 | 10,438,645 | 1.0853 | 125,265 | 0.0776 | 0.4697 | 0.0079 | 1.5238 | 0.4362 | 0.0638 |
| 1989 | 6,638 | 8,188,477 | 305 | 1,234,664 | 6.6321 | 8,655 | 10,676,327 | 0.7670 | 118,153 | 0.0957 | 0.5494 | 0.0078 | 1.5579 | 0.4404 | 0.0596 |
| 1990 | 4,671 | 5,761,414 | 227 | 916,905 | 6.2835 | 7,151 | 8,820,539 | 0.6532 | 130,286 | 0.1421 | 0.7159 | 0.0101 | 1.1340 | 0.3715 | 0.1285 |
| 1991 | 4,299 | 5,302,358 | 209 | 847,168 | 6.2589 | 9,798 | 12,085,121 | 0.4388 | 177,962 | 0.2101 | 0.9033 | 0.0105 | 1.0568 | 0.3546 | 0.1454 |
| 1992 | 2,863 | 3,531,322 | 147 | 595,508 | 5.9299 | 4,815 | 5,939,369 | 0.5946 | 85,117 | 0.1429 | 0.7433 | 0.0099 | 1.1548 | 0.3758 | 0.1242 |
| 1993 | 6,359 | 7,843,935 | 295 | 1,192,607 | 6.5771 | 9,780 | 12,063,285 | 0.6502 | 219,524 | 0.1841 | 0.8117 | 0.0119 | 0.8558 | 0.3040 | 0.1960 |
| 1994 | 4,509 | 5,561,328 | 218 | 882,497 | 6.3018 | 8,294 | 10,230,852 | 0.5436 | 127,445 | 0.1444 | 0.7215 | 0.0089 | 1.3282 | 0.4079 | 0.0921 |
| 1995 | 10,587 | 13,058,583 | 447 | 1,810,115 | 7.2142 | 8,653 | 10,672,931 | 1.2235 | 264,934 | 0.1464 | 0.6716 | 0.0136 | 0.6336 | 0.2370 | 0.2630 |
| 1996 | 11,681 | 14,408,864 | 480 | 1,942,012 | 7.4196 | 9,003 | 11,105,678 | 1.2974 | 173,199 | 0.0892 | 0.4934 | 0.0095 | 1.2278 | 0.3901 | 0.1099 |
| 1997 | 14,721 | 18,157,815 | 564 | 2,280,789 | 7.9612 | 9,709 | 11,975,564 | 1.5162 | 241,400 | 0.1058 | 0.5236 | 0.0112 | 0.9520 | 0.3294 | 0.1706 |
| 1998 | 14,940 | 18,428,249 | 569 | 2,303,892 | 7.9987 | 9,797 | 12,084,367 | 1.5250 | 179,291 | 0.0778 | 0.4356 | 0.0089 | 1.3343 | 0.4089 | 0.0911 |
| 1999 | 14,847 | 18,313,742 | 567 | 2,294,502 | 7.9816 | 8,673 | 10,697,548 | 1.7120 | 211,183 | 0.0920 | 0.4815 | 0.0108 | 1.0142 | 0.3447 | 0.1553 |
| 2000 | 12,842 | 15,840,268 | 514 | 2,078,171 | 7.6222 | 8,103 | 9,995,303 | 1.5848 | 115,895 | 0.0558 | 0.3683 | 0.0073 | 1.6594 | 0.4515 | 0.0485 |
| 2001 | 10,497 | 12,948,229 | 443 | 1,792,356 | 7.2241 | 8,202 | 10,117,653 | 1.2798 | 113,559 | 0.0634 | 0.4098 | 0.0074 | 1.6502 | 0.4506 | 0.0494 |
| 2002 | 7,147 | 8,815,368 | 325 | 1,314,641 | 6.7055 | 7,501 | 9,253,006 | 0.9527 | 86,975 | 0.0662 | 0.4392 | 0.0066 | 1.8241 | 0.4660 | 0.0340 |
| 2003 | 3,543 | 4,369,925 | 177 | 715,014 | 6.1117 | 7,339 | 9,052,754 | 0.4827 | 85,471 | 0.1195 | 0.6572 | 0.0072 | 1.6945 | 0.4550 | 0.0450 |
| 2004 | 2,650 | 3,269,126 | 137 | 556,104 | 5.8786 | 3,616 | 4,459,807 | 0.7330 | 72,606 | 0.1306 | 0.7083 | 0.0107 | 1.0304 | 0.3485 | 0.1515 |
| 2005 | 4,443 | 5,480,750 | 215 | 870,978 | 6.2926 | 7,844 | 9,675,523 | 0.5665 | 164,550 | 0.1889 | 0.8460 | 0.0115 | 0.9142 | 0.3197 | 0.1803 |
| Average | 9,744 | 12,019,287 | 402 | 1,628,687 | 7.1208 | 9,183 | 11,326,827 | 1.0541 | 175,562 | 0.1146 | 0.5835 | 0.0097 | 1.2245 | | 0.1213 |

* Table D-4 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Table D-2

# Lower Gooseberry Reservoir (with Narrows) Eutrophication Study

## Phosphorus Content and Probability of Eutrophication

| Year | Contents of Lower Gooseberry Reservoir Jun - Sep Average | Contents of Lower Gooseberry Reservoir Jun - Sep Average (V) | Surface Area at Volume of Lower Gooseberry | Surface Area at Volume of Lower Gooseberry (A) | Mean Lake Depth of Lower Gooseberry (z) | Reservoir Outflow of Lower Gooseberry | Reservoir Outflow of Lower Gooseberry ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus In Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table D-4)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | $m^3$ | Acres | $m^2$ | m | AF | $m^3/yr$ | yr | g/yr | $g/m^2/yr$ | | mg/L | | | |
| 1978 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,106 | 9,998,566 | 0.0262 | 137,827 | 0.5944 | 4.5741 | 0.0123 | 0.8012 | 0.2885 | 0.2115 |
| 1979 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 6,033 | 7,441,818 | 0.0351 | 98,832 | 0.4262 | 3.7604 | 0.0117 | 0.8810 | 0.3109 | 0.1891 |
| 1980 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,255 | 10,182,854 | 0.0257 | 141,665 | 0.6109 | 4.6487 | 0.0124 | 0.7856 | 0.2840 | 0.2160 |
| 1981 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 4,914 | 6,061,739 | 0.0431 | 78,397 | 0.3381 | 3.2808 | 0.0113 | 0.9385 | 0.3260 | 0.1740 |
| 1982 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,625 | 10,638,728 | 0.0246 | 146,463 | 0.6316 | 4.7408 | 0.0123 | 0.7987 | 0.2878 | 0.2122 |
| 1983 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 16,939 | 20,893,583 | 0.0125 | 276,400 | 1.1920 | 6.8913 | 0.0122 | 0.8191 | 0.2937 | 0.2063 |
| 1984 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 23,619 | 29,135,985 | 0.0090 | 343,332 | 1.4806 | 7.8302 | 0.0110 | 0.9856 | 0.3378 | 0.1622 |
| 1985 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 14,015 | 17,287,211 | 0.0151 | 219,372 | 0.9460 | 6.0144 | 0.0116 | 0.8950 | 0.3146 | 0.1854 |
| 1986 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 17,904 | 22,084,818 | 0.0118 | 274,856 | 1.1853 | 6.8686 | 0.0115 | 0.9125 | 0.3192 | 0.1808 |
| 1987 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 4,736 | 5,841,883 | 0.0448 | 79,153 | 0.3413 | 3.2994 | 0.0118 | 0.8705 | 0.3080 | 0.1920 |
| 1988 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 5,196 | 6,409,136 | 0.0408 | 84,059 | 0.3625 | 3.4183 | 0.0115 | 0.9124 | 0.3192 | 0.1808 |
| 1989 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 5,215 | 6,432,804 | 0.0407 | 83,672 | 0.3608 | 3.4091 | 0.0114 | 0.9248 | 0.3224 | 0.1776 |
| 1990 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 5,607 | 6,916,340 | 0.0378 | 96,944 | 0.4181 | 3.7179 | 0.0123 | 0.8042 | 0.2894 | 0.2106 |
| 1991 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 6,634 | 8,183,371 | 0.0320 | 117,184 | 0.5054 | 4.1572 | 0.0126 | 0.7577 | 0.2757 | 0.2243 |
| 1992 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 4,419 | 5,450,984 | 0.0480 | 70,072 | 0.3022 | 3.0709 | 0.0112 | 0.9568 | 0.3306 | 0.1694 |
| 1993 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,510 | 11,730,463 | 0.0223 | 162,698 | 0.7016 | 5.0436 | 0.0125 | 0.7804 | 0.2825 | 0.2175 |
| 1994 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 5,006 | 6,174,633 | 0.0424 | 84,484 | 0.3643 | 3.4285 | 0.0119 | 0.8507 | 0.3026 | 0.1974 |
| 1995 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 10,050 | 12,396,513 | 0.0211 | 169,818 | 0.7323 | 5.1724 | 0.0124 | 0.7959 | 0.2870 | 0.2130 |
| 1996 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 7,536 | 9,295,801 | 0.0281 | 120,197 | 0.5183 | 4.2198 | 0.0116 | 0.9055 | 0.3174 | 0.1826 |
| 1997 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 11,943 | 14,731,625 | 0.0178 | 197,074 | 0.8499 | 5.6464 | 0.0122 | 0.8218 | 0.2944 | 0.2056 |
| 1998 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 9,571 | 11,805,534 | 0.0222 | 143,671 | 0.6196 | 4.6873 | 0.0110 | 0.9834 | 0.3373 | 0.1627 |
| 1999 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 7,175 | 8,849,680 | 0.0295 | 137,504 | 0.5930 | 4.5678 | 0.0137 | 0.6260 | 0.2344 | 0.2656 |
| 2000 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 4,863 | 5,998,345 | 0.0436 | 75,857 | 0.3271 | 3.2178 | 0.0111 | 0.9737 | 0.3348 | 0.1652 |
| 2001 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 4,976 | 6,137,565 | 0.0426 | 76,521 | 0.3300 | 3.2343 | 0.0110 | 0.9936 | 0.3397 | 0.1603 |
| 2002 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 3,298 | 4,067,980 | 0.0643 | 49,344 | 0.2128 | 2.4978 | 0.0105 | 1.0716 | 0.3580 | 0.1420 |
| 2003 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,004 | 9,873,239 | 0.0265 | 139,329 | 0.6009 | 4.6034 | 0.0126 | 0.7658 | 0.2782 | 0.2218 |
| 2004 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 6,371 | 7,858,555 | 0.0333 | 116,456 | 0.5022 | 4.1419 | 0.0130 | 0.7083 | 0.2607 | 0.2393 |
| 2005 | 212 | 261,500 | 57 | 231,886 | 1.1277 | 11,666 | 14,390,490 | 0.0182 | 205,859 | 0.8878 | 5.7933 | 0.0129 | 0.7186 | 0.2639 | 0.2361 |
| Average | 212 | 261,500 | 57 | 231,886 | 1.1277 | 8,578 | 10,581,009 | 0.0307 | 140,252 | 0.6048 | 4.4977 | 0.0119 | 0.8585 | | 0.1965 |

* Table D-4 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Table D-3

# Scofield Reservoir (with Narrows) Eutrophication Study

## Phosphorus Content and Probability of Eutrophication

| Year | Contents of Scofield Reservoir Jun - Sep Average | Contents of Scofield Reservoir Jun - Sep Average (V) | Surface Area at Volume of Scofield | Surface Area of Scofield (A) | Mean Lake Depth of Scofield (z) | Reservoir Outflow of Scofield | Reservoir Outflow of Scofield ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus in Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table D-4)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | $m^3$ | Acres | $m^2$ | m | AF | $m^3/yr$ | yr | g/yr | $g/m^2/yr$ | | mg/L | | | |
| 1978 | 31,101 | 38,362,523 | 2,064 | 8,352,998 | 4.5927 | 35,827 | 44,192,210 | 0.8681 | 4,005,622 | 0.4795 | 1.7627 | 0.0358 | -0.9625 | 0.3321 | 0.8321 |
| 1979 | 31,332 | 38,647,827 | 2,074 | 8,391,825 | 4.6054 | 45,190 | 55,741,368 | 0.6933 | 4,004,315 | 0.4772 | 1.7547 | 0.0324 | -0.7971 | 0.2874 | 0.7874 |
| 1980 | 44,471 | 54,854,276 | 2,388 | 9,663,565 | 5.6764 | 52,145 | 64,320,292 | 0.8528 | 5,469,912 | 0.5660 | 1.7155 | 0.0345 | -0.9016 | 0.3164 | 0.8164 |
| 1981 | 21,670 | 26,729,688 | 1,751 | 7,084,806 | 3.7728 | 42,659 | 52,619,407 | 0.5080 | 1,597,747 | 0.2255 | 1.2691 | 0.0185 | 0.1321 | 0.0524 | 0.4476 |
| 1982 | 54,276 | 66,949,395 | 2,547 | 10,309,110 | 6.4942 | 53,200 | 65,621,880 | 1.0202 | 13,969,624 | 1.3551 | 2.6502 | 0.0575 | -1.7432 | 0.4594 | 0.9594 |
| 1983 | 61,584 | 75,963,415 | 2,649 | 10,720,460 | 7.0858 | 132,107 | 162,952,566 | 0.4662 | 8,103,646 | 0.7559 | 1.7851 | 0.0271 | -0.5043 | 0.1931 | 0.6931 |
| 1984 | 63,155 | 77,900,781 | 2,671 | 10,808,744 | 7.2072 | 147,059 | 181,395,663 | 0.4295 | 10,768,324 | 0.9963 | 2.0794 | 0.0314 | -0.7427 | 0.2713 | 0.7713 |
| 1985 | 55,346 | 68,268,651 | 2,560 | 10,361,989 | 6.5884 | 86,058 | 106,151,568 | 0.6431 | 7,230,616 | 0.6978 | 1.7776 | 0.0318 | -0.7649 | 0.2779 | 0.7779 |
| 1986 | 60,146 | 74,189,600 | 2,630 | 10,644,437 | 6.9698 | 101,797 | 125,565,946 | 0.5908 | 7,732,351 | 0.7264 | 1.7608 | 0.0302 | -0.6795 | 0.2517 | 0.7517 |
| 1987 | 45,448 | 56,060,109 | 2,410 | 9,750,953 | 5.7492 | 37,075 | 45,731,605 | 1.2259 | 1,977,370 | 0.2028 | 0.9302 | 0.0202 | -0.0166 | 0.0069 | 0.5069 |
| 1988 | 33,886 | 41,797,502 | 2,148 | 8,692,200 | 4.8086 | 38,435 | 47,409,150 | 0.8816 | 2,830,979 | 0.3257 | 1.3660 | 0.0271 | -0.5010 | 0.1919 | 0.6919 |
| 1989 | 12,650 | 15,604,025 | 1,343 | 5,434,420 | 2.8713 | 37,766 | 46,583,667 | 0.3350 | 1,688,336 | 0.3107 | 1.8000 | 0.0226 | -0.2026 | 0.0801 | 0.5801 |
| 1990 | 9,470 | 11,681,409 | 1,185 | 4,793,772 | 2.4368 | 24,399 | 30,096,404 | 0.3881 | 1,676,668 | 0.3498 | 2.1260 | 0.0305 | -0.6981 | 0.2575 | 0.7575 |
| 1991 | 14,185 | 17,496,734 | 1,416 | 5,728,802 | 3.0542 | 32,323 | 39,870,245 | 0.4388 | 3,427,124 | 0.5982 | 2.5533 | 0.0405 | -1.1666 | 0.3782 | 0.8782 |
| 1992 | 7,800 | 9,621,214 | 1,090 | 4,409,878 | 2.1817 | 13,175 | 16,251,052 | 0.5920 | 1,008,887 | 0.2288 | 1.7671 | 0.0303 | -0.6881 | 0.2544 | 0.7544 |
| 1993 | 41,665 | 51,392,992 | 2,331 | 9,434,126 | 5.4476 | 31,531 | 38,890,661 | 1.3214 | 5,059,683 | 0.5363 | 1.7027 | 0.0400 | -1.1458 | 0.3740 | 0.8740 |
| 1994 | 15,417 | 19,017,174 | 1,462 | 5,915,686 | 3.2147 | 42,581 | 52,523,148 | 0.3621 | 1,936,917 | 0.3274 | 1.7371 | 0.0226 | -0.2047 | 0.0809 | 0.5809 |
| 1995 | 36,553 | 45,088,000 | 2,208 | 8,934,585 | 5.0465 | 52,788 | 65,113,259 | 0.6925 | 4,534,401 | 0.5075 | 1.7241 | 0.0317 | -0.7628 | 0.2773 | 0.7773 |
| 1996 | 33,850 | 41,753,749 | 2,140 | 8,661,770 | 4.8205 | 49,140 | 60,613,377 | 0.6889 | 4,118,199 | 0.4754 | 1.7045 | 0.0312 | -0.7370 | 0.2695 | 0.7695 |
| 1997 | 59,560 | 73,466,619 | 2,623 | 10,613,498 | 6.9220 | 44,989 | 55,493,520 | 1.3239 | 6,179,530 | 0.5822 | 1.5519 | 0.0365 | -0.9914 | 0.3392 | 0.8392 |
| 1998 | 59,334 | 73,187,778 | 2,619 | 10,598,626 | 6.9054 | 57,698 | 71,169,709 | 1.0284 | 4,516,513 | 0.4261 | 1.2932 | 0.0272 | -0.5101 | 0.1951 | 0.6951 |
| 1999 | 52,274 | 64,479,836 | 2,519 | 10,193,102 | 6.3258 | 47,941 | 59,135,096 | 1.0904 | 3,936,392 | 0.3862 | 1.2850 | 0.0277 | -0.5392 | 0.2052 | 0.7052 |
| 2000 | 27,696 | 34,162,220 | 1,975 | 7,992,842 | 4.2741 | 45,426 | 56,032,108 | 0.6097 | 2,177,355 | 0.2724 | 1.3180 | 0.0215 | -0.1229 | 0.0488 | 0.5488 |
| 2001 | 21,171 | 26,113,926 | 1,741 | 7,045,059 | 3.7067 | 35,437 | 43,710,992 | 0.5974 | 2,561,160 | 0.3635 | 1.6989 | 0.0291 | -0.6181 | 0.2319 | 0.7319 |
| 2002 | 9,478 | 11,691,348 | 1,192 | 4,822,494 | 2.4243 | 31,210 | 38,497,045 | 0.3037 | 2,077,837 | 0.4309 | 2.4112 | 0.0312 | -0.7321 | 0.2680 | 0.7680 |
| 2003 | 18,811 | 23,202,610 | 1,628 | 6,589,290 | 3.5213 | 36,594 | 45,138,570 | 0.5140 | 2,132,259 | 0.3236 | 1.6350 | 0.0257 | -0.4120 | 0.1598 | 0.6598 |
| 2004 | 10,253 | 12,646,422 | 1,228 | 4,970,879 | 2.5441 | 27,979 | 34,511,910 | 0.3664 | 2,026,313 | 0.4076 | 2.2684 | 0.0321 | -0.7793 | 0.2822 | 0.7822 |
| 2005 | 49,340 | 60,860,926 | 2,475 | 10,017,120 | 6.0757 | 26,053 | 32,135,696 | 1.8939 | 4,473,773 | 0.4466 | 1.4335 | 0.0375 | -1.0369 | 0.3500 | 0.8500 |
| Average | 35,069 | 43,256,812 | 2,038 | 8,247,751 | 4.8330 | 50,307 | 62,052,540 | 0.7402 | 4,329,353 | 0.4922 | 1.7450 | 0.0309 | -0.6725 | | 0.7353 |

* Table D-4 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Table D-4 Normal curve areas for values of z (from Mendenhall, 1975)

| | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0000 | 0.0040 | 0.0080 | 0.0120 | 0.0160 | 0.0199 | 0.0239 | 0.0279 | 0.0319 | 0.0359 |
| 0.1 | 0.0398 | 0.0438 | 0 0478 | 0.0517 | 0.0557 | 0.0596 | 0.0636 | 0.0675 | 0.0714 | 0.0753 |
| 0.2 | 0.0793 | 0.0832 | 0 0871 | 0.0910 | 0.0948 | 0.0987 | 0.1026 | 0.1064 | 0.1103 | 0.1141 |
| 0.3 | 0.1179 | 0.1217 | 0.1255 | 0.1293 | 0.1331 | 0.1368 | 0.1406 | 0.1443 | 0.1480 | 0.1517 |
| 0.4 | 0.1554 | 0.1591 | 0.1628 | 0.1664 | 0.1700 | 0.1736 | 0.1772 | 0.1808 | 0.1844 | 0.1879 |
| 0.5 | 0.1915 | 0.1950 | 0.1985 | 0.2019 | 0.2054 | 0.2088 | 0.2123 | 0.2157 | 0.2190 | 0.2224 |
| 0.6 | 0.2257 | 0.2291 | 0.2324 | 0.2357 | 0.2389 | 0.2422 | 0.2454 | 0.2486 | 0.2517 | 0.2549 |
| 0.7 | 0.2580 | 0.2611 | 0.2642 | 0.2673 | 0.2704 | 0.2734 | 0.2764 | 0.2794 | 0.2823 | 0.2852 |
| 0.8 | 0.2881 | 0.2910 | 0.2939 | 0.2967 | 0.2995 | 0.3023 | 0.3051 | 0.3078 | 0.3106 | 0.3133 |
| 0.9 | 0.3159 | 0.3186 | 0.3212 | 0.3238 | 0.3264 | 0.3289 | 0.3315 | 0.3340 | 0.3365 | 0.3389 |
| 1.0 | 0.3413 | 0.3438 | 0.3461 | 0.3485 | 0.3508 | 0.3531 | 0.3554 | 0.3577 | 0.3599 | 0.3621 |
| 1.1 | 0.3643 | 0.3665 | 0.3686 | 0.3708 | 0.3729 | 0.3749 | 0.3770 | 0.3790 | 0.3810 | 0.3830 |
| 1.2 | 0.3849 | 0.3869 | 0.3888 | 0.3907 | 0.3925 | 0.3944 | 0.3962 | 0.3980 | 0.3997 | 0.4015 |
| 1.3 | 0.4032 | 0.4049 | 0.4066 | 0.4082 | 0.4099 | 0.4115 | 0.4131 | 0.4147 | 0.4162 | 0.4177 |
| 1.4 | 0.4192 | 0.4207 | 0.4222 | 0.4236 | 0.4251 | 0.4265 | 0.4279 | 0.4292 | 0.4306 | 0.4319 |
| 1.5 | 0.4332 | 0.4345 | 0.4357 | 0.4370 | 0.4382 | 0.4394 | 0.4406 | 0.4418 | 0.4429 | 0.4441 |
| 1.6 | 0.4452 | 0.4463 | 0.4474 | 0.4484 | 0.4495 | 0.4505 | 0.4515 | 0.4525 | 0.4535 | 0.4545 |
| 1.7 | 0.4554 | 0.4564 | 0.4573 | 0.4582 | 0.4591 | 0.4599 | 0.4608 | 0.4616 | 0.4625 | 0.4633 |
| 1.8 | 0.4641 | 0.4649 | 0.4656 | 0.4664 | 0.4671 | 0.4678 | 0.4686 | 0.4693 | 0.4699 | 0.4706 |
| 1.9 | 0.4713 | 0.4719 | 0.4726 | 0.4732 | 0.4738 | 0.4744 | 0.4750 | 0.4756 | 0.4761 | 0.4767 |
| 2.0 | 0.4772 | 0.4778 | 0.4783 | 0.4788 | 0.4793 | 0.4798 | 0.4803 | 0.4808 | 0.4812 | 0.4817 |
| 2.1 | 0.4821 | 0.4826 | 0.4830 | 0.4834 | 0.4838 | 0.4842 | 0.4846 | 0.4850 | 0.4854 | 0.4857 |
| 2.2 | 0.4861 | 0.4864 | 0.4868 | 0.4871 | 0.4875 | 0.4878 | 0.4881 | 0.4884 | 0.4887 | 0.4890 |
| 2.3 | 0.4893 | 0.4896 | 0.4898 | 0.4901 | 0.4904 | 0.4906 | 0.4909 | 0.4911 | 0.4913 | 0.4916 |
| 2.4 | 0.4918 | 0.4920 | 0.4922 | 0.4925 | 0.4927 | 0.4929 | 0.4931 | 0.4932 | 0.4934 | 0.4936 |
| 2.5 | 0.4938 | 0.4940 | 0.4941 | 0.4943 | 0.4945 | 0.4946 | 0.4948 | 0.4949 | 0.4951 | 0.4952 |
| 2.6 | 0.4953 | 0.4955 | 0.4956 | 0.4957 | 0.4959 | 0.4960 | 0.4961 | 0.4962 | 0.4963 | 0.4964 |
| 2.7 | 0.4965 | 0.4966 | 0.4967 | 0.4968 | 0.4969 | 0.4970 | 0.4971 | 0.4972 | 0.4973 | 0.4974 |
| 2.8 | 0.4974 | 0.4975 | 0.4976 | 0.4977 | 0.4977 | 0.4978 | 0.4979 | 0.4979 | 0.4980 | 0.4981 |
| 2.9 | 0.4981 | 0.4982 | 0.4982 | 0.4983 | 0.4984 | 0.4984 | 0.4985 | 0.4985 | 0.4986 | 0.4986 |
| 3.0 | 0.4987 | 0.4987 | 0.4987 | 0.4988 | 0.4988 | 0.4989 | 0.4989 | 0.4989 | 0.4990 | 0.4990 |

## Appendix E - Supplemental Information

**Phosphorus Data Development**

This section is provided to document the development of phosphorus data for Gooseberry Creek and Fish Creek. The Utah State Department of Water Quality collects water quality samples about twice per bi-annually on most Utah streams. The laboratory analytical results from these samples are posted on STORET for public use. In order to estimate phosphorus concentration for the Natural Flow above Narrows Reservoir, all available Total Phosphorus data from Fairview Lakes #2, and Gooseberry Creek above Lower Gooseberry Reservoir were evaluated to generate a composite monthly concentration for all points above Lower Gooseberry Reservoir (see Table E-1). Sample results for Lower Gooseberry Reservoir have been included in Table E-1 to allow comparison of the composite monthly concentrations with the reservoir measurements.

Substantially more data for Fish Creek are available. See Table E-2 for a list of Total Phosphorus at Fish Creek above Scofield Reservoir that is used in this study. A typical monthly distribution was estimated for both Gooseberry Creek and Fish Creek based on all sample results posted on STORET. This typical monthly distribution was used when measured data was not available. Previously the typical monthly distribution was estimated using the procedures outlined in the *State of Utah Scofield Reservoir Phase I Clean Lakes Study, December 1983.* This monthly distribution was based on only 4 years of data. The additional 24 years of data collected since this study was published warranted the update of the monthly distribution.

Table E-3 shows a list of Total Phosphorus at Mud Creek above Scofield Reservoir for 1992 – 2005 and Table E-4 is a list of Total Phosphorus at Pond Town Creek for the same period. As with Fish Creek and Gooseberry Creek, a typical monthly distribution is used when measured data is not available. This typical monthly distribution was generated using all of the available data posted on STORET.

Table E-5 was created to determine whether the model in Table B-2 was accurately predicting the average annual phosphorus concentrations in Scofield Reservoir. Table E-5 contains all of the phosphorus concentration data reported for the Scofield Reservoir in the STORET database. The samples were collected from three sites at various depths. As can be seen in the table the phosphorus concentration can vary by an order of magnitude at different sites for a given month. However, there are months that phosphorus data for the three sites agree very well. The sample results from all three sites have been averaged to estimate a phosphorus concentration for the given month. This monthly data was then used in conjunction with the end of month reservoir contents to determine an actual average reservoir phosphorus concentration that could be compared to the predicted values in Table B-2. The results of the comparison are discussed in the Scofield Reservoir Operation <u>without</u> Narrows Project Section

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**TABLE E-1**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT NARROWS DAMSITE**

| Date | | Fairview Lakes No. 2 mg/L | Monthly Average | Ab. Lower Gooseberry mg/l | Monthly Average | Lower Goose abv Dam mg/l | Monthly Average | Recommended mg/L |
|---|---|---|---|---|---|---|---|---|
| 10/31/1980 | Phosphorus as P | | | | | 0.050 | 0.050 | 0.050 |
| 6/11/1981 | Phosphorus as P | 0.010 | | 0.010 | | 0.005 | | |
| 6/11/1981 | Phosphorus as P | 0.010 | 0.010 | | 0.010 | 0.005 | 0.005 | 0.010 |
| 7/22/1983 | Phosphorus as P | | | 0.010 | 0.010 | | | 0.010 |
| 6/13/1990 | Phosphorus as P | 0.019 | | 0.019 | | 0.029 | | |
| 6/13/1990 | Phosphorus as P | 0.034 | 0.027 | | 0.019 | 0.027 | 0.028 | 0.023 |
| 8/1/1990 | Phosphorus as P | 0.053 | | 0.014 | | 0.016 | | |
| 8/1/1990 | Phosphorus as P | 0.030 | 0.042 | | 0.014 | 0.024 | 0.020 | 0.028 |
| 6/6/1991 | Phosphorus as P | | | 0.019 | | 0.036 | | |
| 6/6/1991 | Phosphorus as P | | | | | 0.017 | | |
| 8/6/1991 | Phosphorus as P | | | | 0.019 | | 0.027 | 0.019 |
| 8/29/1991 | Phosphorus as P | | | | | | | |
| 8/29/1991 | Phosphorus as P | | | 0.005 | | 0.021 | | |
| 8/29/1991 | Phosphorus as P | | | | 0.005 | 0.005 | 0.013 | 0.005 |
| 10/7/1991 | | | | | | | | 0.040 |
| 6/10/1992 | Phosphorus as P | 0.005 | | | | | | |
| 6/10/1992 | Phosphorus as P | 0.012 | 0.009 | | | | | 0.009 |
| 8/18/1992 | Phosphorus as P | 0.029 | | | | | | |
| 8/18/1992 | Phosphorus as P | 0.012 | 0.021 | | | | | 0.021 |
| 6/16/1993 | Phosphorus as P | | | 0.015 | | 0.019 | | |
| 6/16/1993 | Phosphorus as P | | | | 0.015 | 0.016 | 0.018 | 0.015 |
| 8/11/1993 | Phosphorus as P | | | 0.005 | | 0.014 | | |
| 8/11/1993 | Phosphorus as P | | | | 0.005 | 0.005 | 0.010 | 0.005 |
| 7/19/1994 | Phosphorus as P | 0.016 | | | | | | |
| 7/19/1994 | Phosphorus as P | 0.021 | 0.019 | | | | | 0.019 |
| 8/30/1994 | Phosphorus as P | 0.023 | | | | | | |
| 8/30/1994 | Phosphorus as P | 0.020 | 0.022 | | | | | 0.022 |
| 7/1/1995 | Phosphorus as P | | | | | 0.010 | | |
| 7/5/1995 | Phosphorus as P | | | 0.005 | 0.005 | 0.010 | 0.010 | 0.005 |
| 10/3/1995 | Phosphorus as P | | | 0.005 | | 0.010 | | |
| 10/3/1995 | Phosphorus as P | | | | | 0.010 | | |
| 10/3/1995 | Phosphorus as P | | | | | 0.010 | | |
| 10/3/1995 | Phosphorus as P | | | | 0.005 | 0.010 | 0.010 | 0.005 |
| 6/25/1996 | Phosphorus as P | 0.010 | | | | | | |
| 6/25/1996 | Phosphorus as P | 0.005 | | | | | | |
| 6/25/1996 | Phosphorus as P | 0.020 | 0.012 | | | | | 0.012 |
| 8/20/1996 | Phosphorus as P | 0.010 | | | | | | |
| 8/20/1996 | Phosphorus as P | 0.040 | 0.025 | | | | | 0.025 |
| 6/30/1998 | Phosphorus as P | 0.010 | | | | | | |
| 6/30/1998 | Phosphorus as P | 0.010 | | | | | | |
| 6/30/1998 | Phosphorus as P | 0.010 | | | | | | |
| 6/30/1998 | Phosphorus as P | 0.010 | 0.010 | | | | | 0.010 |
| 9/1/1998 | Phosphorus as P | 0.010 | | | | | | |
| 9/1/1998 | Phosphorus as P | 0.010 | | | | | | |
| 9/1/1998 | Phosphorus as P | 0.025 | 0.015 | | | | | 0.015 |
| 6/2/1999 | Phosphorus as P | | | 0.023 | | 0.021 | | |
| 6/2/1999 | Phosphorus as P | | | | 0.023 | 0.067 | 0.044 | 0.023 |
| 8/11/1999 | Phosphorus as P | | | 0.025 | | 0.020 | | |
| 8/11/1999 | Phosphorus as P | | | | 0.025 | 0.010 | 0.010 | 0.025 |
| 6/13/2000 | Phosphorus as P | 0.010 | | | | | | |
| 6/13/2000 | Phosphorus as P | 0.010 | 0.010 | | | | | 0.010 |
| 8/9/2000 | Phosphorus as P | 0.026 | | | | | | |
| 8/9/2000 | Phosphorus as P | 0.010 | 0.018 | | | | | 0.018 |
| 6/20/2001 | Phosphorus as P | | | 0.010 | 0.010 | 0.024 | 0.024 | 0.010 |
| 8/22/2001 | Phosphorus as P | | | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| 6/17/2003 | Phosphorus as P | 0.035 | | | | 0.010 | | |
| 6/17/2003 | Phosphorus as P | 0.010 | | | | | | |
| 6/17/2003 | Phosphorus as P | 0.029 | | | | 0.010 | | |
| 6/17/2003 | Phosphorus as P | 0.026 | 0.025 | 0.010 | 0.010 | | 0.010 | 0.018 |
| 8/27/2003 | Phosphorus as P | 0.022 | 0.022 | 0.010 | 0.010 | 0.020 | 0.020 | 0.016 |
| 7/5/2005 | Phosphorus as P | | | 0.010 | | 0.010 | | |
| 7/5/2005 | Phosphorus as P | | | | 0.010 | 0.025 | 0.018 | 0.010 |
| 8/23/2005 | Phosphorus as P | | | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| 9/20/2005 | Phosphorus as P | | | 0.010 | | 0.010 | | |
| 9/20/2005 | Phosphorus as P | | | | 0.010 | 0.010 | 0.010 | 0.010 |

* Measurement at Narrows Dam site.
Note: Non-detect samples have been highlighted. Half the minimum detection limit has been input for non-detect samples.
The recommended column is generated from the Fairview Lakes and Above Lower Gooseberry Res. Data and does not use the Lower Gooseberry above the dam data since this calculation is to determine a phosphorus concentration for the Narrows Reservoir.
The phosphorus concentrations measured in Lower Gooseberry Reservoir are included for reference.

## TABLE E-2
## FISH CREEK ABOVE SCOFIELD RESERVOIR (TOTAL PHOSPHORUS)

| Date | | mg/L | Monthly Average |
|---|---|---|---|
| 6/12/1979 | Phosphorus as P | 0.03 | 0.0300 |
| 9/25/1979 | Phosphorus as P | 0.02 | 0.0200 |
| 6/18/1980 | Phosphorus as P | 0.03 | 0.0300 |
| 7/9/1980 | Phosphorus as P | 0.02 | 0.0200 |
| 9/18/1980 | Phosphorus as P | 0.10 | 0.1000 |
| 11/20/1980 | Phosphorus as P | 0.025 | 0.0250 |
| 1/21/1981 | Phosphorus as P | 0.025 | 0.0250 |
| 4/2/1981 | Phosphorus as P | 0.02 | |
| 4/21/1981 | Phosphorus as P | 0.02 | |
| 4/28/1981 | Phosphorus as P | 0.04 | 0.0267 |
| 5/5/1981 | Phosphorus as P | 0.06 | |
| 5/13/1981 | Phosphorus as P | 0.01 | |
| 5/28/1981 | Phosphorus as P | 0.10 | 0.0567 |
| 6/11/1981 | Phosphorus as P | 0.01 | |
| 6/24/1981 | Phosphorus as P | 0.06 | 0.0350 |
| 7/8/1981 | Phosphorus as P | 0.03 | |
| 7/22/1981 | Phosphorus as P | 0.005 | 0.0050 |
| 8/17/1981 | Phosphorus as P | 0.005 | 0.0050 |
| 9/28/1981 | Phosphorus as P | 0.01 | 0.0100 |
| 11/3/1981 | Phosphorus as P | 0.03 | 0.0300 |
| 12/1/1981 | Phosphorus as P | 0.04 | 0.0400 |
| 5/4/1982 | Phosphorus as P | 0.15 | |
| 5/20/1982 | Phosphorus as P | 0.15 | 0.1500 |
| 6/3/1982 | Phosphorus as P | 0.09 | |
| 6/15/1982 | Phosphorus as P | 0.01 | |
| 6/30/1982 | Phosphorus as P | 0.04 | 0.0467 |
| 7/13/1982 | Phosphorus as P | 0.04 | 0.0400 |
| 7/30/1982 | Phosphorus as P | 2.3 | 2.3000 |
| 8/19/1982 | Phosphorus as P | 0.09 | 0.0900 |
| 9/16/1982 | Phosphorus as P | 0.10 | 0.1000 |
| 10/7/1982 | Phosphorus as P | 0.06 | 0.0600 |
| 9/6/1983 | Phosphorus as P | 0.02 | 0.0200 |
| 5/7/1985 | Phosphorus as P | 0.15 | |
| 5/30/1985 | Phosphorus as P | 0.04 | 0.0950 |
| 6/20/1985 | Phosphorus as P | 0.02 | 0.0200 |
| 8/14/1985 | Phosphorus as P | 0.005 | 0.0050 |
| 9/11/1985 | Phosphorus as P | 0.02 | 0.0200 |
| 9/23/1986 | Phosphorus as P | 0.08 | 0.0800 |
| 5/6/1987 | Phosphorus as P | 0.07 | |
| 5/21/1987 | Phosphorus as P | 0.04 | 0.0550 |
| 6/3/1987 | Phosphorus as P | 0.02 | |
| 6/9/1987 | Phosphorus as P | 0.02 | |
| 6/25/1987 | Phosphorus as P | 0.02 | 0.0200 |
| 8/11/1987 | Phosphorus as P | 0.03 | 0.0300 |
| 10/14/1987 | Phosphorus as P | 0.03 | 0.0300 |

## TABLE E-2
## FISH CREEK ABOVE SCOFIELD RESERVOIR (TOTAL PHOSPHORUS)

| Date | | mg/L | Monthly Average |
|---|---|---|---|
| 5/18/1988 | Phosphorus as P | 0.09 | 0.0900 |
| 8/19/1988 | Phosphorus as P | 0.0025 | |
| 8/19/1988 | Phosphorus as P | 0.0025 | 0.0025 |
| 5/4/1989 | Phosphorus as P | 0.031 | |
| 5/16/1989 | Phosphorus as P | 0.0025 | |
| 5/16/1989 | Phosphorus as P | 0.0025 | 0.0120 |
| 6/6/1989 | Phosphorus as P | 0.006 | 0.0060 |
| 7/3/1989 | Phosphorus as P | 0.049 | 0.0490 |
| 8/7/1989 | Phosphorus as P | 0.036 | |
| 8/22/1989 | Phosphorus as P | 0.031 | 0.0335 |
| 9/5/1989 | Phosphorus as P | 0.016 | 0.0160 |
| 10/24/1989 | Phosphorus as P | 0.01 | 0.0100 |
| 11/6/1989 | Phosphorus as P | 0.0025 | |
| 11/6/1989 | Phosphorus as P | 0.0025 | 0.0025 |
| 3/22/1990 | Phosphorus as P | 0.005 | 0.0050 |
| 5/3/1990 | Phosphorus as P | 0.031 | |
| 5/19/1990 | Phosphorus as P | 0.04 | 0.0355 |
| 7/25/1990 | Phosphorus as P | 0.0025 | |
| 7/25/1990 | Phosphorus as P | 0.0025 | 0.0025 |
| 5/21/1991 | Phosphorus as P | 0.118 | 0.1180 |
| 8/8/1991 | Phosphorus as P | 0.022 | 0.0220 |
| 6/10/1992 | Phosphorus as P | 0.005 | 0.0050 |
| 8/18/1992 | Phosphorus as P | 0.012 | 0.0120 |
| 6/8/1993 | Phosphorus as P | 0.019 | 0.0190 |
| 8/12/1993 | Phosphorus as P | 0.035 | 0.0350 |
| 7/13/1994 | Phosphorus as P | 0.027 | |
| 7/18/1994 | Phosphorus as P | 0.011 | 0.0190 |
| 8/30/1994 | Phosphorus as P | 0.005 | 0.0050 |
| 6/27/1995 | Phosphorus as P | 0.01 | 0.0100 |
| 8/30/1995 | Phosphorus as P | 0.01 | 0.0100 |
| 6/25/1996 | Phosphorus as P | 0.02 | 0.0200 |
| 8/20/1996 | Phosphorus as P | 0.005 | 0.0050 |
| 7/2/1998 | Phosphorus as P | 0.010 | 0.0100 |
| 9/3/1998 | Phosphorus as P | 0.095 | 0.0950 |
| 8/10/1999 | Phosphorus as P | 0.032 | 0.0320 |
| 6/13/2000 | Phosphorus as P | 0.04 | 0.0400 |
| 8/9/2000 | Phosphorus as P | 0.02 | 0.0200 |
| 8/21/2001 | Phosphorus as P | 0.028 | 0.0280 |
| 6/6/2002 | Phosphorus as P | 0.01 | 0.0100 |
| 7/16/2002 | Phosphorus as P | 0.031 | 0.0310 |
| 8/20/2002 | Phosphorus as P | 0.071 | |
| 8/15/2002 | Phosphorus as P | 0.01 | 0.0405 |

## TABLE E-2
## FISH CREEK ABOVE SCOFIELD RESERVOIR (TOTAL PHOSPHORUS)

| Date | | mg/L | Monthly Average |
|---|---|---|---|
| 9/17/2002 | Phosphorus as P | 0.01 | 0.0100 |
| 10/17/2002 | Phosphorus as P | 0.027 | 0.0270 |
| 11/21/2002 | Phosphorus as P | 0.06 | 0.0600 |
| 1/21/2003 | Phosphorus as P | 0.01 | 0.0100 |
| 5/20/2003 | Phosphorus as P | 0.055 | |
| 5/6/2003 | Phosphorus as P | 0.01 | 0.0325 |
| 6/6/2003 | Phosphorus as P | 0.01 | |
| 6/17/2003 | Phosphorus as P | 0.01 | 0.0100 |
| 8/26/2003 | Phosphorus as P | 0.01 | 0.0100 |
| 9/8/2003 | Phosphorus as P | 0.01 | 0.0100 |
| 10/27/2003 | Phosphorus as P | 0.01 | 0.0100 |
| 6/29/2004 | Phosphorus as P | 0.021 | 0.0210 |
| 8/13/2004 | Phosphorus as P | 0.01 | |
| 8/24/2004 | Phosphorus as P | 0.01 | 0.0100 |
| 10/13/2004 | Phosphorus as P | 0.01 | 0.0100 |
| 12/15/2004 | Phosphorus as P | 0.01 | 0.0100 |
| 4/27/2005 | Phosphorus as P | 0.025 | 0.0250 |
| 5/28/2005 | Phosphorus as P | 0.061 | 0.0610 |
| 7/5/2005 | Phosphorus as P | 0.01 | 0.0100 |
| 8/24/2005 | Phosphorus as P | 0.01 | 0.0100 |
| 9/20/2005 | Phosphorus as P | 0.01 | 0.0100 |

Notes: Non-detect samples have been highlighted.
Half the minimum detection limit has been input for non-detect samples

**Table E-3**
**Mud Creek Above Scofield Reservoir**

| Date | Phosphorus mg/l | Average (mg/l) |
|---|---|---|
| 11/20/1980 | 0.05 | 0.050 |
| 1/21/1981 | 0.05 | 0.050 |
| 4/21/1981 | 0.08 | |
| 4/28/1981 | 0.07 | 0.075 |
| 5/5/1981 | 0.1 | |
| 5/13/1981 | 0.01 | |
| 5/28/1981 | 0.1 | 0.070 |
| 6/11/1981 | 0.04 | |
| 6/24/1981 | 0.03 | 0.035 |
| 7/8/1981 | 0.02 | |
| 7/22/1981 | 0.06 | 0.040 |
| 8/10/1981 | 0.36 | |
| 8/17/1981 | 0.03 | |
| 8/31/1981 | 0.03 | 0.140 |
| 9/28/1991 | 0.02 | 0.020 |
| 11/3/1981 | 0.02 | 0.020 |
| 12/1/1981 | 0.05 | 0.050 |
| 1/12/1982 | 0.05 | 0.050 |
| 2/17/1982 | 0.05 | 0.050 |
| 3/23/1982 | 2.35 | Outlier |
| 4/22/1982 | 0.4 | 0.400 |
| 5/4/1982 | 1.1 | Outlier |
| 5/20/1982 | 0.29 | 0.290 |
| 6/3/1982 | 0.22 | |
| 6/15/1982 | 0.1 | |
| 6/30/1982 | 0.12 | 0.147 |
| 7/13/1982 | 0.07 | |
| 7/30/1982 | 2.9 | 0.070 |
| 8/19/1982 | 0.15 | 0.150 |
| 9/1/1982 | 0.15 | |
| 9/16/1982 | 0.05 | 0.100 |
| 10/7/1982 | 0.25 | 0.250 |
| 9/6/1983 | 0.04 | 0.040 |
| 3/1/1984 | 0.08 | 0.080 |
| 1/29/1985 | 0.03 | 0.030 |
| 5/30/1985 | 0.13 | 0.130 |
| 6/20/1985 | 0.01 | 0.010 |
| 8/14/1985 | 0.01 | 0.010 |
| 9/9/1985 | 0.01 | 0.010 |
| 1/22/1986 | 0.03 | 0.030 |
| 9/23/1986 | 0.01 | 0.010 |
| 5/6/1987 | 0.09 | 0.090 |
| 6/5/1989 | 0.32 | 0.320 |
| 7/3/1989 | 0.093 | 0.093 |
| 8/7/1989 | 0.038 | 0.038 |
| 9/5/1989 | 0.034 | 0.034 |

**Table E-3**
**Mud Creek Above Scofield Reservoir**

| Date | Phosphorus mg/l | Average (mg/l) |
|---|---|---|
| 11/6/1989 | 0.13 | 0.130 |
| 1/10/1990 | 0.027 | |
| 1/22/1990 | 0.033 | 0.030 |
| 3/19/1990 | 0.026 | 0.026 |
| 5/3/1990 | 0.043 | 0.043 |
| 5/21/1991 | 0.112 | 0.078 |
| 8/8/1991 | 0.049 | 0.049 |
| 6/10/1992 | 0.021 | 0.021 |
| 8/18/1992 | 0.071 | 0.071 |
| 6/8/1993 | 0.091 | 0.091 |
| 8/12/1993 | 0.159 | 0.159 |
| 7/12/1994 | 0.046 | 0.046 |
| 8/30/1994 | 0.043 | 0.043 |
| 6/27/1995 | 0.08 | 0.080 |
| 8/30/1995 | 0.03 | 0.030 |
| 6/25/1996 | 0.04 | 0.040 |
| 8/20/1996 | 0.04 | 0.040 |
| 7/2/1998 | 0.021 | 0.021 |
| 9/3/1998 | 0.022 | 0.022 |
| 6/1/1999 | 0.078 | 0.078 |
| 8/10/1999 | 0.327 | 0.327 |
| 6/13/2000 | 0.037 | 0.037 |
| 8/9/2000 | 0.021 | 0.021 |
| 6/6/2002 | 0.03 | 0.030 |
| 8/15/2002 | 0.01 | 0.010 |
| 6/17/2003 | 0.01 | 0.010 |
| 8/26/2003 | 0.01 | 0.01 |
| 6/29/2004 | 0.039 | 0.039 |
| 8/24/2004 | 0.01 | 0.010 |
| 7/5/2005 | 0.01 | 0.010 |
| 8/23/2005 | 0.01 | 0.010 |
| 9/20/2005 | 0.01 | 0.010 |

Notes: Non-detect samples have been highlighted.
Half the minimum detection limit has been input for non-detect samples

**Table E-4**
**Pond Town Creek Above Scofield Reservoir**

| Date | Phosphorus mg/l | Average (mg/l) |
|---|---|---|
| 7/4/1978 | 0.03 | 0.0300 |
| 9/21/1978 | 0.05 | 0.0500 |
| 6/12/1979 | 0.05 | 0.0500 |
| 6/18/1980 | 0.01 | 0.0100 |
| 7/29/1980 | 0.05 | 0.0500 |
| 9/18/1980 | 0.1 | 0.1000 |
| 11/20/1980 | 0.025 | 0.0250 |
| 4/2/1981 | 0.03 | |
| 4/28/1981 | 0.03 | 0.0300 |
| 5/5/1981 | 0.15 | |
| 5/13/1981 | 0.01 | |
| 5/28/1981 | 0.1 | 0.0870 |
| 6/11/1981 | 0.02 | |
| 6/24/1981 | 0.04 | 0.0300 |
| 7/8/1981 | 0.02 | |
| 7/22/1981 | 0.04 | 0.0300 |
| 8/10/1981 | 0.6 | |
| 8/17/1981 | 0.03 | |
| 8/31/1981 | 0.03 | 0.2200 |
| 9/28/1981 | 0.04 | 0.0400 |
| 11/3/1981 | 0.03 | 0.0300 |
| 12/1/1981 | 0.03 | 0.0300 |
| 5/20/1982 | 0.15 | 0.1500 |
| 6/3/1982 | 0.08 | |
| 6/15/1982 | 0.02 | |
| 6/30/1982 | 0.08 | 0.0600 |
| 7/13/1982 | 0.06 | |
| 7/30/1982 | 0.25 | 0.1550 |
| 8/19/1982 | 0.1 | 0.1000 |
| 9/1/1982 | 0.1 | |
| 9/16/1982 | 0.1 | 0.1000 |
| 9/6/1983 | 0.02 | 0.0733 |
| 10/12/1983 | 0.04 | 0.0400 |
| 5/7/1985 | 0.28 | |
| 5/30/1985 | 0.05 | 0.1650 |
| 6/20/1985 | 0.01 | 0.0100 |
| 8/14/1985 | 0.04 | 0.0400 |
| 9/11/1985 | 0.05 | 0.0600 |
| 9/23/1986 | 0.07 | 0.0700 |
| 5/6/1987 | 0.05 | |
| 5/21/1987 | 0.07 | 0.0600 |
| 6/3/1987 | 0.04 | |
| 6/9/1987 | 0.04 | |
| 6/25/1987 | 0.07 | 0.0500 |
| 8/11/1987 | 0.07 | 0.0700 |
| 10/14/1987 | 0.04 | 0.0400 |
| 5/18/1988 | 0.15 | 0.1500 |
| 8/19/1988 | 0.1 | 0.1000 |
| 10/6/1988 | 0.04 | 0.0400 |

**Table E-4**
**Pond Town Creek Above Scofield Reservoir**

| Date | Phosphorus mg/l | Average (mg/l) |
|---|---|---|
| 5/4/1989 | 0.014 | |
| 5/16/1989 | 0.27 | 0.1420 |
| 6/5/1989 | 0.19 | |
| 6/6/1989 | 0.0025 | 0.0960 |
| 7/3/1989 | 0.091 | 0.0910 |
| 8/7/1989 | 0.086 | |
| 8/22/1989 | 0.005 | 0.0910 |
| 9/5/1989 | 0.038 | 0.0380 |
| 10/24/1989 | 0.02 | 0.0200 |
| 11/6/1989 | 0.0025 | 0.0025 |
| 1/10/1990 | 0.026 | 0.0260 |
| 3/22/1990 | 0.024 | 0.0240 |
| 5/3/1990 | 0.043 | |
| 5/19/1990 | 0.066 | 0.0545 |
| 7/25/1990 | 0.0025 | 0.0025 |
| 5/21/1991 | 0.136 | 0.1360 |
| 8/8/1991 | 0.036 | 0.0360 |
| 6/10/1992 | 0.037 | |
| 6/10/1992 | 0.015 | 0.0260 |
| 8/18/1992 | 0.265 | 0.2650 |
| 6/9/1993 | 0.042 | 0.0420 |
| 8/11/1993 | 2.005 | Outlier |
| 7/13/1994 | 0.067 | 0.0670 |
| 8/30/1994 | 0.057 | 0.0570 |
| 6/27/1995 | 0.02 | 0.0200 |
| 8/30/1995 | 0.02 | 0.0200 |
| 6/25/1996 | 0.03 | 0.0300 |
| 8/20/1996 | 0.03 | 0.0300 |
| 9/3/1998 | 0.047 | 0.0470 |
| 6/1/1999 | 0.065 | 0.0650 |
| 8/10/1999 | 0.025 | 0.0250 |
| 6/13/2000 | 0.039 | 0.0390 |
| 8/9/2000 | 0.034 | 0.0340 |
| 6/20/2001 | 0.037 | 0.0370 |
| 8/21/2001 | 0.062 | 0.0620 |
| 6/6/2002 | 0.057 | 0.0570 |
| 6/17/2003 | 0.02375 | 0.0240 |
| 6/29/2004 | 0.048 | 0.0480 |
| 8/24/2004 | 0.044 | 0.0440 |
| 7/5/2005 | 0.02 | 0.0200 |
| 8/23/2005 | 0.01 | 0.0100 |
| 9/20/2005 | 0.01 | 0.0100 |

Notes: Non-detect samples have been highlighted.
Half the minimum detection limit has been input for non-detect samples

**TABLE E-5**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR**

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 06/12/79 | Phosphorus as P | | | 0.020 | 0.020 | 0.0200 | 0.020 | 0.0200 |
| 09/25/79 | Phosphorus as P | | | 0.040 | 0.040 | 0.0300 | 0.030 | 0.0350 |
| 06/18/80 | Phosphorus as P | | | 0.010 | | 0.0100 | | |
| 06/18/80 | Phosphorus as P | | | 0.010 | 0.010 | 0.0100 | 0.010 | 0.0100 |
| 07/29/80 | Phosphorus as P | | | 0.030 | 0.030 | 0.0200 | 0.020 | 0.0250 |
| 09/18/80 | Phosphorus as P | 0.05 | | 0.070 | | 0.0500 | | |
| 09/18/80 | Phosphorus as P | 0.06 | | 0.070 | | 0.0500 | | |
| 09/18/80 | Phosphorus as P | 0.05 | 0.053 | | 0.070 | | 0.050 | 0.0578 |
| 11/20/80 | Phosphorus as P | 0.025 | | | | | | |
| 11/20/80 | Phosphorus as P | 0.025 | | | | | | |
| 11/20/80 | Phosphorus as P | 0.025 | 0.025 | | | | | 0.0250 |
| 05/13/81 | Phosphorus as P | 0.005 | | 0.010 | | 0.0300 | | |
| 05/13/81 | Phosphorus as P | 0.05 | | 0.040 | | 0.0200 | | |
| 05/13/81 | Phosphorus as P | 0.01 | | | | | | |
| 05/15/81 | Phosphorus as P | 0.02 | | | | | | |
| 05/28/81 | Phosphorus as P | 0.05 | | 0.010 | | 0.0500 | | |
| 05/28/81 | Phosphorus as P | 0.04 | | 0.070 | | 0.0300 | | |
| 05/28/81 | Phosphorus as P | 0.02 | | | | | | |
| 05/28/81 | Phosphorus as P | 0.06 | 0.032 | | 0.033 | | 0.033 | 0.0323 |
| 06/11/81 | Phosphorus as P | 0.005 | | 0.010 | | 0.0050 | | |
| 06/11/81 | Phosphorus as P | 0.01 | | 0.050 | | 0.0100 | | |
| 06/11/81 | Phosphorus as P | 0.01 | | | | | | |
| 06/11/81 | Phosphorus as P | 0.01 | | | | | | |
| 06/24/81 | Phosphorus as P | 0.03 | | 0.020 | | 0.0300 | | |
| 06/24/81 | Phosphorus as P | 0.02 | | 0.020 | | | | |
| 06/24/81 | Phosphorus as P | 0.03 | | 0.040 | | | | |
| 06/24/81 | Phosphorus as P | 0.03 | 0.018 | | 0.028 | | 0.015 | 0.0204 |
| 07/08/81 | Phosphorus as P | 0.01 | | 0.040 | | 0.0200 | | |
| 07/08/81 | Phosphorus as P | 0.01 | | 0.040 | | 0.0300 | | |
| 07/08/81 | Phosphorus as P | 0.01 | | | | | | |
| 07/08/81 | Phosphorus as P | 0.11 | | | | | | |
| 07/22/81 | Phosphorus as P | 0.005 | | 0.005 | | 0.0050 | | |
| 07/22/81 | Phosphorus as P | 0.005 | | 0.005 | | 0.0050 | | |
| 07/22/81 | Phosphorus as P | 0.04 | | | | | | |
| 07/22/81 | Phosphorus as P | 0.005 | 0.024 | | 0.023 | | 0.015 | 0.0206 |
| 08/17/81 | Phosphorus as P | 0.03 | | 0.030 | | 0.0300 | | |
| 08/17/81 | Phosphorus as P | 0.04 | | 0.020 | | 0.0300 | | |
| 08/17/81 | Phosphorus as P | 0.03 | | | | | | |
| 08/17/81 | Phosphorus as P | 0.05 | | | | | | |
| 08/31/81 | Phosphorus as P | 0.1 | | 0.030 | | 0.0100 | | |
| 08/31/81 | Phosphorus as P | 0.03 | | 0.010 | | 0.0100 | | |
| 08/31/81 | Phosphorus as P | 0.01 | | | | | | |
| 08/31/81 | Phosphorus as P | 0.02 | 0.039 | | 0.023 | | 0.020 | 0.0271 |
| 09/28/81 | Phosphorus as P | 0.03 | | 0.040 | | 0.0400 | | |
| 09/28/81 | Phosphorus as P | 0.03 | | 0.050 | | 0.0400 | | |
| 09/28/81 | Phosphorus as P | 0.03 | | | | | | |
| 09/28/81 | Phosphorus as P | 0.04 | 0.033 | | 0.045 | | 0.040 | 0.0392 |
| 11/03/81 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 11/03/81 | Phosphorus as P | 0.02 | | 0.020 | | 0.0200 | | |
| 11/03/81 | Phosphorus as P | 0.01 | | | | | | |
| 11/03/81 | Phosphorus as P | 0.02 | 0.015 | | 0.015 | | 0.015 | 0.0150 |
| 02/17/82 | Phosphorus as P | 0.05 | | | | | | |
| 02/17/82 | Phosphorus as P | 0.05 | | | | | | |
| 02/17/82 | Phosphorus as P | 0.05 | | | | | | |
| 02/17/82 | Phosphorus as P | 0.07 | 0.055 | | | | | 0.0550 |
| 03/23/82 | Phosphorus as P | 0.07 | | | | | | |
| 03/23/82 | Phosphorus as P | 0.05 | | | | | | |
| 03/23/82 | Phosphorus as P | 0.05 | | | | | | |
| 03/23/82 | Phosphorus as P | 0.07 | 0.060 | | | | | 0.0600 |

**TABLE E-5**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR**

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 05/20/82 | Phosphorus as P | 0.05 | | 0.010 | | 0.0600 | | |
| 05/20/82 | Phosphorus as P | 0.02 | | 0.050 | | 0.0400 | | |
| 05/20/82 | Phosphorus as P | 0.03 | | | | | | |
| 05/20/82 | Phosphorus as P | 0.05 | 0.038 | | 0.030 | | 0.050 | 0.0392 |
| 06/03/82 | Phosphorus as P | 0.03 | | 0.030 | | 0.0300 | | |
| 06/03/82 | Phosphorus as P | 0.02 | | 0.030 | | 0.0300 | | |
| 06/03/82 | Phosphorus as P | 0.03 | | | | | | |
| 06/03/82 | Phosphorus as P | 0.04 | | | | | | |
| 06/15/82 | Phosphorus as P | 0.005 | | 0.010 | | 0.0050 | | |
| 06/15/82 | Phosphorus as P | 0.01 | | 0.005 | | 0.1000 | | |
| 06/15/82 | Phosphorus as P | 0.01 | | | | | | |
| 06/15/82 | Phosphorus as P | 0.01 | | | | | | |
| 06/30/82 | Phosphorus as P | 0.04 | | 0.050 | | 0.1200 | | |
| 06/30/82 | Phosphorus as P | 0.07 | | 0.060 | | 0.0700 | | |
| 06/30/82 | Phosphorus as P | 0.06 | | | | | | |
| 06/30/82 | Phosphorus as P | 0.03 | 0.030 | | 0.031 | | 0.059 | 0.0399 |
| 07/13/82 | Phosphorus as P | 0.04 | | 0.040 | | 0.0800 | | |
| 07/13/82 | Phosphorus as P | 0.04 | | 0.060 | | 0.0700 | | |
| 07/13/82 | Phosphorus as P | 0.04 | | | | | | |
| 07/13/82 | Phosphorus as P | 0.1 | | | | | | |
| 07/30/82 | Phosphorus as P | 0.67 | | 0.100 | | | | |
| 07/30/82 | Phosphorus as P | 1.5 | | 0.010 | | | | |
| 07/30/82 | Phosphorus as P | 0.1 | | | | | | |
| 07/30/82 | Phosphorus as P | | 0.356 | | 0.053 | | 0.075 | 0.1611 |
| 08/19/82 | Phosphorus as P | 0.1 | | 0.050 | | | | |
| 08/19/82 | Phosphorus as P | 0.05 | | 0.100 | | | | |
| 08/19/82 | Phosphorus as P | 0.07 | | | | | | |
| 08/19/82 | Phosphorus as P | 0.25 | 0.118 | | 0.075 | | | 0.0963 |
| 09/01/82 | Phosphorus as P | 0.1 | | 0.100 | | | | |
| 09/01/82 | Phosphorus as P | 0.15 | | 0.100 | | | | |
| 09/01/82 | Phosphorus as P | 0.35 | | | | | | |
| 09/01/82 | Phosphorus as P | 0.1 | | | | | | |
| 09/06/82 | Phosphorus as P | | | 0.180 | | | | |
| 09/16/82 | Phosphorus as P | 0.16 | | 0.100 | | | | |
| 09/16/82 | Phosphorus as P | 0.12 | | | | | | |
| 09/16/82 | Phosphorus as P | 0.12 | | | | | | |
| 09/16/82 | Phosphorus as P | 0.29 | 0.174 | | 0.120 | | | 0.1469 |
| 10/07/82 | Phosphorus as P | 0.07 | | 6.190 | | 0.0900 | | |
| 10/07/82 | Phosphorus as P | 0.14 | | | | 0.1600 | | |
| 10/07/82 | Phosphorus as P | 0.12 | | | | | | |
| 10/07/82 | Phosphorus as P | 0.15 | 0.120 | | | | 0.125 | 0.1225 |
| 09/07/83 | Phosphorus as P | 0.02 | | 0.020 | | 0.0200 | | |
| 09/07/83 | Phosphorus as P | 0.01 | | 0.020 | | 0.0200 | | |
| 09/07/83 | Phosphorus as P | 0.01 | | | | | | |
| 09/07/83 | Phosphorus as P | 0.02 | 0.015 | | 0.020 | | 0.020 | 0.0183 |
| 10/12/83 | Phosphorus as P | 0.03 | | 0.020 | | 0.0400 | | |
| 10/12/83 | Phosphorus as P | 0.01 | | 0.040 | | 0.0500 | | |
| 10/12/83 | Phosphorus as P | 0.02 | | | | | | |
| 10/12/83 | Phosphorus as P | 0.03 | 0.023 | | 0.030 | | 0.045 | 0.0325 |
| 03/01/84 | Phosphorus as P | 0.03 | | | | | | |
| 03/01/84 | Phosphorus as P | 0.03 | | | | | | |
| 03/01/84 | Phosphorus as P | 0.03 | | | | | | |
| 03/01/84 | Phosphorus as P | 0.03 | 0.030 | | | | | 0.0300 |
| 01/29/85 | Phosphorus as P | 0.03 | | | | | | |
| 01/29/85 | Phosphorus as P | 0.02 | | | | 0.0200 | | |
| 01/29/85 | Phosphorus as P | 0.03 | | | | 0.0500 | | |
| 01/29/85 | Phosphorus as P | 0.05 | 0.033 | | | | | 0.0325 |
| 05/30/85 | Phosphorus as P | 0.13 | | | | 0.0600 | | |
| 05/30/85 | Phosphorus as P | 0.04 | | | | | | |
| 05/30/85 | Phosphorus as P | 0.03 | | | | | | |
| 05/30/85 | Phosphorus as P | 0.08 | 0.070 | | | | 0.060 | 0.0650 |

**TABLE E-5**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR**

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 06/20/85 | Phosphorus as P | 0.01 | | | | 0.0025 | | |
| 06/20/85 | Phosphorus as P | 0.01 | | | | | | |
| 06/20/85 | Phosphorus as P | 0.0025 | | | | | | |
| 06/20/85 | Phosphorus as P | 0.0025 | 0.006 | | | | 0.003 | 0.0044 |
| 08/14/85 | Phosphorus as P | 0.05 | | | | 0.0100 | | |
| 08/14/85 | Phosphorus as P | 0.02 | | | | | | |
| 08/14/85 | Phosphorus as P | 0.02 | 0.030 | | | | 0.010 | 0.0200 |
| 09/11/85 | Phosphorus as P | 0.05 | | | | | | |
| 09/11/85 | Phosphorus as P | 0.05 | | | | | | |
| 09/11/85 | Phosphorus as P | 0.05 | | | | | | |
| 09/11/85 | Phosphorus as P | 0.05 | | | | | | |
| 09/14/85 | Phosphorus as P | | 0.050 | | | 0.0500 | 0.050 | 0.0500 |
| 01/22/86 | Phosphorus as P | 0.02 | | | | | | |
| 01/22/86 | Phosphorus as P | 0.01 | | | | | | |
| 01/22/86 | Phosphorus as P | 0.05 | | | | | | |
| 01/22/86 | Phosphorus as P | 0.04 | 0.030 | | | | | 0.0300 |
| 09/23/86 | Phosphorus as P | 0.03 | | | | 0.0400 | | |
| 09/23/86 | Phosphorus as P | 0.05 | | | | | | |
| 09/23/86 | Phosphorus as P | 0.01 | | | | | | |
| 09/23/86 | Phosphorus as P | 0.03 | 0.030 | | | | 0.040 | 0.0350 |
| 02/12/87 | Phosphorus as P | 0.021 | | | | 0.0160 | | |
| 02/12/87 | Phosphorus as P | 0.015 | | | | | | |
| 02/12/87 | Phosphorus as P | 0.025 | | | | | | |
| 02/12/87 | Phosphorus as P | 0.046 | 0.027 | | | | 0.016 | 0.0214 |
| 05/06/87 | Phosphorus as P | 0.03 | | | | 0.0400 | | |
| 05/06/87 | Phosphorus as P | 0.03 | | | | 0.0400 | | |
| 05/06/87 | Phosphorus as P | 0.02 | | | | | | |
| 05/06/87 | Phosphorus as P | 0.04 | 0.030 | | | | 0.040 | 0.0350 |
| 06/24/87 | Phosphorus as P | 0.02 | | 0.020 | | 0.0300 | | |
| 06/24/87 | Phosphorus as P | 0.02 | | 0.050 | | 0.0300 | | |
| 06/24/87 | Phosphorus as P | 0.04 | | | | | | |
| 06/24/87 | Phosphorus as P | 0.05 | 0.033 | | 0.035 | | 0.030 | 0.0325 |
| 08/11/87 | Phosphorus as P | 0.02 | | 0.030 | | 0.0200 | | |
| 08/11/87 | Phosphorus as P | 0.02 | | 0.060 | | 0.0400 | | |
| 08/11/87 | Phosphorus as P | 0.04 | | | | | | |
| 08/11/87 | Phosphorus as P | 0.21 | 0.073 | | 0.045 | | 0.030 | 0.0492 |
| 02/04/88 | Phosphorus as P | 0.02 | | | | 0.0300 | | |
| 02/04/88 | Phosphorus as P | 0.02 | | | | 0.0700 | | |
| 02/04/88 | Phosphorus as P | 0.02 | | | | | | |
| 02/04/88 | Phosphorus as P | 0.08 | 0.035 | | | | 0.050 | 0.0425 |
| 05/18/88 | Phosphorus as P | 0.11 | | 0.040 | | 0.0500 | | |
| 05/18/88 | Phosphorus as P | 0.11 | | 0.070 | | 0.0300 | | |
| 05/18/88 | Phosphorus as P | 0.02 | | | | | | |
| 05/18/88 | Phosphorus as P | 0.06 | 0.075 | | 0.055 | | 0.040 | 0.0567 |
| 08/19/88 | Phosphorus as P | 0.02 | | 0.010 | | 0.0200 | | |
| 08/19/88 | Phosphorus as P | 0.006 | | 0.090 | | 0.0025 | | |
| 08/19/88 | Phosphorus as P | 0.0025 | | | | | | |
| 08/19/88 | Phosphorus as P | 0.01 | 0.010 | | 0.050 | | 0.011 | 0.0236 |
| 10/06/88 | Phosphorus as P | 0.03 | | 0.030 | | 0.0200 | | |
| 10/06/88 | Phosphorus as P | 0.02 | | 0.040 | | 0.0400 | | |
| 10/06/88 | Phosphorus as P | 0.02 | | | | | | |
| 10/06/88 | Phosphorus as P | 0.05 | 0.030 | | 0.035 | | 0.030 | 0.0317 |
| 05/04/89 | Phosphorus as P | 0.033 | | 0.048 | | 0.0270 | | |
| 05/04/89 | Phosphorus as P | 0.031 | | 0.054 | | 0.0210 | | |
| 05/04/89 | Phosphorus as P | 0.053 | | | | | | |
| 05/04/89 | Phosphorus as P | 0.065 | | | | | | |
| 05/15/89 | Phosphorus as P | 0.042 | | 0.022 | | 0.0200 | | |
| 05/15/89 | Phosphorus as P | 0.026 | | 0.027 | | 0.0230 | | |
| 05/15/89 | Phosphorus as P | 0.028 | | | | | | |
| 05/15/89 | Phosphorus as P | 0.012 | 0.036 | | 0.038 | | 0.023 | 0.0323 |

## TABLE E-5
## COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 06/05/89 | Phosphorus as P | 0.013 | | | | 0.0180 | | |
| 06/06/89 | Phosphorus as P | 0.008 | | 0.005 | | 0.0060 | | |
| 06/06/89 | Phosphorus as P | 0.0025 | | 0.015 | | 0.0025 | | |
| 06/06/89 | Phosphorus as P | 0.0025 | | | | | | |
| 06/06/89 | Phosphorus as P | 0.005 | 0.006 | | 0.010 | | 0.009 | 0.0083 |
| 07/03/89 | Phosphorus as P | 0.013 | 0.013 | | | 0.0260 | 0.026 | 0.0195 |
| 08/07/89 | Phosphorus as P | 0.162 | | | | 0.1160 | | |
| 08/22/89 | Phosphorus as P | 0.045 | | | | 0.0450 | | |
| 08/22/89 | Phosphorus as P | 0.057 | | | | | | |
| 08/22/89 | Phosphorus as P | 0.071 | | | | | | |
| 08/22/89 | Phosphorus as P | 0.054 | 0.078 | | | | 0.081 | 0.0792 |
| 09/05/89 | Phosphorus as P | 0.067 | 0.067 | | | 0.0480 | 0.048 | 0.0575 |
| 10/24/89 | Phosphorus as P | 0.04 | | | | | | |
| 10/24/89 | Phosphorus as P | 0.047 | | | | | | |
| 10/24/89 | Phosphorus as P | 0.049 | | | | | | |
| 10/24/89 | Phosphorus as P | 0.07 | 0.052 | | | | | 0.0515 |
| 11/06/89 | Phosphorus as P | 0.031 | 0.031 | | 0.000 | 0.0110 | 0.011 | 0.0140 |
| 01/10/90 | Phosphorus as P | 0.016 | | | | | | |
| 01/10/90 | Phosphorus as P | 0.039 | | | | | | |
| 01/25/90 | Phosphorus as P | 0.041 | 0.032 | | | | | 0.0320 |
| 02/07/90 | Phosphorus as P | 0.047 | 0.047 | | | | | 0.0470 |
| 03/02/90 | Phosphorus as P | 0.115 | | | | | | |
| 03/22/90 | Phosphorus as P | 0.047 | | | | | | |
| 03/22/90 | Phosphorus as P | 0.037 | | | | | | |
| 03/22/90 | Phosphorus as P | 0.14 | | | | | | |
| 03/22/90 | Phosphorus as P | 0.081 | 0.084 | | | | | 0.0840 |
| 04/03/90 | Phosphorus as P | 0.104 | 0.104 | | | | | 0.1040 |
| 05/03/90 | Phosphorus as P | 0.044 | | | | 0.0320 | | |
| 05/19/90 | Phosphorus as P | 0.07 | | 0.067 | | 0.0980 | | |
| 05/19/90 | Phosphorus as P | 0.089 | | 0.055 | | 0.0630 | | |
| 05/19/90 | Phosphorus as P | 0.068 | | | | | | |
| 05/19/90 | Phosphorus as P | 0.132 | 0.081 | | 0.061 | | 0.064 | 0.0686 |
| 07/25/90 | Phosphorus as P | 0.132 | | | | 0.0025 | | |
| 07/25/90 | Phosphorus as P | 0.091 | | | | 0.0930 | | |
| 07/25/90 | Phosphorus as P | 0.0025 | | | | | | |
| 07/25/90 | Phosphorus as P | 0.104 | 0.082 | | | | 0.048 | 0.0651 |
| 11/21/90 | Phosphorus as P | 0.005 | 0.005 | | | | | 0.0050 |
| 01/09/91 | Phosphorus as P | 0.05 | | | | | | |
| 01/09/91 | Phosphorus as P | 0.03 | 0.040 | | | | | 0.0400 |
| 02/07/91 | Phosphorus as P | 0.039 | 0.039 | | | | | 0.0390 |
| 03/07/91 | Phosphorus as P | 0.105 | 0.105 | | | | | 0.1050 |
| 04/16/91 | Phosphorus as P | 0.014 | | | | | | |
| 04/16/91 | Phosphorus as P | 0.01 | | | | | | |
| 04/16/91 | Phosphorus as P | 0.031 | 0.018 | | | | | 0.0183 |
| 05/21/91 | Phosphorus as P | 0.052 | | 0.058 | | 0.0510 | | |
| 05/21/91 | Phosphorus as P | 0.076 | 0.064 | | 0.058 | 0.0540 | 0.053 | 0.0582 |
| 08/08/91 | Phosphorus as P | 0.021 | | | | 0.0790 | | |
| 08/08/91 | Phosphorus as P | 0.027 | 0.024 | | 0.000 | | 0.079 | 0.0343 |
| 09/24/91 | Phosphorus as P | 0.068 | | 0.028 | | 0.0350 | | |
| 09/24/91 | Phosphorus as P | 0.06 | | 0.051 | | 0.0520 | | |
| 09/25/91 | Phosphorus as P | 0.048 | | | | | | |
| 09/25/91 | Phosphorus as P | 0.036 | 0.053 | | 0.040 | | 0.044 | 0.0453 |
| 02/25/92 | Phosphorus as P | 0.052 | | | | | | |
| 02/25/92 | Phosphorus as P | 0.229 | 0.141 | | | | | 0.1405 |
| 06/10/92 | Phosphorus as P | 0.018 | | 0.018 | | 0.0340 | | |
| 06/10/92 | Phosphorus as P | 0.022 | 0.020 | 0.028 | 0.023 | 0.0280 | 0.031 | 0.0247 |
| 08/18/92 | Phosphorus as P | 0.084 | | | | | | |
| 08/18/92 | Phosphorus as P | 0.107 | 0.096 | | | | | 0.0955 |

**TABLE E-5**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR**

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 06/08/93 | Phosphorus as P | 0.017 | | 0.015 | | 0.0180 | | |
| 06/08/93 | Phosphorus as P | 0.013 | | | | 0.0180 | | |
| 06/08/93 | Phosphorus as P | 0.013 | | | | | | |
| 06/08/93 | Phosphorus as P | 0.022 | | | | | | |
| 06/09/93 | Phosphorus as P | | 0.016 | 0.013 | 0.014 | | 0.018 | 0.0161 |
| 08/12/93 | Phosphorus as P | 0.046 | | 0.055 | | 0.0460 | | |
| 08/12/93 | Phosphorus as P | 0.049 | | 0.057 | | 0.0490 | | |
| 08/12/93 | Phosphorus as P | 0.052 | | | | | | |
| 08/12/93 | Phosphorus as P | 0.06 | 0.052 | | 0.056 | | 0.048 | 0.0518 |
| 07/12/94 | Phosphorus as P | 0.378 | | 0.025 | | 0.1100 | | |
| 07/12/94 | Phosphorus as P | 0.017 | | 0.030 | | 0.0830 | | |
| 07/12/94 | Phosphorus as P | 0.024 | | | | | | |
| 07/12/94 | Phosphorus as P | 0.048 | 0.117 | | 0.028 | | 0.097 | 0.0803 |
| 08/30/94 | Phosphorus as P | 0.065 | | 0.307 | | 0.0270 | | |
| 08/30/94 | Phosphorus as P | 0.049 | | 0.274 | | 0.0330 | | |
| 08/30/94 | Phosphorus as P | 0.047 | | | | | | |
| 08/30/94 | Phosphorus as P | 0.085 | 0.062 | | 0.291 | | 0.030 | 0.1273 |
| 07/05/95 | Phosphorus as P | 0.01 | | 0.005 | | 0.0050 | | |
| 07/05/95 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 07/05/95 | Phosphorus as P | 0.02 | | | | | | |
| 07/05/95 | Phosphorus as P | 0.05 | 0.023 | | 0.008 | | 0.008 | 0.0125 |
| 08/30/95 | Phosphorus as P | 0.02 | | 0.020 | | 0.0400 | | |
| 08/30/95 | Phosphorus as P | 0.04 | | 0.040 | | 0.0300 | | |
| 08/30/95 | Phosphorus as P | 0.02 | | | | | | |
| 08/30/95 | Phosphorus as P | 0.1 | 0.045 | | 0.030 | | 0.035 | 0.0367 |
| 06/25/96 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 06/25/96 | Phosphorus as P | 0.005 | | 0.020 | | 0.0200 | | |
| 06/25/96 | Phosphorus as P | 0.02 | | | | | | |
| 06/25/96 | Phosphorus as P | 0.09 | 0.031 | | 0.015 | | 0.015 | 0.0204 |
| 08/20/96 | Phosphorus as P | 0.01 | | 0.010 | | 0.0300 | | |
| 08/20/96 | Phosphorus as P | 0.01 | | 0.005 | | 0.0500 | | |
| 08/20/96 | Phosphorus as P | 0.01 | | | | | | |
| 08/20/96 | Phosphorus as P | 0.02 | 0.013 | | 0.008 | | 0.040 | 0.0200 |
| 07/02/98 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 07/02/98 | Phosphorus as P | 0.01 | | 0.010 | | | | |
| 07/02/98 | Phosphorus as P | 0.03 | 0.017 | | 0.010 | | 0.010 | 0.0122 |
| 09/03/98 | Phosphorus as P | 0.031 | | 0.030 | | 0.0310 | | |
| 09/03/98 | Phosphorus as P | 0.033 | 0.032 | 0.051 | 0.041 | 0.0500 | 0.041 | 0.0377 |
| 06/01/99 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 06/01/99 | Phosphorus as P | 0.01 | | 0.010 | | 0.0220 | | |
| 06/01/99 | Phosphorus as P | 0.01 | | | | | | |
| 06/01/99 | Phosphorus as P | 0.01 | 0.010 | | 0.010 | | 0.016 | 0.0120 |
| 08/10/99 | Phosphorus as P | 0.027 | | 0.024 | | 0.0460 | | |
| 08/10/99 | Phosphorus as P | 0.026 | | 0.064 | | 0.0600 | | |
| 08/10/99 | Phosphorus as P | 0.078 | | | | | | |
| 08/10/99 | Phosphorus as P | 0.0261 | 0.039 | | 0.044 | | 0.053 | 0.0454 |
| 06/13/00 | Phosphorus as P | 0.021 | | 0.030 | | 0.0250 | | |
| 06/13/00 | Phosphorus as P | 0.033 | | 0.028 | | 0.0300 | | |
| 06/13/00 | Phosphorus as P | 0.48 | | | | | | |
| 06/13/00 | Phosphorus as P | 0.021 | 0.139 | | 0.029 | | 0.028 | 0.0651 |
| 08/09/00 | Phosphorus as P | 0.093 | | 0.074 | | 0.0920 | | |
| 08/09/00 | Phosphorus as P | 0.047 | | 0.082 | | 0.0990 | | |
| 08/09/00 | Phosphorus as P | 0.102 | | | | | | |
| 08/09/00 | Phosphorus as P | 0.034 | 0.069 | | 0.078 | | 0.096 | 0.0808 |
| 06/20/01 | Phosphorus as P | 0.028 | | 0.036 | | 0.0350 | | |
| 06/20/01 | Phosphorus as P | 0.035 | | 0.075 | | 0.2560 | | |
| 06/20/01 | Phosphorus as P | 0.045 | | | | | | |
| 06/20/01 | Phosphorus as P | 0.179 | 0.072 | | 0.056 | | 0.146 | 0.0909 |
| 08/21/01 | Phosphorus as P | 0.109 | | 0.050 | | 0.1070 | | |
| 08/21/01 | Phosphorus as P | 0.108 | | 0.071 | | 0.1710 | | |
| 08/21/01 | Phosphorus as P | 0.113 | | | | | | |
| 08/21/01 | Phosphorus as P | 0.126 | 0.114 | | 0.061 | | 0.139 | 0.1045 |

**TABLE E-5**
**COMPARISON OF TOTAL PHOSPHORUS VALUES AT SCOFIELD RESERVOIR**

| | | SW Perry Boot Camp '04 | | West Bay '02 | | South Bay '03 | | |
|---|---|---|---|---|---|---|---|---|
| Date | | mg/L | Monthly Average | mg/l | Monthly Average | mg/l | Monthly Average | Recommended mg/L |
| 06/06/02 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 06/06/02 | Phosphorus as P | 0.01 | | 0.010 | | 0.0210 | | |
| 06/06/02 | Phosphorus as P | 0.01 | | | | | | |
| 06/06/02 | Phosphorus as P | 0.01 | 0.010 | | 0.010 | | 0.016 | 0.0118 |
| 08/15/02 | Phosphorus as P | 0.07 | | 0.055 | | | | |
| 08/15/02 | Phosphorus as P | 0.078 | 0.074 | | 0.055 | | 0.000 | 0.0430 |
| 06/17/03 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 06/17/03 | Phosphorus as P | 0.01 | | | | 0.0100 | | |
| 06/17/03 | Phosphorus as P | 0.05759 | | | | | | |
| 06/17/03 | Phosphorus as P | 0.01 | 0.022 | | 0.010 | | 0.010 | 0.0140 |
| 08/26/03 | Phosphorus as P | 0.029 | | 0.061 | | 0.0520 | | |
| 08/26/03 | Phosphorus as P | 0.041 | | | | | | |
| 08/26/03 | Phosphorus as P | 0.074 | | | | | | |
| 08/26/03 | Phosphorus as P | 0.105 | 0.062 | | 0.061 | | 0.052 | 0.0584 |
| 06/29/04 | Phosphorus as P | 0.029 | | 0.010 | | 0.0100 | | |
| 06/29/04 | Phosphorus as P | 0.025 | | | | | | |
| 06/29/04 | Phosphorus as P | 0.024 | | | | | | |
| 06/29/04 | Phosphorus as P | 0.025 | 0.026 | | 0.010 | | 0.010 | 0.0153 |
| 08/24/04 | Phosphorus as P | 0.1 | | | | 0.0340 | | |
| 08/24/04 | Phosphorus as P | 0.137 | 0.119 | | | | 0.034 | 0.0763 |
| 07/05/05 | Phosphorus as P | 0.01 | | 0.010 | | 0.0100 | | |
| 07/05/05 | Phosphorus as P | 0.01 | | 0.051 | | 0.0100 | | |
| 07/05/05 | Phosphorus as P | 0.01 | | | | | | |
| 07/05/05 | Phosphorus as P | 0.035 | 0.016 | | 0.031 | | 0.010 | 0.0189 |
| 08/23/05 | Phosphorus as P | 0.0296 | | 0.035 | | 0.0100 | | |
| 08/23/05 | Phosphorus as P | 0.046 | | 0.026 | | 0.0100 | | |
| 08/23/05 | Phosphorus as P | 0.029 | | | | | | |
| 08/23/05 | Phosphorus as P | 0.528 | 0.158 | | 0.031 | | 0.010 | 0.0662 |
| 09/20/05 | Phosphorus as P | 0.044 | | 0.050 | | 0.0100 | | |
| 09/20/05 | Phosphorus as P | 0.04 | | 0.029 | | 0.0310 | | |
| 09/20/05 | Phosphorus as P | 0.032 | | | | | | |
| 09/20/05 | Phosphorus as P | 0.036 | 0.038 | | 0.040 | | 0.021 | 0.0327 |

Date: 25-Sep-06

Table F-1

# Scofield Reservoir (with Narrows) Eutrophication Study

## Phosphorus Content and Probability of Eutrophication After Mitigation

| Year | Contents of Scofield Reservoir Jun - Sep Average | Contents of Scofield Reservoir Jun - Sep Average (V) | Surface Area at Volume of Scofield | Surface Area of Scofield (A) | Mean Lake Depth of Scofield (z) | Reservoir Outflow of Scofield | Reservoir Outflow of Scofield ($Q_o$) | Reservoir Hydraulic Detention Time (t) | Annual Mass Inflow Phosphorus (J) | Areal Phosphorus Loading Rate (L) | Sedimentation Coefficient (s) | Phosphorus in Lake Concentration (P) | Standard Normal Variate (S) | Normal Curve Area (Table D-4)* | Probability of Eutrophication |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AF | $m^3$ | Acres | $m^2$ | m | AF | $m^3/yr$ | yr | g/yr | $g/m^2/yr$ | | mg/L | | | |
| 1978 | 31,101 | 38,362,523 | 2,064 | 8,352,998 | 4.5927 | 35,827 | 44,192,210 | 0.8681 | 3,390,994 | 0.4060 | 1.5980 | 0.0321 | -0.7835 | 0.2834 | 0.7834 |
| 1979 | 31,332 | 38,647,827 | 2,074 | 8,391,825 | 4.6054 | 45,190 | 55,741,368 | 0.6933 | 3,476,130 | 0.4142 | 1.6144 | 0.0294 | -0.6376 | 0.2382 | 0.7382 |
| 1980 | 44,471 | 54,854,276 | 2,388 | 9,663,565 | 5.6764 | 52,145 | 64,320,292 | 0.8528 | 4,757,181 | 0.4923 | 1.5801 | 0.0315 | -0.7504 | 0.2736 | 0.7736 |
| 1981 | 21,670 | 26,729,688 | 1,751 | 7,084,806 | 3.7728 | 42,659 | 52,619,407 | 0.5080 | 1,417,946 | 0.2001 | 1.1829 | 0.0168 | 0.2847 | 0.1120 | 0.3880 |
| 1982 | 54,276 | 66,949,395 | 2,547 | 10,309,110 | 6.4942 | 53,200 | 65,621,880 | 1.0202 | 12,607,697 | 1.2230 | 2.4948 | 0.0542 | -1.6460 | 0.4502 | 0.9502 |
| 1983 | 61,584 | 75,963,415 | 2,649 | 10,720,460 | 7.0858 | 132,107 | 162,952,566 | 0.4662 | 7,231,643 | 0.6746 | 1.6693 | 0.0250 | -0.3657 | 0.1427 | 0.6427 |
| 1984 | 63,155 | 77,900,781 | 2,671 | 10,808,744 | 7.2072 | 147,059 | 181,395,663 | 0.4295 | 9,683,701 | 0.8959 | 1.9534 | 0.0290 | -0.6153 | 0.2309 | 0.7309 |
| 1985 | 55,346 | 68,268,651 | 2,560 | 10,361,989 | 6.5884 | 86,058 | 106,151,568 | 0.6431 | 6,485,585 | 0.6259 | 1.6673 | 0.0295 | -0.6409 | 0.2393 | 0.7393 |
| 1986 | 60,146 | 74,189,600 | 2,630 | 10,644,437 | 6.9698 | 101,797 | 125,565,946 | 0.5908 | 6,913,727 | 0.6495 | 1.6485 | 0.0279 | -0.5493 | 0.2087 | 0.7087 |
| 1987 | 45,448 | 56,060,109 | 2,410 | 9,750,953 | 5.7492 | 37,075 | 45,731,605 | 1.2259 | 1,722,875 | 0.1767 | 0.8577 | 0.0184 | 0.1408 | 0.0559 | 0.4441 |
| 1988 | 33,886 | 41,797,502 | 2,148 | 8,692,200 | 4.8086 | 38,435 | 47,409,150 | 0.8816 | 2,400,910 | 0.2762 | 1.2397 | 0.0242 | -0.3145 | 0.1234 | 0.6234 |
| 1989 | 12,650 | 15,604,025 | 1,343 | 5,434,420 | 2.8713 | 37,766 | 46,583,667 | 0.3350 | 1,379,768 | 0.2539 | 1.5983 | 0.0193 | 0.0596 | 0.0238 | 0.4762 |
| 1990 | 9,470 | 11,681,409 | 1,185 | 4,793,772 | 2.4368 | 24,399 | 30,096,404 | 0.3881 | 1,424,970 | 0.2973 | 1.9318 | 0.0271 | -0.4991 | 0.1912 | 0.6912 |
| 1991 | 14,185 | 17,496,734 | 1,416 | 5,728,802 | 3.0542 | 32,323 | 39,870,245 | 0.4388 | 3,019,899 | 0.5271 | 2.3700 | 0.0371 | -1.0216 | 0.3464 | 0.8464 |
| 1992 | 7,800 | 9,621,214 | 1,090 | 4,409,878 | 2.1817 | 13,175 | 16,251,052 | 0.5920 | 810,991 | 0.1839 | 1.5539 | 0.0260 | -0.4328 | 0.1674 | 0.6674 |
| 1993 | 41,665 | 51,392,992 | 2,331 | 9,434,126 | 5.4476 | 31,531 | 38,893,661 | 1.3214 | 4,383,288 | 0.4646 | 1.5647 | 0.0367 | -1.0042 | 0.3423 | 0.8423 |
| 1994 | 15,417 | 19,017,174 | 1,462 | 5,915,686 | 3.2147 | 42,581 | 52,523,148 | 0.3621 | 1,628,570 | 0.2753 | 1.5684 | 0.0198 | 0.0186 | 0.0077 | 0.4923 |
| 1995 | 36,553 | 45,088,000 | 2,208 | 8,934,585 | 5.0465 | 52,788 | 65,113,259 | 0.6925 | 3,895,978 | 0.4361 | 1.5767 | 0.0286 | -0.5909 | 0.2228 | 0.7228 |
| 1996 | 33,850 | 41,753,749 | 2,140 | 8,661,770 | 4.8205 | 49,140 | 60,613,377 | 0.6889 | 3,563,920 | 0.4115 | 1.5654 | 0.0283 | -0.5727 | 0.2167 | 0.7167 |
| 1997 | 59,560 | 73,466,619 | 2,623 | 10,613,498 | 6.9220 | 44,989 | 55,493,520 | 1.3239 | 5,479,913 | 0.5163 | 1.4459 | 0.0339 | -0.8707 | 0.3080 | 0.8080 |
| 1998 | 59,334 | 73,187,778 | 2,619 | 10,598,626 | 6.9054 | 57,698 | 71,169,709 | 1.0284 | 3,963,717 | 0.3740 | 1.1974 | 0.0250 | -0.3658 | 0.1427 | 0.6427 |
| 1999 | 52,274 | 64,479,836 | 2,519 | 10,193,102 | 6.3258 | 47,941 | 59,135,096 | 1.0904 | 3,449,013 | 0.3384 | 1.1887 | 0.0254 | -0.3947 | 0.1535 | 0.6535 |
| 2000 | 27,696 | 34,162,220 | 1,975 | 7,992,842 | 4.2741 | 45,426 | 56,032,108 | 0.6097 | 1,862,618 | 0.2330 | 1.2022 | 0.0192 | 0.0689 | 0.0275 | 0.4725 |
| 2001 | 21,171 | 26,113,926 | 1,741 | 7,045,059 | 3.7067 | 35,437 | 43,710,992 | 0.5974 | 2,230,492 | 0.3166 | 1.5660 | 0.0264 | -0.4562 | 0.1759 | 0.6759 |
| 2002 | 9,478 | 11,691,348 | 1,192 | 4,822,494 | 2.4243 | 31,210 | 38,497,045 | 0.3037 | 1,840,848 | 0.3817 | 2.2452 | 0.0284 | -0.5809 | 0.2195 | 0.7195 |
| 2003 | 18,811 | 23,202,610 | 1,628 | 6,589,290 | 3.5213 | 35,594 | 45,138,570 | 0.5140 | 1,840,848 | 0.2794 | 1.4994 | 0.0230 | -0.2330 | 0.0920 | 0.5920 |
| 2004 | 10,253 | 12,646,422 | 1,228 | 4,970,879 | 2.5441 | 27,979 | 34,511,910 | 0.3664 | 1,723,387 | 0.3467 | 2.0620 | 0.0284 | -0.5816 | 0.2197 | 0.7197 |
| 2005 | 49,340 | 60,860,926 | 2,475 | 10,017,120 | 6.0757 | 26,053 | 32,135,696 | 1.8939 | 3,868,185 | 0.3862 | 1.3158 | 0.0345 | -0.8989 | 0.3156 | 0.8156 |
| | | | | | | | | | | | | | | | |
| Average | 35,069 | 43,256,812 | 2,038 | 8,247,751 | 4.8330 | 50,307 | 62,052,540 | 0.7402 | 3,801,957 | 0.4306 | 1.6056 | 0.0280 | -0.5083 | | 0.6813 |

* Table D-4 "Normal Curve Areas for Standard Normal Variate", taken from *Guidelines for Studies of Potential Eutrophication, Bureau of Reclamation, December 1981.*
Formula for Curve Areas was created and is used to calculate the number

Table F-2
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
## Scofield Reservoir Operation

| Year / Month | [illegible] |
|---|---|
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1978 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1979 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1980 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1981 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1982 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |
| Oct | [illegible] |
| Nov | [illegible] |
| Dec | [illegible] |
| 1983 Jan | [illegible] |
| Feb | [illegible] |
| Mar | [illegible] |
| Apr | [illegible] |
| May | [illegible] |
| Jun | [illegible] |
| Jul | [illegible] |
| Aug | [illegible] |
| Sep | [illegible] |
| WY Total/Average | [illegible] |

Date: September 25, 2006

Table F-2
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
## Scofield Reservoir Operation

| Year | Month | Values |
|---|---|---|
| 1984 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1985 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1986 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1987 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1988 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1989 | Oct–Sep | [illegible] |
| WY Total/Average | | [illegible] |

Table F-2
**Flow and Phosphorus Routing WITH Proposed Narrows Project**
## Scofield Reservoir Operation

Date: September 23, 2006

Table F-2
Flow and Phosphorus Routing WITH Proposed Narrows Project
## Scofield Reservoir Operation

| Year | Month | Values (Gooseberry Creek; Fish Creek; Pondtown Creek; other inflows; Scofield Reservoir; Price River below Scofield Dam) |
|---|---|---|
| 1996 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1997 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1998 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 1999 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 2000 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |
| 2001 | Oct | [illegible] |
| | Nov | [illegible] |
| | Dec | [illegible] |
| | Jan | [illegible] |
| | Feb | [illegible] |
| | Mar | [illegible] |
| | Apr | [illegible] |
| | May | [illegible] |
| | Jun | [illegible] |
| | Jul | [illegible] |
| | Aug | [illegible] |
| | Sep | [illegible] |
| WY Total/Average | | [illegible] |

Date: September 25, 2006

# Table F-2
## Flow and Phosphorus Routing WITH Proposed Narrows Project
## Scofield Reservoir Operation

(Adjusted Phosphorus Inflow to match Annual Average Pre-Project Phosphorus Concentration in Scofield)

| Year | Month | (CALC) Stream Flow-Gooseberry Creek Near Scofield: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (Calculated) Outlet for Fish Creek Above Scofield Reservoir: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (CALC) Stream Flow-Fish Creek Above Scofield Reservoir: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Stream Flow-Mud Creek Above Scofield Reservoir: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | Stream Flow-Pondtown Creek Above Scofield Reservoir: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (CALC) Other Reservoir Inflow Above Scofield Reservoir: Flow (Acre-Feet) | Concentration (mg/l) | Weight (Grams) | (CALC) Total Inflow Above Scofield Reservoir: Flow (Acre-Feet) | Scofield Reservoir: Evaporation (Acre-Feet) | Total (Acre-Feet) | End of Month Concentration | Price River Below Scofield Dam (Acre-Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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NOTE: Average Annual Concentrations are Flow Weighted.

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX G

# ENVIRONMENTAL COMMITMENTS

## Appendix G

# Narrows Project
# Final Environmental Impact Statement
# Environmental Commitments

When implementing this action, the following specific environmental commitments will be implemented as integral parts of the decision to avoid or minimize adverse effects.

1. Evaluate three previously recorded sites in pool area as to National Register of Historic Places (NRHP) eligibility. Limited testing necessary to evaluate the sites will be accomplished through placing auger holes in a pattern on each site or excavating test units.

2. Inventory for cultural resources any of the pool area, dam construction zone, and road realignments not inventoried in 1979, including ¼-mile zone around pool area that will be impacted by recreational use of the reservoir. In addition to all areas slated for wetlands enhancement, inventory the location of all recreational facilities proposed in the project plan.

3. Inventory for cultural resources the rights-of-way for the proposed East Bench and Oak Creek Pipelines, consisting of 16.1 linear miles of proposed water pipeline near Fairfield in Sanpete County.

4. Inventory for cultural resources and evaluate the existing historic tunnel delivery system on Gooseberry Creek as to its NRHP eligibility.

5. Conduct a cultural resources overview of United States Department of Agriculture Forest Service (USDA Forest Service) information on historic features in and near the project area and evaluate any features within the project area as to their NRHP eligibility.

6. Conduct a paleontological literature search and survey of the project area and its immediate vicinity, with the particular view of assessing the likelihood of recovering Pleistocene fauna during the project (the project area is near the site of the Huntington Mammoth discovery).

7. Consult with the State Historic Preservation Office (SHPO) regarding the NRHP eligibility of any historic or archaeological sites found during work associated with any of the above commitments. If Reclamation and the SHPO jointly reach the conclusion that significant sites will be impacted by the project, the Bureau of Reclamation (Reclamation) will then consult with the SHPO and with the Advisory Council on Historic Preservation to negotiate an memorandum of agreement (MOA) that

outlines mitigation measures to be taken prior to project construction to avoid adverse effects of the project on historic properties.

8. Conduct Class I and Class III cultural resource inventories for the entire area of potential effects, as defined in section 3.16.1, prior to initiation of final design and construction.

9. Conduct consultation with the SHPO and other consulting parties on all findings and determinations made throughout the Section 106 process.

10. In the event that any cultural site, feature, or artifact (historic or prehistoric) is discovered during construction, whether on the surface or as an inadvertent subsurface discovery, construction in the area of discovery shall cease immediately, and it shall be reported immediately to the Provo Area Office archaeologist. Construction in the area of discovery shall not resume until an assessment of the cultural material and an evaluation to determine appropriate actions to prevent loss of significant cultural or scientific value can be made by a professional archaeologist.

11. Any person who knows or has reason to know that he/she has inadvertently discovered possible human remains on Federal land, he/she must provide immediate telephone notification of the discovery to Reclamation's Provo Area Office archaeologist. Work will stop until the proper authorities are able to assess the situation onsite. This action will promptly be followed by written confirmation to the responsible Federal agency official with respect to Federal lands. The Utah SHPO and interested Native American tribal representatives will be promptly notified. Consultation will begin immediately. This requirement is prescribed under the Native American Graves Protection and Repatriation Act (43 Code of Federal Regulations Part 10); and the Archaeological Resources Protection Act of 1979 (16 United States Code 470).

12. Should vertebrate fossils be encountered during ground disturbing actions, construction in the area of discovery must be suspended until a qualified paleontologist can be contacted to assess the find.

13. All construction activities will comply with applicable Federal and State laws, orders, and regulations relating to air and water quality. This will include obtaining proper permits, such as a 402 Storm Water Permit, from the State of Utah, and complying with any limitations imposed by those permits. Best Management Practices, specified in the Nonpoint Source Water Pollution Control Plan for Hydrologic Modification in Utah, will be implemented as a requirement of all construction contracts.

14. All construction contractors will be required to comply with Federal and State laws concerning the use of pesticides and hazardous wastes.

15. The asphalt road surface will be removed from the reservoir basin.

16. All disturbed lands will be re-contoured and re-vegetated using an approved, weed free, native seed mix and appropriate seeding methods. Success of this effort will be evaluated on the basis of percent vegetative cover of the ground surface and level of plant species diversity. The composition of seed mixes will be coordinated with wildlife habitat specialists. Weed control on all disturbed areas will be required.

17. Appropriate steps will be taken to prevent the spread of, and to otherwise control, undesirable plants and animals within areas affected by construction activities. Equipment used for the project will be inspected for reproductive and vegetative parts, foreign soil, mud, or other debris that may cause the spread of weeds, invasive species, and other pests. Such material will be removed before moving vehicles and equipment onto any Federal land. Upon the completion of work, decontamination will be performed within the work area before the vehicle and/or equipment are removed from Federal project lands.

18. Sanpete Water Conservancy District (SWCD) will implement all wildlife measures described in chapter 2 and 3 of the final environmental impact statement (FEIS). SWCD will be responsible for funding and acquiring all lands and easements. SWCD will provide native seed to supplement the USDA Forest Service native seed mixture for the watershed and range improvement project. SWCD will fund and construct all improvements, such as fencing. This work will be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way will be acquired, and initial construction of wildlife measures will be completed prior to initial filling of the reservoir. SWCD also will be responsible for funding the mitigation monitoring. SWCD will be responsible to enter into MOAs with the Utah Department of Wildlife Resources (UDWR), USDA Forest Service, and other appropriate agencies for all wildlife measures. The MOAs clearly will define the roles and responsibilities of the SWCD, UDWR, USDA Forest Service, and other parties for implementation and maintenance of the wildlife measures.

19. SWCD will implement the wetland mitigation measures described in chapters 2 and 3 of the FEIS. SWCD will be responsible for funding and acquiring all lands and rights-of-way. SWCD will provide and transplant any native plantings needed. SWCD will be responsible to ensure that all fences are in good repair and are maintained properly. SWCD also will be responsible to install and maintain any diversion and/or irrigation facilities. This work will be performed concurrently with construction of other project facilities, such as the dam, tunnel rehabilitation, pipelines, and canals. All lands and rights-of-way will be acquired, and initial construction of wetland measures will be completed prior to initial filling

of the reservoir. SWCD also will be responsible to fund the monitoring of the wetland mitigation. SWCD will be responsible to enter into MOAs with UDWR, United States Army Corps of Engineers (USACE), and other appropriate agencies for all wetland measures. The MOAs will clearly define the roles and responsibilities of SWCD, UDWR, USACE, and other parties for implementation and maintenance of the wetland measures.

20. SWCD will implement all fishery mitigation measures described in chapter 2 and 3 of the FEIS. SWCD will be responsible for funding and acquiring all lands and rights-of-way. SWCD will fund and construct all improvements, such as fencing and stream channel improvements. SWCD will provide water from its water rights or enter into operating agreements for all instream flows described in chapter 2 of the FEIS. This work will be performed concurrently with construction of other project facilities, such as the dam, tunnel rehabilitation, pipelines, and canals. All lands and rights-of-way will be acquired, and initial construction of fishery measures will be completed prior to initial filling of the reservoir. SWCD will be responsible to fund all operation and maintenance costs of mitigation facilities. SWCD will be responsible to enter into a MOA with the UDWR and other appropriate agencies for all fishery measures. The MOA will clearly define roles and responsibilities of SWCD, UDWR, and other parties for implementing, monitoring, and maintaining the fishery measures.

21. SWCD will comply with all existing policies and regulations requiring the preparation, submittal, and implementation of a water conservation plan.

22. A water quality monitoring plan for all project-related features, impacted downstream water bodies, and potential mitigation locations will be developed in coordination with the Utah Division of Water Quality and other parties. Monitoring will begin prior to construction of project facilities and will establish baseline conditions for water quality and phosphorus loading at potential mitigation locations. Monitoring will continue through all phases of construction to determine construction-related impacts, if any. Monitoring also will continue postconstruction to determine the effectiveness of mitigation measures and determine other impacts from operation of the project, if any. SWCD will implement the water quality monitoring plan.

23. SWCD will require all recipients of Narrows Project water to implement conservation practices to be eligible for project water.

24. Re-initiation of the Endangered Species Act Section 7 consultation will be required to discuss additional conservation measures in the event sufficient progress has not been achieved under the Recovery Implementation Program.

25. Prior to design of the Narrows Dam and appurtenant structures, a seismic study, as outlined in the Federal and Utah State Guidelines, will be conducted for the dam and reservoir site that reflects the current standard of care prescribed. Additional geologic field evaluation and assessment of the dam and reservoir site will be completed that address the proximal active faults associated with the site and further characterize the earth materials underlying the dam site, reservoir, and reservoir rim to evaluate their engineering properties to ensure adequate design of features associated with the dam and reservoir. Designs will incorporate maximum accelerations associated with natural and or manmade seismic events that are determined probable to potentially occur in the area. Mitigation for other potential geologic hazards also will be integrated into project design.

26. Prior to dam construction, a reservoir study will be required to determine the possibility of leakage from the reservoir basin into adjacent fault and fissures and into coal veins. This will require drilling or other methods to assess the likely seepage rate into the fault zones through the overlaying material. Permeability testing in the overburden and in the fault zone will be evaluated to assess seepage rates.

27. Standard Reclamation management practices will be applied during construction activities to minimize environmental effects and will be included in construction specifications. Such practices or specifications include sections in the present report on public safety, dust abatement, air pollution, noise abatement, water pollution abatement, waste material disposal, erosion control, archaeological and historical resources, vegetation, and wildlife. All public access roads used during construction will be repaired if needed before construction contractors leave the project area.

28. If the action changes significantly from that described in the FEIS because of additional or new information, or if other construction areas are required outside the areas analyzed in the FEIS, additional environmental analysis will be undertaken if necessary.

29. The SWCD will obtain a Clean Water Act Section 404 permit from the USACE. The USACE regulates all the jurisdictional waters of the United States including jurisdictional wetlands. The conditions and requirements of the 404 permit will be strictly adhered to by SWCD.

30. Best management practices will be implemented to control fugitive dust during construction. The contractor will follow the U.S. Environmental Protection Agency recommended control methods for aggregate storage pile emissions to minimize dust generation, including periodic watering of equipment staging areas, along with dirt and gravel roads. All loads that have the potential of leaving the bed of the truck during transportation will be covered or watered to prevent the generation of fugitive dust. Chemical stabilization will not be allowed.

31. A Utah Pollutant Discharge Elimination System Permit will be obtained by SWCD from the State of Utah before any discharges of water as a point source into any water body.

32. Appropriate measures will be taken to ensure that construction-related sediments will not enter any water bodies either during or after construction.

33. Construction activities will be confined to previously disturbed areas, to the extent practicable. Construction activities occurring within 0.5 mile of raptor nests will be restricted to the hours between 9 a.m. and 4 p.m.

34. Construction sites will be closed to public access. Temporary fencing, along with signs, will be installed to prevent public access.

35. A survey of ground nesting birds will be conducted prior to any ground disturbing activities. This survey will be conducted by a biologist to avoid, to the extent possible, any negative impacts to these birds.

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX H

# COMMENTS AND RESPONSES

# Appendix H

# Narrows Project
# Final Environmental Impact Statement
# Comments and Responses

## 1. INTRODUCTION

Under the Council on Environmental Quality's regulations implementing the National Environmental Policy Act (NEPA) (40 Code of Federal Regulations [CFR] 1503.1), an agency that publishes a draft environmental impact statement (EIS) is required to obtain the comments of any Federal agency with jurisdiction by law or special expertise and to request comments from appropriate agencies at all levels of government, Indian tribes, and the public. The agency has a responsibility to solicit comments from those persons and organizations that may be interested or affected by a Proposed Action.

This Comments and Responses Appendix is the result of the Bureau of Reclamation's comment-response process for the supplemental draft environmental impact statement (SDEIS) for the Narrows Project, Sanpete County, Utah (Narrows Project). Section 1 describes how public comments were acquired, summarized, and indexed by the Bureau of Reclamation (Reclamation) during the comment period following publication of the SDEIS. It also describes how the SDEIS was distributed to agencies and members of the public and how public meetings were conducted. Section 2 describes how comments were categorized, addressed, and documented. Section 3 provides instructions for readers on how to use this document to find particular comments and responses. Section 4 summarizes the major comments received on the SDEIS. Section 5 describes the changes to the SDEIS that resulted from the public comment response process. The following section provides indexes of all comments received during the 63-day comment period, including the public hearings. Before turning to these sections, readers are encouraged to review the following definitions used in this comment-response document.

### 1.1 Terms Used in Process

Several terms need to be defined to assist the reader in finding their respective comment.

**Comment –** A distinct statement or question about a particular topic, such as:

- Purpose and need for action
- Merits of the Proposed Action or any of the alternatives

- Any aspect of potential environment impacts arising from the proposed action or alternatives
- Reclamation's use of facts, methods, or analyses in the EIS
- Reclamation's implementation of the NEPA process
- Matters outside the scope of the EIS

**Comment document –** The written version of comments submitted by a commenter. This could be a letter, postcard, email, or transcript of oral comments at a public hearing. A comment document may contain any number of comments.

**Comment category –** The topic or issue (e.g., the NEPA process, the affected environment section of the EIS, water quality, etc.) to which a comment is addressed.

**Comment index –** The alphabetized list of commenters' names (individuals and organizations) or comment topics with information on where to find the comment document and Reclamation's responses to the comment(s).

**Duplicate comment document –** A comment document that is the same in wording or so similar as to be virtually identical to another comment document. Examples are a postcard emailed as part of an organized campaign to encourage people to comment on the DEIS or a petition through which more than one individual indicates agreement with the same comment.

**Public –** A term broadly used to include any and all potentially interested or affected parties, whether private citizens; State, local, and tribal governments; environmental groups; water or irrigation districts; civic and community organizations; businesses; and independent experts from the scientific, technical, and academic communities.

**Substantive comment –** A comment that is relevant to the EIS scope, analysis, or process and requires a response.

**Summary comment –** A summary capturing the essence of similar comments on a given topic.

## 2. PUBLIC COMMENT ANALYTICAL PROCESS FOR THE NARROWS SDEIS

The Narrows Project SDEIS updated information and analyses contained in the Narrows Project Draft EIS (DES 98-10) published in March 1998 and disclosed the direct, indirect, and cumulative effects of the Proposed Action and alternative

actions for water development in northern Sanpete County, Utah. A notice of intent to prepare the Narrows Project SDEIS was published in the *Federal Register* (FR) on November 25, 2003 (68 FR 66123–66124). The SDEIS was mailed to 438 individuals and agencies. A 63-day public review period began with publication of the Notice of Availability in the *Federal Register* on March 29, 2009. Reclamation allowed a formal, 63-day public comment period, through June 2010. Two public hearings were held: one on April 28, 2010, in Manti, Utah, and the other on April 29, 2010, in Price, Utah. There were 10 people who provided comments at the Manti meeting and 12 people at the Price meeting.

Following the comment period, Reclamation logged in all comment documents received, including letters, hearing transcripts, emails, and faxes, and listed the attachments and supplemental material in a spreadsheet log.

Through administrative error, three letters (numbers 694, 695, and 696) were not originally included in the appendix. They were reviewed and considered in the FEIS and did not have substantive comments that needed to be addressed or that had not been addressed in similar letters. These letters are listed at the end of the appendix under the section, Additional Letters.

Each comment document was scanned electronically, and originals were maintained for the administrative record. The copies were given a unique number to make it easier to track through the process. Each comment document was read by the EIS interdisciplinary team in its entirety to understand the overall intent and perspective of the commenter. Again, all forms of comment documents were included in this process, including emails, letters, and transcripts from public meetings. Attachments to comment documents also were reviewed to determine whether they contained information relevant to the SDEIS. Substantive comments were identified and submitted to the EIS interdisciplinary team for responses. All comment documents received are appended here, and all substantive comments are numbered within the comment document. In compliance with 40 CFR 1503.4, possible responses to substantive comments may include the need to:

- Modify alternatives including the Proposed Action
- Develop and evaluate alternatives not previously given serious consideration
- Supplement, improve, or modify the analyses
- Make factual corrections to the document
- Explain why no further response is necessary

# 3. INSTRUCTIONS TO READERS ON HOW TO USE THIS COMMENT RESPONSE DOCUMENT

To allow the individual commenter or reader to locate their comments and Reclamation's response(s), there is a table showing the commenter's identification number assigned to those persons or organizations that submitted comments. These numbers were consecutive and arranged alphabetically within the following categories: Federal agencies, State agencies, local agencies, water user agencies and organizations, organizations, businesses, individuals, and public hearings.

To find one's own comments, the reader should first open the Commenter pdf file to locate a commenter's name and note the corresponding commenter identification number associated with that name. This document contains the scanned letter of each individual. Comments are numbered consecutively within the letter. The reader can "click" on the comment number within the letter, and this, in turn, will take them to the comment response, within the Response table. This table is in numeric order by commenter identification number and the corresponding comment number within the comment document.

# 4. MAJOR COMMENTS RECEIVED

## 4.1 Summary of Public Comments Received on the SDEIS

Reclamation received 696 comment documents since the SDEIS was published in March 2010. Several of these letters were received after the 63-day comment period ending on June 1, 2010; all letters were reviewed and considered prior to finalizing the final environmental impact statement (FEIS). Forty-nine comment documents included substantive comments that required a response and/or clarifying edits to the FEIS. No new issues were raised that required further analysis. The following general comments and responses are summarized here and then fully addressed in this appendix.

### Climate Change

***Issue Summary –*** Nine comments. The impact of climate change was not sufficiently addressed in the SDEIS.

***General Response –*** Climate change models have not been developed with sufficient detail or sensitivity to capture small projects such as the proposed Narrows Project, which involves storage and distribution of up to 5,400 acre-feet of water per year. Section 1.7 of the FEIS states that, without downscaled models addressing climate change at this project level, at this time, a meaningful analysis of a small project cannot be achieved.

## Cultural Resources

***Issue Summary –*** Sixteen comments. Only a portion of the area associated with the dam, reservoir, and project features were inventoried in 1979 before a decision was made.

***General Response –*** The NEPA process does not require completion of the 36 CFR 800 process but, rather, consideration of the potential effects on historic properties. An environmental commitment requiring Reclamation to conduct consultations with the appropriate State Historic Preservation Officer (SHPO), tribes, and additional consulting parties is in the FEIS. It is anticipated that the entire area of potential effects (APE) will be inventoried to current standards if the project is approved.

## Economics

***Issue Summary –*** Fifty-one comments. The SDEIS did not sufficiently address economic impacts associated with the Narrows Project. The project depends on conversion of water to finance the project. How will the conversion of water from irrigation water to municipal and industrial (M&I) water be accomplished?

***General Response –*** To the extent there is available information, economic effects are analyzed in section 3.17 of the FEIS. All of the costs of the proposed project are included in the loan application, which is updated and appended to the FEIS.

The conversion of water from irrigation to M&I use will occur in stages. It is unknown at this time when water will be needed and how much water will be needed.

## Fisheries

***Issue Summary –*** Thirty-nine comments. The impacts to fish in small streams inundated by the reservoir, the stream below the dam, Scofield Reservoir, and the Price River are underestimated and not sufficiently mitigated.

***General Response –*** The impacts to fish are most pronounced near the dam. The FEIS acknowledges that negative effects will occur to fisheries in the inundation area, below the dam and in certain stream reaches within the project area. The FEIS has designed mitigation measures in the Proposed Action to compensate to the extent possible for these impacts.

Scofield fishery is not expected to be impacted significantly. The *Eutrophication Study, Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir* (October 2006, revised) determined that overall water quality in Scofield Reservoir will be degraded by the Proposed Action without mitigation. Mitigation measures are designed to offset this potential impact. Lowered water

quality standards (e.g., water temperature, phosphorous loading) can affect the aquatic food chain within the reservoir. If water quality effects are slight, then their effect to the food chain and the fishery will be slight as well.

Scofield Reservoir will be operated within the range of historic operations. Peak flows may be reduced in some years; but, in general, the flow below Scofield Dam will not be severely impacted; therefore, the fishery below Scofield Dam will not be severely impacted.

Specific Proposed Action fish and wildlife mitigation measures include the following:

- Restoring year-round flows in two small tributaries to Gooseberry Creek (above the proposed Narrows Reservoir); providing minimum instream flows of 1.0 cubic feet per second (cfs) in Gooseberry Creek below Narrows Dam.
- Providing a multilevel outlet at Narrows Dam to regulate the temperature of releases to Gooseberry Creek from Narrows Reservoir.
- Modifying and/or stabilizing streambanks and associated riparian zones along Middle Gooseberry Creek.
- Providing releases from the Narrows Reservoir into Gooseberry Creek for flushing flows.
- Acquiring and/or improving stream channel for fish habitat (Middle Gooseberry Creek).
- Providing winter releases to Cottonwood Creek.
- Providing summer flows in lower Cottonwood Creek.
- Constructing a pipeline in the Upper Cottonwood Creek area to convey project water outside the stream channel (from the tunnel outlet to a point 300 feet downstream from the confluence of Cottonwood Creek and Left Hand Fork)
- Providing a minimum 2,500-acre-foot conservation pool in Narrows Reservoir for fish.
- Reducing external phosphorus loading to Scofield Reservoir.
- Providing mitigation and enhancement of upland habitat (quantified in terms of mule deer and Brewer's sparrow habitat units, each of which represent other wildlife species dependent on similar habitat) in the following ways:
    - Acquiring conservation easements around the Narrows Reservoir.

- Acquiring and fencing land adjacent to the Price River below Scofield Reservoir to protect wildlife habitat.
- Creating new wetlands and enhancing existing wetlands to mitigate for 100 acres of wetlands areas inundated by the reservoir and affected by changes in the stream channels.

## Geologic

***Issue Summary –*** Twenty comments. The seismic standards to which the Narrows Dam is proposed are out of date.

***General Response –*** These Federal and State guidelines for dam design were not introduced in the SDEIS due to the expected time lag between issuing the document and the probable date of final design. Should the project be approved and Sanpete Water Conservancy District (SWCD) proceeds, current standards will be required. Final design is not required in an EIS.

## Land Use

***Issue Summary –*** Twenty-four comments. Private land will be impacted by the project. Is it legal for the Government to allow a non-Federal project on Federal lands?

***General Response –*** SWCD will purchase or lease any private lands needed for the project, which includes compensation for impacts. SWCD will evaluate and compensate landowners to the extent possible for all of the impacts to privately owned land.

Reclamation made the decision to keep the lands initially reserved for the Gooseberry Project under withdrawal and has the authority to issue licenses, permits, or other land use grants on withdrawn lands under Section 10 of the Reclamation Project Act of 1939 (53 Statute 1187, 43 United States Code 485a).

## Mitigation

***Issue Summary –*** Twenty-seven comments. Can Reclamation ensure that mitigation measures are met? Who will pay for mitigation? The U.S. Department of Agriculture Forest Service (USDA Forest Service) wants mitigation completed on their land. Proposed mitigation is insufficient and will not compensate for adverse impacts.

***General Response –*** The mitigation measures will be included in construction contracts and other agreements to ensure implementation. Mitigation is required by Reclamation to enter into a license agreement. SWCD will pay for all mitigation.

Mitigation for the Narrows Project does not need to be exclusively on USDA Forest Service lands. Mitigation will be completed primarily within the area of project influence, which could be lands both inside and outside USDA Forest Service lands.

It is SWCD's intention to totally mitigate all impacts, where possible and to the extent possible, to find mitigation measures that could be implemented "in place" and "in kind."

## NEPA Process

***Issue Summary –*** Forty-four comments. Information seems outdated and incomplete. There was insufficient opportunity for the public to comment during the NEPA process and have an influence on the decision.

***General Response –*** Reclamation considers that the information in the FEIS is accurate and complete. All data in the FEIS were reviewed by resource specialists and updated based on the comments received and as new data became available.

Reclamation made a diligent effort to involve the public in the NEPA process, including scoping, public comment periods, and public hearings. The public has been provided notice of the availability of environmental documents and given the opportunity to comment. All comments submitted have been fully considered in the decision and, where appropriate, incorporated into the document.

## Proposed Action/Alternatives

***Issue Summary –*** Seven comments. The range of alternatives is too limited. Reclamation adopted SWCD's purpose and need statement and, thus, overly restricted the scope and range of alternatives. More variability in the reservoir sizes and locations should have been explored and considered.

***General Response –*** Reclamation's action is deciding whether to approve the loan application and/or use of the withdrawn land; thus, the range of alternatives, size, and location were driven by SWCD's request and loan application and to enable the U.S. Army Corps of Engineers (USACE) to determine the Least Environmentally Damaging Practicable Alternative (LEDPA). Thirteen alternate damsites and other ways to meet the purpose and need are analyzed and discussed at length in the SDEIS. All practical alternatives based on the outcome of the 1984 Compromise Agreement and the requirements for late season irrigation have been explored, and the preferred alternative satisfies those requirements. The range of alternatives meets the legal and regulatory definition of a reasonable range of alternatives.

## Public Health and Safety

***Issue Summary –*** Seven comments. Dam safety is a concern. Who will be responsible to keep the dam safe? The negative impact to drinking water, especially during drought years, is a concern as well as the increased potential for West Nile virus and gastrointestinal disease.

***General Response –*** The responsibility for operation and maintenance oversight, which includes all facility inspections and oversight of dam safety, will fall under the Utah State Engineer's office.

The EIS team does not expect a significant change in the mosquito population; therefore, the risk of contracting West Nile virus will remain the same.

Additional discussion of the gastrointestinal effects was added to the public health and safety section of the FEIS. The analysis does not indicate water quality issues for Price.

## Recreation

***Issue Summary –*** Ten comments. The Narrows Project is touted as necessary and needed to help offset the increasing demand for recreation facilities in the area. This is an expensive project just to satisfy that need. What will the Narrows Reservoir provide to the public that Scofield does not already provide? Adjacent landowners are concerned that dispersed recreation will increase in the area. Scofield Reservoir will suffer because the Narrows Reservoir will draw away public recreational use. Who will manage the Narrows recreation facilities, and will they have a fee?

***General Response –*** The justification of the Narrows Project is to provide needed water and enable SWCD to act on its non-Federal Narrows water right. The justification for the Narrows Project is not to be 'different' from other developed recreation areas but to help offset the projected future pressure from an increasing population. Fishing and recreation are not "needs" in the sense that, standing alone, they would warrant construction of a dam. In the FEIS, these functions are described in section 1.4 as "additional benefits."

The dispersed recreational classification of the project area will not change. There would be some changes in recreational use; however, these are disclosed in section 3.15 of the FEIS.

Since the Narrows Reservoir is not a Federal project, it is unclear who will manage recreation, or if fees will be collected. These specific details will need to be negotiated among the interested parties and those agencies with jurisdiction.

## Threatened and Endangered Species

***Issue Summary –*** Twenty-six comments. The final 2000 Biological Opinion is old, and consultation should be reinitiated. Instream flow requirements should be considered in the lower Price River, and impacts to endangered species need to be sufficiently mitigated.

***General Response –*** The U.S. Fish and Wildlife Service (Service) responded to Reclamation in writing during scoping but did not request a new consultation. The Proposed Action and predicted impacts have not changed since the final Biological Opinion was issued. Reclamation considers that the final Biological Opinion, prepared in 2000, adequately addresses impacts of the proposed project to threatened, endangered, and candidate species. The FEIS has considered other information regarding each of these species' current listing, status, and ranges.

A position paper, entitled "The Upper Colorado River Endangered Fish Recovery Program's Position on the Role of the Price River in Recovery of Endangered Fish and the Need for Flow Management," was drafted during 2011. The results of the draft study included having the Recovery Implementation Program (RIP) investigate opportunities to protect existing flows and to avoid dewatering the lower Price River. The report is being finalized at this time. Instream flow requirements are a function of Utah water law and beyond the scope of the FEIS.

The Narrows Project relies on the RIP as the reasonable and prudent alternative for depletion impacts. The RIP determines what actions to take and funds these actions with payments made under the Section 7 consultation agreement process.

## Visual Resources

***Issue Summary –*** Two comments. Reservoir basin below the high water mark (bathtub ring) will be an eye sore and detract from the beautiful valley. Why didn't Reclamation assess visual impacts to private land?

***General Response –*** It is anticipated that the visual impact of exposed mud flat or shoreline will be negligible, due to steeper topography and angle of view. In general, water bodies tend to attract people and are an asset to an area.

Generally, only public lands or lands viewed from public lands, which could include private lands, are given visual quality objective ratings. The rating in the SDEIS included private lands.

## Water Quality

***Issue Summary –*** Eighty-four comments. Water quality needs to be monitored. Mitigation should be sufficient to ensure water quality impacts are fully compensated. There will be an increased potential for disease. There will be an increase in algae blooms in Scofield Reservoir. Water quality in Scofield

Reservoir will be severely impacted. Release temperatures will be higher than normal and negatively impact the stream below Narrows Dam. Water quality data is out dated and incomplete.

***General Response –*** There might be adverse impacts on water quality in lower Gooseberry Reservoir and Scofield Reservoir, and specific measures are identified and planned to mitigate any possible impact on water quality. The most significant measures that address water quality include the following:

- Providing a multilevel outlet at the proposed Narrows Dam
- Stabilizing stream banks along middle Gooseberry Creek
- Providing winter releases to lower Gooseberry Reservoir
- Reducing external phosphorus loading to Scofield Reservoir

The improvements will be jointly designed on a site-specific basis, and joint approval by the agencies listed will ensure that the most effective measures will be selected.

A water quality monitoring program will be developed and implemented as an environmental commitment. Monitoring will take place prior to implementation of the mitigation measures to identify specific locations for streambank improvements and to determine the reduction in phosphorus loading that the identified improvements will have. Water quality monitoring and identification of mitigation measures will be done in coordination with the Utah Division of Water Quality and other Federal, State, and local agencies. Water quality monitoring will continue following implementation of the proposed mitigation measures to verify the effectiveness of those measures.

The SDEIS analyzes the impact the project may have on the potable water supply in Scofield Reservoir. Implementation of proposed mitigation measures is expected to reduce phosphorus levels to preproject conditions, which also are expected to maintain algal growth at preproject conditions. Drinking water treatment costs are not expected to increase since water quality is maintained at preproject conditions.

The *Eutrophication Study, Flow and Phosphorus Impacts of Proposed Narrows Project on Scofield Reservoir* (October 2006, revised) determined that overall water quality in Scofield Reservoir will be degraded by the Proposed Action without mitigation. Mitigation measures are designed to offset this potential impact.

Scofield Reservoir will maintain phosphorus levels at preproject conditions so as to not have an adverse impact on water quality, including the approved total maximum daily load. The determination of phosphorus load reduction for the

mitigation measures was made based on water quality data from 1978–2005. This represents current data.

The proposed project entails a relatively small, high altitude dam and reservoir. The release temperatures from such a facility through the selective withdraw structure are not expected to deviate very far from those naturally occurring in streams in the area due to the selective withdrawal structure. The multilevel release structure (unusual for a small, high altitude reservoir) would simply provide a means of fine tuning such aspects of release operations. Warmer water could be released during colder periods of the year, and somewhat cooler water could be released during summer months to maintain optimum downstream temperatures for the fishery.

The water quality data presented in the SDEIS was the most current available through the U.S. Environmental Protection Agency STORET Web site at the time of the writing and editing. As shown in the footnotes of tables in the water quality section, data through 2007 are represented.

## Water Resources

***Issue Summary –*** Fifty-six comments. The hydrologic data is old and incomplete. The last drought was not included in the analysis. Sanpete residents should practice conservation to recover needed water rather than build a dam. Low flows below Narrows Dam will negatively impact streams. Low flows in the Price River will negatively impact Price and the surrounding area. Power generation at PacifiCorp will be impacted by reduced flows in the Price River, and the lost power will need to be replaced adding extra cost to users. Instream flows should be required below Narrows and Scofield Reservoirs.

***General Response –*** The recent drought is not reflected in the data. Averages are based on the 1960–2002 hydrologic period of record. The hydrologic analysis uses U.S. Geological Survey (USGS) stream gauge data, and a majority of the USGS stream gauge data was discontinued in 1989 and 2003. The additional effort to add 1 year (2003) of stream gauge data resulted in an insignificant improvement in the overall analysis.

Water conservation alone will not increase the volume of water that Sanpete County farmers need during late season irrigation.

The FEIS recognizes that flow reductions in Lower Gooseberry Creek and Fish Creek will negatively affect aquatic resources. These impacts are addressed to the extent possible through mitigation measures.

The Narrows Project will have minimal effects on the Price River. Historically, Carbon County has shut off the releases from Scofield Reservoir every year. The frequency or degree to which this will occur in the future is likely to continue.

Price River flows below Scofield Reservoir that could impact the municipal water supply for Helper and Price were analyzed, and there was no significant difference from the flow analysis outlined in the SDEIS.

Concern with replacement power and potential increased costs to rate payers is noted. Ensuring cost-effective and long-term water supplies to its customers is part of Reclamation's mission, and we understand the concern.

Minimum flows will be released from the proposed Narrows Reservoir, but no minimum flows have been established below Scofield Dam. Instream flows are a Utah water law issue and are beyond the scope of this FEIS.

## Water Rights

***Issue Summary –*** Twenty comments. The Narrows Project will infringe on Carbon County water rights. Sanpete County wants to take Carbon County water that has been in use for decades. Sanpete County is already diverting more than their share. Who will be responsible to measure flows diverted through the tunnel?

***General Response –*** The Proposed Action will impact only storage releases. Direct flow rights that have a senior priority date to the Narrows water rights will be unaffected by the project.

Concerns regarding SWCD's current use of its water rights are outside the scope of this FEIS and should be directed to the Utah State Engineer and the appointed River Commissioner. The State Engineer has jurisdiction over the amounts and legality of any transbasin diversions.

The development of the Narrows Project should have a limited impact on the already developed Carbon County water right holder. First, the 5,400-acre-foot annual depletion of the Narrows water rights represents only about 6.6 percent of the average annual yield of the Price River above the city of Price, and, secondly, because of the manner in which Scofield Reservoir is operated (i.e., it is shut off completely for flood control when the White River is running high and then opened as needed to meet the downstream agricultural demands).

All flow measurements will be monitored by the River Commissioner to ensure that the Narrows Project is operated in a manner consistent with its underlying water rights.

## Wetlands

***Issue Summary –*** Twenty-four comments. The Service and USACE need to approve the wetland mitigation plan. Wetland resource will be significantly impacted in the inundation area and below the Narrows Dam. Wetland mitigation

needs to be long term and provide the same kind of habitat that presently exists. Function and service provided by wetlands need to be fully mitigated.

***General Response –*** For mitigation purposes, SWCD will follow the approved USACE Mitigation Guidelines. SWCD will work with the USACE and the Service to find alternatives that will ensure a permanent hydrology source to help with the establishment and success of the hydrolytic vegetation and not impair the wetland function.

Impacts to wetlands have been fully identified in the study conducted in 2009 by Franson Civil Engineers on the "Effects of the Narrows Project on the Riparian Vegetation in Fish and Gooseberry Creeks." This information will be used in designing the final mitigation plan.

The SDEIS identifies the wetlands to be impacted and their functions and values. Wetland mitigation measures are included in the description of the project alternatives and are required. The wetland mitigation measures will provide similar wildlife habitat values lost due to the inundation of the reservoir and reduction of flows downstream.

## Wildlife

***Issue Summary –*** Thirteen comments. Construction of Narrows Dam and other project features will have negative impacts on wildlife. It is not clear how wildlife habitat will be mitigated to achieve current values for wildlife. A new consultation under the Fish and Wildlife Conservation Act should be initiated.

***General Response –*** All of the project features have been analyzed in the FEIS. Construction activity will have short-term negative impacts to wildlife habitat. These effects will occur during construction when wildlife will be displaced to other nearby similar habitats. Wildlife will continue to be affected until these areas are revegetated and restored, to the extent possible, to preproject conditions.

The proposed mitigation replaces a quantity of habitat units for an equal or larger quantity of habitat units lost. The method used to evaluate the effects is a Habitat Evaluation Procedure, which is a "species habitat" approach to impact assessment and habitat quality. The program uses selected species as indicators to evaluate habitat for a host of other species, assuming that these indicator (evaluation) species are functioning units of an ecosystem. Impacts to a particular indicator species presumes that there also will be impacts to the group of species it represents. Habitat Suitability Indices' (HSI) were ascertained for each evaluation (indicator) species. The project includes a comprehensive monitoring and maintenance program and a list of detailed mitigation commitments, designed to ensure that the actual functions of the lost aquatic and wildlife habitat values are replaced by mitigation measures.

The Fish and Wildlife Coordination Act Report, prepared in 1997, adequately addresses impacts of the proposal on fish and wildlife resources and proposes appropriate mitigation.

# 5. CHANGES MADE TO THE SDEIS

Changes made in finalizing the SDEIS are listed below. The number is the comment that generated the change to the document. For example, 1.01 is the first comment or question in letter number one.

## Cultural Resources

**5.62** A memorandum of understanding (MOA) would be developed only to resolve adverse effects to any historic properties found within the APE for the Proposed Action. The text in the SDEIS related to the criteria necessary to warrant the development of an MOA and the protocols to be included in a potential MOA was inconsistent. The text in the FEIS was updated to reflect the accurate purpose of a potential MOA or a programmatic agreement wherein inventory would be stipulated.

**51.20, 51.42** Reclamation clarified that a Federal undertaking has not been initiated; and, therefore, the 36 CFR 800 process is not yet required. Reclamation does not need to conduct an inventory as stated in this comment but rather, given the requirements of NEPA, to project the likely effects to historic properties and Indian sacred sites should the undertaking be initiated. A commitment to comply with 36 CFR 800 was included in a mitigation measure.

## Economics

**3.10, 21.05, 22.02, 51.13, 51.69** To the extent there is available information, economic effects are analyzed in section 3.17. Reclamation considered the economic impact of the project in the FEIS. All of the costs of the proposed project, ability to repay, cost/benefit data, and assessment of effects have been included in the loan application appended to the FEIS, which should sufficiently address these concerns.

**3.11, 65.09, 510.28** The criteria for approval of a loan under the Small Reclamation Projects Act of 1956 (SRPA) and approval for the use of the land have been clarified and added to chapter 1. This is one of the criteria for approval of the SRPA loan and is used to evaluate the potential for the SWCD to repay its obligation to the United States.

**5.48** There currently is not an estimated construction date. The costs of the project are disclosed in the loan application that the proponent submitted with the FEIS.

**21.04** The EIS team complied with 40 CFR 1502.22 and acknowledges that some information is unavailable.

**65.10** The rehabilitation of the tunnel has proceeded without the Narrows Project, so it will not be a factor in assessing the loan application and proposed use of Federal land.

**81.01, 620.12** The costs in the FEIS are indexed from previous estimates. Also, the loan application was updated by SWCD with more current costs and is appended to the FEIS.

**510.24** The $40.3 million in 2008 dollars would be approximately $40.7 million in 2010 dollars. The table is using the most updated numbers. The text has been updated to reflect this amount.

## Fisheries

**4.26** The EIS has been updated and now identifies blue ribbon fishery areas. Scofield Reservoir would be operated within the range of historic operations. Peak flows may be reduced in some years. Riparian and aquatic habitats and animals dependant on these habitats, including fish, would not be significantly affected by these changes.

**5.52** The Service responded to Reclamation during scoping in writing but did not request a new consultation. Reclamation considers that the Biological Opinion, prepared in 2000, adequately addresses impacts of the proposed project on threatened, endangered, and candidate species. The FEIS has considered other information regarding these species current listing, status, and ranges.

**5.58** A listing of fish populations found in the various creeks has been added to the FEIS in Section 3.10, “Fisheries.”

**10.17, 510.10** A position paper entitled “The Upper Colorado River Endangered Fish Recovery Program’s Position on the Role of the Price River in Recovery of Endangered Fish and the Need for Flow Management” was drafted during 2011. The results of the draft study included having the RIP describe flow conditions they believe are conducive to Colorado pikeminnow use of the lower Price River, to investigate opportunities to protect existing flows and to avoid dewatering the lower Price River. The report is being finalized at this time. Instream flow requirements are a function of Utah water law and beyond the scope of this FEIS.

## Geologic

**1.03** Section 3.6, “Geologic Resources,” of the FEIS has been edited to include all seismic events, including mining.

**419.01** It is possible to get leakage from a reservoir along a fault zone and into a coal deposit. A mitigation measure has been added to study this potential. A reservoir study that would require drilling to assess the likely seepage rate into the fault zones has been added to an appendix. Depending on the type of bedrock involved in the faulting, the zone could be either composed of crushed rock, which is quite permeable, or clayey gouge, which is not so permeable. The overlying material is also very important. If the faults are located in a sequence of sandstone, it would be possible for seepage along the fault and through the overlying material. If a layer of thick clay was found in the basin, it would effectively cap the faults and fissures in the reservoir basin and prevent seepages from the reservoir. Permeability testing in the overburden and in the fault zone would be evaluated to assess the seepage rates.

**686.03** State guidelines would be followed for the dam and reservoir site that reflects the current standard of care prescribed. Additional geologic field evaluation and assessment of the dam and reservoir site would be completed that address the proximal active faults associated with the site and further characterize the earth materials underlying the damsite, reservoir, and reservoir rim to evaluate engineering properties to ensure adequate design of features associated with the dam and reservoir. Designs would incorporate maximum accelerations associated with natural and/or manmade seismic events that are determined or probable to potentially occur in the area. Mitigation for other potential geologic hazards also would be integrated into design. An environmental commitment has been added to appendix F of the FEIS requiring this seismic study.

## Mitigation

**3.02, 3.09, 51.32** Mitigation measures will be implemented prior to storage and diversion of water as part of the Proposed Action. The FEIS has been edited to include details of adaptive management regarding identification and implementation of mitigation measures.

## NEPA Process

**4.11** Reclamation's purpose and need is described as considering approval of SWCD's SRPA loan application to build the Narrows Project and SWCD's request for authorization to use withdrawn lands to construct and operate the proposed dam and reservoir (section 1.4 of the FEIS). SWCD has stated its primary purpose of the project is to supply additional irrigation water to lands that are serviceable, and the secondary purpose is to deliver water for municipal and industrial (M&I) purposes. The projections for Sanpete County show that additional M&I water may be needed in the future; however, there is no current plan for such a conversion. Based on the U.S. Department of the Interior NEPA regulations, the lack of a definite plan or proposal for such a conversion means the M&I water conversion would not be reasonably foreseeable; therefore, analysis of such a conversion would be speculative. Based on this, SWCD has

determined that it could convert irrigation water over to M&I uses based on that need if it materializes. Existing water supplies for the area are not sufficient to cover the anticipated needs.

**5.06** All data in the EIS were reviewed by resource specialists and updated based on the comments received and as new data became available.

**5.70** The reservoir release scenario that mimics the natural flow regime does provide late season irrigation. Different operational or release strategies change the presumptions of SWCD's purpose and need, which is that the existing land users in Sanpete County need and want additional water in late season. In the absence of some form of storage, water available in the early season would not be available for late season use; only direct flows would be available for late season irrigation. Those flows currently are insufficient. There are no reservoirs in the project area to store early season water. Therefore, the early season water would not be available to offset late season shortages. Also, the reason for analyzing different sized reservoirs was to enable USACE to determine the LEDPA. New text was added to section 1.6, in response to this and other comments.

**51.02** The November 25, 2003, *Federal Register* Notice of Intent identifies what is being updated in the SDEIS. It states that the SDEIS will incorporate comments received on the DEIS in 1998 as well as new information received since that time. Reclamation has addressed and incorporated comments received on the 1998 DEIS and engaged in written and oral communication with the interested public, including its cooperating agencies, and other State and Federal regulatory agencies throughout the NEPA process.

**51.36** Section 1.8 has been updated to include all required permits anticipated for the project.

**51.57, 65.03** The Federal action is described in chapter 1. Reclamation examined different reservoir sizes to ensure a reasonable range of action alternatives were analyzed and to enable USACE to determine the LEDPA. The purpose and need section was clarified.

**658.02** The organization for chapter 3 was reordered; it is now physical, natural (by trophic level), cultural, and socioeconomic.

**686.02** Section 4.3 of the FEIS describes how previous comments were addressed and incorporated into the FEIS. After the 1995 Record of Decision was rescinded, a new DEIS was prepared, beginning in 1996, and was published in 1998. Comments were received on that DEIS (and public hearings were held to receive comments); those comments were analyzed and responded to, and the 1998 DEIS was revised based on input from those comments. Since a decision was made in 2003 to prepare this SDEIS in lieu of publishing a FEIS based on the 1998 DEIS, it should be noted that the SDEIS does capture revisions made earlier based on public comments and input.

**686.05** The purpose and need section has been clarified to explain that Reclamation's action is making a decision on the loan application and use of Federal land. In addition, Reclamation analyzed the size of the reservoir to ensure a reasonable range of alternatives and to enable USACE to determine the LEDPA. SWCD's proposal is to build a reservoir to store its water supply—this is not Reclamation's proposal. The aquifer recharge alternative was provided to SWCD and analyzed in the SDEIS. The USACE is a cooperating agency on this NEPA analysis, and they will be responsible for compliance related to the Clean Water Act and the 404 Permit.

## Proposed Action/Alternatives

**5.70, 65.11** Given that Reclamation is making a decision on approving the loan and use of Federal land, the range of alternatives to be analyzed in the FEIS is defined in part by the applicant's proposal. Chapter 1 has been updated to clarify that Reclamation examined a range of reservoir sizes to ensure that a reasonable range of alternatives was considered and to enable USACE to determine the LEDPA. Also, the reason for analyzing different sized reservoirs was added to Section 1.6, "Decisions To Be Made Based on this Analysis."

## Public Health and Safety

**1.02, 51.15, 51.72, 81.03, 620.13** The text has been edited in section 3.6. Should the dam be approved for construction, it would be built to appropriate Federal or State seismic standards (i.e., Federal Guidelines for Dam Safety, Federal Emergency Management Agency, 2005; and Requirements for the Design, Construction, and Abandonment of Dams, Utah Administrative Code Rule R655-11, respectively).

**67.04** Additional discussion of the gastrointestinal effects was added to the public health and safety section (3.19).

**51.30, 71.01 and 72.01** This discussion was added to Section 3.3, "Water Quality." Price River flows below Scofield Reservoir that would impact the municipal water supply for Helper and Price were analyzed, and there was no significant difference from the flow analysis outlined in the EIS. No further flow analysis is needed.

**419.17** Cobalt concentrations discussed for the project area were reported in the National Geochemical Database from the National Uranium Resource Evaluation Survey. Clarification has been added to the FEIS regarding cobalt concentrations.

**690.03, 690.04** The FEIS has been edited in section 3.3 to reflect the impacts increased phosphorus would have on other resources, including culinary water. Also, the use of municipal drinking water was addressed in Section 3.19, "Public Health and Safety."

## Recreation

**5.26** The Narrows FEIS has been updated to include the 2009 State Comprehensive Recreation Plan.

**8.04** There will be effects to the trout fishery, and there could be a negative effect on tourism related to the sport fishery. However, based on the updated Section 3.15, "Recreation and Visuals," in the FEIS, the losses to that industry should be offset by the increases due to the new boating and reservoir angling opportunities.

**510.04** The recreational impacts were recalculated, but there were no firm data to use for the fishing days on Upper Fish Creek, Lower Fish Creek, and the Price River below Scofield Reservoir.

**684.04** Recreational user days were recalculated. See section 3.15 of the FEIS.

## Threatened and Endangered Species

**3.15, 4.14, 51.68, 67.18** The analysis was updated and included in the text under Section 3.12, "Threatened and Endangered Species." Reclamation and the project applicant would cooperate in implementing the measures prescribed in the Spotted Frog Conservation Agreement and Strategy (Final, 1998).

**4.04** Mitigation measures have been appended to the FEIS to address this impact. As stated in Section 3.12, "Threatened and Endangered Species," of the FEIS,

> *"Prior to construction of the proposed project, greater sage-grouse habitat would be surveyed for any use by these birds. If active nests are found in the area, construction would be delayed until these birds have left their nests, probably in early June. A survey for golden eagle nest use would be conducted prior to construction. If active nests are found, construction activities within 0.5 miles of the nest would not be allowed from January 1–August 31."*

**5.05, 5.51, 51.67** The Service responded to Reclamation in writing during scoping but did not request additional consultation. Reclamation considers that the Biological Opinion, prepared in 2000, adequately addresses impacts of the proposed project on threatened, endangered, and candidate species. The FEIS has considered other information regarding these species current listing, status, and ranges.

**10.14, 51.22** Section 3.12 of the FEIS incorporates updated information and effects analysis for all Endangered Species Act listed or otherwise sensitive species within the project area.

**51.35** The Recovery Implementation Program's recommendations are incorporated into section 3.12 (Threatened and Endangered Species) of the FEIS.

## Visual Resources

**419.05** It is anticipated that the visual impact of exposed mud flat or shoreline would be negligible due to steeper topography and the duration and angle of view. The text of the visual resources section (3.15) was modified to indicate that the presence of the reservoir would alter the view.

## Water Quality

**3.02, 3.08, 10.08, 51.32, 65.25, 65.29** A water quality monitoring program is included as an environmental commitment and will be developed and implemented if the project is approved.

**3.09** Section 3.3 of the FEIS identifies an annual phosphorus load reduction target of 805 kilograms per year (kg/year). The load reduction was identified from the eutrophication study. Mitigation measures were proposed and evaluated by an interagency team of water quality specialists. Specific locations for mitigation will be identified by a water quality monitoring program. If identified improvements do not meet the required phosphorus load reduction target identified in the FEIS, then additional mitigation measures will be identified and implemented. Mitigation measures will be implemented prior to storage and diversion of water as part of the Proposed Action. The FEIS has been edited to include details of adaptive management regarding identification and implementation of mitigation measures.

**4.43** The description of cumulative effects on water quality in the FEIS has been edited accordingly.

**10.01** If the project is approved, all necessary requirements relating to discharge from the dam will be met to obtain certification from the Utah Department of Water Quality (UDWQ). The predicted water quality effects section of the FEIS (section 3.3.3) has been updated to address predicted water quality effects of discharges from the Narrows Dam.

**10.12** The EIS team agrees that the estimated evaporation for Narrows Reservoir is high. The team re-ran the reservoir operation studies with the reduced evaporation rates recommended by the UDWQ but found that the differences in project yield and in downstream flows were very minor. Using the higher evaporation rates produces slightly conservative results. Therefore, we chose to continue to use the operation studies and flow values described in the EIS.

**51.03** Total organic carbon data collected by UDWQ have been added to Section 3.3, "Water Quality."

**51.10** During the writing and editing of the EIS document, the most current available information regarding Scofield Reservoir's trophic state was from the *Utah 2006 Integrated Report Volume I – 305(b) Assessment*. At the writing of this response, the most current available information regarding the trophic state was from the *Part 2 Draft 2010 Utah Integrated Report Water Quality Assessment 305(b) Report*. The FEIS (section 3.6.3) has been updated to reflect the most current information.

**51.25** The water quality impacts identified during scoping were the potential for increased sedimentation during construction, increased phosphorus loading, and increased eutrophication in Scofield Reservoir. These impacts and proposed mitigation are discussed in section 3.3, and some of the discussion has been modified to address similar comments.

**51.27** The FEIS has been edited to reflect the impacts the project may have on the potable water supply in Scofield Reservoir. Implementation of proposed mitigation measures (see appendices) is expected to reduce phosphorus levels to preproject conditions, which also are expected to maintain algal growth at preproject conditions. Drinking water treatment costs would not be expected to be affected if water quality is maintained at preproject conditions. Additionally, Scofield Reservoir was enlarged to mitigate any potential adverse effects of the Proposed Action; therefore, any potential impacts already are mitigated in part by the reservoir enlargement.

**51.63** Drinking water concerns are addressed in the change to section 3.3 about Scofield Reservoir.

**51.73** The salinity control program related to the Narrows Project being a participating project in the Colorado River Storage Project was added to Section 3.3, "Water Quality."

**65.16** Surface water temperature data collected in July and August by UDWQ on Scofield Reservoir between 1981–2007 does not show differences in temperature between low storage and high storage years. Summer surface water temperatures are determined primarily by solar input and wind mixing. Surface water temperatures would be expected to be similar between the Proposed Action and the No Action Alternative. The Proposed Action will reduce the volume of the hypolimnion and metalimnion of Scofield Reservoir due to the reduced storage.

Reduction in volume in these zones will result in warmer temperatures through the entire water column during the summer. Discussion of these changes has been included in the FEIS.

**66.13, 65.29** The total phosphorus load to Scofield Reservoir will decrease as a result of the Proposed Action, but the in-lake phosphorus concentration will increase due to depletions. Due to the acknowledged increase in phosphorus concentration, which is considered an adverse impact, specific mitigation

measures are proposed to offset this impact. These measures are discussed in section 3.3 of the FEIS and will reduce phosphorus loading to Scofield Reservoir by 805 kg/yr. Water clarity may be affected by decreased storage in Scofield Reservoir. Additional discussion has been added to the FEIS discussing these potential effects. Scofield Reservoir was enlarged to mitigate any potential adverse effects of the Narrows Project; therefore, any potential impacts are already mitigated in part by the reservoir enlargement.

## Water Resources

**4.19, 5.07, 65.18, 66.17** The Water resource section (3.1) has been updated using available information. Averages are based on the 1960–2002 hydrologic period of record. The hydrologic analysis uses USGS stream gauge data, and a majority of the USGS stream gauge data was discontinued in 1989 and 2003. The additional effort to add 1 year of stream gauge data results in an insignificant improvement in the overall analysis.

**5.09, 5.14** Price River flows below Scofield Reservoir that would impact the municipal water supply for Helper and Price were analyzed, and there was no significant difference from the flow analysis outlined in the SDEIS. The EIS team searched for additional data, and most of those years were not available. Available data was added, and the FEIS was updated. The new data made no significant difference in the results. No further analysis is needed.

**5.33** The 1968 average year was determined by ranking water volume for each year from 1960–2002 and choosing the corresponding median volume of water. Modeling methodology is disclosed in a new appendix that describes the modeling in detail.

**5.80** Text has been added to section 2.2.2.2.3.10 to emphasize that the minimum pool is 2,500 acre-feet of water with a surface area of 144 acres.

**5.83, 51.71** Monthly averages are a reasonable way to display the modeling outputs. Modeling information is available in the project files at the Provo Area Office. Limitations of the models are disclosed in a new appendix that describes the modeling in detail.

**51.52** The operational studies have been updated, and the FEIS has been revised.

## Water Rights

**4.22** We updated section 3.1 to be more explanatory. The Proposed Action would impact only storage releases. Direct flow rights that have a senior priority date to the Narrows water rights would be unaffected by the project.

**22.05** A water rights section (section 3.2) was added. Section 3.3.3 of the FEIS evaluates the impacts of proposed alternatives to the water available to

downstream water rights in the Gooseberry Creek, Fish Creek, Cottonwood Creek, Price River, Green River, and San Pitch River systems.

**51.16, 689.02, 686.06** A section on water rights has been added to the FEIS. The Narrow's water rights have a 1941 priority date that makes them senior to the Flaming Gorge Reservoir, Central Utah Project, and many other water rights in the Colorado River Basin.

## Wetlands

**4.02** The reference to mountain riparian habitat was added to Section 3.13, "Vegetative Resources." The FEIS incorporates mitigation to fully compensate for adverse impacts to wetland resources.

**4.37** The status of willows in the creeks was added to the text.

**51.18** The wetland delineation history, section 3.14, was altered in response to this comment. Should SWCD proceed with its project, consultation and coordination with the USACE and the Utah Division of Water Quality would be required.

**67.07** Wetland effects were updated in the FEIS (see section 3.14).

## Wildlife

**3.15, 4.14** The analysis was updated and included in the text under section 3.12. Reclamation and the project applicant would cooperate in implementing the measures prescribed in the Spotted Frog Conservation Agreement and Strategy (Final, 1998).

**4.01, 4.04, 409, 4.13, 51.23** The FEIS has been revised in section 3.12 to include the greater sage grouse. Sage grouse habitat lost due to the proposed project would be replaced by habitat improvements to other areas.

**4.03** Section 3.11, "Wildlife," of the FEIS has been revised to include effects to migratory birds. Mitigation measures for these effects have been specified in the FEIS.

**4.06** Raptor protection measures have been incorporated into appendix G of the FEIS.

**4.12** A discussion has been added to Section 3.11, "Wildlife," covering the possible use of the project area by eagles; and appropriate mitigation measures have been included in an appendix.

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX I

# NARROWS ENVIRONMENTAL IMPACT STATEMENT MODELING METHODOLOGY

# Appendix I

# Narrows Project
# Final Environmental Impact Statement
# Narrows Environmental Impact Statement
# Modeling Methodology

HANSEN ALLEN & LUCE inc
ENGINEERS

## Technical Memorandum



DATE: November 20, 2011

TO: Files

FROM: Richard M. Noble, P.E.

PROJECT NO.: 2011 Narrows Project Final Environmental Impact Statement
Hydrology and Water Resources Technical Memorandum

REGISTERED PROFESSIONAL ENGINEER
No. 168241
RICHARD M. NOBLE
11-20-11
STATE OF UTAH

This Hydrology and Water Resources Technical Memorandum provides a summary description of the methodology used in Narrows Project operation studies. The operation studies include operational analysis of Narrows Reservoir, Narrows Tunnel, Gooseberry Creek, Fish Creek, Scofield Reservoir, and the Price River under historical, No Action Alternative, and the various Narrows Project alternative conditions. The purposes of this analysis are as follows:

1. Verify water supply for the Narrows Project
2. Identify historical and future without project stream flows and reservoir contents which serve as a baseline for environmental impact analysis
3. Identify stream flows and reservoir contents with project alternatives in place
4. Identify changes in stream flow and reservoir contents for use in identifying environmental impacts

Historical Records

The operation studies are based on monthly historical records for the 1960 through 2002 time period. This period of record is assumed to be representative of potential future conditions, as it contains a wide range of dry and wet years and multiple periods of consecutive dry and wet years. Historical records are available for 12 USGS gaging stations within the project area of influence. The locations of these gaging stations are shown on Figure 1 and the ranges of available data are summarized in Table 1.

In many cases, the available USGS data is incomplete for the period of study. In those instances missing data were provided from Reclamation and River Commissioner records (Table 2) or estimated by correlating with other gaging stations (Table 3).

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Operation Studies

Impacts to water resources were determined by using seven distinct and detailed operation studies, which simulate stream flows and reservoir operations under historical, future without project, and project conditions. As mentioned previously, these studies are based on the 1960-2002 hydrologic period of record and utilize USGS stream gage data. A majority of the USGS stream gage data was discontinued in 1989 and 2003. Because analyses had been completed for the 1960 – 2002 period, the additional effort to add one year of stream gage data results in an insignificant improvement in the overall analysis.

These operation studies are Microsoft Excel spreadsheets that were developed specifically for the Narrows Project. The spreadsheets are accounting-type models that track changes in reservoir inflow, outflow, and change in storage at reservoirs, and changes in flow at key stream locations based on water demands on the Price River and transmountain diversions to the San Pitch River basin. The analysis is not an "operations model" that can be used to forecast potential future conditions or be used as a tool in operations decision making. The seven operation studies are briefly described as follows:

- **Scofield Reservoir Historical Operation Study** – The Scofield Reservoir historical operation study was performed to simulate the historical operation of Scofield Reservoir and to calculate ungaged inflow and outflow data. The study is based on historical data on Fish Creek immediately upstream from the reservoir, the reservoir contents, and the reservoir outflow. Calculated data include: total inflow minus evaporation, evaporation, total inflow, and other inflow (inflow other than from Fish Creek).

- **Scofield Reservoir Demand Study** – The Scofield Reservoir demand study was performed to segregate the outflow from Scofield Reservoir to separate the releases for downstream demands from spills and operational releases (releases made in anticipation of a large spill). The releases for downstream demands are then used as demands on Scofield Reservoir for the Future Without Narrows Project Operation Study and the Future With Narrows Project Operation Study. In performing this study the historical releases from Scofield Reservoir, as well as all other intervening tributary inflows, were compared against the maximum diversion capacity at each point of diversion. The maximum diversion capacity was assumed to be the largest diversion recorded in 1983 and 1984. It was assumed that surplus water was available in these years and the canals were at their capacity. For diversions that did not have data for 1983 or 1984, the maximum water right was used as the diversion capacity.

  When reservoir outflow added to the intervening inflows was less than or equal to the diversion capacity, the total reservoir outflow was assumed to be a legitimate release for downstream demand. When reservoir outflow added to the intervening inflows was greater than the diversion capacity, the excess reservoir outflow was assumed to be a spill or operational release.

  This analysis ignores the State Engineer's irrigation duty in the Price area. The study could underestimate spills and operational releases in years when diversions exceeded the irrigation duty. However, this approach was assumed to be conservative and represents the worst case scenario for determining impacts of the Narrows Project.

HANSEN ALLEN & LUCE inc ENGINEERS

# Technical Memorandum



- **Future without Project Operation Study** – This study shows the flows of Gooseberry and Fish Creeks and the Price River below Scofield Dam and the operation of Scofield Reservoir under the future without Narrows Project conditions. These conditions are the same as the No Action Alternative. The study also calculates reach gains between Gooseberry Creek Near Fairview, Utah (09309800) and Gooseberry Creek Near Scofield Utah (09310000) and between Gooseberry Creek Near Scofield Utah (09310000) and Fish Creek Above Reservoir Near Scofield, Utah (09310500).

  Historical inflows, evaporation (calclulated based on previous end-of-month reservoir surface area), and demands identified in the Scofield Reservoir Dam and Study are used to operate Scofield Reservoir. Releases are made to satisfy all demands unless there is insufficient inflow and active storage available. Additionally, controlled releases from storage are limited to the 30,000-acre-foot water right, which does not include bypasses for direct flow rights. Spills occur when the previous end-of-month active contents plus the inflow minus the controlled releases exceeds the reservoir active capacity.

  The study is based on the existing Scofield Reservoir capacity allocation which includes a minimum or inactive pool of 7,800 acre-feet and an active storage capacity of 65,700 acre-feet for a total reservoir capacity of 73,500 acre-feet.

  Stream flows and reservoir contents under the Future Without Project operation are generally the same as those that occurred historically. The primary exception is that the active storage content of Scofield Reservoir is limited to 65,700 acre-feet to ensure that the reservoir is operated in accordance with existing water rights and operating agreements.

- **Future with Narrows Project Operation Study** – This study shows the flows of Gooseberry and Fish Creeks and the Price River below Scofield Dam and the operation of Narrows Reservoir and Scofield Reservoir under the Proposed Action. Transmountain releases to Cottonwood Creek through tne Narrows Tunnel also are modeled.

  The study relies on information in the Future without Project Operation Study, the Scofield Reservoir Historical Operation Study, and the Scofield Reservoir Demand Study.

  Inflows, evaporation (calclulated based on previous end-of-month reservoir surface area), and a 5,400 acre-feet per year demand for transmountain releases through Narrows Tunnel are used to operate Narrows Reservoir. Releases through the Narrows Tunnel are made to satisfy demands in the Narrows Project area unless there is insufficient inflow and active storage available. A 1 cfs minimum stream flow release to Gooseberry Creek below Narrows Dam is always maintained. An additional 300-acre-feet release to Gooseberry Creek for channel maintenance flows is also made in May of each year. Spills occur when the previous end-of-month active contents plus the inflow minus the controlled releases exceeds the reservoir active capacity.

  The study is based on the Narrows Reservoir capacity allocation described in the 1984 Compromise Agreement which includes a minimum or inactive pool of 2,500 acre-feet, an active water supply storage capacity of 10,000 acre-feet, and an active capacity of 4,500 acre-feet to be used exclusively for minimum stream flow in Gooseberry Creek for a total reservoir capacity of 17,000 acre-feet.

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Stream flow at Gooseberry Creek Near Scofield, Utah (09310000) is calculated by adding the stream flow below Narrows Dam to the reach gains calculated in the Future Without Project Operation Study. Stream flow at Fish Creek Above Reservoir Near Scofield, Utah (09310500) is calculated by using the previously calculated stream flow at Gooseberry Creek Near Scofield, Utah and adding the reach gains calculated in the Future Without Project Operation Study.

Modified Fish Creek inflows, evaporation (calclulated based on previous end-of-month reservoir surface area), and demands identified in the Scofield Reservoir Demand Study are used to operate Scofield Reservoir. Releases are made to satisfy all demands unless there is insufficient inflow and active storage available, in which case shortages are calculated. However, controlled releases from storage are limited to the 30,000-acre-foot water right, which does not include bypasses for direct flow rights. Spills occur when the previous end-of-month active contents plus the inflow minus the controlled releases exceeds the reservoir active capacity.

The study is based on the existing Scofield Reservoir capacity allocation which includes a minimum or inactive pool of 7,800 acre-feet and an active storage capacity of 65,700 acre-feet for a total reservoir capacity of 73,500 acre-feet.

Stream flows belows Scofield Dam and Scofield Reservoir contents under the Future With Narrows Project operation vary from the Future Without Project due to decreased reservoir spills and when shortages occur to Scofield Reservoir demands.

- **Mid-Sized Reservoir Alternative Operation Study** – This study is similar to the Future with Narrows Project Operation Study, except that it is based on the Mid-Sized Reservoir Alternative instead of the Proposed Action. With this alternative the Narrows Reservoir has an inactive capacity of 2,500 acre-feet, a water supply pool of 9,950 acre-feet, and no minimum streamflow pool. The 1 cfs minimum stream flow release to Gooseberry Creek and the additional 300 acre-feet supplemental release in May for channel maintenance are provided by this alternative.

- **Small Reservoir Alternative Operation Study** – This study is similar to the Future with Narrows Project Operation Study, except that it is based on the Small Reservoir Alternative instead of the Proposed Action. With this alternative the Narrows Reservoir has an inactive pool of 2,500 acre-feet, a water supply pool of 5,400 acre-feet and no minimum streamflow pool. The 300 acre-foot per year supplemental release to Gooseberry Creek for channel maintenance is not provided by this alternative. Only the 1 cfs minimum release is made.

- **Small Scofield Study** – The Small Scofield Reservoir operation study is intended to show the water supply available to Carbon County and the monthly Scofield Reservoir contents that would have occurred if Scofield Reservoir had not been enlarged to accommodate the Narrows Project. The study uses historical inflows to Scofield Reservoir and water release demands identified in the Scofield Reservoir demand study. Scofield Reservoir capacity is limited to 30,000 acre-feet active capacity and no inactive capacity.

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# Technical Memorandum



Price River at Woodside Analysis

An evaluation of flows for the Price River at Woodside, Utah (09314500) was not included in the operation studies described above. Instead, differences in flows between the Future without Project and the Future with Narrows Project were evaluated separately based on results from the Future without Project and Future with Narrows Project operation studies.

The first attempt was to start the analysis at Scofield Reservoir and move down the river, factoring in diversions, return flows, and reach gains. However, due to limited streamflow data and diversion records, the correlation on Price River near Heiner was inadequate. And this method was not successful. Instead, the approach described below was used.

Under the Future With Narrows Project there are several months when shortages to Carbon County water users occur due to Scofield Reservoir having water available in storage. In these months, the change in outflow was not directly subtracted from the flow at Woodside because if the water had been available, it would have been diverted by Carbon County water users. In those months, the following assumptions were used to adjust the flow of the Price River at Woodside:

- the irrigation efficiency is 50%,
- the diversion consumption by phreatophytes is 10%
- the return flow to the river is 40%, with 20% returning in the first month, and 20% in the second month.

It was also proposed that during the high runoff months, the change in flows at Woodside be calculated by subtracting the change in spills at Scofield Reservoir from the historical flow of the Price River at Woodside. However, a concern was expressed that a change in spills might also cause a change in diversion. If a change in diversions occurred, then other factors such as consumptive use and return flows would need to be considered in determining the flows at Woodside. This study was performed to determine if project changes in Scofield Reservoir spills could cause a change in diversions.

To determine this, the Future Without Project flows and spills below Scofield Dam were used because they are the baseline conditions for the environmental impact analysis. The diversions and tributary inflows between the reservoir and the gage at Heiner were taken into account to determine the estimated flow of Price River at Heiner. The total capacity of the canals below Heiner (Canals 14-21) was compared against the estimated Price River flow without the diversions. This study shows that in most cases, there is not enough flow in the river to fill the canals to capacity. When there is enough flow, the No Action spills were examined. In all cases except for May 1971, the spills were less than the difference between the Price River flow below Wildcat Canyon and the canals' capacity. Therefore, the reduced spills under the Future with Narrows Project will not change the canal diversions. Changes in flow during high runoff months were calculated directly subtracting the reduction in spills under the Future With Narrows Project from the Future Without Narrows Project flow at Woodside.

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Flow comparisons for Dry, Wet, and Average Years

For convenience of the reader in evaluating project effects on stream flows and other flow-dependent resources such as fisheries, comparisons are presented in the EIS at various locations for dry, wet and average years. The rationale behind this methodology is that this comparison not only provides a comparison under average conditions, but also under the dry and wet extreme conditions.

In selecting which years represent the dry and wet extremes and "average" or typical year, the annual flows of Gooseberry Creek Near Scofield, Utah (09310000) were examined for water years 1960 – 1989. This was the period of record used in the 1993 Draft EIS. During this period 1977 had the lowest annual flow and 1984 had the highest flow. The average annual flow was 13,970 acre-feet. The years closest to this numeric average were 1967 and 1968 with 13,948 acre-feet and 14,176 acre-feet, respectively. Because 1967 had incomplete data (there was no recorded flow for Fairview Ditch or Tunnel) 1968 was selected to represent "typical" or "average" conditions for evaluating project effects on stream flows.

When the period of record was updated for the Final EIS to water years 1960 – 2002, 1977 and 1984 were still the driest and wettest years for this extended period. The average annual flow for this period decreased slightly to 13,574 acre-feet. However, 1968 with an annual flow of 14,176 acre-feet was within 5 percent of the average for this extended period and 1968 was therefore considered to be representative of "average" conditions.

HANSEN ALLEN & LUCE INC ENGINEERS

# Technical Memorandum



**Table 1. Summary of USGS Data Used in Narrows Project Operation Studies**

| USGS Station ID | Station Name | Range of Data Available for Water Years 1960 - 2002 |
|---|---|---|
| 09309500 | Fairview Ditch Near Fairview, Utah | October 1959 – September 1965 |
| 09309600 | Fairview Tunnel Near Fairview, Utah | October 1967 – September 2002 |
| 09309800 | Gooseberry Creek Near Fairview, Utah | October 1959 – September 1963, October 1964 – June 1969 |
| 09310000 | Gooseberry Creek Near Scofield, Utah | October 1959 – September 2002 |
| 09310500 | Fish Creek Above Reservoir Near Scofield, Utah | October 1959 – September 2002 |
| 09311000 | Scofield Reservoir Near Scofield, Utah | October 1965 – September 1970, October 1990 – September 1993 |
| 09311500 | Price River Near Scofield, Utah | October 1959 – July 1969, October 1979 – September 1980 |
| 09312600 | White River Below Tabbyune Creek Near Soldier Summit, Utah | October 1967 – September 2002 |
| 09312700 | Beaver Creek Near Soldier Summit, Utah | October 1960 – September 1989 |
| 09312800 | Willow Creek Near Castle Gate, Utah | October 1962 – September 1989 |
| 09313000 | Price River Near Heiner, Utah | October 1959 – September 1969, October 1979 – September 1981, October 1990 – September 2002 |
| 09314500 | Price River At Woodside, Utah | October 1959 – September 1992, August 2000 – September 2002 |

**Table 2. Summary of Reclamation and River Commissioner Data Used in Narrows Project Operation Studies**

| USGS Station ID | Station Name | Range of Data Used for Water Years 1960 - 2002 |
|---|---|---|
| 09311000 | Scofield Reservoir Near Scofield, Utah | October 1959 – September 1965, October 1970 – September 1990, October 1993 – September 2002 |
| 09311500 | Price River Near Scofield, Utah | August 1969 – September 1979, October 1980 – September 2002 |

**Table 3. Summary Estimated Data Used in Narrows Project Operation Studies**

| USGS Station ID | Station Name | Method of Estimating Missing Data |
|---|---|---|
| 09309500 | Fairview Ditch Near Fairview, Utah | Estimated |
| 09309800 | Gooseberry Creek Near Fairview, Utah | Estimated by correlation with Gooseberry Creek Near Scofield, Utah (09310000) using linear regression |
| 09312600 | White River Below Tabbyune Creek Near Soldier Summit, Utah | Estimated by correlation with Price River Near Heiner, Utah (09313000) using linear regression |
| 09312700 | Beaver Creek Near Soldier Summit, Utah | Estimated by correlation with Price River Near Heiner, Utah (09313000) using linear regression |
| 09312800 | Willow Creek Near Castle Gate, Utah | Estimated by correlation with Price River Near Heiner, Utah (09313000) using linear regression |
| 09314500 | Price River At Woodside, Utah | None - no accurate method of estimating flows |

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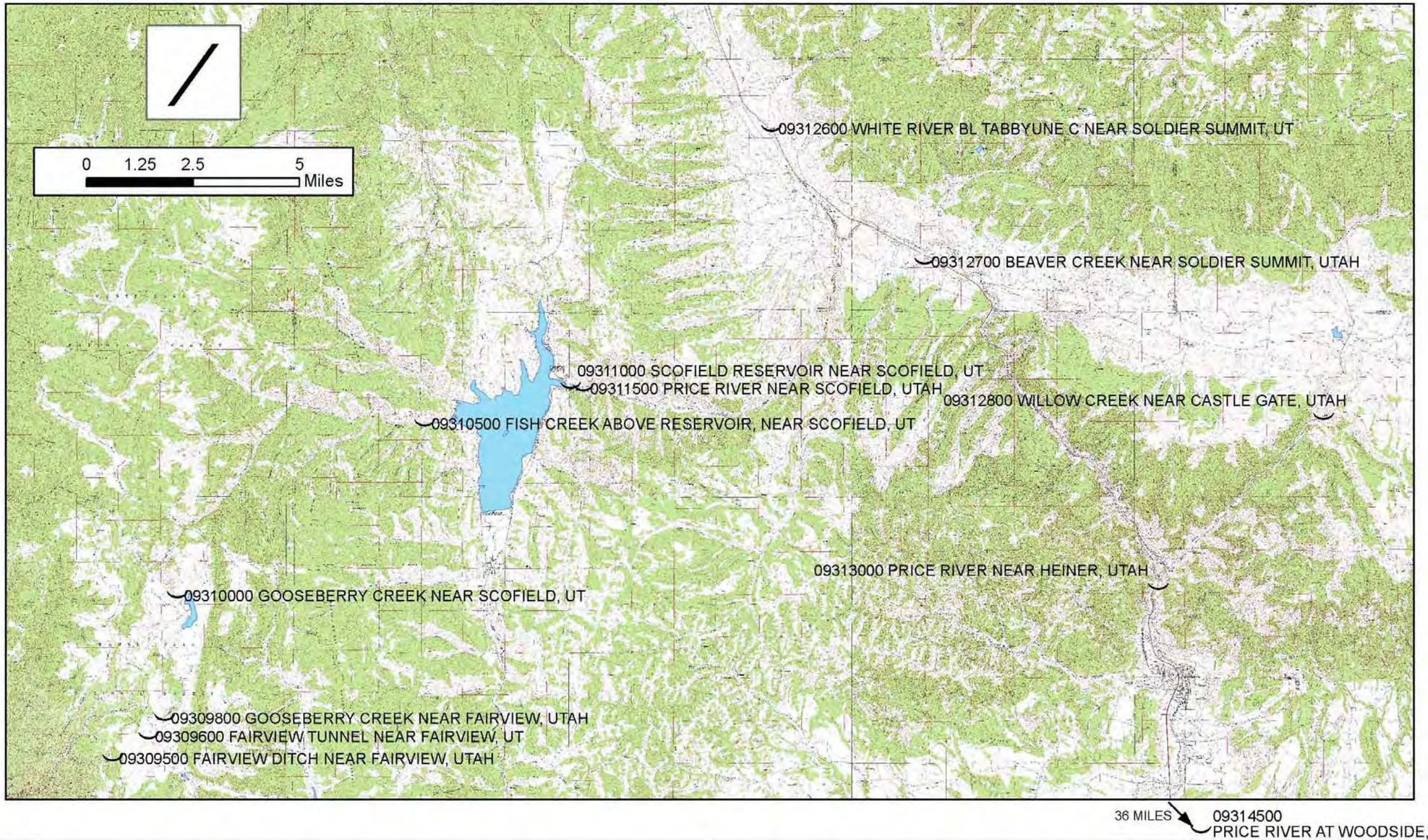



| | | | |
|---|---|---|---|
| HANSEN ALLEN & LUCE INC ENGINEERS | SANPETE WATER CONSERVANCY DISTRICT<br>NARROWS PROJECT | STREAM GAGES USED FOR PROJECT OPERATION STUDIES<br>LOCATION MAP | FIGURE<br>1 |

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX J

# SMALL RECLAMATION PROJECTS ACT
# LOAN APPLICATION

Sanpete Water Conservancy District

# NARROWS PROJECT

## Loan Application Report

Submitted to the United States Department of the Interior, Bureau of Reclamation, Under the Guidelines of the Small Reclamation Projects Act, PL 84-984

**March 2012**

# SANPETE WATER CONSERVANCY DISTRICT

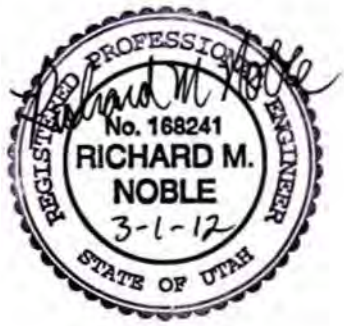
# NARROWS PROJECT

# LOAN APPLICATION REPORT

## (HAL Project No.: 321.01.100)

**Submitted to:**

**U.S. Bureau of Reclamation**
**Under the Guidelines of the**
**Small Reclamation Projects Act, PL 84-984**

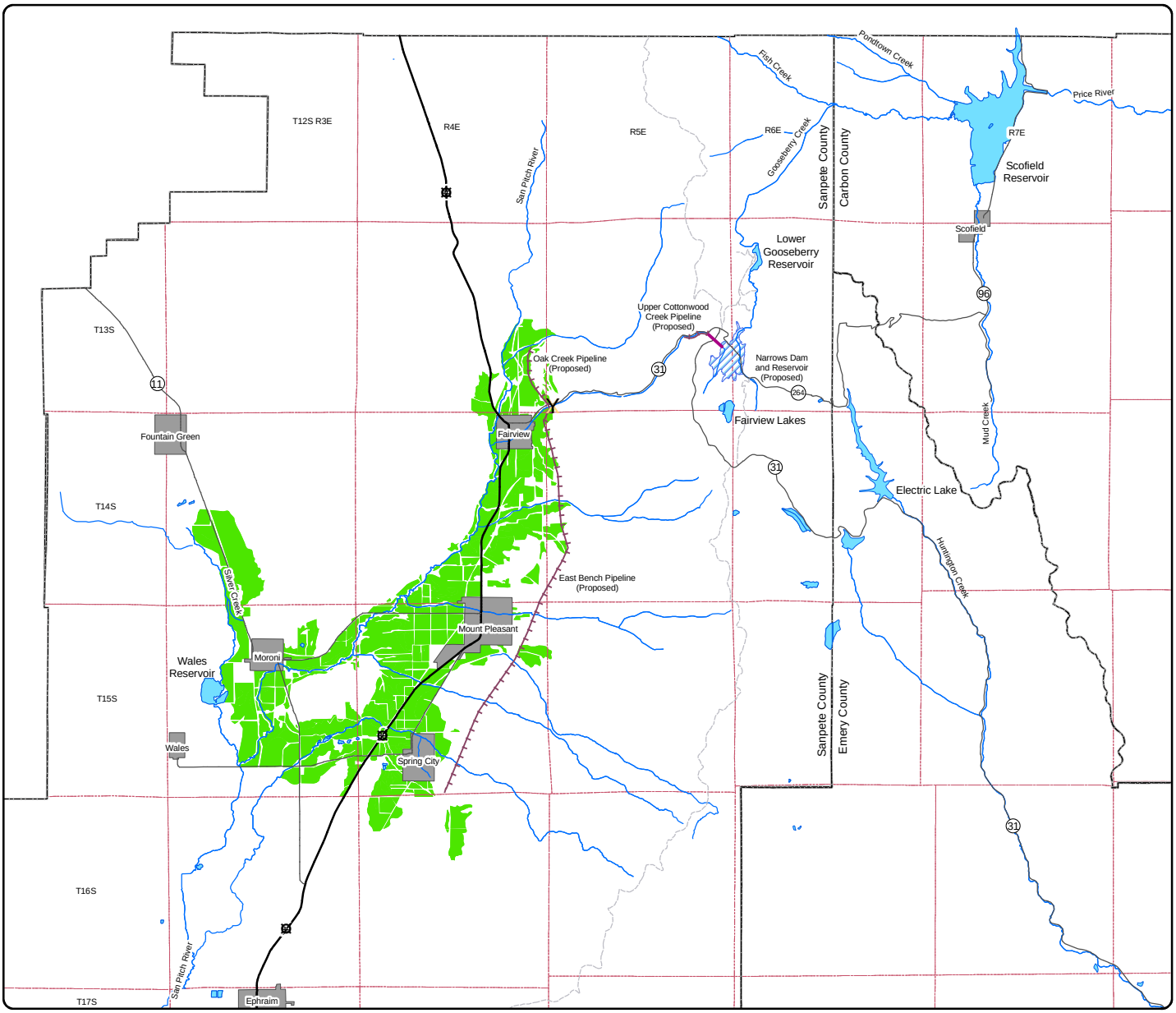



**Richard M. Noble, P.E.**

**Project Manager**

HANSEN ALLEN & LUCE inc
ENGINEERS

**March 2012**




# Legend

- Municipalities
- Lakes and Reservoirs
- Proposed Reservoir
- Lands to Receive Project Water
- County Boundaries
- Township and Range
- East Bench Diversion Dam
- Proposed Pipeline
- Unimproved Roads
- State Route
- U.S. Highway
- Narrows Tunnel

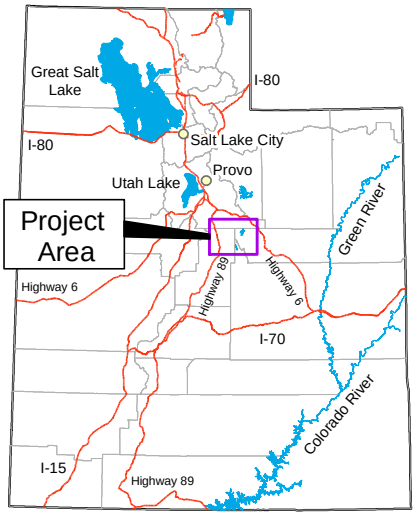
3

0 1 2 3 4 5 Miles

# Narrows Project

## GENERAL MAP

Sanpete Water Conservancy District



# PREFACING MATERIAL

Sanpete Water
Conservancy District

Sanpete Water Conservancy District

90 West Union Street

Manti, Utah 84642

435/835-5671

435/835-5678 fax

March 1, 2011

Mr. Larry Walkoviak
Regional Director
U.S. Bureau of Reclamation
125 South State, Room 6107
Salt Lake City, Utah 84138-1102

Dear Mr. Walkoviak:

Enclosed is the updated Small Reclamation Loan Application Report for the Narrows Project. The document was prepared for Sanpete Water Conservancy District and is submitted under the guidelines of the Small Reclamation Projects Act, PL 84-984.

The Sanpete Water Conservancy District is seeking $21,792,000 in loans and $3,692,000 in grants from the United States under the provisions of P.L. 84-984 as amended. The District proposes to build a multiple purpose water development project that would provide water for irrigation and municipal use. In addition to providing a water supply, the project would include recreation opportunities and measures to improve fish and wildlife habitat. Water from the project would come from a transmountain diversion from upper Gooseberry Creek and its tributaries which are located in the Price River drainage. The water would be used in north Sanpete County.

Please let me know if you have any questions regarding this document.

Sincerely yours,

Edwin B. Sunderland
Chairman

Enclosure

**RESOLUTION - LOAN**

RESOLUTION APPROVING APPLICATION REPORT AND AUTHORIZING THE FILING OF APPLICATION FOR LOAN AND GRANT UNDER PUBLIC LAW 84-984, AS AMENDED

WHEREAS, the SANPETE WATER CONSERVANCY DISTRICT desires to secure a Federal loan and grant under the Small Reclamation Projects Act. P.L. 84-984, as amended, and has authorized its consulting engineers, HANSEN, ALLEN & LUCE, INC., to prepare a feasibility report in support of an application for said loan and grant to finance construction of a dam and reservoir, pipelines to convey project water to areas of use, rehabilitation of the existing Narrows Tunnel, relocation of State Road-264, and construction of recreation facilities; and

WHEREAS, said consulting engineers have prepared a supporting Loan Application Report, as required under the Small Reclamation Projects Act, entitled "Narrows Project, Small Reclamation Loan Application Report," dated March 2012; and

WHEREAS, the Board of Trustees of the SANPETE WATER CONSERVANCY DISTRICT concurs in and approves said application report which proposes a project having a total estimated cost of $37,401,000 of which $21,792,000 would be obtained by a loan from the United States under provisions of P.L. 84-984 as amended, to be repaid within a 30-year period; $3,692,000 in grants from the United States; a $3,692,000 contribution from the State of Utah; a $4,300,000 loan from the Utah Division of Water Resources to be repaid within a 30-year period; and $3,925,000 expended to date by the Recipient.

NOW, THEREFORE, BE IT RESOLVED by the Board of Trustees of the SANPETE WATER CONSERVANCY DISTRICT that the Chairman be and is hereby authorized and directed to make application to the U.S. Department of the Interior, Bureau of Reclamation, for said loan, and that he and the engineering consultants are further authorized and directed to perform any other acts necessary in connection with the filing of such application.

BE IT FURTHER RESOLVED that a copy of this resolution be transmitted to the U.S. Department of the Interior, Bureau of Reclamation, with the application report.

PASSED, ADOPTED AND APPROVED by the Board of Trustees of the SANPETE WATER CONSERVANCY DISTRICT at a special meeting of said Board held on March 1, 2012, by the following roll call vote:

**AYES:** Trustees Chad Olson, Ken Bench, Dave Cox, and Edwin Sunderland, Joe Frischknecht

**NOES:** Trustees_____

**ABSENT:** Richard Dyreng, Kenneth Palmer

**(Chairman of the Board of Trustees)**

* * * * * * * * *

**ATTEST:**

**I HEREBY CERTIFY THAT** I am the Secretary of **SANPETE WATER CONSERVANCY DISTRICT** and that the foregoing resolution was duly adopted by the Board of Trustees of said District at a special meeting thereof duly held at Manti, Utah, on March 1, 2012, at which meeting a quorum of said Board of Trustees was at all times present and acting.

**SANPETE WATER CONSERVANCY DISTRICT**

**Secretary**

State of Utah
DEPARTMENT OF NATURAL RESOURCES

Michael O. Leavitt
Governor
Ted Stewart
Executive Director

1636 West North Temple, Suite 316
Salt Lake City, Utah 84116-3193
801-538-7200
801-538-7315 (Fax)

February 14, 1994

Mr. David L. Peterson, President
Sanpete Water Conservancy District
1484 S. 70 W.
Mt. Pleasant, UT 84647

Dear Mr. Peterson:

Re: Narrows Project, Sanpete County

To comply with the Bureau of Reclamation's Small Reclamation Project Act, I am responding for the Governor concerning the state's views on the Narrows Project, its financial feasibility, and the validity and accuracy of the water rights claimed by your district.

The Division of Water Resources is finalizing a financial and technical feasibility report on the Narrows Project for which you seek funding from the Utah Board of Water Resources; it will be presented at a future meeting. Much of the information of the Division's report will come from your loan application report to the Bureau of Reclamation. You must attend that meeting, and the public will be welcome to attend and comment on the final report.

Based on my conversations with you and members of the staff of Water Resources, it appears the Narrows Project is financially feasible as it is proposed in the loan application report to the Bureau. The project demands a considerable commitment by members of the district to pay for the water, but a sacrifice of developing the water today will provide a significant advantage to future water users.

The water rights for your project have been properly filed in accordance with Utah State Law. They have been amended by a Compromise Settlement Agreement of June 28, 1984, and are sufficient for the project you are proposing.

Concurrent with your loan application to the Bureau of Reclamation, the Division and Board will move ahead with your application to the state. Additional state comments and reviews will come during the Division's preparation of its final report and its work with both your district and engineer.

I am pleased to know your project is moving ahead and wish you much success as you move toward realization of this worthwhile undertaking.

Sincerely,

Ted Stewart

Ted Stewart
Executive Director

U.S. Department of the Interior
Bureau of Reclamation

ASSURANCE OF COMPLIANCE
WITH CIVIL RIGHTS LAWS AND REGULATIONS

Sanpete Water Conservancy District (hereinafter called "Recipient")

HEREBY AGREES THAT IT will comply with Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d), section 504 of the Rehabilitation Act of 1975 (P.L. 93-112, as amended, the Age Discrimination Act of 1975 (42 U.S.C. 6101, et seq) and any other applicable civil rights laws, as well as with their respective implementing regulations and guidelines imposed by the U.S. Department of the Interior and/or Bureau of Reclamation.

These statutes require that no person in the United States shall, on the grounds of race, color, national origin, handicap, or age, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving financial assistance from the Bureau of Reclamation. The recipient HEREBY GIVES ASSURANCE THAT IT will immediately take any measures necessary to implement this assurance, including permitting officials to inspect premises, programs, and documents.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property discounts or other Federal financial assistance extended after the date hereof to the Recipient by the Bureau of Reclamation, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall reserve the right to seek judicial enforcement of this assurance. This assurance is binding on the Recipient, its successors, transferees, an assigns. The person or persons whose signature appears below are authorized to sign this assurance on behalf of the Recipient.

1/3/12
Date

Chairman of the Board of Trustees

SANPETE WATER CONSERVANCY DISTRICT
90 W. Union
Manti, Utah 84642

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Sanpete Water Conservancy District

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# PROJECT SUMMARY

Sanpete Water Conservancy District

**PROJECT SUMMARY**

**NARROWS PROJECT**

**LOAN APPLICATION REPORT**

**SANPETE WATER CONSERVANCY DISTRICT**

## LOCATION

The Sanpete Water Conservancy District is located in the northern portion of Sanpete County in central Utah (see Frontispiece Map). The project area includes lands surrounding the small rural communities of Fairview on the north, Mount Pleasant and Spring City on the south, and Moroni to the west.

## ORGANIZATION

The Sanpete Water Conservancy District was established January 1, 1964, under the laws of the State of Utah. It has authority to execute a contract with the United States for repayment of the loan; power of eminent domain, and the authority to levy such taxes as necessary for repayment of the loan. The District's assets and liabilities as of December 2010 are shown below:

### Assets

| | |
|---|---|
| Current Assets: | |
| Cash and Investments | $359,332 |
| Accounts Receivable | 15,300 |
| Taxes Receivable | 972,514 |
| Total Current Assets | 1,347,146 |
| Noncurrent Assets: | |
| Capital Assets (Net of Accumulated Depreciation): | |
| Water Metering System | 21,297 |
| Construction in Progress | 3,924,739 |
| Total Noncurrent Assets | 3,946,036 |
| TOTAL ASSETS | $5,293,182 |

**Liabilities and Net Assets**

| | |
|---|---|
| Current Liabilities: | |
| Accounts Payable | 61,713 |
| Noncurrent Liabilities: | |
| Note Payable – Due More Than One Year | 49,566 |
| TOTAL LIABILITIES | 111,279 |
| Net Assets | |
| Invested In Capital Assets, Net of Related Debt | 3,896,470 |
| Restricted for Capital Projects | 1,198,958 |
| Unrestricted | 86,475 |
| TOTAL NET ASSETS | 5,181,903 |
| TOTAL LIABILITIES AND NET ASSETS | 5,293,182 |

**PROPOSAL**

| **PROPOSAL** | | |
|---|---|---|
| Total Project Cost | | $ 37,401,000 |
| Federal Loan (30-year repayment) | | 21,792,000 |
| Federal Grant | | 3,692,000 |
| Local Contribution | | 11,917,000 |
| Engineering investigations, water rights, legal fees, acquisition of rights-of-way, loan application report and EIS | $3,925,000 | |
| State Loan | 4,300,000 | |
| State Grant | 3,692,000 | |

## PLAN

### Purpose and Need

The primary purpose of the Narrows Project is to enable Sanpete Water Conservancy District (SWCD to develop an irrigation and M&I supply source for users in north Sanpete County, Utah, whereby the average annual shortages to irrigators in the project area might be reduced as nearly as possible to 5 percent (%), which is considered full irrigation supply for Reclamation projects. Specifically, the following are water related needs addressed by the proposed project:

- Demand for municipal water for present and future use exceeds the currently available supply. The proposed Narrows Project would develop, through exchange, an additional supply of municipal water to offset current shortages and accommodate anticipated population growth in the project area.
- The current water supply for agricultural irrigation does not provide adequate supply and storage at the times when it is needed—typically in July, August, and September of each year. The proposed Narrows Project would provide late season irrigation water to offset at least some of the current shortages.

In addition to the primary purpose of supplying water to Sanpete County, the project would have the additional benefit of providing improved and additional recreation and fishery opportunities in Sanpete County.

### History of the Project

The Narrows Project, as defined in this document, is a non-Federal project that fulfills the intent of the larger Federal Gooseberry Project that was formulated more than 70 years ago but not completed. The original Gooseberry Project was formulated over a period of several years in response to efforts by Sanpete County individuals and entities to supplement existing irrigation water supplies and to alleviate shortages that consistently have occurred during the late irrigation season. The portion of that project that was not built was the proposal to appropriate and store Gooseberry Creek waters originating in Sanpete County and to transport those waters through a transmountain tunnel for use in north Sanpete County. The other component of the original Federal project, which was completed, was to enlarge Scofield Reservoir by 35,000 acre-feet to compensate Carbon County water users for the transmountain diversion of water to Sanpete County.

The earliest efforts to appropriate Gooseberry Creek water and transport it to use in north Sanpete County began in the early 1900s. In 1924, predecessors to SWCD filed an application with the Utah State Engineer to appropriate 15,000 acre-feet of Gooseberry Creek water and deliver it via a transmountain tunnel to Sanpete County.

Beginning in the 1930s, Reclamation, the Utah Water Storage Commission, and local Sanpete County interests undertook cooperative studies to formulate a water development plan and enhance water supplies in Sanpete County. The first published cooperative study, undertaken

by Reclamation and released in May 1933, outlined what would become known as the Gooseberry Project. This report defined the Gooseberry Project as:

- Construction of a reservoir on Gooseberry Creek with an active capacity of 15,000 acre-feet and an annual yield of 9,400 acre-feet.
- Construction of a transmountain tunnel.
- Construction of feeder canals to deliver waters from other streams to the dam for transmountain diversion.

In September 1940, Reclamation released another cooperative study that revised the original plan and included expanding Scofield Reservoir as a principal feature of the Gooseberry Project. On November 2, 1940, the Utah Water Storage Commission recommended construction of the Gooseberry Project, defined as:

- Construction of a dam on Gooseberry Creek providing an annual average yield of 10,800 acre-feet to Sanpete County.
- Construction of a transmountain tunnel to deliver the water.
- Construction of feeder canals.
- Enlargement of Scofield Reservoir to provide exchange water for the unrestricted diversion of Gooseberry Creek water to Sanpete County.

On March 6, 1941, the lands necessary to complete the Gooseberry Project were withdrawn from public entry under a First Form Reclamation Withdrawal, 32 Statute (Stat.) 388; 43 United States Code (U.S.C.) Section (§) 372, et seq.

On January 2, 1942, Reclamation released a draft report outlining the Gooseberry Project Plan, including constructing an additional 43,000 acre-feet of storage capacity in Scofield Reservoir to support the unrestricted transmountain diversion of Gooseberry Creek water to Sanpete County.

In 1943, the United States decided that the Scofield Dam and Reservoir portion of the Gooseberry Project Plan should be completed first because of the hazardous conditions the existing structure posed to the war effort and the health, welfare, and safety of Carbon County residents. Reconstruction of Scofield Dam began the same year and was completed in 1946.

On October 11, 1943, and February 28, 1944, the United States entered into reconstruction and repayment contracts on Scofield Dam and Reservoir with local sponsors. The October 11, 1943, contract has subsequently become known as the “Tripartite Agreement.” Among the conditions identified for reconstructing and enlarging Scofield Dam and Reservoir, the agreement:

- Described the United States’ intent to construct and operate the remaining Gooseberry Project works.
- Stipulated that the Gooseberry Project has the right to divert and store all flows of Gooseberry Creek at or above the confluence with Cabin Hollow.
- Stipulated that Carbon County’s storage rights in Scofield Reservoir are subordinate to those of the Gooseberry Project.

On April 11, 1956, Congress enacted the Colorado River Storage Project Act (CRSP). Priority planning was directed for the Gooseberry Project at 43 U.S.C. 620a.

In September 1961, the Soil Conservation Service of the U.S. Department of Agriculture proposed the North Sanpete Watershed Work Plan to complete the 1942 Gooseberry Project Plan.

In 1962, the USDA Forest Service issued a Special Use Permit to the Gooseberry Project sponsors to construct, operate, and maintain a tunnel and appurtenances for transmountain diversion of water from the proposed Narrows Reservoir in Gooseberry Creek to Cottonwood Creek for irrigation purposes.

On July 22, 1975 with the Federal Gooseberry Project remaining un-built, Reclamation assigned the Narrow's portion of the Gooseberry Project water right to SWCD to complete the Gooseberry Project Plan.

On March 13, 1981, SWCD filed a notice of intent (NOI) to apply for a SRPA loan to help finance the Narrows Project. The project would include:

- The Narrows Reservoir with a capacity of 17,000 acre-feet (10,000 acre-feet active storage and 7,000 acre-feet for fish and recreation).
- Two hydropower plants to provide power for project purposes.
- Improved flows in the San Pitch River by improving select facilities that would allow for more reliable exchanges without interfering with existing water rights.
- An additional 10 to 12 exchange wells in the San Pitch River Basin to provide exchange water to municipalities.
- Rehabilitation of the existing Gooseberry (Narrows) Tunnel.

On June 28, 1984, Reclamation approved the 1984 Compromise Agreement by and among the SWCD, the Price River Water Users' Association, and the Carbon Water Conservancy District (appendix A). According to the agreement's terms, among other things, SWCD:

- Relinquished and withdrew certain water rights.
- Agreed to a much lower transmountain diversion figure than previously contemplated (reduced to 5,400 acre-feet per year).
- Restricted sources of the water supply by excluding certain stream sources of water from the project plan.
- Limited the active and inactive storage capacity of the reservoir.
- Agreed to locate the dam and reservoir site further up the drainage of the Narrows Project site, thereby relinquishing the historic Mammoth site.

On November 1, 1984, SWCD filed an amended NOI to apply for a SRPA loan. The project had been reformulated in response to the 1984 Compromise Agreement. Specifically, SWCD proposed to:

- Construct the Narrows Reservoir to a capacity of no more than 14,500 acre-feet of active storage and 2,500 acre-feet of dead storage for fish and recreation purposes.
- Construct four hydropower plants to provide power for project purposes.
- Improve flows of the San Pitch River by improving select facilities that would allow for more reliable exchanges without interference with existing water rights.

- Drill 5 to 10 exchange wells in the San Pitch River Basin to provide exchange water to municipalities and irrigation companies.
- Rehabilitate the existing Gooseberry Tunnel.
- Enlarge the existing Gunnison Reservoir by at least 5,400 acre-feet.

On January 7, 1985, the Utah State Engineer approved both the Narrows and Scofield portion of the Gooseberry Project Plan water rights. With respect to the Narrows Project water rights, among other things, the approval:

- Set the approximate physical location of the Narrows damsite and its active storage capacity (14,500 acre-feet).
- Reduced the amount of an annual transmountain diversion to 5,400 acre-feet.
- Set the instream flow requirements.
- Restricted the sources of water supply that could be used for project purposes.

With respect to the Scofield Project water rights, the approval provided the legal authority to use 43,000 acre-feet of additional storage water in Scofield Reservoir. Both approvals were expressly made subject to the terms of the 1984 Compromise Agreement.

The effect of this decision was to give SWCD the right to divert the first 5,400 acre-feet of water occurring in Gooseberry Creek at the Narrows damsite. The decision also established a Scofield Project water right for the additional 43,000 acre-feet of storage capacity in the enlarged Scofield Reservoir. Of the 43,000 acre-feet, 8,000 acre-feet is for fish propagation. The remaining 35,000 acre-feet of capacity is for Scofield Project purposes (i.e., project water for use in Carbon County), subject only to an obligation to satisfy early water rights that otherwise would be impaired by the diversion and storage of the Narrows Project. Delays in completing the Narrows Project allow the 5,400 acre-feet of Narrows Project water to be delivered to Scofield Reservoir on a temporary basis for storage and use in Carbon County.

At this time, the hydropower plants, exchange wells, and expansion of Gunnison Reservoir were dropped as part of the project plan because of the technical and financial infeasibility of these components.

On March 7, 1985, the USDA Forest Service notified the Utah State Engineer of its claim to Federal reserved water rights in the Gooseberry Creek drainage. Because of potential conflict between water use under the Federal reserved water rights and the Gooseberry Project water rights, the United States and the Sanpete Water Conservancy District agreed on July 13, 1989, to a water use plan to allow for continued development of the Gooseberry Project Plan. This agreement stipulated that all Federal reserved water rights, which fall within the Gooseberry Creek drainage, shall be subordinate to the Gooseberry Project water rights.

On July 20, 1990, SWCD filed a second amended NOI to apply for a SRPA loan. The project had been reformulated to conform to the agreements and stipulations contained in the 1984 Compromise Agreement and the State Engineer's Memorandum Decision. SWCD proposed to:

- Construct the 17,000-acre-foot Narrows Reservoir with an active capacity of 14,500 acre-feet supporting an annual transmountain diversion of 5,400 acrefeet.

- Rehabilitate the existing 3,100-foot-long Narrows Tunnel to facilitate releases from Narrows Reservoir.
- Relocate about 2.9 miles of State highway around the Narrows Reservoir.

On May 19, 1992, the draft SRPA Loan Application Report and Environmental Report were submitted to Reclamation for review and comment.

On September 20, 1993, Reclamation released a draft environmental impact statement (DEIS) for public review and comment. Approximately 60 letters of comment were received from various Federal, State, and local agencies as well as members of the public. These comments and accompanying responses were included in the January 1995 final environmental impact statement (1995 FEIS).

On December 23, 1994, SWCD submitted the final Loan Application Report for processing. On January 23, 1995, Reclamation filed the 1995 FEIS with the United States Environmental Protection Agency (EPA).

On May 8, 1995, Reclamation's Upper Colorado Regional Director signed a Record of Decision (ROD). The ROD's recommendation was to proceed with the recommended plan identified in the 1995 FEIS.

On July 28, 1995, a Complaint was filed in United States Federal District Court, District of Utah, by the Carbon Water Committee, Utah Rivers Conservation Council, Utah Wilderness Association, and three individuals (Plaintiffs) against officials of the U.S. Department of the Interior (Interior), alleging that Reclamation failed to comply with the National Environmental Policy Act (NEPA) in preparing the environmental impact statement (EIS).

In response, Reclamation hired the Environmental Chemical Corporation (ECC), an environmental consultant, to conduct an independent review of the 1995 FEIS. ECC concluded that "the Narrows Project FEIS was complete and technically complied with NEPA, fulfilling most requirements of the Council on Environmental Quality (CEQ), Reclamation, and Department of the Interior guidelines."

In September 1995, a Civil Complaint was filed in the Sixth Judicial District Court of Sanpete County, State of Utah by SWCD (Plaintiff) against Carbon Water Conservancy District and Pacificorp, also known as Utah Power and Light (Defendants). The Plaintiffs alleged a breach of contract by the Defendants by willfully interfering and hindering the Plaintiff's attempts to develop its Gooseberry Creek water rights and construct the Narrows Project. In June 1999, the court dismissed the suit, and SWCD appealed to the Tenth Circuit Court of Appeals of the United States. The court of appeals upheld the original district court ruling.

On September 11, 1995, Reclamation published a Federal Register Notice for recision of the ROD on the 1995 FEIS for the Narrows Project, due to certain procedural errors in the final environmental impact statement (FEIS) process.

On February 8, 1996, Reclamation published a Federal Register NOI to prepare a new DEIS, wherein it announced that the new DEIS and subsequent FEIS would supersede the 1995 FEIS. Reclamation said it would use the 1995 FEIS, along with other materials submitted by SWCD,

as the basis for preparing the new DEIS but would prepare the new EIS itself, rather than use a contractor.

Reclamation's new DEIS was published in March 1998. Comments were received by mail and at public hearings in Price and Mount Pleasant, Utah, on April 22 and 23, 1998, respectively.

On November 25, 2003, Reclamation published a NOI to prepare a Supplemental Draft EIS (SDEIS) in the Federal Register. Based on scoping results, discussions with interested parties and cooperating agencies, existing laws and regulations, and comments on the 1998 DEIS, Reclamation updated or added the hydrology, water quality, population and demographics, water usage, recreation, discussion regarding Skyline Mine water development, fisheries, project cost estimates, wetlands delineations, Wild and Scenic Rivers, and Endangered Species Act compliance in the SDEIS.

Reclamation's SDEIS was published in March 2010. Comments were received by mail and at public hearings in Manti and Price, Utah, on April 28 and 29, 2010, respectively.

This document updates the Final Loan Application Report submitted in December 1994. Major updates include updated cost estimates and elimination of most of the cost associated with the Narrows Tunnel rehabilitation. Narrows Tunnel was rehabilitated in 2010-2012 using funding from other sources.

**Physical Works**

Principal features of the Narrows Project are:

- Narrows Dam and Reservoir constructed on Gooseberry Creek, about 9 miles east of Fairview, Utah. Narrows Dam will be a zoned earthfill embankment structure, 120 feet high, with a crest length of 550 feet and a crest width of 30 feet. Narrows Reservoir will have a total capacity of 17,000 acre-feet with 14,500 acre-feet of active capacity and 2,500 acre-feet of inactive and dead storage.
- Construction of East Bench, Oak Creek, and Upper Cottonwood Creek Pipelines with a total length of 16.8 miles to convey project water to areas of use.
- Rehabilitation of the Narrows Tunnel inlet and gate structure. The tunnel is an existing water conveyance facility approximately 3,100 feet long. The tunnel has a discharge capacity of 60 cfs.
- Relocation of 2.9 miles of State Road-264.
- Construction of recreation facilities along the northwest shore of Narrows Reservoir.
- Numerous wetlands, fishery and wildlife measures to mitigate project impacts.
- A 60-unit campground and recreation area.

Design data for project features are summarized in Table S-1.

**Construction Costs**

| | |
|---|---|
| Narrows Dam and Reservoir | $9,153,000 |
| Narrows Tunnel Inlet Rehabilitation | 211,000 |
| Upper Cottonwood Creek Pipeline | 534,000 |
| East Bench Pipeline | 7,079,000 |
| Oak Creek Pipeline | 354,000 |
| Highway SR-264 Relocation | 2,138,000 |
| Recreation Facilities | 835,000 |
| Wetlands, Wildlife and Fishery Mitigation | 3,600,000 |
| Subtotal | $23,904,000 |
| Contingencies | $2,349,000 |
| Projected Cost Increase | 3,095,000 |
| Engineering & Administration | 3,938,000 |
| Reimbursable Interest During Construction | 190,000 |
| Costs Spent to Date | 3,925,000 |
| Total Project Cost | $37,401,000 |

**Table S-1**

**Design Data Summary**

| Item | Unit | Project |
|---|---|---|
| Dam | | |
| Height | feet | 120 |
| Crest length | feet | 550 |
| Crest width | feet | 30 |
| Material volume | cu. yds. | 363,000 |
| Discharge capacity | | |
| Outlet works | cfs | 305 |
| Spillway | cfs | 775 |
| Reservoir capacity | | |
| Active storage | acre-feet | 14,500 |
| Inactive and dead storage | acre-feet | 2,500 |
| Total | acre-feet | 17,000 |
| Surface area | | |
| At top of active capacity | acres | 604 |
| At top of inactive and dead capacity | acres | 144 |
| Average during recreation season 1/ | acres | 454 |
| Drawdown | | |
| Average annual | feet | 12 |
| Average during recreation season 1/ | feet | 9 |
| Maximum | feet | 18 |
| Drawdown | | |
| Average annual | acre-feet | 5,058 |
| Average during recreation season 1/ | acre-feet | 4,043 |
| Pipelines | | |
| Oak Creek | | |
| Length | miles | 2.5 |
| Capacity | cfs | 2.5 |
| Diameter | inches | 10 |
| East Bench | | |
| Length | miles | 13.5 |
| Capacity | cfs | 21.5 |
| Diameter | inches | 27.18 |
| Upper Cottonwood Creek | | |
| Length | miles | 0.8 |
| Capacity | cfs | 50 |
| Diameter | inches | 30 |
| Narrows Tunnel Inlet Rehabilitation | | |
| Capacity | cfs | 60 |
| SR-264 Relocation | | |
| Length | miles | 2.9 |
| Width | feet | 24 |

(1) June through September

## OM&R Costs

| | |
|---|---|
| Personnel | $28,000 |
| Equipment | 8,000 |
| Supplies and materials | 4,000 |
| Total | $40,000 |

## LAND

### Land Classification

| Class[1] | Net Acres | | |
|---|---|---|---|
| | Irrigated | Non-irrigated | Total |
| 2 | 8,790 | 1,870 | 10,660 |
| 3 | 6,630 | 2,760 | 9,390 |
| Subtotal | 15,420 | 4,630 | 20,050 |
| 6w | 7,760 | 0 | 7,760 |
| 6/std | 0 | 16,430 | 16,430 |
| ROW, etc. | 0 | 5,190 | 5,190 |
| Total | 23,180 | 26,250 | 49,430 |

(1) Class 1 lands were not identified in the project area due to climatic constraints.

### Project Cropping Patterns

| | Crops (Unit--percent) | | | | | |
|---|---|---|---|---|---|---|
| **Area** | **Small Grains** | **Pasture** | **Hay** | **Alfalfa** | **Fallow and Idle** | **Total** |
| Group 1 (Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, Oak Creek) | 5 | 49 | 9 | 33 | 4 | 100 |
| Group 2 ( Horseshoe, Cedar Creek Twin Creek) | 10 | 39 | 8 | 35 | 8 | 100 |
| Group 3 (Meadow, Sheep, Mower, Brady, Graveyard, San Pitch, Miner & Turpin, M&M, Olsen & Seely, Frandsen McArthur, Moroni, Rock Dam) | 10 | 39 | 8 | 35 | 8 | 100 |

### Land Ownership

The District has 23,180 irrigated acres. Within the District, there are 892 acres of irrigated land (about .038 percent) which are held in excess of 320 acres per ownership; 20,870 acres in tracts of 10 to 320 acres; and 1,418 acres in small tract ownerships of 10 acres or less.

### WATER

| Water Supply (average year) | Volume (acre-feet) |
|---|---|
| Irrigation | |
| Present supply | 44,159 |
| Project supply | 4,750 |
| Total Irrigation Water Supply (Net) | 48,909 |
| Project M&I | 500 |

### Consumptive Use of Water

| | Average annual consumptive use requirement (Unit--acre-feet per acre) | | | | |
|---|---|---|---|---|---|
| Area | Small Grains | Pasture | Hay | Alfalfa | Weighted average |
| Group 1 (Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, Oak Creek) | 1.39 | 1.53 | 1.53 | 2.23 | 1.69 |
| Group 2 ( Horseshoe, Cedar Creek Twin Creek) | 1.39 | 1.53 | 1.53 | 2.23 | 1.64 |
| Group 3 (Meadow, Sheep, Mower, Brady, Graveyard, San Pitch, Miner & Turpin, M&M, Olsen & Seely, Frandsen-McArthur, Moroni, Rock Dam) | 1.39 | 1.53 | 1.53 | 2.23 | 1.64 |

### Water Rights

Water rights for the Narrows Project are based on three approved filings subject to the Compromise Agreement of June 28, 1984.

| Application No. | Claimed Date of Priority | Nature and Amount of Claimed Right |
|---|---|---|
| 14025 (91-130)<br>Change Application a-9237 | January 16, 1941 | Storage 30 cfs |
| 14026 (91-131)<br>Change Application a-9236 | January 16, 1941 | Storage 17,000 acre-feet |
| 1447 (91-132)<br>Change Application a-9238 | September 6, 1941 | Storage 130 cfs |

## PAYMENT RESOURCES

The weighted payment capacity is $12.75 per acre-foot of project water and $15.91 per acre on 23,180 acres. The annual irrigation payment capacity associated with the project will be $429,356. Revenue from municipal water sales will average $355.14 per acre-foot. Total revenue from municipal water sales will increase over time with population growth and will average $344,379 per year. In addition, $476,481 of ad-valorem tax revenues will be available from the District to repay project costs.

## FINANCIAL PROGRAM

| Item | Annual Amount | |
|---|---|---|
| Period of repayment, years | 0 - 5 | 6 - 30 |
| Average annual loan repayment | | |
| SRPA[1] loan ($21,792,000) | | |
| (30 years) | $ 566,456[2] | $ 809,545[2] |
| SRPA interest[3] | | |
| (maximum year) | 28,224 | 77,138 |
| State loan ($4,300,000) | | |
| (30 years) | 191,995 | 191,995 |
| State loan interest[4] | | |
| (maximum year) | 86,000 | 74,968 |
| O&M costs | 40,000 | 40,000 |
| Operating reserve[5] | 8,000 | 0 |
| Total average annual cost[2] | $ 806,451 | $ 1,041,540 |

[1] Small Reclamation Projects Act.
[2] The annual rates are variables. These amounts are average for the time periods.
[3] At 5.75 percent interest on interest-bearing portion of unpaid balance.
[4] At 2.0 percent interest on unpaid balance
[5] To accumulate emergency operating reserve during first 5 years of repayment period.

# CHAPTER 1

## GENERAL INFORMATION

Sanpete Water Conservancy District

# CHAPTER 1

# GENERAL INFORMATION

## INTRODUCTION

The Narrows Project will be located in central Utah in Sanpete and Carbon Counties, Utah. Features of the project and the service area will be located in Sanpete County. Because the dam and diversion diminish the water flows in the Price River drainage and there are critical water-rights contracts and agreements with water users downstream in Carbon County, that county will also be considered as part of the project study area. The service area encompasses about 49,000 acres. The project features and project area are shown on the Frontispiece Map.

The eastern portion of the project area is in the Manti-La Sal National Forest along the Wasatch Plateau. The service area will be situated in the San Pitch River (a northern tributary of the Sevier River) drainage. The project will include a transbasin diversion from the Price--Green--Colorado River Basins. Head waters of the San Pitch River are located on the mountainous Wasatch Plateau at elevations reaching over 11,000 feet. Cottonwood Creek, a major tributary of the San Pitch River, is on the northeastern edge of the Sanpete Valley. There are numerous smaller streams that are tributary to the San Pitch River and all are diverted for irrigation in the project area. Gooseberry Creek is just across the ridge in the Price River drainage.

The Wasatch Plateau Range is the principal topographic feature of both counties and separates them geographically (north-south). The Great Basin, Colorado Plateau, and Rocky Mountains all converge near north Sanpete County. The San Pitch River valley lies at the eastern edge of the Basin and Range Province of North America. It is a narrow north-south trending valley bordered on the east by the high Wasatch Plateau and on the north by the low Cedar Hills, part of the Wasatch Range; and on the west by the San Pitch Mountains.

### Relationship of Application to Water Rights Contracts and Agreements

As early as May 31, 1933, the U.S. Bureau of Reclamation recognized the need to develop a comprehensive water development plan on the Price River system to meet the water needs of both Carbon and Sanpete Counties. The plan which evolved became known as the Gooseberry Project Plan and constitutes the basis upon which the Scofield Dam and Reservoir were reconstructed and enlarged to their present size.

Originally, the Gooseberry Project Plan included three major features: (1) a dry dam on Gooseberry Creek with feeder canals from Brooks Canyon and Cabin Hollow Creeks; (2) a transmountain tunnel; and (3) an enlarged Scofield Reservoir to provide water by exchange to support the unrestricted transmountain diversion of water at Narrows Dam site. The following measures were taken to implement this plan:

- In 1940, the U.S. Bureau of Reclamation (Reclamation) filed the requisite applications with the Utah State Engineer to appropriate water for transmountain diversion to the San Pitch River system.
- On March 6, 1941, the Gooseberry Project lands (now Narrows Project lands) were withdrawn from public domain.
- In 1942, Reclamation issued its Gooseberry Project Report which explained how the Scofield Reservoir will provide replacement storage for the water of the transmountain diversion. Reclamation also filed its application with the Utah State Engineer to enlarge the storage capacity of Scofield Reservoir to also permit the transmountain diversion of water.
- On October 11, 1943 and February 28, 1944, the United States entered into Reconstruction and Repayment Contracts on Scofield Reservoir. Significant points of each contract included:

**Reconstruction Contract**

1. Additional storage capacity will be built into Scofield Reservoir to implement the Gooseberry Plan.
2. To facilitate the Gooseberry plan, the Price River water rights were subordinated to Reclamation rights on Gooseberry Creek.

**Repayment Contract**

1. The Carbon Water Conservancy District, sponsor of the reconstruction project, agreed to operate Scofield in accordance with the Gooseberry Project plan.
2. Sanpete interests will pay in excess of one-half reimbursable costs if the Gooseberry plan is fully implemented.

Because the original Scofield Dam was unsafe and posed an immediate threat to the war effort in the event of failure, i.e., loss of life, and disruption of rail service and access to coal supplies, Reclamation and the State of Utah recommended that this portion of the Gooseberry Project Plan be constructed first, ahead of the Narrows Dam and transmountain tunnel. The new Scofield Reservoir, authorized June 24, 1943, included 30,000 acre-feet of replacement storage capacity (replacing the then existing 30,000 acre-foot structure), 8,000 acre-feet of dead storage (conservation pool), and 35,000 acre-feet of exchange capacity to support the unrestricted transmountain diversion of Gooseberry Creek water at the Narrows damsite. Significantly, the reconstruction efforts also included the following considerations:

1. The near doubling in size of Scofield Reservoir was originally accomplished for the sole purpose of implementing the Gooseberry Project Plan - with the full 35,000 acre-feet of additional active storage capacity being expressly reserved to support, by exchange, the transmountain diversion of water at the Narrows site.

2. A second feature of the Gooseberry Project Plan, the transmountain tunnel, was constructed in 1962 as a precursor to the North Sanpete Watershed Work Plan. The plan was sponsored by the U.S. Department of Agriculture to implement the final two portions of the Gooseberry Project Plan. But, controversy developed over the use of the Gooseberry Creek water for transmountain diversion. Further work on the North Sanpete Watershed Work Plan ground to a halt. That controversy has now been resolved. Specifically:

   - On July 29, 1982, the Utah Supreme Court affirmed a declaratory judgment of the trial court holding the Price River Water Users Association and the Carbon Water Conservancy District bound by the terms of a 1943 tripartite contract among the United States Bureau of Reclamation, the Carbon Water Conservancy District, and the Price River Water Conservancy District (predecessor to Price River Water Users Association) and to a 1944 repayment contract involving the reconstruction of Scofield Dam and Reservoir.

   - On June 8, 1984, a compromise agreement resolving the long-standing controversy concerning the building of storage and diversion works on the Price River System for transmountain diversion of Gooseberry Creek water to the San Pitch River system was entered into by and between Sanpete Water Conservancy District, the Carbon Water Conservancy District, and the Price River Water Users Association.

   - On January 7, 1985, the Utah State Engineer issued memorandum of decision approving the water applications covering the Gooseberry Project waters--both for Scofield Reservoir and for the proposed Narrows Project. That decision incorporated many of the terms agreed upon in the June 8, 1984, Compromise Agreement, described above. In addition, the memorandum of decision memorialized an agreement reached by and between Sanpete Water Conservancy District and the Utah Division of Wildlife Resources over instream flows and fishery releases from the proposed Narrows Dam.

   - An agreement was reached, July 13, 1989, by and between Sanpete Water Conservancy District and the United States of America acting through its Department of Justice which resolved the reserved rights claims of the United States to the Gooseberry Project waters.

In summary, when Scofield Reservoir was reconstructed in 1944, it was clearly recognized that the Narrows Dam and the transmountain tunnel would be completed at a later date. The operational agreement covering the reconstruction effort on Scofield Reservoir specifically recognized this and allowed the Carbon County interests to utilize the excess storage capacity being built into the reservoir until the remaining features of the Gooseberry Project Plan were

completed. In this respect, for 50 years Carbon County has reaped a tremendous economic benefit from the Gooseberry Project. It received and has placed to use up to 35,000 acre-feet of water annually that it would not otherwise have had. It began reaping the economic benefit of the Gooseberry Project Plan in 1944, when Scofield Reservoir was reconstructed. It did not have to wait -- as Sanpete County has -- for the completion of the other project features to realize its benefit. However, Carbon County is not entitled to all the economic benefit of the Gooseberry Project Plan. The plan anticipated benefits for both counties by providing additional water to both counties. The completion of the plan simply means that Scofield Reservoir will spill less often and Carbon County will no longer have the use of a small amount of water meant for Sanpete County. Carbon County still received a new dam, over 35,000 acre-feet of storage capacity it did not otherwise have and would not have otherwise received, and another party to help defray the repayment costs of its dam. The use of this storage capacity, both directly and by way of carry-over storage, represents a clear benefit to Carbon County.

It should also be noted that following the Scofield reconstruction effort, Sanpete County agreed to take even less water transmountain than was anticipated by the original Gooseberry Project Plan. By virtue of the Compromise Agreement of 1984, Sanpete County agreed to reduce its annual transmountain diversions by over two-thirds of what was originally contemplated -- the original water filings contemplated Sanpete County diverting up to 17,000 acre-feet of water annually. Carbon County is receiving even more water, and thus a greater economic benefit, than was originally anticipated when it negotiated for the reconstruction of Scofield Reservoir and agreed to the Gooseberry Project Plan.

In view of the above, it appears clear that Carbon County has received a tremendous economic advantage by having signed agreements to the Gooseberry Project Plan. The benefits began immediately with the reconstruction of Scofield Dam and will continue after the project plan is fully implemented.

**Location**

Sanpete Valley, where the land to be served by irrigation is situated, is bordered on the east by the Wasatch Plateau and on the west by the San Pitch Mountains. Elevations in the valley range from 6200 feet at the community of Oak Creek on the north to 5500 feet at Spring City on the south and average 5900 feet at Mount Pleasant. These elevations include benches, terraces, washes, uplands, badlands, and flood plains, all cut from soft sedimentary rocks.

Sanpete County is separated from the main Utah route (I-15) south to California by the high mountains and plateaus. The project area includes lands surrounding the small rural communities of Fairview on the north, Mount Pleasant and Spring City on the south, and Moroni to the west. U.S. Highway 89 extends through the Narrows Project service area, connecting Fairview; Mount Pleasant; Ephraim; and Manti, the county seat; with Salt Lake City about 130 miles to the north. Utah State Highway 30 connects the other three principal communities in the area, Spring City, Moroni, and Fountain Green, with Interstate Highway 15 at Nephi. State Road-31 climbs up Fairview Canyon out of the Sanpete Valley to intersect with State Road-264 (SR-264). Both highways have been designated as National and State Scenic byways. Portions of SR-264 will be rerouted to cross the proposed Narrows Dam. U.S. Highway 50/6 extends through Carbon County. It connects Price, the county seat, with Salt Lake City to the

north about 120 miles. Only Carbon County is served by railroads and regularly scheduled interstate buses. Both counties are served by regularly scheduled trucklines but have no regularly scheduled airline service.

**Climate**

The climate of the project service area is semiarid to arid. It is characterized by wide daily and annual variations in both temperature and precipitation. There are four, well-defined seasons. The summers are warm with occasional hot spells. Winters are cold with some severe temperatures below zero. The spring and fall seasons are mild and balmy.

Precipitation in the valley varies with elevation, but ranges from 10 to 14 inches annually, which is sufficient to support only light growths of native brush and trees. Irrigation is essential to crop production. The growing season averages 125 days, with only about 50 percent of the annual precipitation occurring during the growing season. Precipitation in the mountainous high water shed areas surrounding the valley ranges from 14 to 35 inches per year and a little more than half occurs in the winter as falling snow.

The following table presents climatological data recorded at three local weather stations in or near the Narrows Project lands.

**Table 1-1**
**Climatological Data**

| | | | Average precipitation | | | |
|---|---|---|---|---|---|---|
| **Station** | **Years of record** | **Elevation (feet)** | **Annual (inches)** | **May to September (inches)** | **Frost-free period (days)** | **Growing season (days)** |
| Ephraim Sorenson Field | 77 | 5670 | 10.60 | 3.61 | 98 | 128 |
| Fairview | 12[1] | 6750 | 15.07 | 5.35 | NA[2] | NA |
| Moroni | 103 | 5525 | 10.70 | 3.43 | 98 | 98 |

[1] Precipitation data only
[2] NA – data not available

# CHAPTER 2

# THE DISTRICT

Sanpete Water Conservancy District

# CHAPTER 2

# SANPETE WATER CONSERVANCY DISTRICT

## HISTORY OF DISTRICT

The Sanpete Water Conservancy District (District) is the sponsoring agency for the Narrows Project. The District was established January 1, 1964, to assist the water users of Sanpete County in developing, managing, supplying, and distributing water. The District is governed by a board of directors appointed by the Sanpete County Commission. Representatives from the entire county serve on the Sanpete Water Conservancy District board.

In accordance with the above-referenced Act, the District has entered into several agreements to facilitate the completion of the Gooseberry and Scofield Projects. Those agreements were discussed in the previous chapter. In addition, the District entered into an agreement with the U.S. Department of the Interior, Bureau of Reclamation on July 22, 1975, for the purposes of securing the requisite water rights and establishing a plan by which the Gooseberry and Scofield Projects could be completed.

### Law Under Which Organized

The Sanpete Water Conservancy District was organized and exists under the Water Conservancy Act of the State of Utah.

### Description of Powers and Authorities of the District

The District has all the powers set forth in the Water Conservancy Act, including but not limited to the right to contract with any agency of the United States (Utah Code Annotated 73-9-13). The Water Conservancy Act also provides the District the powers of eminent domain; the authority to hold water rights; to construct and operate irrigation works; the right to contract with political entities other than the Federal Government; the right to sell bonds; and the power to tax water users within the District.

### Financial Status

The Sanpete Water Conservancy District is in good financial condition and operates on a calendar year basis. Detailed financial statements for calendar year 2010 are included in Attachment A, Sanpete Water Conservancy District Financial Statements.

Operating revenues are currently derived from Class A ad valorem taxes. The District has all other means of collecting revenue as is particularly provided for in the Water Conservancy Act.

The District conducts an annual audit. A copy of the 2010 audit is included in Attachment A, Sanpete Water Conservancy District Financial Statements.

The District has not had a need for a bond rating and therefore does not have one at the present time. For comparison purposes, the following information is provided. The bond rating for North Sanpete School District, which encompasses most of the project area, has a Moody Investor's Service "Aaa" bond rating. Because of the District's lack of debt, its rating would probably be comparable.

**Physical Assets**

A major purpose in creating the Sanpete Water Conservancy District was to pursue the completion of the Narrows Project. That project has not yet created a need for physical assets and the Board of Directors has postponed purchase of physical assets until a future time, when it becomes necessary.

# CHAPTER 3

## LAND RESOURCES AND OWNERSHIP

Sanpete Water Conservancy District

# CHAPTER 3

# LAND RESOURCES AND OWNERSHIP

## PROJECT LAND SUITABILITY DETERMINATION

### Land Classification and Soil Survey

The land area to receive supplemental service is shown on the frontispiece map and in Attachment B, Land Classification Maps. A semi-detailed land classification was made of the area in the early 1940's by Reclamation. The survey was conducted as part of the Gooseberry Project investigations and involved the determination and delineation of the irrigated and nonirrigated lands. The irrigable lands totaled 16,400 acres.

A Soil Survey of Sanpete Valley Area, Utah, undated, was published by the U.S. Department of Agriculture, Soil Conservation Service (SCS). This survey was a joint effort and included other State and Federal agencies in cooperation with the Utah Agricultural Experiment Station and Utah State Department of Wildlife Resources. Field work was accomplished in the period 1964-1970. Soil names and descriptions were approved in 1971. This work was used extensively in the updated land use and land classification data in this report.

For this report, a land use study and an update of the 1940 semi-detailed land classification was conducted and completed in the fall of 1990. Aerial photographs with a scale of 1 inch equals 660 feet or 1:7920 were used as base maps. The land use study was conducted on presently irrigated lands within the boundaries of the proposed Narrows Project. The updated land classification resulted in a reduction of about 980 acres of land from that reported in the 1940 survey. It reflects the higher standards for project land as presently required by Reclamation.

Soils in the project area have developed under semi-arid conditions. They are highly calcareous, high in inherent plant nutrients, have weak to moderate developed soil profiles, and a wide range of soil textures. They are derived principally from both old and recent alluvial materials eroded from geologic materials of the Wasatch Plateau. The lands are found on benches and terraces formed by the coalesced alluvial fans of the streams tributary to the San Pitch River. A broad area of valley fill material of deeper soils is found west of Mount Pleasant and in small cove areas at the base of the large alluvial fans. Valley fill is also found in the flat valley or river bottom areas west and southwest of Moroni.

The refinement of the 1940 land classification was conducted using updated specifications as shown on Table 3-1. These refined land classification specifications were developed incorporating the previous investigations and specifications and then updating the information to allow for recent restrictions developed by Reclamation for an arable land class. The specifications properly typify the local physical and economic conditions, including climatic constraints.

Class 1 lands were not identified in the project area due to climatic constraints. The arable or project lands were delineated as Class 2 and Class 3. Nonarable lands included Class 6w.

**Table 3-1**
**Narrows Project**
**Specifications for Semi-Detailed Land Classification**

| Land Characteristics | Class 1 Arable | Class 2 Arable | Class 3 Arable |
|---|---|---|---|
| SOILS 0-8 feet "s" | | | |
| Texture | | | |
| 0-3 feet | Sandy loam to friable clay loam | Loamy fine sand to very permeable clay | Loamy sand to permeable clay |
| 3-8 feet | Sandy loam to clay loam | Loamy sand to permeable clay | Loamy sand to permeable clay |
| Salinity and alkalinity | Less than 4 millimhos or equivalent percent salt | Less than 8 millimhos or equivalent percent salt | Less than 8 millimhos per cm. or equivalent percent salt. May be as high as 12 millimhos under conditions of good drainability. |
| Exchangeable sodium percentage | Less than 10 percent | Less than 15 percent | Less than 15 percent |
| Depth to: | | | |
| Sand or gravel (water washed) | 48 inches for sandy loams<br>42 inches for loam and clay loams | 42 inches for loamy sands<br>36 inches for sandy loams | 36 inches for loamy sands<br>30 inches for sandy loams<br>24 inches for loams, clay loams, and clays. |
| Gravel or cobble with a soil matrix[1] | 48 inches | 36 inches | 12 inches for cropland |
| Creviced sandstone | 60 inches | 48 inches | 30 inches |
| Shale | 96 inches | 96 inches | 96 inches |
| TOPOGRAPHY "t" | | | |
| Slope | 0.5 to 3 percent in general gradient. Smooth slopes in one plane. | Up to 5 percent in general gradient. Smooth slopes in one plane. | Up to 8 percent in general gradient. Smooth slopes in one plane. |
| Surface | Areas greater than 500 feet in direction of irrigation runs leveled by moving less than 300 cubic yards per acre. Minimum depths required after leveling. | Areas greater than 300 feet in direction of irrigation runs leveled by moving less than 400 cubic yards per acre. Minimum depths required after leveling. | Areas greater than 200 feet in direction of irrigation runs leveled by moving less than 500 cubic yards per acre. Minimum depths required after leveling. |
| Rock and stony soil | No surface rock or stony soil to interfere with cultivation. | No surface rock or stony soil to interfere with ordinary cultivation. | Some surface rock and stony soil will limit cultivation practices. |
| DRAINAGE "d" | | | |
| Farm drainage | No farm drainage anticipated. | No farm drainage anticipated. | No farm drainage anticipated. |

Note: Class 6 - Nonarable lands which do not meet the minimum requirements for a higher land class.
Class 6w - Nonarable lands possessing water rights but with insufficient payment capacity to justify their inclusion in a higher land class .
[1] Gravel or cobble generally absent to these depths for cropping classes. May have some gravel and cobble mixed with soil to this depth for grass hay and pasture class 3 lands.

Those are irrigated lands that fail to meet an arable class because of one or more deficiencies in soil, drainage, and/or topography. Class 6/std were lands that failed to meet arable requirements because of more than one deficiency in soils, topography, and drainage. Table 3-2 is a summary of the gross area investigated and classified. This table shows a total of 49,430 acres classified, of which 20,050 acres are arable.

**Table 3-2**
**1990 Land Classification Refinement**
**(acres)**

| Land Class | Irrigated | Non-irrigated | Total |
|---|---|---|---|
| Class 2 | 8,790 | 1,870 | 10,660 |
| Class 3 | 6,630 | 2,760 | 9,390 |
| Subtotal | 15,420 | 4,630 | 20,050 |
| Class 6w | 7,760 | 0 | 7,760 |
| Class 6/std | 0 | 16,430 | 16,430 |
| Rights-of-Way | 0 | 450 | 450 |
| Townsite/Homestead | 0 | 4,740 | 4,740 |
| Subtotal | 0 | 21,620 | 21,620 |
| Total | 23,180 | 26,250 | 49,430 |

Most of the project lands are Class 2. Slopes are long to moderately long, smooth to slightly undulating, and range from less than 1 to 5 percent in gradient. Soil textures range from loamy sand to friable clay. Both surface and internal drainage is good. Soils are deep, 48 to 96 inches, and are well suited for all crops grown in the area.

The remaining portion of lands that would receive project water are Class 3. These lands are usually located on the upper slopes of the alluvial fans. Slopes may range from 3 to 8 percent. They are slightly undulating, rolling, and uneven. Because of their location on alluvial fans and terraces, the soils are shallow with stony sub-soils and may contain some surface rock. They are somewhat limited in their suitability and cropping patterns. Some Class 3 lands include low-lying lands affected with high water tables during part of the irrigation season and utilized as rotation pasture and grass hay lands.

The Class 6w lands are presently irrigated but fail to meet the minimum requirements for an arable land class. They are not included as project lands. These lands usually have one or more deficiencies in soil, drainage, and/or topography. They are interspersed throughout the area, principally in the valley bottoms adjacent to the river.

The Class 6/std lands fail to meet the minimum requirements for arable land. They are considered permanently nonarable due to one or more deficiencies in soil, topography, or drainage characteristics and are not included as project lands.

Land classification designations for the project area are shown on the maps in Attachment B, Land Classification Maps.

### Trace Element Studies

A trace element study was conducted as part of the 1990 land classification update. It included a generalized screening approach in which the area soils were included as land form represented by (1) the deep phased soils of the lower slopes and valley fill material, (2) moderately deep soils found on the terraces, and coalesced alluvial fans, and (3) the shallow phased soils of the upper alluvial fans and rolling foothills.

Three sites were selected: one for each soil phase which represented an overall assessment of the project lands. A total of 11 samples were collected from those sites and forwarded to Reclamation's Interregional Soil and Water Laboratory, Denver, Colorado, for analysis. The results are shown in Table 3-3 for arsenic, mercury, and selenium and are from three representative sites in the project area.

**Table 3-3**
**Trace Elements**
**Total Concentrations in Soil**

| Site and Sample Number | Arsenic (ppm) | Mercury (ppm) | Selenium (ppm) |
|---|---|---|---|
| Upper Alluvial Fans Shallow Phase | | | |
| 1 | 6.4 | 0.02 | 0.2 |
| 2 | 7.6 | N0.02 | 0.2 |
| Alluvial Fans Mod to Deep Phase | | | |
| 3 | 6.2 | 0.02 | 0.2 |
| 4 | 6.3 | 0.02 | 0.2 |
| 5 | 5.3 | N0.02 | 0.2 |
| 6 | 4.9 | N0.02 | 0.1 |
| Valley Fill Deep Phase | | | |
| 7 | 4.0 | N0.02 | 0.2 |
| 8 | 3.7 | 0.02 | 0.2 |
| 9 | 4.5 | N0.02 | 0.2 |
| 10 | 5.0 | N0.02 | <0.1 |
| 11 | 5.6 | N0.02 | <0.1 |
| Geometric Mean Concentration of 733 Western Soils[1] | 5.5 | 0.046 | 0.23 |
| Common Range in Western Soils[2] | 1.2-22.0 | 0.0085-0.25 | 0.039-1.4 |

[1] Shacklette and Boerngen, USGS Paper 1270, 1984.
[2] Values chosen to represent an expected 95 percent range. (Tidball and Ebens, 1976).

Study results indicate that all three elements analyzed are present in low to moderate concentrations; therefore, further testing for these elements was not considered necessary.

Data was also gathered from the National Geochemical Data Base which contained extensive information on soils in the vicinity of the survey area. Most of the data was from the National Uranium Resource Evaluation Surveys conducted from 1976-80. A total of 59 soil sampling sites from this data base was located in the vicinity of the survey area. Almost all sites were in Quaternary alluvium.

The data indicate that most trace elements are present in concentrations within the common range for western soils. Cobalt was the only element consistently present in concentrations outside the common range. However, cobalt is not considered hazardous in the alkaline soils of the region. Limited water analysis data indicate cobalt was not detected in the San Pitch River.

Although silver, molybdenum, uranium, and selenium were found at elevated concentrations at scattered sites, it appears that none of the elements are present in concentrations of concern in the existing project return flows.

Return flow water quality data was also included as part of the trace element study. This data is presented in Table 3-4.

**Benefitted Area**

The Narrows Project will provide 4,920 acre-feet of irrigation water to northern Sanpete County, Utah. Project water will be delivered from project facilities to existing irrigation companies, who will in turn deliver it to individual water users. The Project will furnish late season water except in years of extreme drought. Normally stream flows meet irrigation demands until mid-July. Project supplies are needed after mid-July to supplement natural stream flows.

Sprinkler and furrow irrigation are the two methods of irrigation used for major crops in the area. With the exception of pastures and meadows, about 60 percent of the irrigated crops are under sprinkler irrigation. Side rolls are very prominent on the sprinkler irrigation systems. Pressurization is by gravity head from ponds. Furrow irrigation is the method used on about 40 percent of the project area.

The Sanpete Water Conservancy District will be responsible for project operation and repayment. The District will maintain a close relationship with the irrigation companies so that water can be delivered and collections for water deliveries can be made in the most efficient manner.

Lands to receive project water are shown on the Frontispiece Map.

**Table 3-4**
**Water Quality Data for the San Pitch River near the Narrows Project Area**

| | | | Soluble Cations, (meq/L) | | | | Soluble Anions, (meq/L) | | | | Toxic Elements, (µg/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STORET Station Location** | **EC at 25 °C** | **SAR** | **Ca** | **Mg** | **Na** | **K** | **$CO_3$** | **$HCO_3$** | **$SO_4$** | **Cl** | **Arsenic** | **Boron** | **Mercury** | **Selenium** |
| **Above Narrows Project** | | | | | | | | | | | | | | |
| San Pitch River 1 mile West of Milburn | 1300.8 | 0.25 | 11.41 | 4.36 | 0.70 | 0.10 | 0.03 | 5.36 | 10.93 | 0.24 | 1.70 | 121 | 0.06 | 0.38 |
| Cottonwood Creek 1.5 miles East of Fairview | 459.0 | 0.19 | 2.63 | 1.80 | 0.29 | 0.04 | 0.00 | 4.38 | 0.58 | 0.09 | 0.93 | 89 | 0.05 | 0.40 |
| Fountain Green Hatchery - East Outflow | 426.0 | 1.00 | 1.70 | 1.48 | 1.26 | 0.03 | 0.00 | 4.36 | 0.10 | 0.14 | 1.00 | 50 | 0.10 | 1.00 |
| Fountain Green Hatchery - West Outflow | 431.9 | 0.28 | 2.30 | 1.48 | 0.39 | 0.03 | 0.00 | 4.30 | 0.16 | 0.11 | 1.00 | 50 | 0.10 | 1.00 |
| **Within Narrows Project** | | | | | | | | | | | | | | |
| San Pitch River above Moroni WWTP Outfall | 791.8 | 0.64 | 3.06 | 4.50 | 1.25 | 0.09 | 0.01 | 6.76 | 1.41 | 0.81 | 2.47 | 75 | 0.14 | 0.97 |
| San Pitch River 2.5 miles West of Mt. Pleasant | 771.4 | 0.56 | 3.33 | 4.23 | 1.09 | 0.08 | 0.00 | 6.72 | 1.47 | 0.54 | 3.09 | 155 | 0.14 | 1.32 |
| **Just Below Narrows Project** | | | | | | | | | | | | | | |
| San Pitch River 1 mile West of Chester | 1111.0 | 1.07 | 3.55 | 5.08 | 2.22 | 0.21 | 0.08 | 7.02 | 2.09 | 1.34 | 3.42 | 220 | 0.00 | 0.45 |
| **Below Narrows Project** | | | | | | | | | | | | | | |
| San Pitch River Northwest of Manti | 1272.0 | 2.28 | 4.28 | 8.31 | 5.71 | 0.13 | 0.00 | 8.12 | 6.15 | 2.20 | 5.00 | 260 | 0.07 | 1.00 |
| San Pitch River below Gunnison Reservoir | 1630.8 | 2.46 | 2.61 | 10.26 | 6.23 | 0.14 | 0.28 | 9.26 | 6.17 | 3.86 | 6.00 | N/A | 0.10 | 1.00 |
| San Pitch River at U-137 Crossing | 2591.3 | 6.78 | 4.26 | 6.85 | 15.99 | 0.14 | 0.07 | 6.87 | 5.73 | 11.59 | 5.54 | 349 | 0.15 | 1.07 |

## LAND USE

Present agricultural land use within the project area is based on the livestock economy of the area; principally, cattle and sheep operations, and a number of Grade A dairies. Land use is devoted almost exclusively to production of livestock feeds. This use is not expected to change under project development.

The principle crops grown in the project area in order of importance are: pasture, alfalfa hay, small grains (barley, oats, and wheat), and meadow hay. Under present conditions, two crops of alfalfa are harvested each year and in some years, when weather conditions are favorable, three crops are harvested. One crop of meadow hay is normally harvested and the aftermath used as late summer and fall pasture. Small grains are used as rotation crops for hay and pasture. Small grains are also sometimes used as a nurse crop for alfalfa. The most common small grain crop is barley. Corn silage, which makes up less than 1 percent of the irrigated area, is raised primarily by dairymen and livestock feeding operations. Present and project crop distribution and yields in Sanpete County are summarized in Table 3-5 below.

**Table 3-5**
**Crop Distribution and Yields Summary**
**Sanpete County**

| | | | Project Yields | |
|---|---|---|---|---|
| **Crop/Unit** | **Distribution (%)[1]** | **1990 Yields[2]** | **w/Full Water Supply[3]** | **Average** |
| Pasture/AUM | 41 | 5.0 | 8.0 | 5.3 |
| Alfalfa hay/ton | 34 | 3.5 | 5.2 | 3.7 |
| Small grains/bu. | 10 | 80.0 | 85.0 | 82.0 |
| Meadow hay/ton | 8 | 2.0 | 2.5 | 2.2 |
| Other crops | 1 | NA[4] | NA | NA |
| Fallow and idle | 6 | NA | NA | NA |

[1] Distribution would be essentially the same for present and project conditions.
[2] Estimates were generated by Sanpete Water Conservancy District for this study.
[3] Estimates for irrigators purchasing enough project water to obtain a full water supply.
[4] NA = Not applicable.

Other land uses include large garden spots, potatoes, raspberries, and Christmas or ornamental trees. Of major importance to the local economy and employment is the turkey industry, which includes a large processing plant at Moroni, Utah.

Cropping patterns will not be significantly altered under project conditions. Irrigators who purchase the water, however, will be able to rotate their alfalfa crops more often and a few irrigators may expand their alfalfa acreage. The relatively small amount of water available for use on the project's 15,420 acres will result in insignificant changes to the crop distribution shown earlier in Table 3-5.

Crop yields will be significantly increased by the use of project water. Water shortages presently occur almost every year after July 10 to 15. Storage water delivered from the project in the latter part of the irrigation season will make it possible for those who purchase project water to harvest a third crop of alfalfa almost every year. Yields for other crops will also be increased, but the biggest effect will be on alfalfa yields.

The project irrigation water supply of 4,920 acre-feet, when added to nonproject supplies, will provide enough supplemental water to furnish 6,336 acres a full water supply. Irrigators who purchase enough project water to obtain a full supply may expect to obtain crop yields similar to those shown earlier in Table 3-5.

## LAND OWNERSHIP

### Excess Lands

Irrigable project lands are held in both private and corporate ownership. Reclamation law permits participation in SRPA projects by individuals or husband and wife joint ownerships of up to 320 acres interest free. Corporations may also receive interest-free project water for up to 320 acres of project land. Individuals or corporations may receive project water for more than 320 acres if they pay full cost including interest. It is not anticipated that project water will be sold for use on acreage in excess of 320 acres.

### Small Tracts

The Small Reclamation Projects Act requires that noncommercial irrigation service to small tracts be charged full cost, including interest. A small tract, as defined by the law, is any ownership less than 2 acres, and those ownerships between 2 and 10 acres in size which produce less than $5,000 in gross annual sales. All ownerships less than 10 acres, within the Narrows Project, will be charged full cost. About 1,418 acres of the project acreage, or about 6 percent, is in ownerships of less than 10 acres.

Most of the land to receive service in the project area is in ownerships of small family farms or part-time farms. A summary of project land ownership is presented in Table 3-6.

**Table 3-6**
**Land Ownership Distribution**

| Size of farms (acres) | Holdings (number) | Amount of acres | Average size of ownership (acres) |
|---|---|---|---|
| 0 - 2 | 121 | 133 | 1.1 |
| 2 - 5 | 122 | 416 | 3.4 |
| 5 - 10 | 124 | 869 | 7.0 |
| 10 - 320 | 422 | 20,870 | 49.5 |
| Over 320 | 2 | 892 | 446.0 |
| Total | 791 | 23,180 | 29.3 |

# CHAPTER 4

## WATER SUPPLY

Sanpete Water Conservancy District

# CHAPTER 4

# WATER SUPPLY

## WATER REQUIREMENTS

### Irrigation Water Requirement

As indicated in the previous chapter, there are 23,180 acres of irrigated farmland within the project area. Of that acreage, 15,420 acres have been identified as irrigable or eligible to receive supplemental water from the project.

In determining water requirements and for clarity and convenience of discussion, the project lands were divided into three groups which are described below.

Group 1 lands include the areas serviced by the Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, and Oak Creek Irrigation Companies. Group 1 contains 9,777 acres of presently irrigated land. Of that acreage, 5,705 acres were identified as irrigable. The land in this group is primarily irrigated by sprinkler.

Group 2 lands include the areas served by the Horseshoe, Cedar Creek, and Twin Creek Irrigation Companies. Group 2 contains 6,407 acres of irrigated farmland, including 4,644 acres of irrigable land. Group 2 lands are mostly flood irrigated.

Group 3 lands use the San Pitch River as their principal water supply. The Meadow Ditch, Sheep Ditch, Mower Ditch, Brady Ditch, Graveyard Ditch, San Pitch Ditch, Miner & Turpin, Moroni & Mount Pleasant (M&M), Olsen & Seely, Frandsen-McArthur, Moroni, and Rock Dam Phillip Irrigation Companies serve this land. Group 3 includes 6,996 acres of irrigated land, 5,071 acres of which are irrigable. Group 3 lands are irrigated by a combination of flood and sprinkler methods.

Table 4-1 presents the cropping patterns for the project area. As shown in the table, the principle crops that are grown in the area include pasture, alfalfa, grass hay, and small grains.

Crop consumptive use requirements were estimated using the modified Blaney-Criddle method as summarized in the Soil Conservation Service publication "Technical Release No. 21, Irrigation Water Requirements, April 1967, Revised September 1970." Attachment C, Water Supply, contains supporting data used to calculate consumptive use and effective precipitation. Consumptive use values were based on average monthly temperatures for the period of study. Table 4-2 shows the average annual consumptive use requirements for each crop type on Group 1, Group 2, and Group 3 lands.

Effective precipitation was calculated for each month of the 1960 through 1989 period of study. This was also calculated according to the Technical Release No. 21 method. The project receives an average of 11.69 inches of precipitation annually. Of the total precipitation, an average of 3.03 inches is effective in meeting consumptive use requirements.

**Table 4-1**
**Project Cropping Patterns**

| Crops (Unit--percent) | | | | | | |
|---|---|---|---|---|---|---|
| **Area** | **Small Grains** | **Pasture** | **Hay** | **Alfalfa** | **Fallow and Idle** | **Total** |
| Group 1 (Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, Oak Creek) | 5 | 49 | 9 | 33 | 4 | 100 |
| Group 2 ( Horseshoe, Cedar Creek Twin Creek) | 10 | 39 | 8 | 35 | 8 | 100 |
| Group 3 (Meadow, Sheep, Mower, Brady, Graveyard, San Pitch, Miner & Turpin, M&M, Olsen & Seely, Frandsen McArthur, Moroni, Rock Dam) | 10 | 39 | 8 | 35 | 8 | 100 |

**Table 4-2**
**Consumptive Use of Water**

| | Average annual consumptive use requirement (Unit--acre-feet per acre) | | | | |
|---|---|---|---|---|---|
| **Area** | **Small Grains** | **Pasture** | **Hay** | **Alfalfa** | **Weighted average** |
| Group 1 (Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, Oak Creek) | 1.39 | 1.53 | 1.53 | 2.23 | 1.69 |
| Group 2 ( Horseshoe, Cedar Creek Twin Creek) | 1.39 | 1.53 | 1.53 | 2.23 | 1.64 |
| Group 3 (Meadow, Sheep, Mower, Brady, Graveyard, San Pitch, Miner & Turpin, M&M, Olsen & Seely, Frandsen-McArthur, Moroni, Rock Dam) | 1.39 | 1.53 | 1.53 | 2.23 | 1.64 |

Table 4-3 summarizes the average annual diversion requirements and shortages per acre for the project area. These average values are based on the 1960 through 1989 period of study. Farm delivery requirements shown in the table are based on an on-farm irrigation efficiency of 60 percent. This efficiency may be higher than farmers currently achieve, particularly on Group 2 lands which are flood irrigated. However, the District has adopted a policy which will only allow farmers who implement conservation measures to receive project water. This policy should result in an overall increase in irrigation efficiency on land that receives project water. Head of canal diversion requirements shown in the table are based on a conveyance efficiency of 98 percent on Group 1 lands and 80 percent on Group 2 and Group 3 lands. Water is delivered to Group 1 lands through pipeline systems; whereas, Group 2 and Group 3 lands receive their water through open canals and ditches.

**Municipal Water Requirement**

There are four cities within the project area: Fairview, Mount Pleasant, Spring City, and Moroni. Each of these cities has two water systems, a municipal system and an irrigation system. This practice allows the untreated surface water to be strictly used for outdoor irrigation of lawns and gardens, freeing up the limited amount of high quality water for inside municipal use.

Because each of these cities rely on the same water sources and the irrigation companies, they experience similar late-season water shortages in their irrigation systems. Average shortages for these systems are about 30 percent. The cities' drinking water sources gave adequate capacity for indoor demands; however, when these late season shortages occur, the municipal water systems become overtaxed as residents try to keeps their lawns and gardens alive by using drinking water.

Based on the average household and lot size in the north Sanpete County area, a total water supply of about 270 gallons per capita per day (GCD) is required. Of this amount about 70 GCD is used indoors and 200 GCD, or 0.22 acre-feet per year per capita is used outdoors. According to the 2010 census the combined population of Fairview, Mt. Pleasant, Moroni, and Spring City is 7,152. This combined population has an outdoor water requirement of 1,573 acre-feet per year. By applying the 30 percent shortage rate, the combined shortage is 472 acre-feet per year. For convenience, this amount was rounded to 500 acre-feet per year.

In addition to satisfying existing shortages, the need for increased municipal water will increase in proportion to population growth. In order to provide 270 GCD supply, 0.3 acre-feet per year will be required for each person of increased population. Table 4-4 summarizes population growth projections for Fairview, Mt. Pleasant, Moroni, and Spring City. These population projections are based on 2010 Census data and growth rates obtained from the Governor's Office of Planning and Budget 2008 sub-county projections.

Table 4-5 summarizes the projected future M&I water use based on the increased population and the 270 GCD water requirement.

**Table 4-3**
**Summary of Average Annual Diversion Requirements and Shortages**

| Area | Weighted Average Consumptive Use (ac-ft/acre) | Effective Precipitation (ac-ft/acre) | To be supplied by irrigation (ac-ft/acre) | Farm Irrigation Efficiency (percent) | Farm Delivery Requirement (ac-ft/acre) | Conveyance Efficiency (percent) | Head of Canal Diversion Requirement (ac-ft/acre) | Usable Existing Irrigation Supply (ac-ft/acre) | Remaining Demand (ac-ft/acre) |
|---|---|---|---|---|---|---|---|---|---|
| Group 1 (Cottonwood-Gooseberry, Birch Creek, Spring Canyon, North Creek, Pleasant Creek, Oak Creek) | 1.69 | 0.25 | 1.45 | 60 | 2.41 | 98 | 2.46 | 1.53 | 0.93 |
| Group 2 ( Horseshoe, Cedar Creek Twin Creek) | 1.64 | 0.25 | 1.39 | 60 | 2.32 | 80 | 2.90 | 2.09 | 0.81 |
| Group 3 (Meadow, Sheep, Mower, Brady, Graveyard, San Pitch, Miner & Turpin, M&M, Olsen & Seely, Frandsen McArthur, Moroni, Rock Dam) | 1.64 | 0.25 | 1.39 | 60 | 2.32 | 80 | 2.90 | 2.27 | 0.63 |
| Weighted Average on Total Area | 1.66 | 0.25 | 1.41 | 60 | 2.35 | 87 | 2.74 | 1.94 | 0.80 |

**Table 4-4**
**Estimated Population Growth**
**Based on 2010 Census and GOPB Growth Rates**

| | 2010[1] | 2020[2] | 2030[2] | 2040[2] | 2050[2] | 2060[2] |
|---|---|---|---|---|---|---|
| Fairview City | 1,247 | 1,427 | 1,635 | 1,821 | 2,067 | 2,403 |
| Moroni City | 1,657 | 1,895 | 2,173 | 2,417 | 2,742 | 3,187 |
| Mount Pleasant City | 3,260 | 3,731 | 4,276 | 4,757 | 5,398 | 6,278 |
| Spring City | 988 | 1,129 | 1,293 | 1,440 | 1,633 | 1,899 |
| Total | 7,152 | 8,182 | 9,377 | 10,434 | 11,840 | 13,768 |

1 Source: 2010 US Census.
2 Growth rates from Governor's Office of Planning and Budget 2008 Sub-County Projections applied to 2010 Census data to obtain population growth projections.

**Table 4-5**
**Projected Narrows Project Future M&I Water Usage**

| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Project M&I Water Use (acre-feet per year) | 500 | 809 | 1,167 | 1,485 | 1,906 | 2,485 |

## SURFACE WATER SUPPLY

### Price River Drainage

The area that drains into the Narrows Reservoir is about 7.6 square miles. Although this area is relatively small, an average of about 8,185 acre-feet of water will flow into the reservoir annually. This inflow is a result of snow accumulation that occurs within the drainage area and is in addition to the water that is presently collected in Fairview Lakes and diverted through Fairview Tunnel.

The gaging station "Gooseberry Creek Near Fairview, Utah," which is located near the proposed dam site, recorded the streamflow from 1960 through 1963 and from 1965 through 1969. Another gaging station, "Gooseberry Creek Near Scofield, Utah," is located 4.25 miles downstream, and has recorded flows from May 1940 to the present. Records for Gooseberry Creek Near Fairview were extended to include 1960 through 1992 by correlation with Gooseberry Creek Near Scofield. These streamflow records are included in Attachment C, Water Supply.

About 0.6 square mile drains into the reservoir downstream from the Gooseberry Creek Near Fairview. This additional inflow was estimated in accordance with the ratio of the drainage area below the gage to the area above the gage.

A simulated operation study for the proposed Narrows Reservoir and Scofield Reservoir is also included in Attachment C, Water Supply, Table C-9. The purposes of study are as follows:

1. Verify water supply for the Narrows Project
2. Identify stream flows and reservoir contents with the Narrows Project
3. Identify changes in stream flow and reservoir contents for use in identifying environmental impacts

The operation study is based on hydrologic data for the 1960 through 2002 period. The study did not go beyond 2002 because several key stream gauging stations were discontinued after that year. As shown in the operation study, Narrows Reservoir will fill and spill in 8 of the 33 years studied. Figure 4-1 illustrates the fluctuations that will occur in the reservoir during the period of study.

Scofield Reservoir will generally operate at a lower level due to implementation of the Narrows Project. Figure 4-2 shows a comparison of Scofield Reservoir contents with and without the Narrows Project.

Depletions to the Price River drainage will average 5,674 acre-feet per year. These reductions in flow will occur primarily as a result of decreased spills out of Scofield Reservoir. During most years, controlled releases from Scofield Reservoir will remain unaltered. However, under prolonged drought conditions, irrigation releases from Scofield Reservoir will be reduced due to lack of water in the reservoir. These reductions occurred in 10 of the 43 years simulated. The reductions for the 1960 through 2002 period averaged 871 acre-feet or less than 2 percent of the historical release. The maximum reduction occurred in year 1992 of the study, when it was about 9,900 acre-feet or 46 percent of the historical release for that year. The project will only impact storage releases. Direct flow rights will be unaffected by the project.

It should be noted, however, that the above reductions in storage releases are based on the 65,700 acre-foot Scofield Reservoir, which was enlarged to accommodate the Gooseberry Project (Narrows Project). Without this enlargement and the associated water rights agreements, the usable capacity of Scofield Reservoir would have remained at 30,000 acre-feet. If the reservoir capacity had remained at 30,000 acre-feet and without the Narrows Project, the storage releases would have been reduced by an average of 970 acre-feet. These reductions would have occurred in 10 of the 33 years simulated with the largest single-year reduction being over 12,000 acre-feet. Therefore, the reductions in storage caused by the Narrows Project are in fact less than the reductions that would have occurred without the enlargement of Scofield Reservoir and the associated water right agreements.

Furthermore, it is important to note that Scofield water users agreed to this reduction in three separate agreements that are discussed later in this chapter.

Figure 4-1

**Narrows Reservoir Operation**

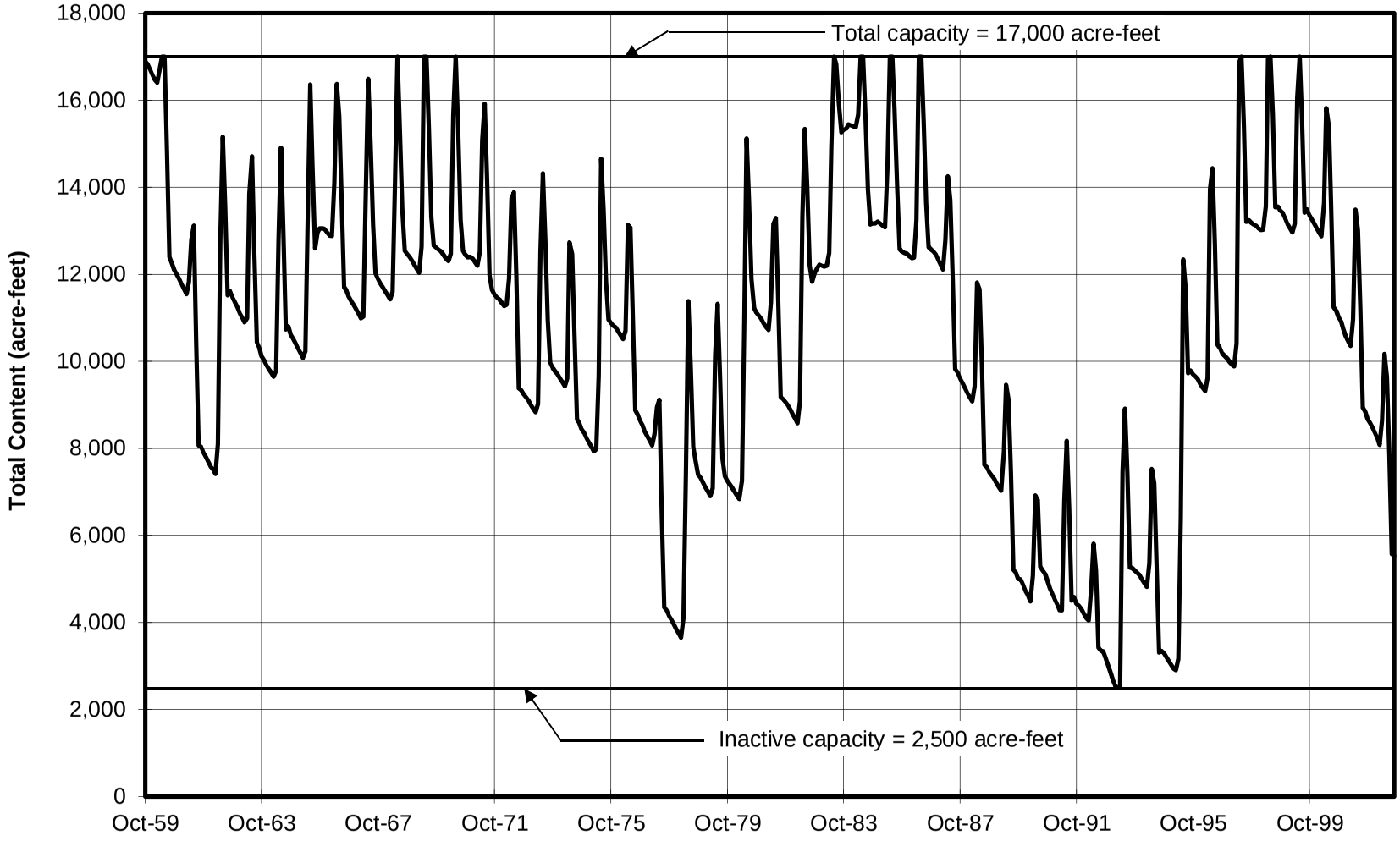
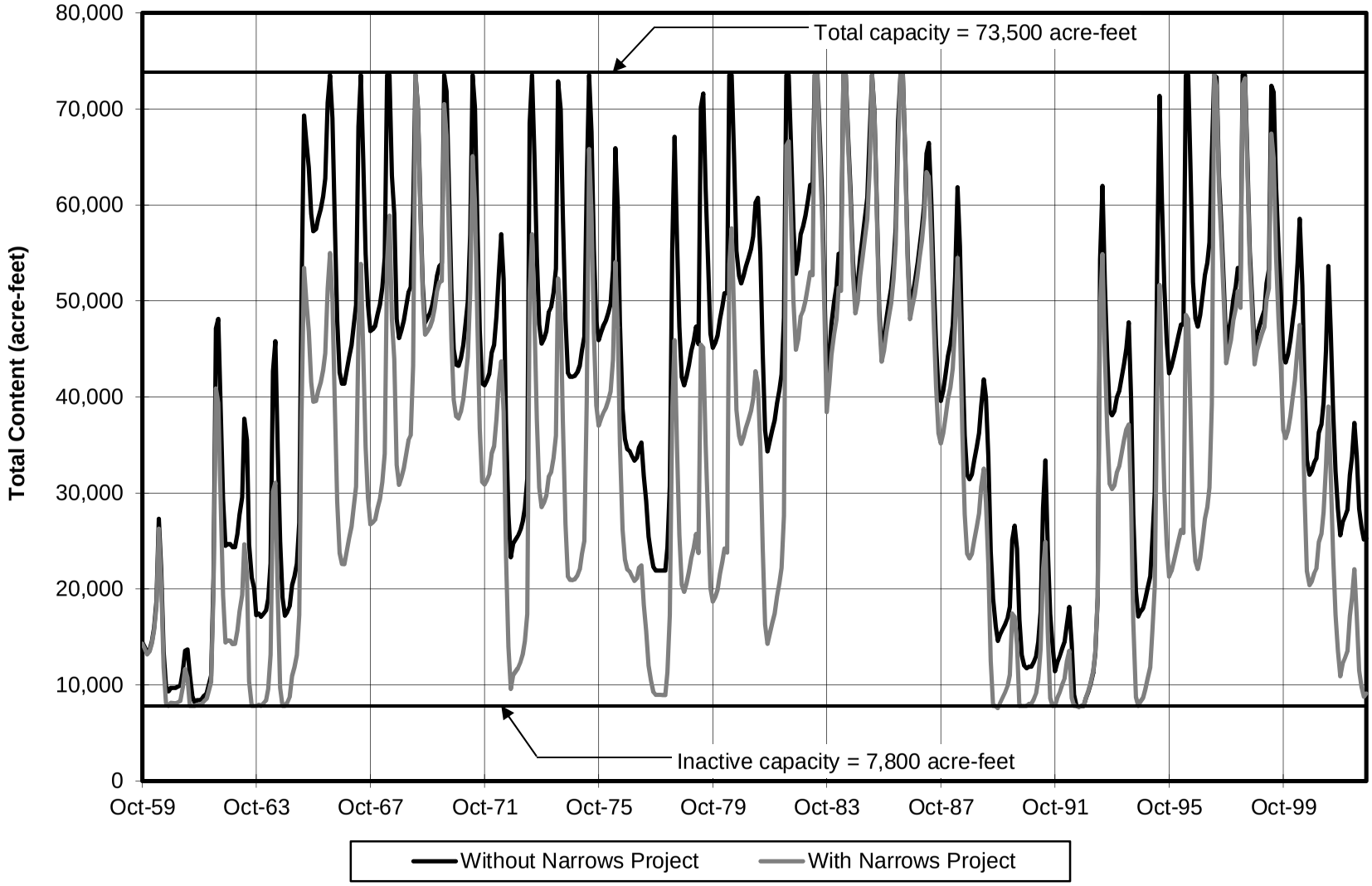


Figure 4-2

**Scofield Reservoir**

Operation Comparison



## San Pitch River Drainage

Lands that will receive project water receive their existing supplies from numerous sources. For clarity and convenience of discussion, the lands have been categorized into three groups.

### Group 1 Lands

Group 1 lands receive their present supply of water from Oak Creek, Cottonwood Creek, Spring Creek, Birch Creek, Cove Creek, Pleasant Creek, and transbasin diversions from the Price and San Rafael River drainages. The transbasin diversions include water delivered through Fairview Tunnel, Candland Ditch, and Coal Fork Ditch.

Table 4-6 summarizes the available recorded data and the methods used to extend missing data. Monthly flow data for Oak, Cottonwood, Spring, Birch, Cove, and Pleasant Creeks are shown in Attachment C, Water Supply. Table 4-7 summarizes the average annual water supply produced by these sources. As shown in the table, the average water supply during the irrigation season for Group 1 lands is 35,198 acre-feet.

**Table 4-6**
**Streamflow Data Summary for Group 1 Lands**

| Water Source | Historical Record | Record Extended by Correlation With |
|---|---|---|
| Oak Creek Near Fairview | 1965 - Present | Pleasant Creek Near Mt. Pleasant |
| Cottonwood Creek | 1990 - Present | Oak Creek Near Fairview |
| Fairview Tunnel | 1951 - 1965<br>1968 - Present | Gooseberry Creek Near Fairview |
| Spring Creek | None | Oak Creek Near Fairview |
| Birch Creek | None | Oak Creek Near Fairview |
| Cove Creek | None | Oak Creek Near Fairview |
| Pleasant Creek | 1955 - 1970 | Oak Creek Near Fairview |
| Candland Ditch | 1950 - 1958 | Spring City Tunnel Near Spring City |
| Coal Fork Ditch | Sept. 1949 - Sept. 1950 | Spring City Tunnel Near Spring City |

**Table 4-7**
**Average Water Supply for All Group 1 Lands**

| Month | Acre-feet |
|---|---|
| April | 1,475 |
| May | 14,830 |
| June | 11,042 |
| July | 3,707 |
| August | 1,953 |
| September | 1,350 |
| October | 841 |
| Total | 35,198 |

### Group 2 Lands

Group 2 lands obtain their present water supply from Twin Creek, Cedar Creek, Oak Creek (near Spring City), Canal Creek, and five transbasin diversions from the San Rafael River drainage. The transbasin diversions include Twin Creek Tunnel, Black Canyon Ditch, Cedar Creek Tunnel, Spring City Tunnel, and Horseshoe Tunnel.

Table 4-8 summarizes the available recorded data and the methods used to extend missing data for Group 2 lands. Monthly flow data for Twin, Cedar, Oak, and Canal Creeks are included in Attachment C, Water Supply. The average annual water supply for Group 2 lands is summarized in Table 4-9. As shown in that table, the average supply during the irrigation season is 23,622 acre-feet.

**Table 4-8**
**Streamflow Data Summary for Group 2 Lands**

| Water Source | Historical Record | Record Extended by Correlation With |
|---|---|---|
| Twin Creek | 1955 - 1960 | Oak Creek Near Fairview |
| Twin Creek Tunnel | 1951 - 1958 | Spring City Tunnel Near Spring City |
| Cedar Creek | 1950 - 1958 | Oak Creek Near Fairview |
| Black Canyon Ditch | 1950 - 1958 | Spring City Tunnel Near Spring City |
| Cedar Creek Tunnel | 1950 - 1958 | Spring City Tunnel Near Spring City |
| Oak Creek Near Spring City | 1965 - 1974<br>July 1979 - Present | Oak Creek Near Fairview |
| Spring City Tunnel | 1950 - Present | NA[1] |
| Canal Creek | None | Oak Creek Near Fairview |
| Horseshoe Tunnel | 1950 - 1958 | Spring City Tunnel Near Spring City |

[1] NA = Not Applicable.

**Table 4-9**
**Average Water Supply for All Group 2 Lands**

| Month | Acre-feet |
|---|---|
| April | 818 |
| May | 3,756 |
| June | 9,685 |
| July | 4,356 |
| August | 1,945 |
| September | 1,845 |
| October | 1,217 |
| Total | 23,622 |

### Group 3 Lands

Group 3 lands receive their water supply from the San Pitch River. Historical diversion records are available for these companies for 1960 through 1983 and 1988 to present. These diversion records are contained in Attachment C, Water Supply.

Average monthly diversion for Group 3 lands are summarized in Table 4-10. As shown in the table, the average annual water supply during the irrigation season is 24,204 acre-feet.

**Table 4-10**
**Average Water Supply for All Group 3 Lands**

| Month | Acre-feet |
|---|---|
| April | 2,592 |
| May | 4,620 |
| June | 4,455 |
| July | 3,999 |
| August | 3,590 |
| September | 3,289 |
| October | 1,659 |
| Total | 24,204 |

### Project Water Deliveries

Attachment C, Water Supply, Table C-37 contains a monthly operation study for the 1960 through 1989 period. Key stream gauging stations in the Sanpitch drainage were discontinued after 1989. The purpose of this study is primarily to document existing water supplies and to demonstrate the need for a supplemental water supply. This study shows pre-project remaining demands and project water deliveries. The typical monthly water deliveries are summarized in Table 4-11. As shown in the table, the typical annual water delivery is 5,400 acre-feet. This amount is limited by water right agreements.

**Table 4-11**
**Typical Monthly Project Releases**

| Month | Acre-feet |
|---|---|
| April | 0 |
| May | 6 |
| June | 373 |
| July | 2,250 |
| August | 2,325 |
| September | 442 |
| October | 4 |
| Total | 5,400 |

During initial operation of the project 500 acre-feet of water per year will be provided for municipal use and 4,900 acre-feet for agricultural use. Over time, as a result of population growth, a portion of the agricultural water will be converted to municipal use.

## WATER RIGHTS

### Background

To understand the water rights for the Narrows Dam and Reservoir Project, one must understand its genesis. It is part of the original Gooseberry Project plan, a plan formulated in the 1930's which included three major features:

- A dam on Gooseberry Creek with feeder canals from Brooks Canyon and Cabin Hollow Creeks;
- A transmountain tunnel to transport the stored water to the San Pitch River basin; and
- An enlarged Scofield Reservoir to provide water by exchange to support the transmountain diversion of water from Gooseberry Creek.

Due to a variety of factors, including the unsafe condition of the original Scofield Dam structure, the reconstruction effort on Scofield Dam was undertaken first, ahead of the Narrows Dam and transmountain tunnel. The new Scofield Dam, authorized June 24, 1943, included 30,000 acre-feet of replacement storage capacity (replacing the existing 30,000 acre-foot structure), 8,000 acre-feet of dead storage (conservation pool), and 35,000 acre-feet of exchange capacity to support the transmountain diversion of Gooseberry Creek water from the Narrows Dam. As a part of the reconstruction effort, several significant agreements and understandings were reached. They include:

#### Tripartite Contract of 1943

The contract of October 11, 1943, between the United States of America, the Carbon Water Conservancy District, and the Price River Water Conservancy District (predecessor to the Price River Water Users Association) is generally known as the Tripartite Contract. It is a contract whereby the United States of America acting through its Bureau of Reclamation conditionally

promised to undertake the reconstruction of Scofield Dam. The contract also established the relative rights of the parties to the use of waters of the Price River both at the Narrows Project site and at the Scofield Reservoir site. The operational plan includes:

- An operational plan on Scofield Reservoir that specifically recognizes the principal features of the Gooseberry Project plan. It expressly gives the United States the right to store and divert in any year all waters arising in the Price River system above the confluence of Cabin Hollow and Gooseberry Creeks for transmountain diversion to the San Pitch River system.
- A subordination of the Price River Water Users Association's water rights to the water rights filed by the U.S. Bureau of Reclamation to cover the additional storage capacity being built into Scofield Reservoir to support the Gooseberry transmountain diversion.
- Subject to certain limitations, the Price River Water Users Association was given the right to full use of the active capacity of Scofield Reservoir, but was required to release such water from Scofield Reservoir as might be necessary to offset any adverse effects resulting from the Gooseberry Creek transmountain diversion.

**Scofield Reservoir Repayment Contract of February 28, 1944**

The contract covering the repayment obligation on Scofield Reservoir was entered into February 28, 1944, by and between the United States of America and the Carbon Water Conservancy District. Therein, the Carbon District agreed to operate Scofield Dam and Reservoir in accordance with the Gooseberry plan as set forth in the Tripartite Contract. Upon implementation of the Gooseberry Project plan, the Project Sponsor of such plan is required to assume a portion of the reimbursable construction costs on Scofield Reservoir.

**Compromise Agreement of June 8, 1984**

On June 8, 1984, a compromise agreement was reached by and between the Sanpete Water Conservancy District, the Carbon Water Conservancy District, and the Price River Water Users Association. This agreement concerned the construction of storage and diversion works on the Price River system for transmountain diversion of Gooseberry Creek water to the San Pitch River system. The agreement was approved by the United States under the Tripartite Contract, except that the Narrows Project is substituted for the Gooseberry plan mentioned therein. The operational plan developed for distributing the water includes:

Narrows Reservoir

- The Price River Water Users Association again subordinated its water rights to the Narrows Project water rights and reconfirmed the right of the Narrows Project to divert and store each year on a first priority basis all the waters of Gooseberry Creek and its tributaries arising above the Narrows Project site.

However, the Narrows Project is now limited to a transmountain diversion of 5,400 acre-feet of water per year for use in the San Pitch River system.

- The total active storage capacity of the Narrows Project Reservoir, including water stored for minimum streamflow purposes, is limited to 14,500 acre-feet.
- Water from Brooks Canyon and Cabin Hollow Creeks can be diverted, stored, and used to provide minimum streamflows in Gooseberry Creek.

Scofield Reservoir

The parties agreed that the Price River Water Users Association and the Carbon Water Conservancy District should be entitled to use the entire storage capacity of Scofield Reservoir. However, storage releases from Scofield are limited to 30,000 acre-feet annually for use by the Price River Water Users Association and the Carbon Water Conservancy District. That amount is exclusive of replacement water needed to supply prior water rights.

### Water Right Filings

Water rights for the Narrows Project are based on three filings made by the Bureau of Reclamation for the Gooseberry Project. These applications were assigned to the Sanpete Water Conservancy District in an agreement dated July 22, 1975. Table 4-11 provides a summary description of these filings. The filings are now subject to the Compromise Agreement of June 8, 1984.

**Table 4-12**
**Water Right Filings Associated With the Narrows Project**

| Application No. | Claimed Date of Priority | Nature and Amount of Claimed Right |
|---|---|---|
| 14025 (91-130)<br>Change Application a-9237 | January 16, 1941 | Storage 30 cfs |
| 14026 (91-131)<br>Change Application a-9236 | January 16, 1941 | Storage 17,000 acre-feet |
| 14477 (91-132)<br>Change Application a-9238 | September 6, 1941 | Storage 130 cfs |

## WATER QUALITY

The San Pitch River and its many tributaries with their headwaters in the high Wasatch Plateau are the present water source for irrigation on most of the project lands. There are a few irrigation wells in the area, but their use is limited. Melt water from the winter snowpack and mountain springs are the main sources of water.

Water quality data indicates that the water used for irrigation in the area is well suited and of good quality for any crop adapted to the area. The water quality data presented earlier in Table 3-4 indicates the normal trend in that water quality deteriorates somewhat as return flows enter the river. This trend is shown by the data from the San Pitch River at Chester Bridge site.

# CHAPTER 5

## DRAINAGE CONDITIONS

Sanpete Water Conservancy District

# CHAPTER 5

## DRAINAGE CONDITIONS

Drainage conditions for Narrows Project lands were appraised during early investigations and are reflected in land classifications. Only those irrigated lands that have good production and that would not require additional drainage facilities under present project conditions have been selected for supplemental service.

The drainage deficient lands, which were excluded from the project, are comprised of low lying meadows and wetland areas adjacent to the San Pitch River and its numerous tributaries as they crossed the project area. These lands were classified as 6w and 6/std.

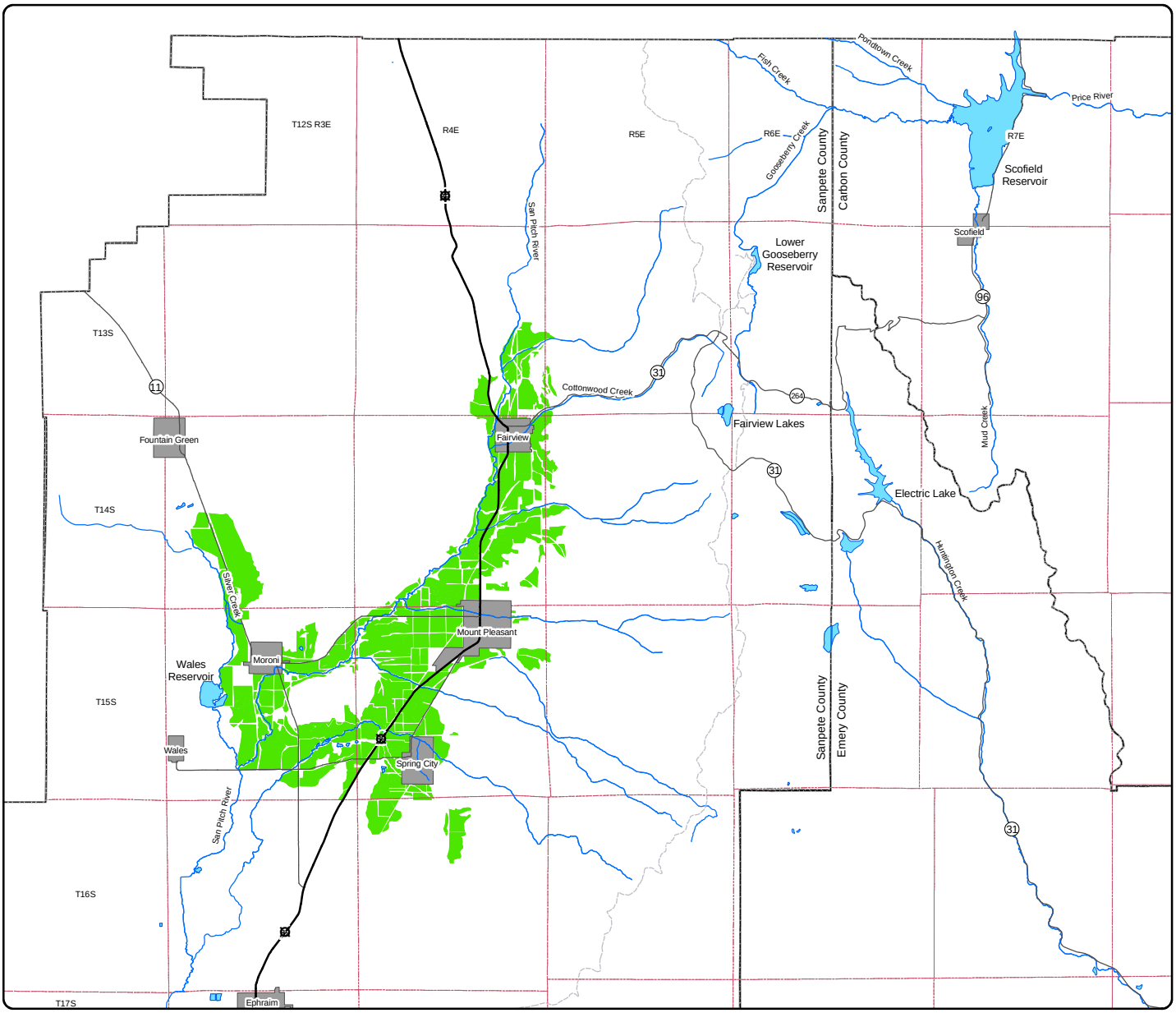
The San Pitch River as it flows south and west through the project lands is deeply entrenched and forms the natural outlet for both surface and subsurface waters. The many tributaries to the river flow from the mountains on the east across the project area and they and the many deep dry washes in the area form an adequate and stable collector system for surface flows.

During the spring of 1984, the area experienced an extremely high runoff and most natural drainage systems were scoured and renewed. Figure 5-1 shows the natural drainage system for the project area.

The wet meadows and grass hay lands are a valuable part of most farm units and fit in well with the existing farm practices of the area. Depth to barrier was not determined for the irrigated wet meadows and topographic low lying lands, either adjacent to or above the river. These lands will continue to be part of the farm economy and will not change under project development.

During the land classification update of project land, water tables were not encountered to depths of 10 feet, as described in the Land Classification Appendix on file in the offices of the Sponsor's consulting engineers, Franson-Noble & Associates, Inc. Lands that had high water tables and lands of low-lying topography were not included as project lands.

No salinity or water table problems are anticipated since project lands have been irrigated for more than 120 years and project development will constitute only one additional irrigation turn per irrigation season.




3

## Legend

- Municipalities
- Lakes and Reservoirs
- Lands to Receive Project Water
- County Boundaries
- Township and Range
- Unimproved Roads
- State Route
- U.S. Highway

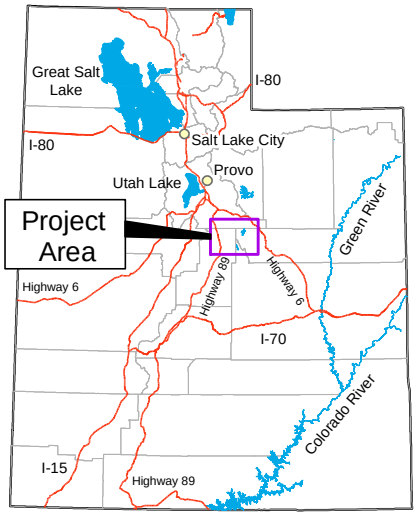
0 1 2 3 4 5 Miles

**Figure 5-1**

# Narrows Project

## Natural Drainage System

Sanpete Water Conservancy District



# CHAPTER 6

## PLAN OF DEVELOPMENT

Sanpete Water Conservancy District

# CHAPTER 6

# PLAN OF DEVELOPMENT

## PROJECT PURPOSE AND OBJECTIVES

### General

This SRPA loan application is for a multi-purpose project that will provide supplemental irrigation water, municipal water, and improve recreation, and fishery opportunities. The project will provide an average annual supply of 4,900 acre-feet of irrigation water for 15,420 acres of presently irrigated farmland and 500 acre-feet of municipal water. Long-standing water rights contracts and agreements will also be honored.

Irrigated farmland within the project area currently experiences average shortages of 30 percent of the annual diversion requirement. Municipal water supplies used for irrigation of lawns and gardens also run short by a similar amount. The Narrows Project will provide a supplemental water supply for these purposes.

There is also a shortage of recreation facilities near the project area. Existing recreation facilities including campgrounds, boat ramps, and reservoirs are overcrowded and inadequate. The Narrows Project will provide improved recreation facilities, including campgrounds, a boat ramp, picnic sites, and restrooms, at Narrows Reservoir. The reservoir will also provide a minimum pool for fish habitat.

### Multipurpose Projects

The SRPA loan program requires that irrigation be a purpose of the proposed project in order to be eligible for SRPA funding. As has been explained previously, this project will provide a supplemental supply of irrigation water for 15,420 acres of farmland.

Water management and conservation will also occur as an indirect project benefit. The District has adopted a resolution which requires irrigators to use sprinklers or other improved efficiency irrigation methods in order to be eligible to receive project water. As a result, the overall efficiency of water use within the project area is expected to increase. The project plan also includes improved outdoor recreation facilities and a minimum pool in Narrows Reservoir for fish habitat.

## PHYSICAL PLAN

### General

The project plan will be accomplished by constructing a dam and reservoir on Gooseberry Creek, a tributary of the Price River, about 9 miles east of Fairview, Utah. Water stored in the reservoir will be released to north Sanpete County through the existing Narrows Tunnel.

Pipelines will be constructed to deliver the water to existing water distribution systems. Oak Creek Pipeline will convey water to the Oak Creek Irrigation Company, north of the community of Fairview. East Bench Pipeline will convey project water from an existing diversion dam on Cottonwood Creek southward to areas of use along the east bench. Upper Cottonwood Creek Pipeline will carry project water from the Narrows Tunnel outlet to the confluence of Cottonwood Creek and Left Hand Fork to protect the stream channel from increased flows that will occur without the pipeline. Another important feature of the project will be the relocation of State Road (SR)-264.

Recreation facilities will be developed adjacent to the reservoir and a minimum pool for fish habitat will be provided. Mitigation measures will be implemented to offset adverse impacts to wetlands, terrestrial wildlife, and stream fisheries. In addition to mitigation measures to offset project impacts, other measures will be included to enhance or improve fish and wildlife habitat. The Frontispiece Map shows the Narrows Project general plan.

## Design and Operation

### Narrows Dam and Reservoir

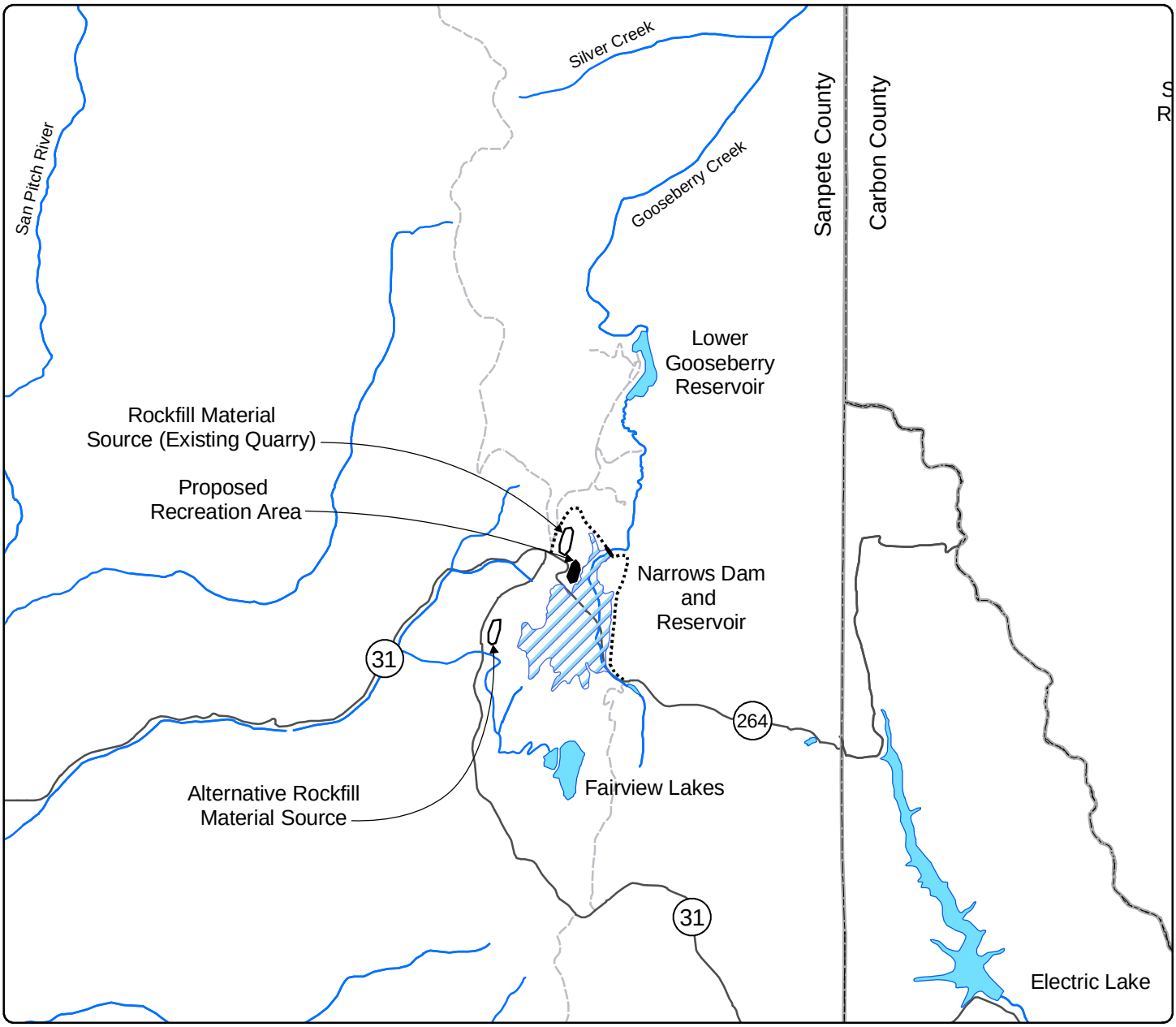
Narrows Dam will be a zoned earthfill embankment structure using locally available earth material. The embankment will have 3:1 (horizontal to vertical) slopes upstream and downstream. The proposed crest width of 30 feet will allow Highway SR-264 to cross the dam. The embankment zones will consist of a relatively impervious core, a random zone both upstream and downstream of the core, and a rockfill zone on the upstream face for slope protection. The embankment will contain a total volume of 363,000 cubic yards of material.

Narrows Reservoir will have two outlets. A Gooseberry Creek outlet will be constructed through the dam to provide downstream releases for fisheries and emergency evacuation of the reservoir. This outlet will have a capacity of 305 cubic feet per second (cfs). Multiple level outlets will be provided to allow temperature control of water released to Gooseberry Creek. Narrows Tunnel, with a capacity of 60 cfs, will serve as the other reservoir outlet and will accommodate releases through the mountain ridge for the transbasin diversion.

Preliminary designs for the dam call for separate low-flow outlets at three different levels within the reservoir. These outlets will have their own gates and will be able to deliver up to a 10 cfs release even when the main outlet is being inspected or maintained.

The spillway will be a drop inlet (morning glory) structure and will have a discharge capacity of 775 cfs. The probable maximum thunderstorm flood could be safely stored in the reservoir without overtopping the dam. However, the spillway will protect the dam against the 100- and 10,000-year snowmelt floods.

Most of the embankment material for the dam will be obtained from the reservoir basin, as shown in Figure 6-1. Rockfill material for upstream slope protection will be obtained from an existing quarry on National Forest System lands near State Road-264. An alternative rockfill material quarry site, located on private land, is also shown on the figure. Granular material for drains will be hauled from commercial pits in Sanpete Valley, near Wales, Utah. Concrete for the outlet works, spillway, and other structures will be batched in Sanpete Valley and hauled to




N

0 1 2
Miles

## Legend

- Proposed Reservoir
- Lakes and Reservoirs
- County Boundaries
- Highway Relocation
- State Route
- Unimproved Roads

**Figure 6-1**

# Narrows Project

**Narrows Dam and Reservoir**

Project Area and Facilities

Sanpete Water Conservancy District

the damsite in transit mixers. Other materials such as pipe, steel gates and structures, electric motors, and operating and control equipment will be manufactured or processed outside the project area. The materials will be hauled to the construction sites by truck.

The reservoir's active capacity, or that portion of stored water that will be used to satisfy project water needs, will consist of 14,500 acre-feet. The dead and inactive capacities of about 2,500 acre-feet will form the reservoir's minimum pool and will not be drawn upon in order to benefit recreation and fishing use at the reservoir. The reservoir is designed for long-term carry-over storage. The dead and inactive storage will be more than adequate to store the 100-year inflow of sediment into the reservoir. Less than 20 acre-feet of sediment will accumulate in a 100-year period, which is less than 1 percent of the inactive capacity. A summary of the design data for Narrows Project facilities is shown in Table 6-1.

Narrows Reservoir will fluctuate on a seasonal basis as water is released during the irrigation season. The drawdown will average about 12 feet annually. Under existing water rights agreements, a maximum of 5,400 acre-feet (without evaporation) per year of project water will be released through Narrows Tunnel. The reservoir will provide long-term carryover storage for consecutive drought years.

Automated flow measurement devices will be installed to collect data in real time using radio or satellite communications. These devices will measure flow at the following locations:

- Discharges from Fairview Lakes
- Discharge from Narrows Dam to Gooseberry creek
- Flow of Gooseberry Creek at USDA Forest Service campground
- Discharge from Narrows Tunnel
- Flow of Cottonwood Creek near the mouth of the canyon

**Oak Creek Pipeline**

The Oak Creek Pipeline will be a 10-inch and 12-inch diameter HDPE buried pipeline with a capacity of 2.5 cfs and a length of 2.3 miles. The pipeline will convey water to the Oak Creek Irrigation Company, north of Fairview. A right-of-way 30 feet wide and 2.5 miles long will be required.

**East Bench Pipeline**

The East Bench Pipeline will convey project water from an existing diversion dam on Cottonwood Creek southward to areas of use along the east bench between Fairview and Spring City. The pipeline will have a total length of 14.5 miles and will have a capacity at its head of 21.5 cfs. The pipeline diameter will vary from 30 inches at the head to 20 inches at the downstream end and will be constructed with HDPE pipe materials. The pipeline will deliver water to the Spring Creek, Birch Creek, North Creek, Pleasant Creek, Twin Creek, Cedar Creek, and Horseshoe Irrigation Companies. Water delivered to each irrigation company will be discharged from the pipeline into the regulating pond for each company’s pressurized irrigation system. This pipeline will also have a 30-foot-wide right of way.

**Table 6-1**
**Design Data Summary**

| Item | Unit | Proposed Plan |
|---|---|---|
| Dam | | |
| Height | feet | 120 |
| Crest length | feet | 550 |
| Crest width | feet | 30 |
| Material volume | cu. yds. | 363,000 |
| Discharge capacity | | |
| Outlet works | cfs | 305 |
| Spillway | cfs | 775 |
| Reservoir capacity | | |
| Active storage | acre-feet | 14,500 |
| Inactive and dead storage | acre-feet | 2,500 |
| Total | acre-feet | 17,000 |
| Surface area | | |
| At top of active capacity | acres | 604 |
| At top of inactive and dead capacity | acres | 144 |
| Average during recreation season[1] | acres | 454 |
| Drawdown | | |
| Average annual | feet | 12 |
| Average during recreation season[1] | feet | 9 |
| Maximum | feet | 18 |
| Drawdown | | |
| Average annual | acre-feet | 5,058 |
| Average during recreation season[1] | acre-feet | 4,043 |
| Pipelines | | |
| Oak Creek | | |
| Length | miles | 2.5 |
| Capacity | cfs | 2.5 |
| Diameter | inches | 10 |
| East Bench | | |
| Length | miles | 13.5 |
| Capacity | cfs | 21.5 |
| Diameter | inches | 27.18 |
| Upper Cottonwood Creek | | |
| Length | miles | 0.8 |
| Capacity | cfs | 50 |
| Diameter | inches | 30 |
| Narrows Tunnel Rehabilitation | | |
| Length | feet | 3,100 |
| Capacity | cfs | 60 |
| Diameter | inches | 36 |
| SR-264 Relocation | | |
| Length | miles | 2.9 |
| Width | feet | 24 |

[1] June through September

### Upper Cottonwood Creek Pipeline

A 50-cfs-capacity pipeline will be constructed from the Narrows Tunnel outlet to the confluence of Cottonwood Creek and Left Hand Fork. The 30-inch diameter pipeline will carry project water outside the stream to prevent damage to the channel. It will be constructed in the shoulder of SR-31, a National and State designated Scenic Byway. It and will have a length of about 0.8 mile. At the tunnel outlet, a control structure will divide the flow. A portion of the flow, that desired for instream flow and the flow in excess of the pipeline capacity, will be released to Cottonwood Creek to improve the fishery. The remainder of the flow will be conveyed in the pipeline. The pipeline flow will be discharged into Cottonwood Creek at the confluence with Left Hand Fork. A right-of-way 30 feet wide and 0.8 mile long will be required.

### Narrows Tunnel

The Narrows Tunnel is an existing water conveyance tunnel approximately 3,100 feet long. The tunnel, which was originally completed in 1968, was constructed to convey irrigation water from Fairview Lakes to the Fairview area and to eventually serve as the outlet for Narrows Reservoir. After its construction, the tunnel began to experience severe stability problems. Steel sets with wooden lagging were installed in selected areas of the tunnel to support the unstable areas. The steel sets, however, were widely spaced and loose rubble significantly loaded the wooden lagging between sets. With time, the lagging began to fail, permitting roof and rib sloughing over significant portions of the tunnel. When it became evident that the tunnel could eventually close, 36-inch corrugated metal pipe (CMP) was installed through the least stable tunnel sections to maintain a waterway. However, this was only a temporary fix because the over time the CMP began to collapse due to rust and excessive earth loads.

During July 2010 through May 2012 the tunnel was rehabilitated by the Cottonwood-Gooseberry Irrigation Company. This work was accomplished by mucking out the tunnel and installing timbers for temporary support. Once the tunnel was fully open and clear, a 54-inch-diameter corrugated high-density polyethylene (HDPE) pipe was installed through the tunnel and backfilled with 3/8-inch gravel to within 1 to 2 feet of the tunnel roof. The backfill provides lateral pipe support and protects the pipe from impact loads in the event of additional collapse of the tunnel roof. The tunnel rehabilitation was designed to provide a discharge capacity of 60 cfs.

### Narrows Tunnel Inlet Rehabilitation

Before the tunnel can be used as an outlet for Narrows Reservoir, additional rehabilitation work is needed near the tunnel inlet. The existing gate shaft concrete is deteriorated and there are significant voids behind the concrete. This concrete will be removed and replaced. All voids will be backfilled with concrete. A new 48-inch control gate will be installed in the gate shaft. An energy dissipation structure will be installed immediately downstream from the control gate. A new guard gate structure will be constructed at the inlet portal of the tunnel. During the tunnel rehabilitation the old 60-inch control gate was removed. This gate and frame will be refurbished and installed at the portal structure where it will serve as the guard gate. Both the control gate and the guard gate will be hydraulically operated. A control building will be constructed at the top of the gate shaft. This building will house the hydraulic gate controls, and SCADA equipment. A small generator set will provide electrical power to operate the hydraulic system

and to recharge a bank of batteries that will operate the SCADA system. Video surveillance and security fencing will also be provided.

### State Road-264 Relocation

Narrows Reservoir will inundate about 0.8 mile of SR-264, a National and State designated Scenic Byway. It provides access between Fairview and Scofield, Utah. Under the project, the road will be relocated by constructing 2.6 miles of new road and providing asphalt surfacing for 0.3 mile of the existing gravel road to Lower Gooseberry Reservoir. The new road will cross Narrows Dam. The road relocation will increase the travel distance between Fairview and Scofield by 1.2 miles. The relocated road will have a total pavement width of 24 feet and will be designed to the same standard as the existing road.

### Recreation Facilities

Public recreation facilities for the Narrows Project will be located along the northwest shore of Narrows Reservoir as shown earlier on Figure 6-1. The facilities will include a boat ramp, boat slips, a day-use area with 10 picnic sites, restroom facilities, and a 60-unit campground. Access for the handicapped will be provided. Municipal water for the recreation facility will be supplied by developing a spring and pumping water to a new storage tank with a hydraulic ram. All recreation facilities will be constructed to Forest Service standards. The Forest Service will operate and maintain the recreation facilities.

### Fishery Measures

A total of 11 fishery measures have been included in the project to mitigate for adverse impacts that have been identified with the project. To the extent possible, an attempt was made to mitigate "in place" and "in kind." The 11 mitigation measures are:

**Restore Streamflow in Gooseberry Creek Tributaries.** Implementation of this aquatic mitigation procedure will consist of altering the release of water from Fairview Lakes, which is owned and operated by the Cottonwood-Gooseberry Irrigation Company. Presently, during the spring runoff period, water is stored in Fairview Lakes and released for irrigation use in the Fairview area. This release is a transbasin diversion of water to the San Pitch River drainage. With the historic operational pattern, the small tributaries to Gooseberry Creek located downstream from Fairview Lakes are dry several months each year. This mitigation measure involves providing year-round releases, averaging about 2.6 cfs, from Fairview Lakes into two of these tributaries to Gooseberry Creek. This amounts to an average flow of 1.3 cfs per channel. The total annual amount of water that is released from Fairview Lakes will not be changed. However, the flow will be dispersed during the entire year rather than the present 18- to 20-week discharge period.

Water released from Fairview Lakes during the year will be captured and stored in Narrows Reservoir. Upon call by the Cottonwood-Gooseberry Irrigation Company, their water will be released through the Narrows Tunnel to the San Pitch River drainage. This mitigation measure not only provides aquatic mitigation benefits to the Narrows Project, but will provide both aesthetic and recreational benefits to Fairview Lakes. These benefits will be a result of the lakes being maintained at a higher water level during the prime summer recreational season.

The District will be responsible for entering into operating agreements necessary to implement these year-round releases. The District will also ensure that the releases are made according to environmental commitments.

Implementation of this mitigation measure will result in the creation of approximately 2.3 stream miles of spawning and rearing habitat for cutthroat trout.

**Provide Minimum Flows Below Narrows Dam.** The Project plan calls for a minimum year-round release of 1 cfs from Narrows Reservoir to Gooseberry Creek. That flow, combined with flows from springs located immediately below the dam, is expected to produce a stream flow of at least 1.5 cfs at the Gooseberry Campground. If the flow at the campground is less than the expected 1.5 cfs, then up to an additional 0.25 cfs will be released to achieve that flow rate.

**Provide a Multiple-Level Outlet at Narrows Dam.** A multiple-level outlet will be provided at Narrows Dam to regulate the temperature of water released to Gooseberry Creek. The outlet will be designed with a capacity of 10 cfs.

**Stabilize Stream Banks Along Middle Gooseberry Creek.** This mitigation measure will involve narrowing the channel of Gooseberry Creek between Gooseberry Reservoir and Narrows Dam so it will provide better habitat with the reduced flows. It is expected that the channel will eventually narrow by itself due to the decreased flow. However, in order to expedite the process, certain man-made improvements will be made. Prior to construction of these improvements by the District, a detailed design will be developed by the District with coordination with the Forest Service, the U.S. Fish and Wildlife Service, the Corps of Engineers, the Utah Division of Wildlife Resources, and the Utah Division of Water Rights. A 40-acre parcel of private land that the stream runs through will be acquired. Fencing will also be provided where needed to protect the stream from livestock. Middle Gooseberry Creek will be used as spawning and rearing habitat for cutthroat trout.

**Provide Flushing Flows and Other Releases to Gooseberry Creek.** The project will provide releases from Narrows Reservoir to Gooseberry Creek in excess of the minimum 1 cfs release described above. These additional releases will be used to provide additional instream flows in excess of the 1 cfs minimum release or to flush accumulated silt and fine sediments from the streambed to enhance spawning habitat. The Utah Division of Wildlife Resources has expressed interest in using this water to provide additional inflow to Lower Gooseberry Reservoir during critical winter period when dissolved oxygen levels in the reservoir are low. The project will provide an average of 300 acre-feet per year of additional water for release to Gooseberry Creek. This water, released from carryover storage in Narrows Reservoir, may be used for fish habitat or flushing flows. The District in cooperation with the Utah Division of Wildlife Resources will determine the timing and quantity of water to be released each year.

**Acquire and/or Improve Stream Segments.** This measure will involve improving fishery habitat and fencing 15.5 miles of stream, 11.5 miles in the Price River drainage and 4 miles in the Spanish Fork River drainage. Most of these stream segments are on private land, therefore approximately 303 acres of right-of-way will be acquired. A corridor, averaging approximately 200-feet wide, will be acquired. Fishery habitat improvements such as riparian plantings and some minor channel work will be performed. About 2 miles of stream will be

improved in conjunction with the Mud Creek wetland restoration area and 1 mile of stream will be improved in conjunction with the acquisition of 640 acres of wildlife habitat adjacent to the Price River below Scofield Reservoir. The various parcels of land will be contiguous with other public lands and will be managed in conjunction with those public lands. Memoranda of Understanding will be required between the District and the managing agencies. The corridor will be fenced with a pole top fence to protect the stream banks and riparian zone from damage caused by grazing. Where the adjacent land is used for grazing, selected stream access points for livestock watering will be provided or other alternative livestock watering means will be provided. Table 6-2 is a list of stream segments that have been recommended for this measure and the proposed managing agencies. Additional parcels will be identified and evaluated if necessary in order to achieve the mitigation goal. The streams improved and protected under this measure will provide habitat for all life stages of cutthroat, rainbow, and/or brown trout. A monitoring program will be established to ensure that the stream segments are acquired, improved, fenced, and maintained as planned.

**Provide Winter Releases to Cottonwood Creek.** A release sufficient to maintain a minimum flow of 2 cfs will be made from Narrows Reservoir to Cottonwood Creek to increase the available fish habitat. Water released during the winter months will be stored in Wales Reservoir on a space-available basis.

**Provide Summer Flows in Lower Cottonwood Creek.** A minimum instream flow of 2 cfs will be provided in lower Cottonwood Creek from the canyon mouth to the confluence with the San Pitch River. This measure will provide year-round flows in the stream which will support fish habitat and create a fishery for local residents and enhance the riparian corridor. This segment of stream has been historically dewatered during the irrigation season.

**Construct Upper Cottonwood Creek Pipeline.** Upper Cottonwood Creek Pipeline will be constructed as described earlier in this chapter.

**Table 6-2**
**Stream Segments to be Acquired and/or Improved for Fishery Habitat**

| Stream Reach | Length of Stream (miles) | Proposed Managing Agency |
|---|---|---|
| **Price River Basin** | | |
| Mud Creek | 4.0 | UDWR[1] |
| Winterquarters Creek | 2.5 | UDWR |
| Pondtown Creek | 2.0 | FS[2] |
| Fish Creek above Scofield Reservoir | 1.0 | FS |
| Price River below Scofield Reservoir | 2.0 | UDWR |
| **Spanish Fork River Basin** | | |
| Starvation Creek | 4.0 | UDWR |

[1] Utah Division of Wildlife Resources
[2] U.S. Forest Service

**Provide a Minimum Pool in Narrows Reservoir.** A minimum pool of 2,500 acre-feet will be provided in Narrows Reservoir for fish habitat. This pool will not be drawn upon for irrigation. At the minimum pool, the reservoir will have a surface area of 144 acres and a maximum depth of 58 feet.

**Reduce External Phosphorus Loading to Scofield Reservoir.** This measure will help improve the water quality in Scofield Reservoir by reducing phosphorus loading and will be implemented in conjunction with the improvement of stream segments on tributary streams above Scofield Reservoir. About 9.5 miles of stream segments will be improved. The improvements will consist of bank stabilization, primarily through riparian plantings. The stream segments will also be fenced to protect them from grazing impacts. This measure will reduce the amount of sediment and animal waste and hence the amount of phosphorus flowing into the reservoir. Historically fish kills have occurred in Scofield Reservoir due to poor water quality. Phosphorus has been identified as the limiting nutrient in the eutrophication of the reservoir. Phosphorus loading occurs through several methods including inflow of sediments which are naturally high in phosphorus and animal waste. The Utah Division of Water Quality in a report entitled "Scofield Reservoir Restoration through Phosphorus Control" concluded that:

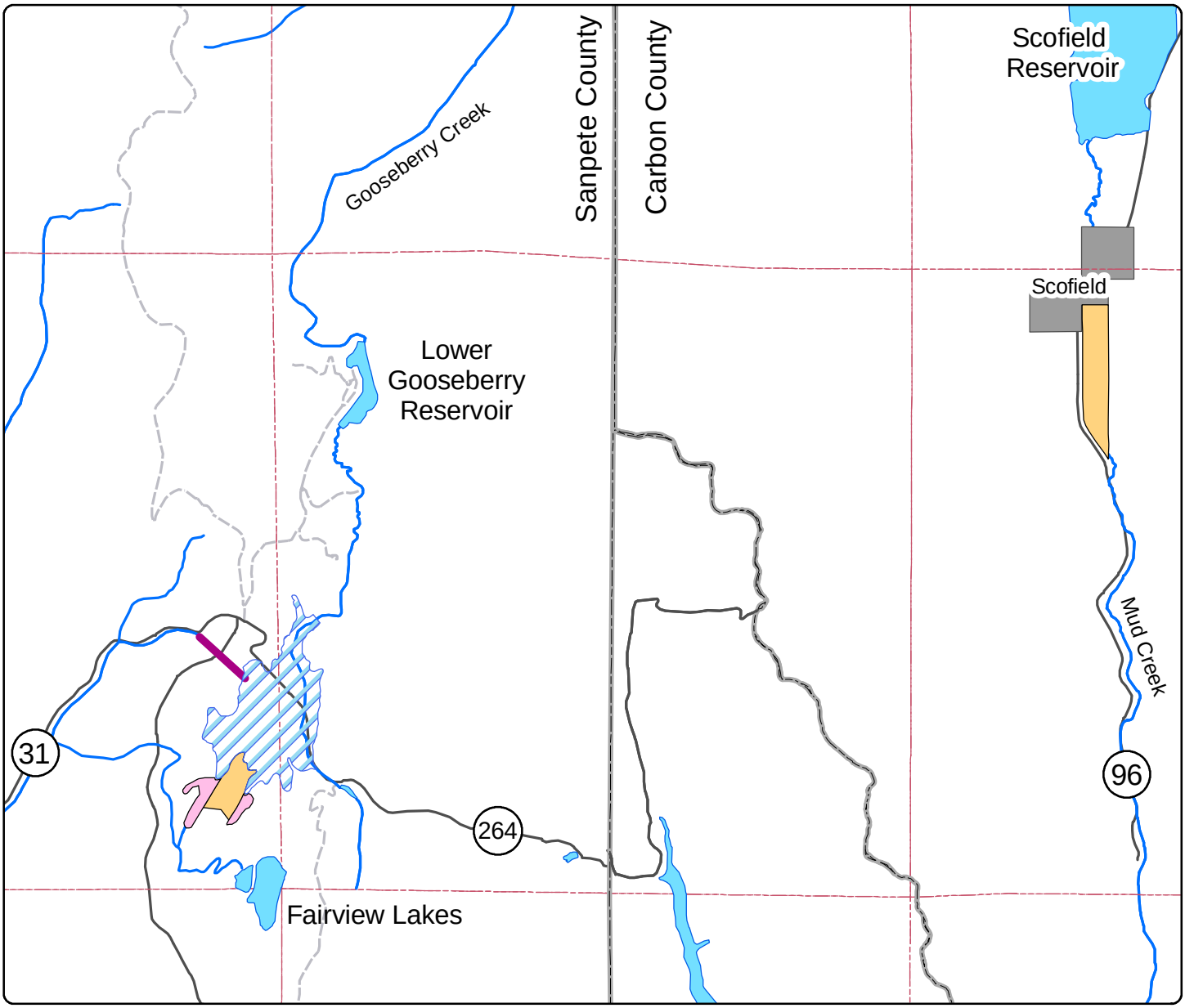
> *The most pragmatic and effective means to control the further eutrophication of Scofield Reservoir, or possibly to effect a moderate reversal of the eutrophication process, appears to be a reduction of the phosphorus load to the lake.*

The District will have primary responsibility for implementation of all fishery measures described above. The District will be responsible for funding and acquiring all lands and rights-of-way. The District will fund and construct all improvements such as fencing and stream channel improvements. The District will provide water from its water rights or enter into operating agreements for all in-stream flows described above. This work will be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way will be acquired and initial construction of fishery measures will be completed prior to initial filling of the reservoir. The District will be responsible to fund all operation and maintenance costs of mitigation facilities. The District will be responsible to enter into a Memorandum of Agreement with the Utah Division of Wildlife Resources and other appropriate agencies for all fishery measures. The Memorandum of Agreement will clearly define the roles and responsibilities of the District, the Utah Division of Wildlife Resources, and other parties for implementation, monitoring, and maintenance of the fishery measures.

**Wetlands Measures**

Wetlands measures will be included in the project to mitigate for unavoidable adverse impacts to wetlands that have been identified with the project. Four alternative wetland mitigation sites have been identified. The actual mitigation that is implemented could be from one or a combination of these alternatives. A brief description of each alternative follows.

**Restore Wetlands Adjacent to Mud Creek Near Scofield.** This measure will entail purchasing about 220 acres of private land adjacent to Mud Creek, south of the town of Scofield, as shown in Figure 6-2. This land is a former wetland that has been severely damaged by cattle. It is anticipated that by removing the cattle the wetland vegetation will return on its own with little or no other outside measures. All or a portion of the required wetland




## Legend

- Municipalities
- Lakes and Reservoirs
- Proposed Reservoir
- Proposed Alternative Wetlands Mitigation Area
- Existing Wetland Area
- County Boundaries
- Township and Range
- State Route
- Unimproved Roads
- Narrows Tunnel

N

0 1 2 Miles

**Figure 6-2**

# Narrows Project

**Alternative Wetlands Mitigation Sites Located Adjacent to Mud Creek and Narrows Reservoir**

Project Area and Facilities

Sanpete Water Conservancy District

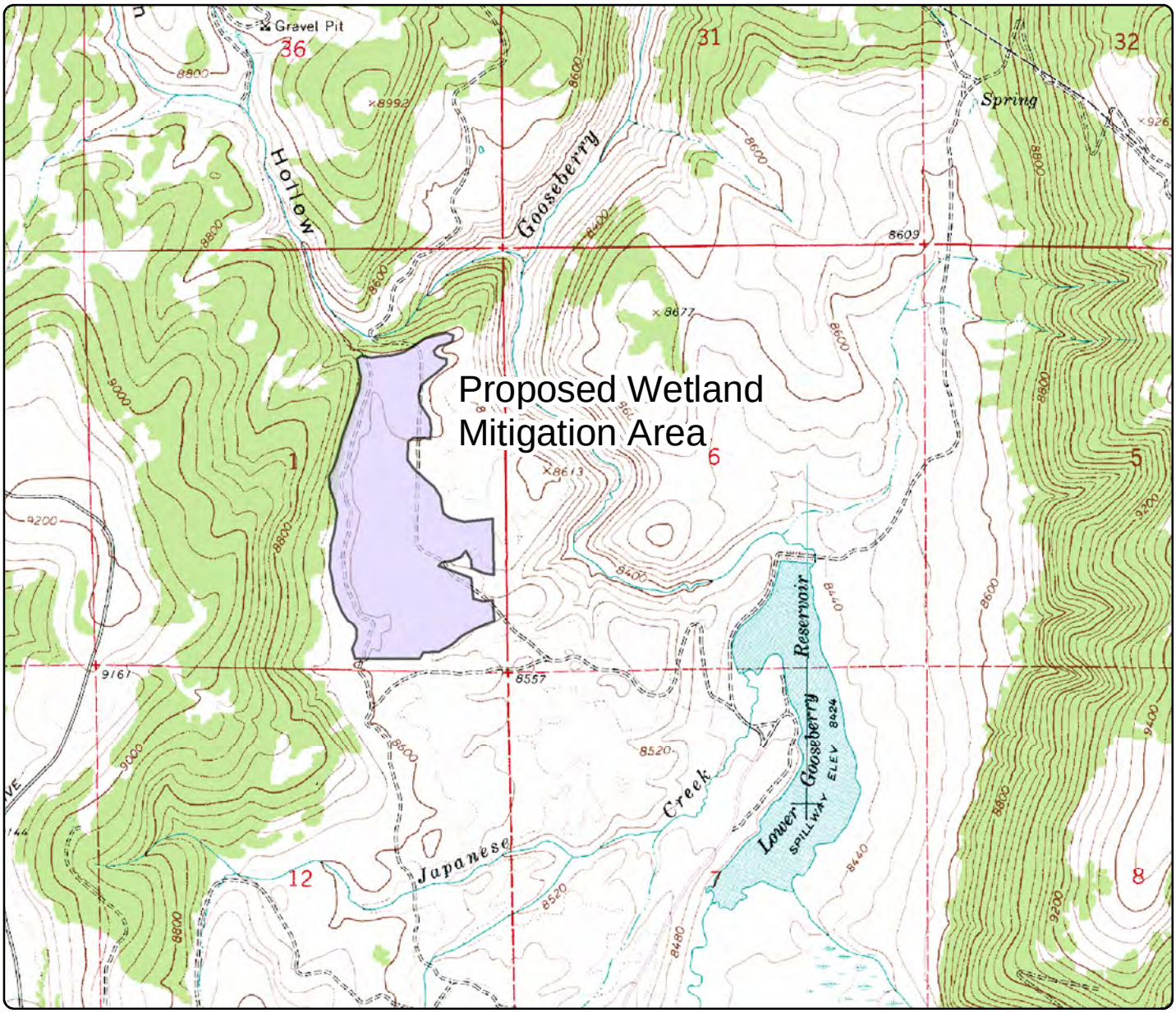
mitigation could be performed at this site. This wetland area will be maintained by the District under a Memorandum of Agreement with the Utah Division of Wildlife Resources.

**Area West of Lower Gooseberry Reservoir.** This alternative, as shown in Figure 6-3, would be developed near Lower Gooseberry Reservoir with an approximate elevation of 8,600 feet above msl. Approximately 120 acres of private land would be acquired west of the reservoir. The land currently is used for grazing sheep, and there are few existing wetlands. Water would be diverted from an existing diversion structure on Cabin Hollow, transported to the site through an existing open ditch, and would cause no additional adverse impacts to Cabin Hollow Creek. The water planned for mitigation purposes is an existing diversion now used for pasture irrigation at the same site. The water would be diverted from the ditch at several locations and allowed to flow across the uplands and the surrounding wetlands. The existing wetlands on this site appear to have been created and maintained by the existing irrigation system. Some earth work would need to be done to create small berms and swales that would create cells of wetlands. The area around the perimeter would be excavated somewhat deeper and to a 20-foot-minimum width and a wider width in some areas so that the edge of the swale is not abrupt but serpentine.

**Enlarge and Create New Wetlands Adjacent to Narrows Reservoir.** This alternative will include enlarging existing wetland areas and creating new wetlands adjacent to Narrows Reservoir. This site is also shown in Figure 6-2. About 100 acres of new wetlands will be created adjacent to Narrows Reservoir. This will be accomplished by releasing water from Narrows Reservoir and spreading it out over land adjacent to existing wetlands. A new outlet from Fairview Lakes will be provided. The outlet will be designed to automatically begin releasing water once Fairview Lakes reaches a certain level. The releases will stop as the water level recedes in the fall. The water will be conveyed to and distributed within the wetland area by a system of open ditches. Some recontouring will be performed to ensure that the soils become saturated. All or a portion of the required wetland mitigation may be performed at this site. This wetland area will be maintained by the Utah Division of Wildlife Resources under a Memorandum of Agreement with the District.

**Manti Meadows**. Under this alternative, return flows from the Narrows Project in the San Pitch River drainage would be made available to UDWR to use at the Manti Meadows Waterfowl Management Area located southwest of Manti as shown in Figure 6-4. The elevation of this site is approximately 5,460 feet above msl. The water would be delivered by diverting Sixmile Creek water, which belongs to the Gunnison Irrigation Company and flows into Gunnison Reservoir, and delivering it to the Manti Meadows area through existing facilities belonging to the Manti Irrigation and Reservoir Company. Narrows Project return flows arising in the San Pitch River would be delivered to Gunnison Reservoir in exchange for the water delivered to Manti Meadows. The water would be used to create at least 100 acres of new wetlands and to improve wetland habitat values of existing wetlands in the area. Some excavation and ground recontouring of existing uplands would be required to control drainage and encourage wetland development.

A final wetlands mitigation plan will be prepared in conjunction with the Clean Water Act Section 404 Permit that will be obtained from the US Army Corps of Engineers. The wetlands measures will need to provide similar functions as the wetlands that will be inundated by the reservoir.




N

0 0.1 0.2 0.3 0.4 0.5
Miles

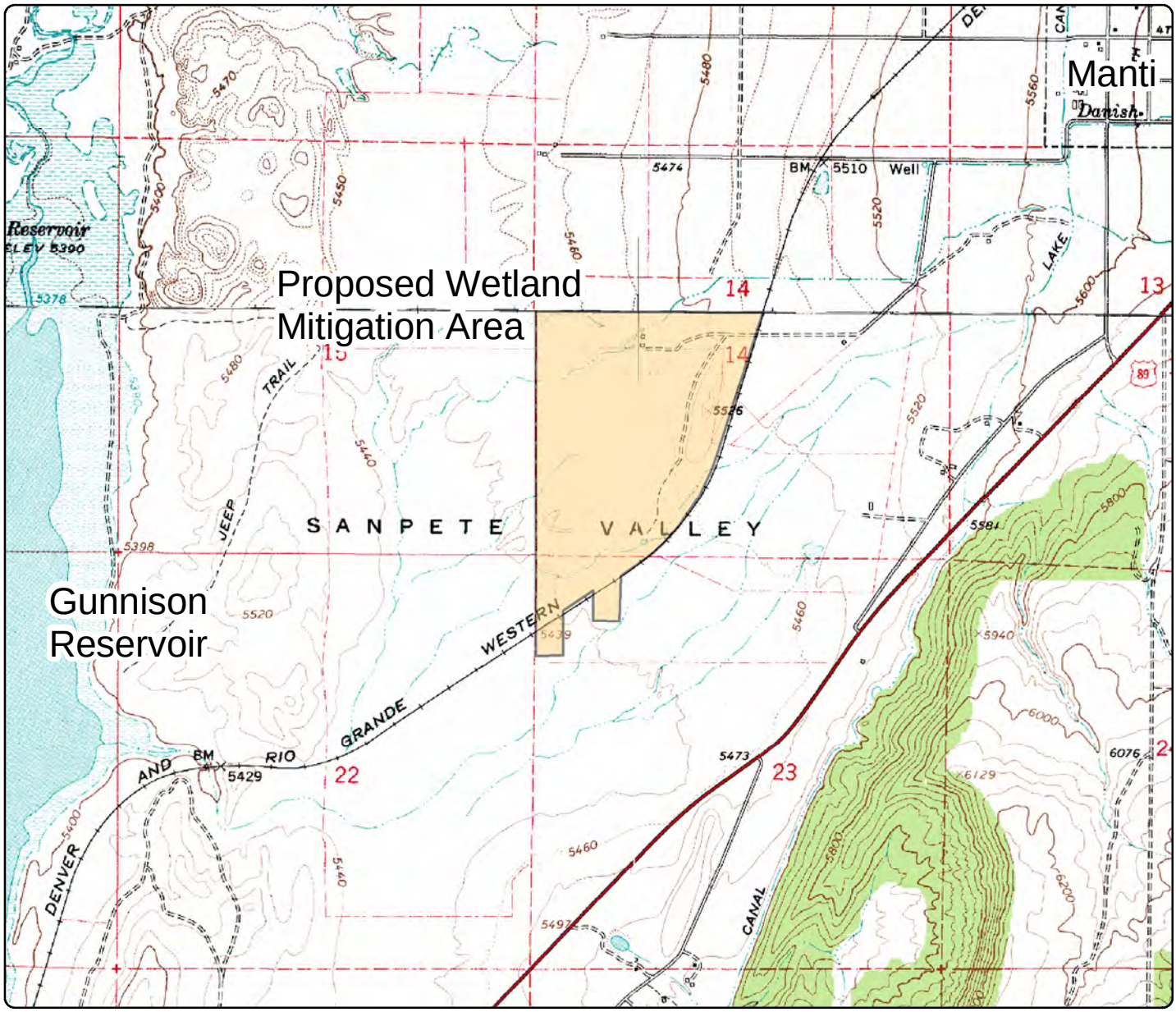
**Figure 6-3**

# Narrows Project

**Alternative Wetland Mitigation Area**
**West of Lower Gooseberry Reservoir**

Project Area and Facilities

Sanpete Water Conservancy District




N

0 0.25 0.5 Miles

**Figure 6-4**

## Narrows Project

**Alternative Wetland Mitigation Area**
**Manti Meadows**

Sanpete Water Conservancy District

Careful monitoring of the mitigation sites will be conducted to ensure that the value of the mitigation sites is at least equal to the value of the wetlands lost. This determination will be accomplished by function assessment that will be conducted before and after implementation of the mitigation.

The District will have primary responsibility for implementation of the wetlands measures described above. The District will be responsible for funding and acquiring all lands and rights-of-way. The District will provide and transplant any plantings needed. The District will be responsible to ensure that all fences are in good repair and are maintained properly. The District will also be responsible to install and maintain any diversion and/or irrigation facilities. This work will be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way will be acquired and initial construction of wetlands measures will be completed prior to initial filling of the reservoir. The District will also be responsible to fund the monitoring of the wetland mitigation. The District will be responsible to enter into Memorandums of Agreement with the Utah Division of Wildlife Resources, Corps of Engineers, and other appropriate agencies for all wetlands measures. The Memorandums of Agreement will clearly define the roles and responsibilities of the District, the Utah Division of Wildlife Resources, the Corps of Engineers, and other parties for implementation and maintenance of the wildlife measures.

**Wildlife Measures**

The wetlands measures described above will offset any losses to wetland habitat caused by inundation. Impacts to upland habitat (mule deer and Brewer's sparrow habitat) will be mitigated by the District in the following ways:

**Watershed and Range Improvement.** Participation in watershed and range improvement projects on the Manti-La Sal National Forest such as the tarweed eradication program. Mitigation credit will be obtained by supplementing the Forest Service's seed mixture with other species to provide bio-diversity and to improve habitat for impacted species. Seeds that could be added to the mixture include big sagebrush and a variety of forbs. The District could also assist the Forest Service in increasing the treatment area.

**Conservation Easements.** Acquisition of 150 acres of conservation easements adjacent to the Narrows Reservoir. These easements will include restrictions on land use that will benefit impacted species. In addition, the conservation easements will provide a setback of about 500 feet for any new development or construction of private land adjacent to the reservoir.

**Acquire Private Land.** Acquisition of 640 acres of private land adjacent to the Price River below Scofield Reservoir. Wildlife values will be enhanced by fencing the land to protect it from livestock grazing.

As with fishery mitigation, the goal of the wildlife mitigation will be to provide as near as possible full mitigation to each impacted species.

As part of the conservation easements for the 150 acres adjacent to Narrows Reservoir, certain restrictions on the landowners' use of their lands will be needed. These restrictions will include

the prohibition of such things as further construction of residential structures; commercial uses such as motels, cafes, hunting or fishing clubs, subdivisions, etc.; livestock grazing; and the storing or use of pesticides, herbicides, or chemical agents, either directly or indirectly lethal to wildlife. In addition, these lands will be made available to the general public for hunting, fishing, or other recreational uses without permit or charge of fees by the landowners. Specific measures or restrictions will be developed individually as part of the easement negotiation process with each involved landowner.

As part of the wildlife mitigation plan, a monitoring program will be developed. Existing wildlife values on mitigation lands will be identified using the same models that were used to identify project impacts. These same models will also be used to measure the success of any wildlife mitigation programs. If the proposed mitigation programs are not as successful as anticipated, additional mitigation will be required. This procedure will apply to both wetland and upland wildlife habitat.

The District will have primary responsibility for implementation of all wildlife measures described above. The District will be responsible for funding and acquiring all lands and easements. The District will provide seed to supplement the Forest Service seed mixture for the watershed and range improvement projects. The District will fund and construct all improvements such as fencing. This work will be performed concurrently with construction of other project facilities such as the dam, tunnel rehabilitation, and pipelines. All lands and rights-of-way will be acquired and initial construction of wildlife measures will be completed prior to initial filling of the reservoir. The District will also be responsible for funding the mitigation monitoring. The District will be responsible to enter into Memorandums of Agreement with the Utah Division of Wildlife Resources, Forest Service, and other appropriate agencies for all wildlife measures. The Memorandums of Agreement will clearly define the roles and responsibilities of the District, the Utah Division of Wildlife Resources, the Forest Service, and other parties for implementation and maintenance of the wildlife measures.

**Construction Materials**

Locations of materials necessary for construction of Narrows Dam and Reservoir were shown earlier in Figure 6-1. Most of the embankment material for the Narrows Dam will be obtained from the reservoir basin. Rockfill material for upstream slope protection will be obtained from an existing quarry on National Forest land near SR-264. An alternative rockfill material quarry site is located on private land and was also shown in Figure 6-1. Granular material for drains will be hauled from commercial pits in Sanpete Valley, near Wales, Utah. Concrete for the outlet works, spillway, and other structures will be batched in Sanpete Valley and hauled to the damsite in transit mixers. Other materials such as pipe, steel gates and structures, electric motors, and operating and control equipment will be manufactured or processed outside the project area. The materials will be hauled to the construction sites by truck.

## LANDS FOR PROJECT FEATURES AND RELOCATION

About 1,868 acres of land will be required for project features, wetland mitigation, fishery and wildlife enhancement and mitigation, and material source areas. About 0.8 mile of SR-264 will be inundated by Narrows Reservoir, as described earlier in this chapter. The amounts of land by present ownership or administration and proposed project use are shown in Table 6-3. There will be no relocation of persons, families, businesses, farms, or nonprofit organizations resulting from construction of the Narrows Project.

National Forest System lands will be obtained for project uses by (1) Reclamation withdrawal, (2) Forest Service right-of-way permits, or (3) Forest Service special-use permits. The District will acquire private lands for project uses from owners by perpetual easement.

The acquisition of private lands required for fish and wildlife mitigation will be primarily by fee title. The conservation area adjacent to the reservoir will be created through conservation easements. These lands will be administered by the District under a cooperative agreement with the Utah Division of Wildlife Resources. To assure proper management of easement lands needed to mitigate fish and wildlife losses attributed to the project, certain restrictions on the landowners' use of their lands will be needed. Specific measures or restrictions, including those to protect fish and wildlife values, will be developed by the Utah Division of Wildlife Resources as part of the easement negotiation process with each involved landowner. If adequate easements cannot be secured, a fee-title acquisition of the lands will be made.

### Access to Features

Construction access is fairly good for all project features. The proposed damsite is near an existing paved highway. This highway should be adequate for hauling materials and equipment to the site. Temporary haul roads will need to be constructed within the reservoir basin to move material from the borrow area to the damsite.

### Construction Program

Construction of the Narrows Project will be under the supervision of the District, with overall supervision furnished by Reclamation's Regional Director in Salt Lake City, Utah. All recreational facilities on National Forest System lands will be built cooperatively by the District and the Forest Service. Temporary construction offices will be located within the proposed reservoir basin.

**Table 6-3**
**Right-of-Way Requirements for Project Features**
**(Unit--acres)**

| Project Feature<br>Type of Acquisition | Ownership or Administration | | |
|---|---|---|---|
| | **Private** | **Reclamation Withdrawal** | **Total** |
| Narrows Dam & Reservoir | | | |
| Reclamation withdrawal | 428 | 176 | 604 |
| East Bench Pipeline | | | |
| Perpetual easement | 51 | | 51 |
| Oak Creek Pipeline | | | |
| Perpetual easement | 9 | | 9 |
| Upper Cottonwood Creek Pipeline | 1.5 | 1.5 | 3.0 |
| SR-264 Relocation | | 34 | 34 |
| Recreation area | | 12 | 12 |
| Fishery mitigation | | | |
| Perpetual conservation easement | 206 | | 206 |
| Wildlife mitigation | | | |
| Fee title purchase of fish and wildlife enhancement area | 640 | | 640 |
| Perpetual conservation easement adjacent to reservoir | 150 | | 150 |
| Wetlands mitigation | | | |
| Perpetual easement or fee title | 220 | | 220 |
| Material source area[1] | | 2 | 2 |
| Total | 1,705.5 | 225.5 | 1,931 |

[1] Embankment material for the dam would be obtained from the reservoir basin. Rockfill material for upstream slope protection would be obtained from an existing quarry located on withdrawn land. An alternative rockfill material quarry site may be located on private land.

## GEOLOGIC INVESTIGATIONS

The site of the proposed Narrows Dam and Reservoir is located in the Wasatch Plateau subprovince of the Colorado plateau. This subprovince represents the transition between the Colorado Plateau to the east and the Basin and Range Province to the west.

The proposed Narrows Dam and Reservoir area is underlain by the Cretaceous age North Horn formation. This formation consists primarily of interbedded sandy, clayey siltstone, silty claystone, silty sandstone, and limestone with occasional thin seams of coal. The North Horn formation is overlain by the Flagstaff Limestone formation which consists primarily of micro-crystalline limestone with thinly bedded shale and silty claystone. Abundant fossils are common within the limestone and the boundary between the formations is transitional. The Flagstaff Limestone formation is generally present in the higher elevations and beyond the actual limits of the proposed dam and reservoir. The Flagstaff Limestone formation is present at the downstream portal area of the existing Narrows Tunnel.

Bedrock is generally covered by a mantle of residual soils (weathered bedrock) and/or colluvium. These unconsolidated sediments are about 5 to 10 feet in thickness with some areas in excess of 27 feet. The unconsolidated sediments are comprised of a mixture of clay, silt and sand with minor amounts of organic deposits. Within the active stream channel of Gooseberry Creek and its tributaries, there are limited deposits of recent alluvial sand and gravel.

The structure of the Wasatch Plateau is dominated by a series of north-trending faults across the broad west-dipping monocline of the Plateau. The local structure is dominated by north-trending faulting around the site area. The dam and reservoir sites are located entirely on a down-dropped block between two fault traces, which is known as the Gooseberry Graben. Variation in orientation of beds indicates that the dam area is located on a westward-plunging synclinal fold with the axis running approximately 1,000 feet south of the proposed dam axis.

Three faults have been mapped in the vicinity of the Narrows Project. These faults, shown in Figure 6-5, are all north-trending normal faults, and from west to east are the West Gooseberry Fault, the Fairview Lakes Fault, and the East Gooseberry Fault.

Observed earthquakes in the region of the Narrows damsite date back to the year 1853, giving an historical data base of about 140 years. A network of seismograph stations throughout the region currently provides accurate location of any seismic event. Geologic evaluation of the Wasatch Plateau area indicates that existing faults are not active. Maximum seismic events for the area are, therefore, projected to be controlled by random background earthquakes -- that is, events not attributable to specific faults or geologic structures.

The largest earthquake recorded in the Wasatch Plateau Province is a magnitude 4.9 event. The maximum random earthquake event postulated for the Wasatch Plateau is a 5.5 event occurring beneath the site at a depth of 3 miles. Such an event will produce a maximum acceleration of approximately 0.35g. Earthquake activity related to mining activities will not be expected to produce events which exceed magnitude 4.5 and, therefore, will not produce the maximum earthquake. Earthquake epicenters are shown on Figure 6-6.

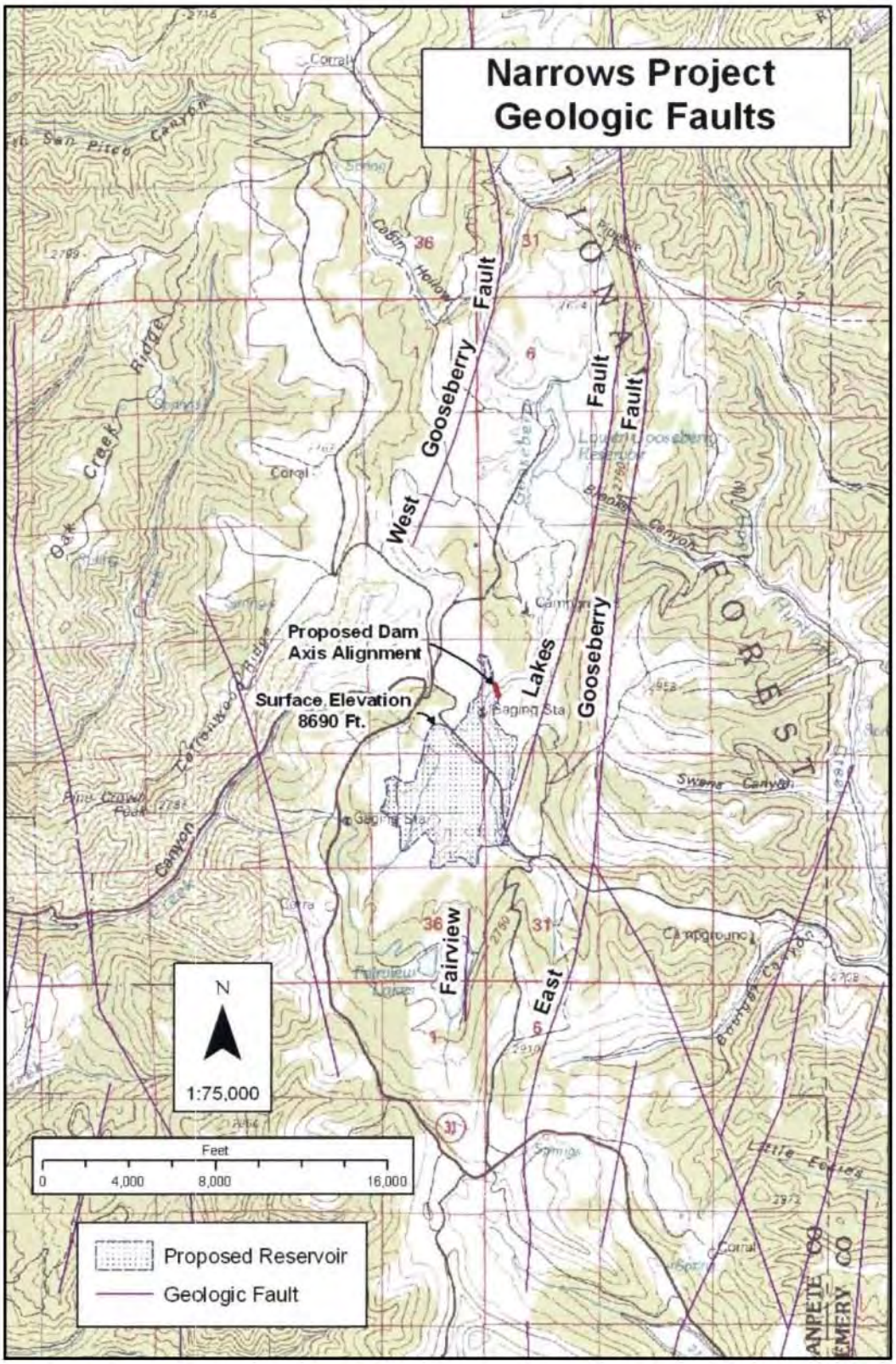



**Figure 6-5. Fault Location Map**

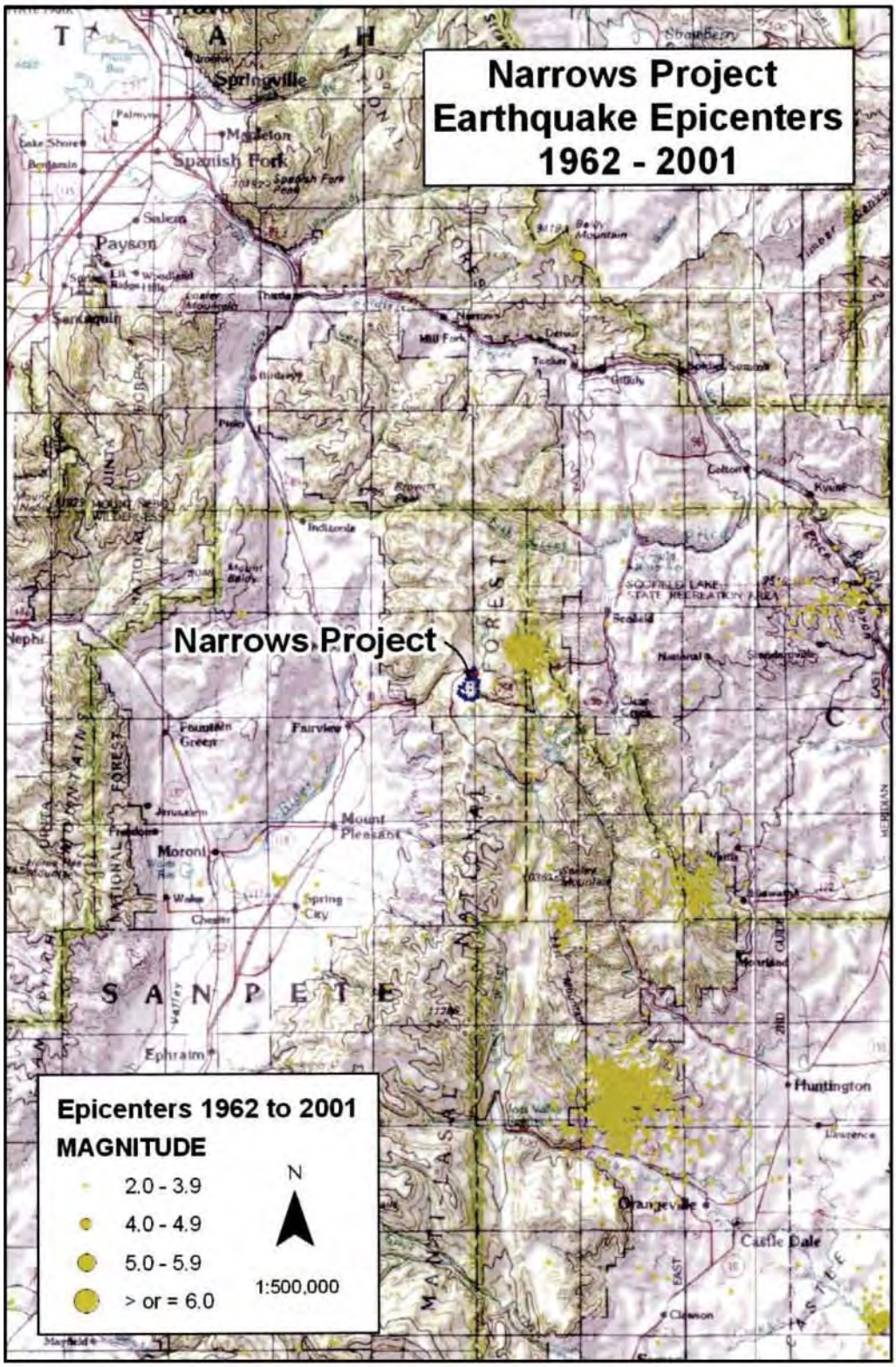



**Figure 6-4. Earthquake Epicenters**

Detailed geologic and materials investigations were performed by Dames & Moore in 1984. The results of these investigations are summarized in a report entitled "Engineering Geology and Geotechnical Engineering Studies, Narrows Dam and Reservoir Near Fairview, Sanpete County, Utah," dated December 4, 1986. Geotechnical field work for the Narrows Project consisted of:

Drilling, logging, and sampling a total of 19 exploration borings at the proposed dam site and within the proposed reservoir area;

Excavation, logging, and sampling of 13 test pits within the proposed borrow area;

Performing field permeability pressure tests in six of the borings (five in the dam foundation area and one in the reservoir);

Performing constant dead permeability tests in five of the reservoir borings; and

Performing 13 seismic refraction line surveys.

The existing, unlined Narrows Tunnel was also examined and mapped.

Further geologic and geotechnical investigations were performed by Woodward-Clyde Consultants during 1993. These investigations are summarized in a report entitled "Geotechnical Investigations, Narrows Dam and Reservoir Near Fairview, Utah," dated February 1994. These investigations included the following:

1) Geotechnical investigation at the dam site.
   a) Two core holes were drilled, one each on the left and right abutments, including packer testing.
   b) Four seismic refraction traverses were conducted to expand previously conducted geophysical survey data.
2) Borrow investigation in the reservoir area.
   a) Fourteen test pits were excavated within the reservoir area and samples obtained to identify types and quantities of borrow available.
   b) Four seismic refraction traverses were conducted to provide additional information for estimating borrow quantities.
3) Geotechnical investigations at the quarry sites.
   a) Three core holes were drilled at the existing quarry. Samples of the rock were obtained for testing, for potential use for riprap and drain materials.
   b) Two seismic refraction traverses were conducted at the existing quarry site to provide information regarding soil cover and rock characteristics.
   c) Two core holes were drilled at the alternate quarry site and samples of the rock, for potential use as rip rap, were obtained for testing.
   d) Two seismic refraction traverses were conducted at the alternate quarry site to provide information regarding soil cover and rock characteristics.

In addition to the above-referenced reports, the following reports are also available as supporting data to this report.

- Preliminary Stability Analyses, April 27, 1979, Dames & Moore
- Seismic Risk Study, October 5, 1979, Dames & Moore
- Supplemental Field and Laboratory Evaluation of Proposed Construction Materials, July 26, 1989, Sergent, Hoskins & Beckwith
- Reconnaissance-Level Study, Narrows Dam and Reservoir Near Fairview, Utah, December 1990, Woodward-Clyde Consultants

## ENGINEERING DESIGNS

Engineering designs for this report have been conducted at feasibility and reconnaissance levels. Major structures have been designed to a greater level of detail than the minor structures.

### Design Standards and Criteria

Each facility for the Narrows Project will be designed and constructed according to the most recent state-of-the-art design criteria. The design standards that will be used for each major type of facility are described below.

#### Narrows Dam and Reservoir

Narrows Dam and Reservoir have been designed to provide a total storage capacity of 17,000 acre-feet. This capacity is in accordance with the water right agreement and has been demonstrated to be adequate through operation studies. The dam embankment will be a zoned earthfill structure. This dam type selection was made based on a cost comparison of earthfill and roller-compacted-concrete structures. In making this comparison, the local availability of construction materials was a consideration.

The embankment will be designed to withstand static and seismic loading conditions. Preliminary studies indicate that a maximum earthquake of magnitude 5.5, occurring directly beneath the site, and producing a maximum acceleration of approximately 0.35g will be appropriate for the site. Further review of the maximum credible earthquake (MCE) will be performed prior to final design of the dam. The MCE will be used for the final design of critical facilities -- that is facilities for which the failure will cause a loss of the pool. During construction, detailed observations of the subsurface conditions will be monitored by qualified personnel.

An operating-basis earthquake, represented by ground motion which has a 50 percent probability of not being exceeded during the 100-year structural lifetime of the dam, will be used. A value of 0.12g will be used for design of noncritical engineering items.

The spillway will be designed to accommodate a 10,000-year snowmelt event. Historical records show that almost all of the annual flood peaks resulted from snowmelt. A flood flow frequency analysis was made of the annual peak flood flows using a log normal distribution. The 10,000-year flood hydrograph has a peak discharge of 838 cfs and a 30-day runoff volume of 34,241 acre-feet.

The probable maximum precipitation for the Narrows Reservoir is 9.61 inches. The flood hydrograph for this event has a peak discharge of 15,550 cfs and a runoff volume of 3,704 acre-feet. The flood from this event could be entirely contained within the reservoir without overtopping the dam.

Because of the very small drainage area above the dam, sediment inflow into the reservoir is expected to be minimal. The 2,500 acre-foot inactive and dead storage pool will be more than adequate to accommodate the sediment inflow that will occur over the 100-year life of the project. Less than 20 acre-feet of sediment will accumulate in a 100-year period, which is less than 1 percent of the inactive capacity.

#### Narrows Tunnel, East Bench, Oak Creek and Upper Cottonwood Creek Pipelines

The existing Narrows Tunnel will be rehabilitated to provide a total capacity of 60 cfs. The East Bench and Oak Creek Pipelines will have a combined capacity of 24 cfs. These capacities are equivalent to approximately 1.75 gallons per minute per acre for the tunnel and 1.25 gallons per minute per acre for the pipelines. These capacities are admittedly much less than the peak demand which will be approximately 8 gallons per minute per acre. However, the project delivers only supplemental irrigation water to existing systems. Furthermore, because the water supply is limited to 5,400 acre-feet and because the average annual shortage is in excess of 12,000 acre-feet, the project area will still experience shortages with the project in place, regardless of the conveyance capacity. The selected capacities will allow the project water supply to be delivered during the peak demand months of July and August. Upper Cottonwood Creek Pipeline will have a capacity of 50 cfs. Its purpose is to convey project water outside the stream channel to prevent erosion and stream degradation.

Turnouts for the Oak Creek and East Bench Pipelines will discharge into existing regulating ponds. The turnout gates will be designed to operate slowly to reduce water hammer in the pipelines. They will also be designed so that they cannot slam shut with an operator failure.

#### State Road-264 Relocation

The relocation of SR-264 will be designed according to the same standards as the existing road. The highway has two asphalt-surfaced, 12-foot-wide travel lanes with 9 inches of gravel base.

### Structural Plans and Drawings

Preliminary plans and drawings for the major features of the Narrows Project are included in Attachment D, Preliminary Design Drawings. These facilities include Narrows Dam embankment, outlet works, and spillway; Narrows Tunnel Inlet Rehabilitation; East Bench Pipeline Headworks, and the East Bench and Oak Creek Pipelines.

### Operation and Maintenance Facilities

The project plan does not include any specific facilities for operation and maintenance. The only equipment and/or vehicles required will be a pickup truck for the dam tender. Any other equipment needed for maintenance will be rented or contracted for on an as-needed basis.

Turnout and other control gates for the pipelines will be designed so that automated controls may be added at a future date.

## CONSTRUCTION CONSIDERATIONS

There are no particularly unusual construction requirements associated with the Narrows Project. Specific construction considerations are described as follows.

### Construction Materials

Materials investigations have identified about 500,000 to 600,000 cubic yards of soils suitable for construction of an embankment dam. About 360,000 cubic yards are required for the dam. The borrow area is located near the center of the reservoir basin. Drain and other granular materials will need to be hauled from the Sanpete Valley. Materials for the construction of an upstream rock zone are available from a limestone rock outcropping along the ridge north and west of the proposed reservoir. About 13,000 cubic yards of rockfill are needed for the dam. Concrete will likely be batched at a ready mix plant near Mount Pleasant and hauled about 15 to 20 miles to the site.

### River Care and Diversion During Construction

It is anticipated that construction of the river-level outlet works will take place prior to construction of the dam embankment. The outlet works could then serve as a conduit for diversion of the stream during construction.

### Special Site Conditions

Construction access is fairly good for all project features. The proposed damsite is near an existing paved highway. Temporary haul roads will need to be constructed within the reservoir basin to move material from the borrow area to the damsite. At the damsite the expected construction period is June through October. The pipelines will have a longer construction season, March through mid-December.

There is an adequate labor force located along the Wasatch Front with several contractors that are qualified to build a project of this nature. Construction will be accomplished by contract and a competitive bidding process will be used to select contractors. Construction management and inspection will be provided by the District's engineer to assure quality control. A resident engineer will be provided during the construction of the project.

## RIGHTS-OF-WAY AND RELOCATION OF PROPERTY

About 1,868 acres of land will be required for project features, wetland mitigation, fish and wildlife enhancement, and material source areas. About 0.8 miles of SR-264 will be inundated by Narrows Reservoir as described earlier in this chapter. The amounts of land by present ownership or administration and proposed project use were shown earlier in Table 6-3.

National Forest System lands will be obtained for project use by (1) Reclamation withdrawal, (2) Forest Service right-of-way permits, or (3) Forest Service special-use permits. Private lands for project use will be acquired from owners by perpetual easement.

The acquisition of private lands required for fish and wildlife mitigation will be primarily by fee title. The construction area adjacent to the reservoir will be created through construction easements. These lands will be administered by the District under a memorandum of agreement with the Utah Division of Wildlife Resources. To assure proper management of easement lands needed to mitigate fish and wildlife losses attributed to the project, certain restrictions on the landowners' use of their lands will be needed. Specific measures or restrictions, including those to protect fish and wildlife values, will be developed by Utah Division of Wildlife Resources as part of the easement negotiation process with each involved landowner. If adequate easements cannot be secured, a fee title acquisition of the lands will be made.

There will be no relocations of persons, families, businesses, farms, or nonprofit organizations resulting from construction of the Narrows Project.

Narrows Reservoir will inundate about 0.8 mile of State Road 264, which provides access between Fairview and Scofield, Utah. Under the project, the road will be relocated by constructing 2.6 miles of new road and providing asphalt surfacing for 0.3 mile of the existing gravel road to Lower Gooseberry Reservoir.

## DAM SAFETY CONSIDERATIONS

Dam construction will be subject to the requirements of the Utah Dam safety act. The Sanpete Water Conservancy District will develop a Safety of Dams program that will satisfy the requirements of the State of Utah. A Dam Safety Permit will be acquired from the Utah State Engineer. Areas of consideration include the designs, standard operating procedures, and emergency action plans. The District, with supervision by the State Engineer, will be responsible for monitoring structural performance and conducting safety inspections during construction and initial filling of the reservoir. Once the reservoir is operational, the State Engineer will conduct annual dam safety inspections. The District will prepare standard operating procedures and an emergency action plan prior to completion of construction. The designs, standing operating procedures, and emergency action plan will be reviewed by the State Engineer.

## PROPOSED WETLANDS AND FISH AND WILDLIFE MITIGATION MEASURES

Environmental measures and features have been added to the Narrows Project plan to accommodate environmental and conservation concerns. These measures have been developed through coordination with various Federal and State agencies and have been described earlier in this chapter.

## OTHER ENVIRONMENTAL CONSIDERATIONS

### Clean Air, Clean Water, and Waste Management

Several water quality permits must be obtained prior to construction of the project. The Clean Water Act of 1977 (Public Law 95-217) requires that Section 402 permits be obtained from the Environmental Protection Agency for the discharge of any wastewater or process water. In accordance with Section 404 of Public Law 95-217, permits must be obtained from the Corps of Engineers to discharge dredge-and-fill material below the normal high water level of streams and other water bodies.

The objective of Section 303 of the clean Water Act will also be met. That objective directs the Environmental Protection Agency to "develop comprehensive programs for preventing, reducing, or eliminating the pollution of navigable waters and ground waters."

The project will meet antipollution requirements of the Clean Water Act, which defines "pollution" to mean the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water. The project will reduce salt pollution by reducing salt-laden return flows, and will, accordingly, restore and maintain water quality as derived by the Environmental Protection Agency from the Act. The Clean Water Act's policies and regulations require that all existing instream beneficial uses be maintained and protected.

Approval by the Utah State Division of Water Quality is required before the installation of any sanitary or industrial pollution control facilities, including turbidity control equipment. This approval will also be obtained before dewatering, diversion, and other such facilities can be constructed. In addition, a temporary waiver of the turbidity standard will be requested from the State Division of Water Quality during those periods of construction when it is physically impossible to provide turbidity control. A State Engineer's permit to alter a natural stream channel will also be requested for the proposed dam.

### Cultural Resources

An on-site cultural resources survey has been conducted for the reservoir basin. Prior to initiation of final design and construction, detailed cultural resource surveys will be performed along the proposed alignments of the Oak Creek, East Bench, and Cottonwood Creek Pipelines. If cultural resource sites are found, the pipelines will be re-routed where possible to avoid the impact. If the pipeline cannot be re-routed, appropriate mitigation will be developed through coordination with the State Historic Preservation Officer.

Contractors will be required to cease work immediately if they should discover prehistoric, historical, or archeological evidence during construction. Work will not be resumed until such evidence is properly evaluated by qualified cultural resource specialists.

### Endangered Species

Project impacts to threatened or endangered species were evaluated by Reclamation in a biological assessment and submitted to the U.S. Fish and Wildlife Service. Subsequently, the Service issued a final biological opinion on August 24, 2000, that found that the proposed project would have no effect upon the bald eagle, which was subsequently delisted in 2007.

The Service believes that the willow flycatcher found at the Fish Creek site is not the endangered subspecies; therefore, no discussion was offered specifically in reference to the SWWF. The Service concluded, however, that the project and associated depletion of water from the Colorado River system may affect the four endangered Colorado River fishes. While the opinion concluded that the proposed project may affect the four endangered fishes, it also stated that the project is not likely to jeopardize their continued existence, provided measures are implemented to offset project impacts (i.e., payment of a one-time financial contribution by SWCD to the Recovery Implementation Plan). The current depletion charge is $18.29 per acre-foot (2009 figure); and when multiplied by the project's 5,597-acre-foot average, annual depletion of flows to the Colorado River system amounts to a financial contribution of $102,369 to the RIP. The Service will notify SWCD of the current depletion charge by September 1 each year. On July 13, 1995, SWCD made a partial payment of $7,063, 10 percent of the total depletion charge as identified in the January 9, 1995, Biological Opinion.

Reliance on the RIP to serve as the reasonable and prudent alternative for project impacts is dependent upon sufficient progress toward recovery being made by the RIP. In the event sufficient progress is not made by the RIP, re-initiation of consultation would be required. Payment of the depletion charge will be made by SWCD prior to beginning construction.

## CONSIDERATION OF PROPOSALS FROM OTHER AGENCIES

In developing the plan for the Narrows Project, an interagency/interdisciplinary team was organized to address environmental and conservation issues. Suggestions and recommendations of this team have been implemented into the project plan. Additional proposals received during the review process were considered and, where appropriate, integrated into the final plan. Those proposals pertained mostly to fish and wildlife measures.

# CHAPTER 7

# ESTIMATED COSTS

Sanpete Water Conservancy District

# CHAPTER 7

# ESTIMATED COSTS

The estimated construction costs for the described project are included in this chapter. The costs are indexed to October 2011. The direct and indirect costs for construction are included, as well as applicable interest during construction

## CONSTRUCTION COSTS

The direct and indirect construction costs are described in the following two sections. The direct costs for each of the major facilities described in Chapter 6 are presented.

### Direct Costs

The direct costs for the proposed project were developed for each of the major facilities based on feasibility- and reconnaissance-level designs. The costs are allocated to: Narrows Dam and Reservoir; Narrows Tunnel Inlet Rehabilitation; Upper Cottonwood Creek Pipeline; East Bench Pipeline; Oak Creek Pipeline; State Road 264 Relocation; Narrows Reservoir Recreation Area; and wetlands, wildlife, and fishery mitigation. A detailed breakdown of costs is presented in Attachment E, Preliminary Cost Estimates and Local Contributions.

#### Narrows Dam and Reservoir

The cost estimate for the proposed Narrows Dam and Reservoir is based on designs prepared by Woodward-Clyde Consultants (WCC) and Franson-Noble & Associates, Inc. (Franson-Noble). Design of the dam embankment was performed by WCC and design of the outlet works and spillway was performed by Franson-Noble.

#### Narrows Tunnel Inlet Rehabilitation

The Narrows Tunnel inlet rehabilitation cost estimate is based on a reconnaissance-level design prepared by Hansen, Allen & Luce, Inc.

#### Upper Cottonwood Creek, East Bench, and Oak Creek Pipelines

Cost estimates for Upper Cottonwood Creek, East Bench, and Oak Creek Pipelines are based on a feasibility-level design prepared by Hansen, Allen & Luce.

#### State Road-264 Relocation

The cost estimate for relocation of SR-264 is a reconnaissance-level estimate based on a typical roadway cross section and corresponding quantities prepared by Hansen, Allen & Luce.

### Narrows Reservoir Recreation Area

The Narrows Reservoir Recreation Area cost estimate is a feasibility-level estimate prepared by Franson-Noble.

### Wetlands, Wildlife, and Fishery Mitigation

Mitigation cost estimates are feasibility-level and were developed in coordination with the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service.

### Direct Cost Summary

The total estimated October 2011 direct costs are shown in Table 7-1.

**Table 7-1**
**Total Direct Costs Summary**

| Facility | 2011 Direct Cost |
|---|---|
| Narrows Dam and Reservoir | $9,152,884 |
| Narrows Tunnel Rehabilitation | 211,493 |
| Upper Cottonwood Creek Pipeline | 534,225 |
| East Bench Pipeline | 7,079,462 |
| Oak Creek Pipeline | 354,120 |
| Highway SR-264 Relocation | 2,138,352 |
| Recreation Area | 834,605 |
| Wetlands, Wildlife, and Fishery | |
| Mitigation | 3,600,191 |
| Total Direct Cost | $23,905,333 |

## Indirect Costs

### Contingencies

An amount for contingencies of 10 percent was used for all features except for the recreation area where a contingency amount of 5 percent was used. The total contingency amount is $2,348,803.

### Projected Cost Increase

The increase in construction cost from 2011 until each of the facilities is constructed is estimated to be $3,094,706 based on a yearly increase of 5 percent. A construction schedule from FY 2013 through FY 2015 was used to estimate the increase. Table E-7 in Attachment E, Preliminary Cost Estimates and Local Contributions, shows the estimate of the cost increase and the yearly budget requirement including the cost increase.

### Engineering and Administration

This cost includes construction designs, the bidding process, contract administration, and construction inspection. An amount of 15 percent of the total direct and indirect costs is included. The allocation for engineering and administration totals $3,938,120.

### Reimbursable Interest During Construction

Costs allocated to municipal water will be funded by a loan from the Utah Board of Water Resources and remaining costs allocated to recreation and fish and wildlife will be funded by a grant from the State of Utah. The State loan for municipal water will be interest-free and concurrent with construction. However, interest during construction will become reimbursable as the use of water changes from irrigation to M&I. This reimbursable component of interest during construction is estimated to be $190,000.

### Applicant's Local Contributions

The District has incurred costs for preparation of the loan application report and EIS and other costs including engineering investigations and legal fees. These costs total $3,925,000. Additionally, $4,300,000 will be provided by the Utah Board of Water Resources as a low interest loan for municipal water. An additional $3,692,000 will be provided by the State of Utah as a grant for the remaining costs allocated to recreation and fish and wildlife. Including costs already incurred by the District and the contribution that will be made by the State of Utah, the total local contribution towards the Narrows Project is $11,917,000.

## FUND REQUIREMENT SCHEDULE

Table 7-2 shows the estimated project costs for fiscal years 2013 through 2015. The costs shown in the schedule reflect an increase in costs of 5 percent per year from 2011 until a construction contract is awarded.

**Table 7-2**
**Estimated Funding**
**Requirement Schedule**
**(Unit - $1,000)**

| | FY 2013 | FY 2014 | FY 2015 |
|---|---|---|---|
| Federal | 0 | 16,869 | 8,426 |
| Local | 1,496 | 6,496 | 0 |
| Total | 1,496 | 23,365 | 8,426 |

Table 7-3 summarizes all of the costs described in the previous section of this chapter. The "Total Project Cost" is shown, which is $37,401. The "Total District Contributions" are $11,917,000. The requested loan amount is $21,792,000. In addition, grants totaling $3,692,000 are requested for recreation and fish and wildlife.

## OPERATION, MAINTENANCE AND REPLACEMENT COSTS

Because the Narrows Project will deliver a supplemental water supply to existing systems which are now being operated and maintained, OM&R costs should be minimal. It is expected that the Cottonwood-Gooseberry Irrigation Company, which owns and operates the nearby Fairview Lakes, and the Sanpete Water Conservancy District will be able to share a dam tender for the two reservoirs. The total OM&R cost for the Narrows Project is estimated to be $85,000 per year. The estimate for the reservoir and water delivery system is based on a part-time dam tender/ditch rider who will monitor and adjust gates during the irrigation season and perform routine maintenance. The recreation area OM&R estimate is based on a comparison with other similar recreation areas in the state. The annual OM&R costs are summarized in Table 7-4.

**Table 7-3**

**Estimated Project Costs Summary**

**(Unit - $1,000)**

| Item | Amount |
|---|---|
| Project Costs | |
| Total Direct Costs | 23,905 |
| Contingencies (approximately 10%) | 2,348 |
| Subtotal | 26,253 |
| Cost Escalation from 1994 to Construction | 3,095 |
| Engineering and Administration (15%) | 3,938 |
| Base Construction Cost | 33,286 |
| Other Project Costs | |
| Reimbursable Interest During Construction | 190 |
| Sunk Costs | 3,925 |
| Total Project Cost | 37,401 |
| District Contributions | |
| Sunk Costs | 3,925 |
| Other Local Contributions | 7,992 |
| Total District Contributions | 11,917 |
| Total Federal Share of Project | 25,484 |
| Recreation Grant | 814 |
| Fish and Wildlife Grant | 2,878 |
| Total Loan Obligation | 21,792 |
| Reimbursable Interest During construction | 190 |
| Total Federal Appropriation requirement | 21,602 |

**Table 7-4**
**Estimated Annual Operation, Maintenance and Replacement Costs**

| Item | Cost |
|---|---|
| Reservoir & water delivery facilities | |
| Personnel | $28,000 |
| Equipment | 8,000 |
| Supplies and materials | 4,000 |
| Subtotal | 40,000 |
| Recreation area | 45,000 |
| Total | $85,000 |

## EMERGENCY RESERVE FUND

The emergency reserve fund is for unexpected costs to repair facilities that may be damaged from floods, wind, etc. The fund amount is estimated to be $40,000, based on annual OM&R for the project of $40,000 (not including the recreation area OM&R). The fund would be fully developed in 5 years, which will require a yearly contribution of $8,000.

# CHAPTER 8

# PROJECT EVALUATION

Sanpete Water Conservancy District

# CHAPTER 8

# PROJECT EVALUATION

## INTRODUCTION

The Narrows Project is evaluated in this chapter in both non-economic and economic terms. Presented first is a discussion of the merits of the project in non-economic terms as they are perceived to relate to environmental effects and to the goals and objectives of the Sanpete Water Conservancy District. Following that material is a discussion of economic benefits under SRPA criteria arising from construction and operation of the project and an allocation of project costs.

## AGENCY RESOURCE MANAGEMENT OBJECTIVES

The Narrows Project has been formulated to contribute toward meeting the District's objectives, as defined in Chapter 2, and to include facilities or actions, discussed in Chapter 6, recommended by agencies participating in the project. As a consequence, the proposed project has attributes that are perceived to contribute to meeting the Department of Interior's resource management objectives in addition to those of the District's. This introductory material discusses those items.

### Partnerships

Formulation of the Narrows Project included the cooperative efforts of not only the Sanpete Water Conservancy District and Reclamation, but the other resource management agencies that normally participate in Federal water resource management endeavors such as the Forest Service and Fish and Wildlife Service. The recreation facilities at Narrows Reservoir will be administered by the Forest Service. The Forest Service will also manage the improved wildlife habitat areas and stream fisheries in the Manti-La Sal National Forest. Along with the District's efforts, participation of the Utah Divisions of Water Resources and Wildlife Resources has been frequent. Private lands acquired for wildlife mitigation will be administered by the District under a cooperative agreement with the Utah Division of Wildlife Resources. The Utah Department of Transportation has also provided assistance in planning a portion of the project.

### Water Conservation

Reclamation’s mission of managing water in the West has at its core better water management by making more efficient use of existing supplies. Reclamation emphasizes water conservation to achieve this goal. Water users in Sanpete County are already actively implementing improved and more efficient irrigation systems. In recent years, there has been a significant shift from the flood method of irrigation to the sprinkler method. Presently about 60 percent of the irrigated land is under sprinkler irrigation. Under project development, the sprinkler irrigation system will be improved. Water saved will not be used on new lands but will be used to alleviate existing shortages. In addition to increased efficiency in water deliveries, the

Narrows Project will save for municipal use high quality water that presently must be used for irrigation.

**Maintaining and Enhancing the Environment**

Environmental enhancement is a key element of the Federal Government's stewardship program. To accommodate environmental and conservation concerns, several environmental measures and features have been added to the Narrows Project plan. Fishery measures include the following:

- Restoring year-round flows in two small tributaries of Gooseberry Creek;
- Providing minimum flows in Gooseberry Creek below Narrows Dam;
- Providing a multiple-level outlet at Narrows Dam to regulate the temperature of releases to Gooseberry Creek from Narrows Reservoir;
- Stabilizing stream banks along middle Gooseberry Creek so better habitat will be provided with the reduced flows;
- Providing releases from the Narrows Reservoir for flushing flows and for fish habitat during critical periods;
- Improving and protecting stream channels and riparian zones by acquiring easements on private land and fencing private and Forest Service land;
- Providing winter releases to Cottonwood Creek to maintain a minimum flow so that available fish habitat may be increased;
- Providing summer flows in lower Cottonwood Creek to provide year-round flows in the stream;
- Constructing a pipeline in the upper Cottonwood Creek area to convey project water outside the stream channel;
- Providing a minimum pool in Narrows Reservoir for fish; and
- Reducing external phosphorus loading to Scofield Reservoir.

Wetlands measures have been included in the project. Four alternative wetlands mitigation measures have been identified to ensure no net loss of wetlands and to make certain that impacted wetlands functions and values are fully replaced.

Wildlife measures will include:

- Acquiring conservation easements around the Narrows Reservoir; and
- Acquiring and fencing private land adjacent to the Price River below Scofield Reservoir to protect wildlife habitat.

### Rural Development

The Federal Government's policy is to improve the economic and social well-being of rural America. Economic and social conditions in the project area are underscored by a century-long dependence upon agriculture. The valley was originally developed for agricultural use and agriculture remains the principal economic activity today. About 44 percent of the land in Sanpete County is in farms. From 1992 to 2002, the census of agriculture data shows the number of farms increased by 9 percent, whereas the number of acres in production changed by less than 1 percent. The average farm size decreased from 643 acres in 1992 to 471 acres in 2002.

Following construction of the project, the economy of the agricultural sector of the project area will benefit. The project will serve to maintain or improve the economic position of agriculture relative to other economic sectors of the area.

Most residents of the area are involved in beliefs and values that are based in rural farm attitudes. These attitudes are traditionally associated with rural farm areas of the United States. This rural-agrarian orientation consists of four basic assertions: (1) a farm person is viewed as a self-reliant and self-sufficient person; (2) agriculture is viewed as the basic industry on which all progress and prosperity is based; (3) the agricultural life is considered natural and morally desirable; and (4) rural values have been characterized as emphasizing the family, especially the extended family. Sanpete County communities also view the family farm as being basic to the economy. Completion of the project will help preserve the economic soundness and strong work ethic, as well as the high moral beliefs and values, of rural America.

## ENVIRONMENTAL EFFECTS

Environmental effects of implementing the Narrows Project are summarized in the Environmental Impact Statement (EIS) prepared by Reclamation. The EIS compares the environmental consequences of the Proposed Action and two other action alternatives against the No Action Plan. The EIS identifies several environmental issues related to the Narrows Project and the associated project effects. These issues and effects are summarized in Table 8-1. For a more detailed discussion of these issues and effects, please refer to the EIS.

**Table 8-1**
**Summary of Narrows Project Environmental Issues and Effects**

| Issue | Project Effect | |
|---|---|---|
| **Water Resources** | | |
| Acre-feet of depletion to the Price River drainage | 5,674 acre-feet | |
| Acre-feet of water available to San Pitch River drainage | 5,250 acre-feet | |
| **Water Rights** | | |
| Appropriations | No change | |
| **Water Quality** | | |
| Change in Scofield Reservoir Trophic State Index | +3.5 | |
| Change in average phosphorus level in Scofield Reservoir based on external phosphorus loading (milligrams per liter) | +0.003 (+10.8%) | |
| **Air Quality** | | |
| Number of days project will exceed National Ambient Air Quality Standards for PM10 | 0 | |
| **Slopes and Channel Stability** | | |
| Exceed 50-year channel-forming discharge | 0 | |
| Lateral and vertical degradation | 0 | |
| **Geologic Hazards** | | |
| Known geologic hazards within vicinity of dam and reservoir | 3 | |
| **Paleontological Resources** | | |
| Paleontological resources inundated or otherwise impacted | Undetermined until completion of environmental commitments | |
| **Soils** | | |
| Acres of new soil disturbance | 668 acres | |
| Change in sediment loads in Gooseberry Creek | -400 tons | |
| **Trace Elements** | | |
| Increase in levels of select trace elements in ground water | 0 | |
| **Fisheries** | | |
| *Instream* | | |
| Change in weighted usable area in fish habitat as measured by instream flow incremental methodology for the following life stages: | Postproject | (Percent Change) |
| ▪ Adult<br>▪ Juvenile<br>▪ Spawning<br>▪ Fry | 10,958.04<br>2,312.67<br>69.9<br>373.25 | (-8.17)<br>(-11.86)<br>(+1.11)<br>(-12.68) |
| *Reservoir* | | |
| Change in surface area in Scofield Reservoir (average) | -290 | |

**Table 8-1**
**Summary of Narrows Project Environmental Issues and Effects**

| Issue | Project Effect | |
|---|---|---|
| **Wildlife** | Species | Without Mitigation (with Mitigation) |
| Change in habitat units for the following species: mule deer, Brewer's sparrow, beaver, Richardson vole, yellow warbler | Mule deer<br>Brewer's sparrow<br>Beaver<br>Richardson vole<br>Yellow warbler | -135 (0)<br>-477 (0)<br>-13 (0)<br>-63 (0)<br>-26 (0) |
| **Threatened and Endangered Species** | | |
| Acre-feet depletion from Colorado River system | 5,491 acre-feet | |
| **Vegetative Resources** | | |
| Miles of stream lost due to inundation of the reservoir | 5.3 miles | |
| Number of miles of stream affected by flow:<br>▪ Increase in flow<br>▪ Decrease in flow | <br>4.9 miles<br>16.1 miles | |
| **Wetland Resources** | | |
| Acres of wetlands lost | 100 acres (without mitigation)<br>0 acres (with mitigation) | |
| **Recreation and Visual** | | |
| Change in projected fisherman days in Scofield | -6,800 | |
| Increase in developed recreation visitor days at Narrows (including fishing) | +46,400 | |
| Increase in dispersed recreation visitor days at Narrows (including fishing) | +910 | |
| Change in visual quality objective | Partial retention | |
| **Cultural Resources** | | |
| Cultural resources inundated or otherwise impacted | Undetermined until completion of environmental commitments | |
| **Economic and Social Resources** | | |
| Number of jobs (Carbon, Sanpete) created during construction | 50–100 | |
| Change in farm income | 11% increase | |
| **Land Resources** | | |
| Change in number of AUMs of forage | -240 AUMs | |
| Acres of mineable coal reserves not available for mining | 0 | |
| **Health and Safety** | | |
| Percent change in the volume of traffic in the project area | 19% increase | |
| **Indian Trust Assets** | | |
| Number of Indian trust assets affected | None | |
| **Environmental Justice** | | |
| Number of minority communities disproportionately affected by the Narrows Project | None | |

## ECONOMIC STUDIES

### Irrigation Benefits

Irrigation benefits are based on the increase in net incomes to farmers coming as a result of improving crop production on approximately 4,395 acres of Irrigated alfalfa that is now affected by water shortages. Alfalfa is the highest value crop in the project area and 4,395 acres the area that could have a full water supply with Narrows Project supplemental water. In computing irrigation benefits the increased net income to farmers was calculated based on crop production data obtained from local sponsors. This information, along with crop budgets from the Economics Department at Utah State University and sponsor's water supply data were used to model effects of the project improvements on local farmers and ranchers. The analysis was completed using the Utah Division of Water Resources' HYCON computer program which was developed to evaluate the economic benefits of irrigation projects developed by the Utah Board of Water Resources. This program has the capability of analyzing the hydrologic and economic effects of changing irrigation systems, efficiencies, timing, and/or water supplies, including the effect of constructing a reservoir. A description of the HYCON computer program and the output for the Narrows Project are included in Attachment F.

Net income is assumed to increase immediately upon completion of project construction by $657,900 annually, or $138.31 per acre-foot. The analysis assumed that there will be no conversion of irrigation systems to sprinkler as most project farmers already have efficient water application systems.

### Municipal Water Benefits

Some project water will be used for municipal purposes. As municipalities continue to grow in the future an increasing amount of project water will be converted to lawn and garden use. The municipal water use and benefit is phased in over the 83 years after which all water developed by the project will be municipal and industrial uses. Consequently, as the municipal use is increasing the amount of water going to irrigation is decreasing by the same amount.

The municipal benefit is estimated as the cost of the next best alternative source of water to serve this need. In the absence of the project, it is assumed additional wells will be needed to serve all additional municipal needs through the culinary water system in each municipality. Water rights would also need to be acquired for these new wells. The estimated cost of water to meet all future lawn and garden demands through the culinary system is $448 per acre-foot. This calculated cost is used to estimate the municipal benefit of the proposed project.

### Recreation and Fish and Wildlife Benefits

Recreation and fish and wildlife benefits for the Narrows Project were estimated based on the unit-day value method as described in the Federal Register of December 14, 1979. In the unit-day value method, points are assigned based on several criteria including quality of the recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental quality. The total point score assigned to the Narrows Project was 50 of a possible 100.

A Corps of Engineers memorandum of November 5, 2010 (copy attached) provides a table for converting points to dollar values. According to the table, a 50-point score is equivalent to $7.62 per user-day for general recreation and $8.29 per user-day for general fishing and hunting in 2011 dollars.

Recreation use rates at Narrows Reservoir would be expected to approximate the use rates at Joe's Valley Reservoir based on the number of campsites and other such facilities per acre of water surface area (1,170 acres). Based on information gathered from the Forest Service annual visitor days at Joe's Valley Reservoir from 2003 – 2008 is 85,000. With 1,170 surface acres, this equates to 72.7 visitor days per year half of which is for general recreation and half for fishing. Joes Valley has a total of 64 campsites, essentially the same as the 60 sites in the Proposed Action. A preliminary estimate includes 46 sites located in the campground and 18 near the boat ramp, of which 10 are picnic sites. Using this visitor-day rate proportioned by the ration of the reservoir surface areas yields an estimate of 43,911 visitor-days at Narrows Reservoir.

Implementing the Narrows Project would cause Scofield Reservoir to operate at a lower level, thus reducing the surface area available for fishing and other forms of recreation by about 12% (274 acres). It is expected that this would result in the loss of about 12,708 visitor days per year, including fishing, based on the Reclamation data. Therefore, the net increase in recreation and fishing due to the Narrows Project is estimated to be 31,202 visitor-days total or 15,601 for general recreation and 15,601 for fishing.

As shown in Table 8-1, the annual benefit for recreation is projected to by $118,880 for recreation and $129,332 for fish and wildlife.

**Table 8-2**
**Recreation and Fish and Wildlife Benefits**

| Purpose | Annual user-days | Value per user-day ($) | Annual benefit ($) |
|---|---|---|---|
| General Recreation | 15,601 | 7.62 | 118,880 |
| Fish and Wildlife | 15,601 | 8.29 | 129,332 |
| Total | 31,202 | | 248,212 |

# CHAPTER 9

## FINANCIAL PROGRAM

Sanpete Water Conservancy District

# CHAPTER 9

# FINANCIAL PROGRAM

## COST ALLOCATION

### Introduction

The objective of the cost allocation is to equitably distribute the costs of the multipurpose project among the purposes served. Purposes to which Narrows project costs will be allocated are irrigation, municipal and industrial water, recreation, and fish and wildlife. Allocation methods used in this report reflect procedures specified for use in SRPA projects as outlined in the Bureau of Reclamation publication Loan Program Guidelines - Small Reclamation Projects Act of 1956, dated September 1990. Costs to be allocated include (1) construction costs; (2) interest during construction; and (3) operation, maintenance, and replacement costs.

### Method of Allocation

The separable cost-remaining benefit (SCRB) method of cost allocation has been used in combination with the use of facilities (UOF) method for allocating costs in this report. The SCRB method is used for the initial allocation to determine costs associated with each of the project purposes. At this stage of the allocation, the "irrigation" and "municipal and industrial" (M&I) water purposes are combined and labeled "water supply." The second stage of the allocation uses the UOF method to sub-allocate costs allocated to water supply to irrigation and M&I water functions.

### Costs to be Allocated

#### Construction Costs

Construction costs total $37,211,000. A breakdown of these costs by project feature is shown in Table 9-1.

#### Interest During Construction

Interest during construction (IDC) was calculated on total project costs by feature. Interest is calculated at 5.75 percent compounded, which is the current repayment rate for SRPA Loans. Expenditures by project feature and construction year are shown in Table 9-2 based on a 3-year development period. Total IDC is estimated at $2,706,000.

#### Operation, Maintenance, and Replacement Costs

Annual operation, maintenance and replacement (OM&R) costs are estimated at $40,000 annually for water storage and conveyance facilities and $45,000 annually for recreation facilities. These costs are detailed in Chapter 7, Estimated Cost.

**Table 9-1**
**Construction Costs**
**(Unit - $1,000)**

| Item | Costs |
|---|---|
| Narrows Dam and Reservoir | 12,765 |
| Narrows Tunnel Inlet Rehabilitation | 295 |
| Upper Cottonwood Creek Pipeline | 745 |
| East Bench Pipeline | 9,873 |
| Oak Creek Pipeline | 494 |
| Highway SR-264 Relocation | 2,982 |
| Recreation Area | 1,111 |
| Wetlands, Wildlife, and Fishery Mitigation | 5,021 |
| Costs Spent to Date | 3,925 |
| **Total** | 37,211 |

## Separable Cost Remaining Benefit (SCRB) Method of Cost Allocation

The SCRB method of cost allocation assigns costs to project purposes in two steps. The first step is to identify costs associated with one purpose and assign them to that purpose.

The second step divides joint costs between the purposes. This method allows each project purpose to share in the economy of the multipurpose project. Each project purpose is allocated at least its separable cost, but not more than its justifiable expenditure.

### Justifiable Expenditure

The justifiable expenditure of each purpose is the lesser of the present worth values of the annual benefits accruing to that purpose or the cost of the most likely single-purpose alternative means of providing comparable services and benefits in the absence of the project. In the case of the Narrows Project, the benefits were limiting for all project purposes, resulting in a total justifiable expenditure smaller than the total costs to be allocated. Justifiable expenditures for each individual purpose are, however, larger than separable costs. In order to make the allocation, the rule cited above, "costs cannot be allocated to a purpose in excess of its justifiable expenditure" was ignored.

### Single Purpose Alternative Costs

Costs of single-purpose alternative projects have been estimated for a water supply for irrigation, recreation, and fish and wildlife. In each case the single-purpose projects were sized to furnish essentially the same benefits to essentially the same geographic area. Costs for these alternative projects were estimated using the same price level, interest rate, and estimating procedures as the multi-purpose project.

**Table 9-2**
**Interest During Construction**
**(Interest rate = 5.75%)**
**(Unit 1,000)**

| Features | Year of Construction FY 2013 | FY 2014 | FY 2015 | Total |
|---|---|---|---|---|
| Narrows Dam and Reservoir | 763 | 8,041 | 3,961 | 12,765 |
| EAC[1] | 382 | 4,805 | 10,785 | |
| IDC[2] | 22 | 276 | 620 | 918 |
| Narrows Tunnel Inlet Rehabilitation | 18 | 277 | | 295 |
| EAC | 9 | 157 | 305 | |
| IDC | 1 | 9 | 18 | 27 |
| Upper Cottonwood Pipeline | 45 | 700 | - | 745 |
| EAC | 23 | 395 | 769 | |
| IDC | 1 | 23 | 44 | 68 |
| East Bench Pipeline | 592 | 9,281 | | 9,873 |
| EAC | 296 | 5,250 | 9,873 | |
| IDC | 17 | 302 | 568 | 887 |
| Oak Creek Pipeline | 29 | 465 | | 494 |
| EAC | 15 | 262 | 510 | |
| IDC | 1 | 15 | 29 | 45 |
| Highway Relocation | 179 | 2,803 | | 2,982 |
| EAC | 90 | 1,586 | 3,078 | |
| IDC | 5 | 91 | 177 | 273 |
| Recreation Facilities | 744 | 367 | | 1,111 |
| EAC | 372 | 949 | 1,187 | |
| IDC | 21 | 55 | 68 | 144 |
| Fish and Wildlife Mitigation | - | 3,365 | 1,656 | 5,021 |
| EAC | | 1,683 | 4,290 | |
| IDC | | 97 | 247 | 343 |
| Costs Spent to Date | 3,925 | - | - | 3,925 |
| EAC | | | | |
| IDC | | | | |
| **Total Construction Costs** | | | | 37,211 |
| **Total IDC** | | | | 2,706 |

[1] Expenditure average cumulative
[2] Interest during construction

**Single Purpose Water Supply Project.** The most likely single-purpose project to furnish the same water supply as the multipurpose project, would be a reservoir at the project site that would include only enough capacity for water supply. This would result in a reservoir slightly smaller than the multipurpose project. Other project features would remain the same as in the multipurpose plan except that recreation facilities would be deleted. This project would result in construction costs of $31,442,000; interest during construction of $2,002,000; and operation, maintenance, and replacement costs of $35,000. These values are shown by feature in Table 9-3.

**Single Purpose Recreation Project.** The most likely single-purpose project to furnish the same recreation benefits as the multipurpose project would be a reservoir at the same site and essentially the same capacity as the multipurpose project. Other multipurpose features would not be required. Construction costs for this alternative are estimated at $18,017,000; interest during construction at $1,027,000; and operation, maintenance, and replacement costs at $21,000. These values are summarized by feature in Table 9-3.

**Single Purpose Fish and Wildlife Project.** The single purpose fish and wildlife project would consist of a reservoir at the project site of about 2,500 acre-feet capacity. Project features associated with water delivery and recreation facilities would not be required. However, environmental studies and fish and wildlife mitigation would be required in the same amount as the multipurpose project. Construction costs for this alternative are estimated at $9,733,000. Interest during construction is estimated at $567,000 and OM&R is estimated at $14,000 annually. This alternative is also shown in Table 9-3.

**Benefits**

Project benefits have been evaluated for use in cost allocation. Water supply benefits are estimated at $881,874 annually. Irrigation benefits are based on an increase in net farm income of $657,000 annually or $138.31 per acre-foot. Municipal water benefits are $448 per acre-foot as explained in Chapter 8. Recreation benefits are estimated at $118,880 annually and Fish and Wildlife benefits are estimated at $129,332. As discussed previously, total project benefits are less than total costs to be allocated as demonstrated in Table 9-4.

**Table 9-3**
**Single Purpose Alternatives - Indexed to 2011**
**(Unit - $1,000)**

| Feature | Water Supply Construction Costs | IDC | Recreation Construction Costs | IDC | Fish & Wildlife Construction Costs | IDC |
|---|---|---|---|---|---|---|
| Narrows Dam and Reservoir | $12,032 | $747 | $12,765 | $793 | $5,130 | $393 |
| Narrows Tunnel Rehabilitation | $295 | $22 | $0 | $0 | $0 | $0 |
| Upper Cottonwood Creek Pipeline | $745 | $58 | $0 | $0 | $0 | $0 |
| East Bench Pipeline | $9,873 | $767 | $0 | $0 | $0 | $0 |
| Oak Creek Pipeline | $494 | $37 | $0 | $0 | $0 | $0 |
| Highway SR-264 Relocation | $2,982 | $81 | $2,982 | $81 | $2,982 | $81 |
| Recreation Area | $0 | $0 | $1,111 | $86 | $0 | $0 |
| Wetlands, Wildlife, and Fishery Mitigation | $5,021 | $290 | $1,159 | $67 | $1,621 | $93 |
| Total | $31,442 | $2,002 | $18,017 | $1,027 | $9,733 | $567 |

**Table 9-4**
**Project Benefits**
**(Unit - $)**

| Purpose | Annual Benefits | Capitalized Benefits (100 yrs @ 5.75%) |
|---|---|---|
| Water Supply | 881,874 | 15,280,000 |
| Recreation | 118,880 | 2,060,000 |
| Fish & Wildlife | 129,332 | 2,241,000 |
| Total | | 19,581,000 |
| Total Costs to be Allocated | | 42,107,000 |

**Separable Joint and Specific Costs**

The separable cost for any purpose of the multipurpose project is the difference between the cost of the multipurpose project and the cost of the project with that purpose omitted. Thus, the separable costs for each purpose include the cost of those facilities used solely for that purpose (specific costs) plus the difference in costs of the joint use facilities that would change in size or design with the purpose omitted (separable joint costs). Separable costs are determined by assuming each purpose in turn as the last purpose added to the multipurpose project. The remaining joint costs are the costs remaining after the sum of the separable costs for the various purposes are subtracted from the total project costs. The derivation and summary of separable costs for each purpose are shown on Table 9-5.

**Project Without Water Supply.** Without the project water supply, the project would serve recreation and fish and wildlife purposes. The same size reservoir would be required to generate the same recreation benefits as the multi-purpose project. All other project costs would also remain the same except the distribution pipelines could be deleted. Cost decreases resulting from omitting water supply as a project purpose are $11,629,000 in construction costs; $1,000,000 in interest costs; and $21,000 in annual operation, maintenance, and replacement costs. Separable costs for water supply are shown in Table 9-5.

**Project Without Recreation.** Without recreation, the project would serve the water supply functions (irrigation and municipal and industrial water) and fish and wildlife. These project purposes would require a reservoir of about the same size and cost as the multipurpose project. The main cost change without the recreation purpose would be the cost of recreation facilities, which could be deleted entirely. This would result in separable costs to recreation of $1,628,000 in construction costs, $144,000 for interest during construction, and zero for OM&R. Separable costs for recreation are shown in Table 9-5.

**Table 9-5**
**Summary of Separable and Remaining Joint Costs**
**(Interest Rate 5.75%)**
**( Unit -$ 1,000)**

| Features | Const. Cost | IDC | Annual OM&R | Multipurpose Project Without Water Supply Const. Cost | IDC | Annual OM&R | Multipurpose Project Without Recreation Const. Cost | IDC | Annual OM&R | Multipurpose Project Without Fish & Wildlife Const. Cost | IDC | Annual OM&R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Narrows Dam & Reservoir | 12,765 | 918 | | 12,248 | 918 | | 12,248 | 918 | | 12,030 | 830 | |
| Narrows Tunnel Inlet Rehabilitation | 295 | 27 | | 295 | 27 | | 295 | 27 | | 295 | 22 | |
| Upper Cottonwood Pipeline | 745 | 68 | | 0 | | | 745 | 68 | | 745 | 68 | |
| East Bench Pipeline | 9,873 | 887 | | 0 | | | 9,873 | 887 | | 9,873 | 887 | |
| Oak Creek Pipeline | 494 | 45 | | 0 | | | 494 | 45 | | 494 | 45 | |
| Highway Relocation | 2,982 | 273 | | 2,982 | 273 | | 2,982 | 273 | | 2982 | 273 | |
| Recreation Facilities | 1,111 | 144 | | 1,111 | 144 | | 0 | 0 | | 1,111 | 144 | |
| Fish & Wildlife Mitigation | 5,021 | 343 | | 5,021 | 343 | | 5,021 | 343 | | 0 | 0 | |
| Costs spent date | 3,925 | 0 | | 3,925 | 0 | | 3,925 | 0 | | 3,925 | 0 | |
| **Total Project Cost** | 37,211 | 2705 | 85 | 25,582 | 1705 | 64 | 35,583 | 2561 | 85 | 31,455 | 2269 | 40 |
| **Separable Costs** | 19,013 | 1580 | 66 | 11,629 | 1000 | 21 | 1,628 | 144 | 0 | 5,756 | 436 | 45 |
| **Remaining Joint Costs** | 18,198 | 1125 | 19 | | | | | | | | | |

**Project Without Fish and Wildlife.** Without fish and wildlife, the project would serve recreation and the water supply functions (irrigation and M&I). This would require a slightly smaller reservoir of about 14,500 acre-feet at the Narrows site. This reduction is the inactive capacity included in the multipurpose reservoir for fishery. All fish and wildlife mitigation would also be deleted from the project. All other project costs would remain the same. The resulting separable costs to fish and wildlife include $5,756,000 for construction costs, $436,000 interest during construction, and $45,000 for OM&R. Separable costs for fish and Wildlife are shown in Table 9-5.

### Allocation of Costs

Allocation of project costs is shown in Table 9-6. Separable costs for each purpose were subtracted from the justifiable expenditure to obtain the remaining justifiable expenditure. Because there was no remaining justifiable expenditure for recreation and fish and wildlife, all remaining joint costs were allocated to water supply.

### Sub-allocation of Water Supply Costs

As discussed earlier in this chapter, the water supply function is sub-allocated to commercial irrigation and M&I purposes by the “use of facilities” (UOF) method of cost allocation. This method assigns specific costs to each purpose and then divides the costs remaining after specifics have been deducted in proportion to water used. The Narrows Project does not have costs specific to either of these purposes. Therefore, the total “water supply allocation” is divided to irrigation and M&I on the basis of water use. The SRPA requires that interest be paid on M&I costs, and that M&I use be determined each year of the repayment period so that interest charges can be assessed. This requires what is termed a “rolling allocation” between irrigation and M&I. A rolling allocation is one that reflects a change in water use as it occurs over time.

It is anticipated that project M&I water use will increase over time with a corresponding decrease in commercial irrigation use. Estimates of project water use over the 30-year repayment period are shown in Table 9-7. Commercial irrigation is defined as water deliveries to ownerships of over 10 acres. These estimates are included to illustrate concepts. Under the terms of the repayment contract, actual use will be determined as it occurs during the repayment period.

Current M&I water use (about 500 acre-feet) will be financed by a low-interest loan from the State of Utah. The State loan is expected to be for $4,300,000. It is anticipated that additional water will convert to M&I use during the repayment period. This conversion has been estimated and displayed in Table 9-7.

The annual values for M&I conversion in Table 9-7 are used to calculate the rolling allocation displayed in Table 9-8. It is expected that urban M&I water will increase each year based on population growth. The total annual increase of M&I water financed by the SRPA loan at the end of the repayment period is estimated at 951 acre-feet.

Water use by year was used to develop the rolling allocation factors shown in Table 9-8.

**Table 9-6**
**Narrows Project Cost Allocation**
**Separable Costs - Remaining Benefits Method**
**(100 Years, 5.75 Percent Interest)**

| Items | Water Supply | Recreation | Fish & Wildlife | Total Project Costs |
|---|---|---|---|---|
| **Costs to be Allocated** | | | | $41,390,000 |
| Construction | | | | $37,211,000 |
| IDC | | | | $2,706,000 |
| OM&R (Capitalized) | | | | $1,473,000 |
| Annual OM&R | | | | $85,000 |
| **Benefits** | | | | |
| Capitalized | $15,280,000 | $2,060,000 | $2,241,000 | $19,581,000 |
| Annual Benefits | $881,874 | $118,880 | $129,332 | |
| **Single Purpose Alternative** | $34,156,000 | $19,471,000 | $10,585,000 | |
| Construction | $31,442,000 | $18,017,000 | $9,733,000 | |
| IDC | $2,002,000 | $1,027,000 | $567,000 | |
| OM&R (Capitalized) | $712,000 | $427,000 | $285,000 | |
| Annual OM&R | $35,000 | $21,000 | $14,000 | |
| **Justifiable Expenditure** | $15,280,000 | $2,060,000 | $2,241,000 | $19,581,000 |
| **Separable Costs** | $12,906,000 | $2,552,000 | $6,192,000 | $21,650,000 |
| Construction | $11,629,000 | $1,628,000 | $5,756,000 | $19,013,000 |
| IDC | $1,000,000 | $144,000 | $436,000 | $1,580,000 |
| OM&R (Capitalized) | $277,000 | $780,000 | $0 | $1,057,000 |
| Annual OM&R | $16,000 | $45,000 | $0 | $61,000 |
| **Remaining Justifiable Expenditure** | $2,374,000 | $0 | $0 | $2,374,000 |
| Percent | 100% | 0% | 0% | 100% |
| **Remaining Joint Costs** | $19,740,000 | $ - | $ - | $19,740,000 |
| Construction | $18,198,000 | $ - | $ - | $18,198,000 |
| IDC | $ 1,126,000 | $ - | $ - | $1,126,000 |
| OM&R (Capitalized) | $ 416,000 | $ - | $ - | $416,000 |
| Annual OM&R | $ 24,000 | $ - | $ - | $24,000 |
| **Total Allocated Costs** | $32,646,000 | $ 2,552,000 | $6,192,000 | $ 41,390,000 |
| Construction | $29,827,000 | $ 1,628,000 | $5,756,000 | $ 37,211,000 |
| IDC | $ 2,126,000 | $ 144,000 | $ 436,000 | $ 2,706,000 |
| OM&R (Capitalized) | $ 693,000 | $ 780,000 | $ - | $ 1,473,000 |
| Annual OM&R | $ 40,000 | $ 45,000 | $ - | $ 85,000 |

**Table 9-7**
**Water Use**

| Year of Repayment | Fiscal Year | Commercial Irrigation (AF) | M&I Water Financed By State (AF) | M&I Water Financed By SRPA Loan (AF) | Total M&I (AF) | **Project Total** (AF) |
|---|---|---|---|---|---|---|
| 1 | 2016 | 4,750 | 500 | 0 | 500 | 5,250 |
| 2 | 2017 | 4,721 | 500 | 29 | 529 | 5,250 |
| 3 | 2018 | 4,691 | 500 | 59 | 559 | 5,250 |
| 4 | 2019 | 4,662 | 500 | 88 | 588 | 5,250 |
| 5 | 2020 | 4,631 | 500 | 119 | 619 | 5,250 |
| 6 | 2021 | 4,601 | 500 | 149 | 649 | 5,250 |
| 7 | 2022 | 4,570 | 500 | 180 | 680 | 5,250 |
| 8 | 2023 | 4,538 | 500 | 212 | 712 | 5,250 |
| 9 | 2024 | 4,506 | 500 | 244 | 744 | 5,250 |
| 10 | 2025 | 4,474 | 500 | 276 | 776 | 5,250 |
| 11 | 2026 | 4,441 | 500 | 309 | 809 | 5,250 |
| 12 | 2027 | 4,407 | 500 | 343 | 843 | 5,250 |
| 13 | 2028 | 4,373 | 500 | 377 | 877 | 5,250 |
| 14 | 2029 | 4,339 | 500 | 411 | 911 | 5,250 |
| 15 | 2030 | 4,304 | 500 | 446 | 946 | 5,250 |
| 16 | 2031 | 4,268 | 500 | 482 | 982 | 5,250 |
| 17 | 2032 | 4,232 | 500 | 518 | 1,018 | 5,250 |
| 18 | 2033 | 4,195 | 500 | 555 | 1,055 | 5,250 |
| 19 | 2034 | 4,158 | 500 | 592 | 1,092 | 5,250 |
| 20 | 2035 | 4,121 | 500 | 629 | 1,129 | 5,250 |
| 21 | 2036 | 4,083 | 500 | 667 | 1,167 | 5,250 |
| 22 | 2037 | 4,052 | 500 | 698 | 1,198 | 5,250 |
| 23 | 2038 | 4,022 | 500 | 728 | 1,228 | 5,250 |
| 24 | 2039 | 3,991 | 500 | 759 | 1,259 | 5,250 |
| 25 | 2040 | 3,960 | 500 | 790 | 1,290 | 5,250 |
| 26 | 2041 | 3,928 | 500 | 822 | 1,322 | 5,250 |
| 27 | 2042 | 3,896 | 500 | 854 | 1,354 | 5,250 |
| 28 | 2043 | 3,864 | 500 | 886 | 1,386 | 5,250 |
| 29 | 2044 | 3,832 | 500 | 918 | 1,418 | 5,250 |
| 30 | 2045 | 3,799 | 500 | 951 | 1,451 | 5,250 |
| **Totals** | | 128,409 | 15,000 | 14,091 | 29,091 | 157,500 |
| **Percent of Total** | | 81.53% | 9.52% | 8.95% | 18.47% | 100% |
| **Percent of Irrigation** | | 100% | | | | |
| **Percent of M&I** | | | 51.56% | 48.44% | 100% | |

## LOAN AND GRANT CALCULATIONS

Loan and grant calculations are displayed in Table 9-9. Allocated capital costs used as a basis for loan and grant calculations were extracted from Table 9-6. Nonreimbursable costs specified by Public Law 84-984, are calculated from figures comprised of the following: (1) interest during construction for irrigation, (2) one-half of the interest during construction for recreation, and (3) one-half of interest during construction for fish and wildlife.

Public Law 84-984 further provides that 50 percent of construction costs allocated to recreation and fish and wildlife are eligible for Federal grant money. Costs remaining after non-reimbursable costs and Federal grants are deducted are the reimbursable costs. State grants are anticipated in the amount of $814,000 for recreation, and $2,878,000 for fish and wildlife. Since the State grants will be funded during the construction period, no interest during construction is charged and repayment schedules for these purposes will not be necessary.

In addition to the State grants, the District will procure an interest-free loan from the State for the portion of the allocated costs assigned to current M&I water costs, or 500 acre-feet. The amount of this loan is estimated at $4,300,000, and will also be funded concurrent with the Federal loan.

Additional local contributions total $3,925,000, which is the amount of District funds that have been spent to date. This results in a total of $11,917,000 that will be funded from local sources concurrent with Federal expenditures.

Since grants from the State are specified for Recreation and Fish and Wildlife, the full amount of the grants were deducted from those purposes. The State loan is specified for M&I water and was deducted from costs allocated to that purpose. Costs spent to date were deducted proportionately between Irrigation and M&I because they are the only two purposes still requiring Federal funding.

The Federal loan amount is the result of reimbursable costs, less local contributions and the State loan plus reimbursable interest during construction. The Federal loan amount is estimated at $21,792,000. The amount of the Federal loan by project purpose is shown on Table 9-10.

**Table 9-8**
**Rolling Allocation: Portion of SRPA Loan Allocated**
**M&I Water Supply**

| Year of Repayment | Total M&I (acre feet) | M&I Financed by SRPA Loan (acre feet) | Total Project Water Financed by SRPA Loan (acre feet) | M&I Portion Of Total Project Water | Portion Of M&I Water Financed by SRPA Loan | M&I Water Financed by State (acre feet) | M&I Water Financed by SRPA Loan (acre feet) | Total Project (acre feet) |
|---|---|---|---|---|---|---|---|---|
| 1 | 500 | 0 | 4750 | 9.52% | | 500 | 0 | 5250 |
| 2 | 529 | 29 | 4750 | 10.08% | 0.61% | 500 | 29 | 5250 |
| 3 | 559 | 59 | 4750 | 10.65% | 1.24% | 500 | 59 | 5250 |
| 4 | 588 | 88 | 4750 | 11.20% | 1.85% | 500 | 88 | 5250 |
| 5 | 619 | 119 | 4750 | 11.79% | 2.51% | 500 | 119 | 5250 |
| 6 | 649 | 149 | 4750 | 12.36% | 3.14% | 500 | 149 | 5250 |
| 7 | 680 | 180 | 4750 | 12.95% | 3.79% | 500 | 180 | 5250 |
| 8 | 712 | 212 | 4750 | 13.56% | 4.46% | 500 | 212 | 5250 |
| 9 | 744 | 244 | 4750 | 14.17% | 5.14% | 500 | 244 | 5250 |
| 10 | 776 | 276 | 4750 | 14.78% | 5.81% | 500 | 276 | 5250 |
| 11 | 809 | 309 | 4750 | 15.41% | 6.51% | 500 | 309 | 5250 |
| 12 | 843 | 343 | 4750 | 16.06% | 7.22% | 500 | 343 | 5250 |
| 13 | 877 | 377 | 4750 | 16.70% | 7.94% | 500 | 377 | 5250 |
| 14 | 911 | 411 | 4750 | 17.35% | 8.65% | 500 | 411 | 5250 |
| 15 | 946 | 446 | 4750 | 18.02% | 9.39% | 500 | 446 | 5250 |
| 16 | 982 | 482 | 4750 | 18.70% | 10.15% | 500 | 482 | 5250 |
| 17 | 1018 | 518 | 4750 | 19.39% | 10.91% | 500 | 518 | 5250 |
| 18 | 1055 | 555 | 4750 | 20.10% | 11.68% | 500 | 555 | 5250 |
| 19 | 1092 | 592 | 4750 | 20.80% | 12.46% | 500 | 592 | 5250 |
| 20 | 1129 | 629 | 4750 | 21.50% | 13.24% | 500 | 629 | 5250 |
| 21 | 1167 | 667 | 4750 | 22.23% | 14.04% | 500 | 667 | 5250 |
| 22 | 1198 | 698 | 4750 | 22.82% | 14.69% | 500 | 698 | 5250 |
| 23 | 1228 | 728 | 4750 | 23.39% | 15.33% | 500 | 728 | 5250 |
| 24 | 1259 | 759 | 4750 | 23.98% | 15.98% | 500 | 759 | 5250 |
| 25 | 1290 | 790 | 4750 | 24.57% | 16.63% | 500 | 790 | 5250 |
| 26 | 1322 | 822 | 4750 | 25.18% | 17.31% | 500 | 822 | 5250 |
| 27 | 1354 | 854 | 4750 | 25.79% | 17.98% | 500 | 854 | 5250 |
| 28 | 1386 | 886 | 4750 | 26.40% | 18.65% | 500 | 886 | 5250 |
| 29 | 1418 | 918 | 4750 | 27.01% | 19.33% | 500 | 918 | 5250 |
| 30 | 1451 | 951 | 4750 | 27.64% | 20.02% | 500 | 951 | 5250 |
| | | | | | Total | 15000 | 14091 | 157500 |
| | | | | | Percent of Total | 9.52% | 8.95% | 100 |

**Table 9-9**
**Calculation of Grants, Distributed Contributions,**
**RIDC, and Loan Amounts**
**(Unit - $1,000)**

| | Water Supply | Recreation | F&WL | Total |
|---|---|---|---|---|
| Project Construction Costs | 29,827 | 1,628 | 5,756 | 37,211 |
| Less Federal Grant | | 814 | 2,878 | 3,692 |
| Less State Grant | | 814 | 2,878 | 3,692 |
| Less State Loan | 4,300 | 0 | 0 | 4,300 |
| Remaining Construction Costs | 25,527 | 0 | 0 | 25,527 |
| Less Amount Spent by District | 3,925 | 0 | 0 | 3,925 |
| Loan Amount Construction Costs | 21,602 | 0 | 0 | 21,602 |
| Allocated IDC | 2,126 | 144 | 436 | 2,706 |
| Less Grants Credit --Federal | | 72 | 218 | 290 |
| Less Grants Credit -- State | | 72 | 218 | 290 |
| Less IDC State Loan | 202 | 0 | 0 | 202 |
| Less non-reimbursable IDC | 1734 | | | |
| Reimbursable IDC | 190 | 0 | 0 | 190 |
| Total Loan Amount | 21,792 | 0 | 0 | 21,792 |

**Table 9-10**
**Distribution of Loan and Calculation of RIDC**
**(Unit - $1,000)**

| | Commerical Irrigation | M&I | Total |
|---|---|---|---|
| Construction Cost | 19,669 | 1,933 | 21,602 |
| Remaining IDC | 1,734 | 190 | 1,924 |
| Less Nonreimbursable IDC | 1,734 | | 1,734 |
| RIDC | | 190 | 190 |
| Total Loan | 19,669 | 2,123 | 21,792 |

## Cost Sharing

Based on the preceding cost allocation and loan and grant calculation, a cost sharing summary is shown on Table 9-11. The table shows that 32 percent of the total project costs, including RIDC, will be provided by local funding; 10 percent will be provided by Federal grants; and the remaining 58 percent will be funded by a Public Law 84-984 loan.

Of the total SRPA loan amount, a total of $18,719,000, or about 86 percent, will be repaid by irrigators without interest. About $3,073,000, or 14 percent, will be repaid by municipal and industrial water users with interest. About 50 percent of construction costs for fish and wildlife and recreation will be funded concurrent with construction from local sources. Concurrent funding for these purposes amounts to $3,692,000. A State loan of $4,300,000 will also be concurrently funded. Costs already expended by the District amount to $3,925,000.

**Table 9-11**
**Cost Sharing Summary**

| Item | Amount ($) | Percent |
|---|---|---|
| Local Funding | 11,917,000 | 32 |
| Federal Grants | 3,692,000 | 10 |
| Public Law 84-984 Loan (Includes RIDC) | 21,792,000 | 58 |
| Total Project Costs & RIDC | 37,401,000 | 100 |
| Repaid by: | | |
| Irrigation | 18,719,470 | 86 |
| M&I Water | 3,072,530 | 14 |
| Total Federal Loan & RIDC | 21,792,000 | 100 |

## REPAYMENT PROGRAM

The terms and conditions for repayment presented in this section provide a basis for contract negotiations. Until a repayment contract is finally executed, the proposed terms and conditions are to be considered preliminary and subject to change.

### Revenues

Project revenues will accrue to the Sanpete Water Conservancy District from (1) the sale of irrigation water, (2) the sale of municipal and industrial water, and (3) ad valorem tax revenues.

#### Irrigation Repayment Ability

Irrigation repayment ability is based on 16 percent of the increased net farm income as detailed in Chapter 8. The 16 percent factor is based on the ratio of the payment capacity to net farm income from the 1994 Narrows Loan Application Report. That report included detailed farm budgets for repayment and benefits. The irrigation payment ability is assumed to represent 100 percent of payment capacity required by Reclamation policy outlined in Loan Program Guidelines - Small Reclamation Projects Act of 1956, dated September 1990.

The Narrows Project area consists of about 23,180 irrigated acres of which 15,420 acres are irrigable. The average water shortage for the project area is about 0.85 acre-feet per acre. The project commercial irrigation water supply of 4,900 acre-feet in the first year of project water delivery would amount to .31 acre-feet per acre if spread evenly over the 15,420 acres of irrigable land. Since it is not known at this time which acres will receive the water, the entire 23,180 acres of presently irrigated land has been included in the repayment analysis. A summary of this analysis is included in Table 9-12.

Data for nonproject OM&R, and debt service for loans currently being amortized by the canal companies were collected from the companies in the fall of 1990. Current loans are primarily for pressurization of all or part of existing nonproject water supplies, and almost all are interest-free loans from the State of Utah. It was found that most of the irrigation companies in the project area are in good financial condition with relatively low debt.

Income from irrigation was determined by multiplying 23,180 acres by the average per acre value of 1990 assessment of $ 15.91 resulting in $368,794. This value is added to $60,563 which is the total payment capacity from 4,750 acre-feet of project irrigation water as shown in Table 9-12.

Costs are deducted from total irrigation income for: (1) irrigation company OM&R, (2) contract obligations, and (3) contributions to a reserve fund. The value remaining for amortizing the Federal loan is $60,500 as shown in Table 9-12. This value is for the first year of the repayment period for commercial irrigation and changes each year as irrigation water use changes over time.

**Table 9-12**
**Irrigation SRPA Loan Repayment Ability**
**(Unit - $)**

| | Irrigators | Ad Valorem Tax |
|---|---|---|
| Income | | |
| Revenue from 23,180 Acres@ 15.91 | $ 368,794 | |
| Payment Capacity from 4750 A F @ 12.75 | $ 60,563 | |
| Total Irrigation Payment Capacity | $ 429,356 | |
| Ad Valorem Tax | | $ 493,481 |
| Total Revenue | $ 429,356 | $ 493,481 |
| OM&R and existing obligations | | |
| District OM&R | | $ 5,000 |
| District Revenues reserved for Other Water Conservation Activities | | $ 12,000 |
| Irrigation Company Loan payments | $ 214,600 | |
| Irrigation Company OM&R | $ 139,300 | |
| Reserve Fund Contribution for Canal Companies | $ 15,000 | |
| Total Obligations | $ 368,900 | $ 17,000 |
| Irrigation Amortization Capacity | $ 60,456 | $ 476,481 |

Payment capacity currently being used for debt retirement by the individual canal companies will become available for other uses as current debts are retired. Revenues from this source will become available beginning in the year 2013. About 50 percent of these revenues are used to assist in repayment of the irrigation portion of the Federal loan as they become available. The remaining 50 percent will be used by the canal companies for additional upgrading of their irrigation systems. Additional work is necessary because many of the canal systems are in need of upgrading to more efficiently use existing supplies. This type of activity is especially important because the project does not bring the area up to a full supply. As discussed earlier in this chapter, irrigation water shortages in the project area amount to .85 acre-feet per acre, and the project will supply about .31 acre-feet per acre. A schedule of payments from this source is shown in Table 9-13.

**Table 9-13**
**Irrigation Company Existing Loans Payout Summary**

| Irrig Co. | BWRE Funding | Current Loan | Annual Payment | Final Year |
|---|---|---|---|---|
| Brady Ditch Irrigation Co. | Y | Y | $ 4,000 | 2013 |
| Horseshoe Irrigation Co | Y | Y | $ 17,960 | 2017 |
| Graveyard Ditch Co. | Y | Y | $ 1,950 | 2019 |
| Chester Irrigation Co | Y | Y | $ 4,750 | 2023 |
| Fountain Green Irrigation Co | Y | Y | $ 9,200 | 2024 |
| Fountain Green Irrigation Co | Y | Y | $ 11,050 | 2025 |
| Cedar Creek Irrigtion Co. | Y | Y | $ 15,600 | 2026 |
| Horshoe Irrigation Co. | Y | Y | $ 24,000 | 2026 |
| Devils Pass Water Co | Y | Y | $ 13,000 | 2028 |
| M&M Irrigation Co. | Y | Y | $ 42,100 | 2031 |
| Fountain Green Irrigation Co | Y | Y | $ 9,700 | 2032 |
| Twin Creek Irrigation Co. | Y | Y | $ 15,900 | 2036 |
| Cottonwood- Gooseberry Irrigation Company | Y | Y | $ 43,600 | 2036 |

### Municipal and Industrial Water Sales

Demands for project M&I water in the first year of project delivery are estimated at 500 acre-feet, as shown earlier in Table 9-8. A loan will be acquired from the State to finance this portion of the M&I water supply. It is assumed that this would be a 30-year loan at 2 percent interest. Revenues of $191,995 will be required to amortize this loan over 30 years, or about $384 per acre-foot.

Additional M&I demands are expected to occur over time. Future M&I demands will be financed by the SRPA loan and repaid with interest. Estimated future demands start at zero for the first year and increase to 941 acre-feet by year 30 of the SRPA loan repayment period. An average rate of about $324 per acre-foot is required to repay the M&I obligation over the 30-year repayment period at 5.75 percent interest. This interest rate is specified SRPA repayment rate for the Narrows Project.

### Ad Valorem Tax

The Sanpete Water Conservancy District has tax-levying authority up to .0004 of assessed valuation. This tax-levying authority is granted by the Conservancy District Act of the State of Utah.

The assessed valuation of the district in 2003 was $734,718,000. This includes all of Sanpete County. A study of the assessed valuation from 2003 to 2010 shows an average growth rate of about 6.93 percent annually. It is anticipated that this same growth rate will continue in the near future. Therefore, assessed valuation and District income were projected by the historical growth rate to the first year of project repayment estimated to be the year 2015. Projections were not made beyond 2015 because of the uncertainty of growth in the area. Estimated revenues to the District from ad valorem tax is shown in Table 9-14.

**Table 9-14**
**Estimated Ad Valorem Tax Revenues to**
**Sanpete Water Conservancy District**

| Year | Total Real Property Assessed Valuation ($1,000) | Tax Rate | Potential Tax Revenue ($1,000) | Growth Rate |
|---|---|---|---|---|
| Historical Data | | | | |
| 2003 | 734,718 | 0.0004 | 294 | N/A[1] |
| 2004 | 766,626 | 0.0004 | 307 | 4.3% |
| 2005 | 796,952 | 0.0004 | 319 | 4.0% |
| 2006 | 845,388 | 0.0004 | 338 | 6.1% |
| 2007 | 945,853 | 0.0004 | 378 | 11.9% |
| 2008 | 1,091,367 | 0.0004 | 437 | 15.4% |
| 2009 | 1,138,745 | 0.0004 | 455 | 4.3% |
| 2010 | 1,167,114 | 0.0004 | 467 | 2.5% |
| | | | Average growth rate = | 6.93% |
| Projected Data | | | | |
| 2011 | 1,247,940 | 0.0004 | 499 | 6.93% |
| 2012 | 1,334,363 | 0.0004 | 534 | 6.93% |
| 2013 | 1,426,772 | 0.0004 | 571 | 6.93% |
| 2014 | 1,525,580 | 0.0004 | 610 | 6.93% |
| 2015 | 1,631,231 | 0.0004 | 652 | 6.93% |

[1] N/A = Not applicable.

### Flow of Revenues

Flow of Revenues consists of OM&R, emergency reserve, and Federal and State loan repayment. These figures are shown in Table 9-15, at the end of this chapter. Because of the rolling allocation discussed earlier, revenues by purpose vary according to water supply for each year of repayment. Table 9-15 details these revenues by year for each project repayment purpose. The values shown on this table are used in the repayment schedule, Table 9-16, also found at the end of this chapter.

## EXPENDITURES

Expenditures for the project are comprised of OM&R costs for each purpose, emergency reserves, and Public Law 84-984 loan payments.

**Table 9-15**
**Flow of Revenues for Irrigation and M&I**

| 1<br>Year of Repayment | 2<br>Fiscal Year | 3<br>Acre-Feet | 4<br>Farmers Increased Net Income $ | 5<br>Farmers Increased Net Income Available 16% | 6<br>Revenues Available After State Loans Repayment $ | 7<br>Ad Valorem Tax Revenues $ | 8<br>Total $ |
|---|---|---|---|---|---|---|---|
| 1 | 2016 | 4750 | $ 657,874 | $ 105,260 | $ 4,000 | $ 476,481 | $ 585,741 |
| 2 | 2017 | 4721 | $ 639,059 | $ 102,249 | $ 4,000 | $ 476,481 | $ 582,730 |
| 3 | 2018 | 4691 | $ 620,782 | $ 99,325 | $ 21,960 | $ 476,481 | $ 597,766 |
| 4 | 2019 | 4662 | $ 603,027 | $ 96,484 | $ 21,960 | $ 476,481 | $ 594,925 |
| 5 | 2020 | 4631 | $ 585,781 | $ 93,725 | $ 23,910 | $ 476,481 | $ 594,116 |
| 6 | 2021 | 4601 | $ 569,027 | $ 91,044 | $ 23,190 | $ 476,481 | $ 590,715 |
| 7 | 2022 | 4570 | $ 552,753 | $ 88,440 | $ 23,190 | $ 476,481 | $ 588,111 |
| 8 | 2023 | 4538 | $ 536,945 | $ 85,911 | $ 23,190 | $ 476,481 | $ 585,582 |
| 9 | 2024 | 4506 | $ 521,588 | $ 83,454 | $ 28,660 | $ 476,481 | $ 588,595 |
| 10 | 2025 | 4474 | $ 506,670 | $ 81,067 | $ 28,660 | $ 476,481 | $ 586,208 |
| 11 | 2026 | 4441 | $ 492,180 | $ 78,749 | $ 39,710 | $ 476,481 | $ 594,940 |
| 12 | 2027 | 4407 | $ 478,103 | $ 76,496 | $ 79,310 | $ 476,481 | $ 632,287 |
| 13 | 2028 | 4373 | $ 464,430 | $ 74,309 | $ 79,310 | $ 476,481 | $ 630,100 |
| 14 | 2029 | 4339 | $ 451,147 | $ 72,184 | $ 92,310 | $ 476,481 | $ 640,975 |
| 15 | 2030 | 4304 | $ 438,244 | $ 70,119 | $ 92,310 | $ 476,481 | $ 638,910 |
| 16 | 2031 | 4268 | $ 425,710 | $ 68,114 | $ 92,310 | $ 476,481 | $ 636,905 |
| 17 | 2032 | 4232 | $ 413,535 | $ 66,166 | $ 134,410 | $ 476,481 | $ 677,057 |
| 18 | 2033 | 4195 | $ 401,708 | $ 64,273 | $ 144,110 | $ 476,481 | $ 684,864 |
| 19 | 2034 | 4158 | $ 390,219 | $ 62,435 | $ 144,110 | $ 476,481 | $ 683,026 |
| 20 | 2035 | 4121 | $ 379,059 | $ 60,649 | $ 144,110 | $ 476,481 | $ 681,240 |
| 21 | 2036 | 4083 | $ 368,218 | $ 58,915 | $ 144,110 | $ 476,481 | $ 679,506 |
| 22 | 2037 | 4052 | $ 357,687 | $ 57,230 | $ 212,810 | $ 476,481 | $ 746,521 |
| 23 | 2038 | 4022 | $ 347,457 | $ 55,593 | $ 212,810 | $ 476,481 | $ 744,884 |
| 24 | 2039 | 3991 | $ 337,520 | $ 54,003 | $ 212,810 | $ 476,481 | $ 743,294 |
| 25 | 2040 | 3960 | $ 327,867 | $ 52,459 | $ 212,810 | $ 476,481 | $ 741,750 |
| 26 | 2041 | 3928 | $ 318,490 | $ 50,958 | $ 212,810 | $ 476,481 | $ 740,249 |
| 27 | 2042 | 3896 | $ 309,381 | $ 49,501 | $ 212,810 | $ 476,481 | $ 738,792 |
| 28 | 2043 | 3864 | $ 300,532 | $ 48,085 | $ 212,810 | $ 476,481 | $ 737,376 |
| 29 | 2044 | 3832 | $ 291,937 | $ 46,710 | $ 212,810 | $ 476,481 | $ 736,001 |
| 30 | 2045 | 3799 | $ 283,588 | $ 45,374 | $ 212,810 | $ 476,481 | $ 734,665 |
| Totals | | 128,409 | $ 13,370,518 | $ 2,139,281 | $ 3,304,120 | $ 14,294,423 | $ 19,737,824 |

**Table 9-15 (Continued)**
**Flow Of Revenues for Irrigation and M&I Water**

| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|
| | Commercial Irrigation | | | Loan From State | | |
| Commercial Irrigation Portion of Water | OM&R ($) | Emergency Fund Acre-Feet | Total Commercial Increased Net Income ($) | M&I Water Financed By State (Acre- Feet) | Loan Payment [1] ($) | OM&R $7.619/af |
| 90.48% | $ 36,190 | $ 8,000 | $ 44,190 | 500 | $ 191,995 | $ 3,810 |
| 89.92% | $ 35,970 | $ 8,000 | $ 43,970 | 500 | $ 191,995 | $ 3,810 |
| 89.35% | $ 35,741 | $ 8,000 | $ 43,741 | 500 | $ 191,995 | $ 3,810 |
| 88.80% | $ 35,520 | $ 8,000 | $ 43,520 | 500 | $ 191,995 | $ 3,810 |
| 88.21% | $ 35,284 | $ 8,000 | $ 43,284 | 500 | $ 191,995 | $ 3,810 |
| 87.64% | $ 35,055 | | $ 35,055 | 500 | $ 191,995 | $ 3,810 |
| 87.05% | $ 34,819 | | $ 34,819 | 500 | $ 191,995 | $ 3,810 |
| 86.44% | $ 34,575 | | $ 34,575 | 500 | $ 191,995 | $ 3,810 |
| 85.83% | $ 34,331 | | $ 34,331 | 500 | $ 191,995 | $ 3,810 |
| 85.22% | $ 34,088 | | $ 34,088 | 500 | $ 191,995 | $ 3,810 |
| 84.59% | $ 33,836 | | $ 33,836 | 500 | $ 191,995 | $ 3,810 |
| 83.94% | $ 33,577 | | $ 33,577 | 500 | $ 191,995 | $ 3,810 |
| 83.30% | $ 33,318 | | $ 33,318 | 500 | $ 191,995 | $ 3,810 |
| 82.65% | $ 33,059 | | $ 33,059 | 500 | $ 191,995 | $ 3,810 |
| 81.98% | $ 32,792 | | $ 32,792 | 500 | $ 191,995 | $ 3,810 |
| 81.30% | $ 32,518 | | $ 32,518 | 500 | $ 191,995 | $ 3,810 |
| 80.61% | $ 32,244 | | $ 32,244 | 500 | $ 191,995 | $ 3,810 |
| 79.90% | $ 31,962 | | $ 31,962 | 500 | $ 191,995 | $ 3,810 |
| 79.20% | $ 31,680 | | $ 31,680 | 500 | $ 191,995 | $ 3,810 |
| 78.50% | $ 31,398 | | $ 31,398 | 500 | $ 191,995 | $ 3,810 |
| 77.77% | $ 31,109 | | $ 31,109 | 500 | $ 191,995 | $ 3,810 |
| 77.18% | $ 30,872 | | $ 30,872 | 500 | $ 191,995 | $ 3,810 |
| 76.61% | $ 30,644 | | $ 30,644 | 500 | $ 191,995 | $ 3,810 |
| 76.02% | $ 30,408 | | $ 30,408 | 500 | $ 191,995 | $ 3,810 |
| 75.43% | $ 30,171 | | $ 30,171 | 500 | $ 191,995 | $ 3,810 |
| 74.82% | $ 29,928 | | $ 29,928 | 500 | $ 191,995 | $ 3,810 |
| 74.21% | $ 29,684 | | $ 29,684 | 500 | $ 191,995 | $ 3,810 |
| 73.60% | $ 29,440 | | $ 29,440 | 500 | $ 191,995 | $ 3,810 |
| 72.99% | $ 29,196 | | $ 29,196 | 500 | $ 191,995 | $ 3,810 |
| 72.36% | $ 28,945 | | $ 28,945 | 500 | $ 191,961 | $ 3,810 |
| | $ 978,354 | 40,000 | $ 1,018,354 | | $ 5,759,816 | $ 114,300 |

[1] Amortized over 30 years at 2% interest

**Table 9-15 (continued)**
**Flow of Revenues for Irrigation and M&I Water**

| 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|
| | M&I Water Financed by SRPA Loan | | | |
| Total Revenues To State $ | Acre-Feet | Revenues $324.43 | OM&R $7.619/af | Total Project (Acre-Feet) |
| $ 195,805 | 0 | $ - | 0 | 5250 |
| $ 195,805 | 29 | $ 9,408 | $ 221 | 5250 |
| $ 195,805 | 59 | $ 19,141 | $ 450 | 5250 |
| $ 195,805 | 88 | $ 28,550 | $ 670 | 5250 |
| $ 195,805 | 119 | $ 38,607 | $ 907 | 5250 |
| $ 195,805 | 149 | $ 48,340 | $ 1,135 | 5250 |
| $ 195,805 | 180 | $ 58,397 | $ 1,371 | 5250 |
| $ 195,805 | 212 | $ 68,779 | $ 1,615 | 5250 |
| $ 195,805 | 244 | $ 79,161 | $ 1,859 | 5250 |
| $ 195,805 | 276 | $ 89,543 | $ 2,103 | 5250 |
| $ 195,805 | 309 | $ 100,249 | $ 2,354 | 5250 |
| $ 195,805 | 343 | $ 111,279 | $ 2,613 | 5250 |
| $ 195,805 | 377 | $ 122,310 | $ 2,872 | 5250 |
| $ 195,805 | 411 | $ 133,341 | $ 3,131 | 5250 |
| $ 195,805 | 446 | $ 144,696 | $ 3,398 | 5250 |
| $ 195,805 | 482 | $ 156,375 | $ 3,672 | 5250 |
| $ 195,805 | 518 | $ 168,055 | $ 3,947 | 5250 |
| $ 195,805 | 555 | $ 180,059 | $ 4,229 | 5250 |
| $ 195,805 | 592 | $ 192,063 | $ 4,510 | 5250 |
| $ 195,805 | 629 | $ 204,066 | $ 4,792 | 5250 |
| $ 195,805 | 667 | $ 216,395 | $ 5,082 | 5250 |
| $ 195,805 | 698 | $ 226,452 | $ 5,318 | 5250 |
| $ 195,805 | 728 | $ 236,185 | $ 5,547 | 5250 |
| $ 195,805 | 759 | $ 246,242 | $ 5,783 | 5250 |
| $ 195,805 | 790 | $ 256,300 | $ 6,019 | 5250 |
| $ 195,805 | 822 | $ 266,681 | $ 6,263 | 5250 |
| $ 195,805 | 854 | $ 277,063 | $ 6,507 | 5250 |
| $ 195,805 | 886 | $ 287,445 | $ 6,750 | 5250 |
| $ 195,805 | 918 | $ 297,827 | $ 6,994 | 5250 |
| $ 195,771 | 951 | $ 308,533 | $ 7,246 | 5250 |
| $5,874,116 | 14,091 | $ 4,571,543 | $ 107,359 | |

### Operation, Maintenance, and Replacement (OM&R) Costs

Annual OM&R costs for each project purpose were determined by the cost allocation (refer to Table 9-6). These costs are estimated to be $40,000 for irrigation and M&I purposes which will be paid in full by the District. Annual OM&R costs of $45,000 for recreation will be paid by the entities that operate the recreation facilities.

### Emergency Reserve

An emergency reserve fund is required to be set aside to cover operating costs that may occur beyond the normal OM&R costs for the project. A $40,000 reserve is suggested to be built up over a 5-year period by setting aside $8,000 per year. The emergency reserve is shown in Table 9-16, at the end of this Chapter.

### Federal Loan Repayment

The Federal loan of $21,792,000 will be repaid over a 30-year period. As discussed previously, the loan has been allocated to irrigation and municipal and industrial water. The allocation to these functions was made by sub-allocating the water supply function by the “use of facilities” method on the basis of water use for each year of the repayment period. This is called a "rolling allocation" and is used to calculate annual payments for irrigation and M&I shown in the repayment schedule (Table 9-16), at the end of this chapter. This process is described below in the paragraph entitled “Payout Schedule.” Irrigation costs will be repaid over a period of 30 years without interest, and M&I will be repaid over the same repayment period with interest at 5.75 percent. All values shown in this chapter are preliminary and will be used as a basis for contract negotiations between the District and the Federal government. Final values will be included in the repayment contract.

A State loan of $4,300,000 will be repaid over a 30-year period at 2 percent interest. This loan is specified by the State for M&I. The amortization of this loan is a shown on Table 9-16.

## PAYOUT SCHEDULE

The financial program and payout schedule for this loan application are shown in Table 9-16, at the end of this chapter. Table 9-17 presents a brief description of each column. Flow of revenues by year used in the repayment schedule are shown in Table 9-15.

**Table 9-16**
**Financial Program Repayment Schedule**

| Year of Study 1 | FY 2 | M&I Financed by State 3 | M&I Financed by SRPA Loan 4 | Total M&I 5 | Commercial Irrigation 6 | Total 7 |
|---|---|---|---|---|---|---|
| | | | **Revenues** | | | |
| 0 | 2015 | | | | | |
| 1 | 2016 | $ 195,805 | $ - | $ 195,805 | $ 585,741 | $ 781,546 |
| 2 | 2017 | $ 195,805 | $ 9,629 | $ 205,434 | $ 582,730 | $ 788,164 |
| 3 | 2018 | $ 195,805 | $ 19,591 | $ 215,396 | $ 597,766 | $ 813,162 |
| 4 | 2019 | $ 195,805 | $ 29,220 | $ 225,025 | $ 594,925 | $ 819,950 |
| 5 | 2020 | $ 195,805 | $ 39,514 | $ 235,319 | $ 594,116 | $ 829,435 |
| 6 | 2021 | $ 195,805 | $ 49,475 | $ 245,280 | $ 590,715 | $ 835,995 |
| 7 | 2022 | $ 195,805 | $ 59,769 | $ 255,574 | $ 588,111 | $ 843,685 |
| 8 | 2023 | $ 195,805 | $ 70,394 | $ 266,199 | $ 585,582 | $ 851,781 |
| 9 | 2024 | $ 195,805 | $ 81,020 | $ 276,825 | $ 588,595 | $ 865,420 |
| 10 | 2025 | $ 195,805 | $ 91,646 | $ 287,451 | $ 586,208 | $ 873,658 |
| 11 | 2026 | $ 195,805 | $ 102,603 | $ 298,408 | $ 594,940 | $ 893,348 |
| 12 | 2027 | $ 195,805 | $ 113,893 | $ 309,698 | $ 632,287 | $ 941,985 |
| 13 | 2028 | $ 195,805 | $ 125,182 | $ 320,987 | $ 630,100 | $ 951,087 |
| 14 | 2029 | $ 195,805 | $ 136,472 | $ 332,277 | $ 640,975 | $ 973,252 |
| 15 | 2030 | $ 195,805 | $ 148,094 | $ 343,899 | $ 638,910 | $ 982,809 |
| 16 | 2031 | $ 195,805 | $ 160,048 | $ 355,853 | $ 636,905 | $ 992,757 |
| 17 | 2032 | $ 195,805 | $ 172,001 | $ 367,806 | $ 677,057 | $ 1,044,863 |
| 18 | 2033 | $ 195,805 | $ 184,287 | $ 380,092 | $ 684,864 | $ 1,064,956 |
| 19 | 2034 | $ 195,805 | $ 196,573 | $ 392,378 | $ 683,026 | $ 1,075,404 |
| 20 | 2035 | $ 195,805 | $ 208,859 | $ 404,664 | $ 681,240 | $ 1,085,904 |
| 21 | 2036 | $ 195,805 | $ 221,477 | $ 417,282 | $ 679,506 | $ 1,096,787 |
| 22 | 2037 | $ 195,805 | $ 231,770 | $ 427,575 | $ 746,521 | $ 1,174,096 |
| 23 | 2038 | $ 195,805 | $ 241,732 | $ 437,537 | $ 744,884 | $ 1,182,420 |
| 24 | 2039 | $ 195,805 | $ 252,025 | $ 447,830 | $ 743,294 | $ 1,191,124 |
| 25 | 2040 | $ 195,805 | $ 262,319 | $ 458,124 | $ 741,750 | $ 1,199,873 |
| 26 | 2041 | $ 195,805 | $ 272,944 | $ 468,749 | $ 740,249 | $ 1,208,998 |
| 27 | 2042 | $ 195,805 | $ 283,570 | $ 479,375 | $ 738,792 | $ 1,218,167 |
| 28 | 2043 | $ 195,805 | $ 294,195 | $ 490,000 | $ 737,376 | $ 1,227,376 |
| 29 | 2044 | $ 195,805 | $ 304,821 | $ 500,626 | $ 736,001 | $ 1,236,627 |
| 30 | 2045 | $ 195,771 | $ 315,779 | $ 511,550 | $ 734,665 | $ 1,246,214 |
| Total | | $ 5,874,116 | $ 4,678,902 | $ 10,553,018 | $ 19,737,830 | $ 30,290,848 |

**Table 9-16 (Continued)**
**Financial Program Repayment Schedule**

| OM&R | | | Emergency Reserve | | |
|---|---|---|---|---|---|
| M&I Financed by SRPA Loan 8 | M&I Financed by State 9 | Commercial Irrigation 10 | Annual Payments 11 | Accumulated Total 12 | Total OM&R Commercial Irrigation 13 |
| $ - | $ 3,810 | $ 36,190 | $ 8,000 | $ 8,000 | $ 44,190 |
| $ 221 | $ 3,810 | $ 35,970 | $ 8,000 | $ 16,000 | $ 43,970 |
| $ 450 | $ 3,810 | $ 35,741 | $ 8,000 | $ 24,000 | $ 43,741 |
| $ 670 | $ 3,810 | $ 35,520 | $ 8,000 | $ 32,000 | $ 43,520 |
| $ 907 | $ 3,810 | $ 35,284 | $ 8,000 | $ 40,000 | $ 43,284 |
| $ 1,135 | $ 3,810 | $ 35,055 | | | $ 35,055 |
| $ 1,371 | $ 3,810 | $ 34,819 | | | $ 34,819 |
| $ 1,615 | $ 3,810 | $ 34,575 | | | $ 34,575 |
| $ 1,859 | $ 3,810 | $ 34,331 | | | $ 34,331 |
| $ 2,103 | $ 3,810 | $ 34,088 | | | $ 34,088 |
| $ 2,354 | $ 3,810 | $ 33,836 | | | $ 33,836 |
| $ 2,613 | $ 3,810 | $ 33,577 | | | $ 33,577 |
| $ 2,872 | $ 3,810 | $ 33,318 | | | $ 33,318 |
| $ 3,131 | $ 3,810 | $ 33,059 | | | $ 33,059 |
| $ 3,398 | $ 3,810 | $ 32,792 | | | $ 32,792 |
| $ 3,672 | $ 3,810 | $ 32,518 | | | $ 32,518 |
| $ 3,947 | $ 3,810 | $ 32,244 | | | $ 32,244 |
| $ 4,229 | $ 3,810 | $ 31,962 | | | $ 31,962 |
| $ 4,510 | $ 3,810 | $ 31,680 | | | $ 31,680 |
| $ 4,792 | $ 3,810 | $ 31,398 | | | $ 31,398 |
| $ 5,082 | $ 3,810 | $ 31,109 | | | $ 31,109 |
| $ 5,318 | $ 3,810 | $ 30,872 | | | $ 30,872 |
| $ 5,547 | $ 3,810 | $ 30,644 | | | $ 30,644 |
| $ 5,783 | $ 3,810 | $ 30,408 | | | $ 30,408 |
| $ 6,019 | $ 3,810 | $ 30,171 | | | $ 30,171 |
| $ 6,263 | $ 3,810 | $ 29,928 | | | $ 29,928 |
| $ 6,507 | $ 3,810 | $ 29,684 | | | $ 29,684 |
| $ 6,750 | $ 3,810 | $ 29,440 | | | $ 29,440 |
| $ 6,994 | $ 3,810 | $ 29,196 | | | $ 29,196 |
| $ 7,246 | $ 3,810 | $ 28,945 | | | $ 28,945 |
| $ 107,359 | $ 114,285 | $ 978,354 | $ 40,000 | | $ 1,018,354 |

**Table 9-16 (Continued)**
**Financial Program Repayment Schedule**

| Total OM&R M&I Water ($) 14 | Total OM&R State ($) 15 | Interest Payments: M&I Portion of SRPA Loan % 16 | Interest Payments: M&I Interest ($) 17 | Principal Payments on Federal Loan: Irrigation $ 18 | Principal Payments on Federal Loan: M&I $ 19 | Principal Payments on Federal Loan: Total Principal Payments $ 20 |
|---|---|---|---|---|---|---|
| $ 3,810 | $ 3,810 | 0.00% | - | $ 541,550 | $ - | $ 541,550 |
| $ 4,030 | $ 3,810 | 0.61% | 7,460 | $ 538,760 | $ 1,948 | $ 540,709 |
| $ 4,259 | $ 3,810 | 1.24% | 14,791 | $ 554,025 | $ 4,350 | $ 558,375 |
| $ 4,480 | $ 3,810 | 1.85% | 21,467 | $ 551,405 | $ 7,083 | $ 558,488 |
| $ 4,716 | $ 3,810 | 2.51% | 28,224 | $ 550,832 | $ 10,383 | $ 561,215 |
| $ 4,945 | $ 3,810 | 3.14% | 34,327 | $ 555,660 | $ 14,013 | $ 569,672 |
| $ 5,181 | $ 3,810 | 3.79% | 40,228 | $ 553,292 | $ 18,170 | $ 571,461 |
| $ 5,425 | $ 3,810 | 4.46% | 45,913 | $ 551,007 | $ 22,866 | $ 573,873 |
| $ 5,669 | $ 3,810 | 5.14% | 51,148 | $ 554,263 | $ 28,013 | $ 582,276 |
| $ 5,912 | $ 3,810 | 5.81% | 55,910 | $ 552,120 | $ 33,632 | $ 585,752 |
| $ 6,164 | $ 3,810 | 6.51% | 60,404 | $ 561,104 | $ 39,845 | $ 600,948 |
| $ 6,423 | $ 3,810 | 7.22% | 64,556 | $ 598,710 | $ 46,724 | $ 645,434 |
| $ 6,682 | $ 3,810 | 7.94% | 68,009 | $ 596,782 | $ 54,301 | $ 651,083 |
| $ 6,941 | $ 3,810 | 8.65% | 70,903 | $ 607,916 | $ 62,437 | $ 670,353 |
| $ 7,208 | $ 3,810 | 9.39% | 73,322 | $ 606,117 | $ 71,374 | $ 677,491 |
| $ 7,482 | $ 3,810 | 10.15% | 75,287 | $ 604,387 | $ 81,088 | $ 685,474 |
| $ 7,756 | $ 3,810 | 10.91% | 76,612 | $ 644,813 | $ 91,442 | $ 736,255 |
| $ 8,038 | $ 3,810 | 11.68% | 77,138 | $ 652,902 | $ 102,921 | $ 755,822 |
| $ 8,320 | $ 3,810 | 12.46% | 76,864 | $ 651,346 | $ 115,198 | $ 766,544 |
| $ 8,602 | $ 3,810 | 13.24% | 75,832 | $ 649,842 | $ 128,235 | $ 778,077 |
| $ 8,891 | $ 3,810 | 14.04% | 74,131 | $ 648,397 | $ 142,264 | $ 790,661 |
| $ 9,128 | $ 3,810 | 14.69% | 70,895 | $ 715,648 | $ 155,557 | $ 871,205 |
| $ 9,356 | $ 3,810 | 15.33% | 66,265 | $ 714,240 | $ 169,920 | $ 884,160 |
| $ 9,592 | $ 3,810 | 15.98% | 60,963 | $ 712,886 | $ 185,280 | $ 898,166 |
| $ 9,829 | $ 3,810 | 16.63% | 54,863 | $ 711,578 | $ 201,436 | $ 913,015 |
| $ 10,072 | $ 3,810 | 17.31% | 48,001 | $ 710,321 | $ 218,681 | $ 929,002 |
| $ 10,316 | $ 3,810 | 17.98% | 40,265 | $ 709,108 | $ 236,798 | $ 945,906 |
| $ 10,560 | $ 3,810 | 18.65% | 31,629 | $ 707,936 | $ 255,816 | $ 963,752 |
| $ 10,804 | $ 3,810 | 19.33% | 22,062 | $ 706,805 | $ 275,765 | $ 982,570 |
| $ 11,055 | $ 3,810 | 20.02% | 11,543 | $ 705,720 | $ 296,990 | $ 1,002,710 |
| $ 221,644 | $ 114,285 | | 1,499,013 | 18,719,470 | 3,072,530 | 21,792,000 |

**Table 9-16 (continued)**
**Financial Program Repayment Schedule**

| Total SRPA Loan Balance $ 21 | Interest Payments on State Loan $ 22 | Principal Payments on State Loan $ 23 | State Loan Balance $ 24 | SRPA Loan Payments $ 25 | Operating Expenditures $ 26 | Total Revenues SRPA Loan $ 27 | Year of Study 28 |
|---|---|---|---|---|---|---|---|
| 21,792,000 | | | $ 4,300,000 | | | | |
| 21,250,450 | 86,000 | $ 105,996 | $ 4,194,005 | 541,550 | $ 48,000 | 585,741 | 1 |
| 20,709,741 | 83,880 | $ 108,115 | $ 4,085,889 | 548,169 | $ 48,000 | 592,359 | 2 |
| 20,151,366 | 81,718 | $ 110,278 | $ 3,975,611 | 573,166 | $ 48,000 | 617,357 | 3 |
| 19,592,878 | 79,512 | $ 112,483 | $ 3,863,128 | 579,955 | $ 48,000 | 624,145 | 4 |
| 19,031,663 | 77,263 | $ 114,733 | $ 3,748,395 | 589,439 | $ 48,000 | 633,630 | 5 |
| 18,461,990 | 74,968 | $ 117,028 | $ 3,631,368 | 604,000 | $ 40,000 | 640,190 | 6 |
| 17,890,529 | 72,627 | $ 119,368 | $ 3,511,999 | 611,689 | $ 40,000 | 647,880 | 7 |
| 17,316,656 | 70,240 | $ 121,756 | $ 3,390,244 | 619,786 | $ 40,000 | 655,976 | 8 |
| 16,734,380 | 67,805 | $ 124,191 | $ 3,266,053 | 633,424 | $ 40,000 | 669,615 | 9 |
| 16,148,627 | 65,321 | $ 126,674 | $ 3,139,379 | 641,663 | $ 40,000 | 677,853 | 10 |
| 15,547,679 | 62,788 | $ 129,208 | $ 3,010,171 | 661,352 | $ 40,000 | 697,543 | 11 |
| 14,902,246 | 60,203 | $ 131,792 | $ 2,878,379 | 709,989 | $ 40,000 | 746,180 | 12 |
| 14,251,163 | 57,568 | $ 134,428 | $ 2,743,951 | 719,092 | $ 40,000 | 755,282 | 13 |
| 13,580,810 | 54,879 | $ 137,116 | $ 2,606,834 | 741,256 | $ 40,000 | 777,447 | 14 |
| 12,903,319 | 52,137 | $ 139,859 | $ 2,466,976 | 750,813 | $ 40,000 | 787,004 | 15 |
| 12,217,844 | 49,340 | $ 142,656 | $ 2,324,320 | 760,762 | $ 40,000 | 796,952 | 16 |
| 11,481,589 | 46,486 | $ 145,509 | $ 2,178,811 | 812,868 | $ 40,000 | 849,058 | 17 |
| 10,725,767 | 43,576 | $ 148,419 | $ 2,030,391 | 832,961 | $ 40,000 | 869,151 | 18 |
| 9,959,223 | 40,608 | $ 151,388 | $ 1,879,004 | 843,408 | $ 40,000 | 879,599 | 19 |
| 9,181,146 | 37,580 | $ 154,415 | $ 1,724,588 | 853,908 | $ 40,000 | 890,099 | 20 |
| 8,390,485 | 34,492 | $ 157,504 | $ 1,567,084 | 864,792 | $ 40,000 | 900,982 | 21 |
| 7,519,279 | 31,342 | $ 160,654 | $ 1,406,431 | 942,101 | $ 40,000 | 978,291 | 22 |
| 6,635,119 | 28,129 | $ 163,867 | $ 1,242,564 | 950,425 | $ 40,000 | 986,615 | 23 |
| 5,736,953 | 24,851 | $ 167,144 | $ 1,075,419 | 959,129 | $ 40,000 | 995,319 | 24 |
| 4,823,938 | 21,508 | $ 170,487 | $ 904,932 | 967,878 | $ 40,000 | 1,004,068 | 25 |
| 3,894,937 | 18,099 | $ 173,897 | $ 731,036 | 977,003 | $ 40,000 | 1,013,193 | 26 |
| 2,949,031 | 14,621 | $ 177,375 | $ 553,661 | 986,171 | $ 40,000 | 1,022,362 | 27 |
| 1,985,279 | 11,073 | $ 180,922 | $ 372,738 | 995,381 | $ 40,000 | 1,031,571 | 28 |
| 1,002,710 | 7,455 | $ 184,541 | $ 188,198 | 1,004,631 | $ 40,000 | 1,040,822 | 29 |
| 0 | 3,764 | $ 188,198 | $ 0 | 1,014,253 | $ 40,000 | 1,050,443 | 30 |
| | 1,459,831 | 4,300,000 | | 23,291,013 | 1,239,999 | 24,416,726 | |

**Table 9-17**

**Payout Schedule Column Description**

| | |
|---|---|
| Column 1 | Year of study. |
| Column 2 | Fiscal year. |
| Column 3 | Revenues from M&I water financed by the State, extracted from column 14, Table 9-15, plus column 15, Table 9-15. |
| Column 4 | M&I revenues financed by SRPA loan, extracted from column 18, Table 9-15, plus column 19 Table 9-15. |
| Column 5 | Total of columns 3 and 4. |
| Column 6 | Commercial Irrigation revenues from column 8, Table 9-15. |
| Column 7 | Column 5 plus column 6. |
| Column 8 | OM&R for M&I water financed by SRPA loan from column 19, Table 9-15. |
| Column 9 | OM&R for M&I water financed by State, column 15, Table 9-15. |
| Column 10 | OM&R for commercial irrigation from column 10, Table 9-15. |
| Column 11 | Emergency reserve fund annual payment estimated at $8,000/yr. |
| Column 12 | Accumulated emergency reserve fund, accumulated to a total of $40,000. |
| Column 13 | Total OM&R for commercial irrigation, column 12, Table 9-15. |
| Column 14 | Column 8 plus column 9. |
| Column 15 | Total OM&R for M&I water financed by the State from column 9. |
| Column 16 | Portion of M&I water financed by Federal loan extracted from column 6, Table 9-8 of this chapter. |
| Column 17 | Interest payments for M&I water repayment are calculated as follows: column 16, times previous year's value from column 21, times 5.75 percent. |
| Column 18 | Irrigation principal payments on Federal loan, column 6 minus column 13. |
| Column 19 | M&I principal payments on Federal loan, column 4 minus column 8, minus column 17. |

**Table 9-17 (continued)**

**Payout Schedule Column Description**

| | |
|---|---|
| Column 20 | Total principal payments are calculated as follows: column 18 plus column 19. |
| Column 21 | The total Federal loan from Table 9-9, this chapter, reduced each year by principal payments from column 20. |
| Column 22 | Interest payments on State loan calculated as follows: column 24 amount from previous year multiplied by 2 percent. |
| Column 23 | Principal payments on State loan: column 3 minus column 22. |
| Column 24 | State loan balance: The total State loan from Table 9-9, this chapter, reduced each year by principal payments from column 23. |
| Column 25 | Federal loan payments: column 17 plus column 20. |
| Column 26 | Operating expenditure: column 13 plus column 14. |
| Column 27 | Total revenues Federal loan: column 25, plus column 26, minus column 9. |
| Column 28 | Year of study. |

**Loan Factor**

The loan factor has been adopted by the Secretary of Interior as a measure of Federal subsidy for the approval and funding of loan applications. The loan factor is basically a measure of the proportion of the total Federal outlay for a project which is not ultimately returned to the United States Treasury by the applicant. In general terms, the total Federal outlay is considered to be comprised of the loan obligation plus the interest paid by the United States Treasury during the construction period. Of that total, a portion will be returned to the Treasury by the District's annual loan payments. The difference between the total outlay and total return to the Treasury is a financial contribution or subsidy to the project. The loan factor is the amount of that difference, divided by the total project cost. Table 9-18 shows the computation of the SRPA loan factor.

The loan factor for the Narrows Project as presented in this report is calculated at 0.038. This factor qualifies the Narrows Project as a Category I Project as described in the Loan Program Guidelines - Small Reclamation Projects Act of 1956, dated September 1990. Category I Projects can be sent forward to the Congress by the Department of Interior without OMB review or approval.

**Table 9-18**
**Computation of SRPA Loan Factor**

| | |
|---|---|
| 1. Total Project Cost | 37,401,000 |
| 2. Amount of SRPA Grant | 3,692,000 |
| 3. Applicant's Contribution | 11,917,000 |
| 4. RIDC | 190,000 |
| 5. Appropriation Requirement | 21,602,000 |
| 6. Federal Discount Interest Rate | 0.75% |
| 7. SRPA Repayment Interest Rate | 5.75% |

8. Compute FIDC Using Rate on Line 6:

| Year | Appro-priation | 1/2 Current Years Approp. | Sum of Previous Years Approp. | Sum of Previous Years Interest | Amount for Computing Interest | Interest |
|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - |
| 2 | 14,406,077 | 7,203,000 | - | - | 7,203,000 | 54,023 |
| 3 | 7,195,923 | 3,598,000 | 14,406,077 | 54,023 | 18,058,100 | 135,436 |

| | |
|---|---|
| 9. FIDC | 189,459 |
| 10. Line 1 less Line 2 (TPC - G) | 33,709,000 |
| 11. Line 10 less (Line 3 + Line 4) (TLO) | 21,602,000 |
| 12. Line 9 plus Line 11 (TLO + FIDC) | 21,791,459 |
| 13. Present Worth of Payments (PWP) | 20,515,084 |
| 14. Line 12 minus Line 13 (TLO + FIDC - PWP) | 1,276,375 |
| 15. Loan Factor (Line 14/Line 10) | 0.038 |

# ATTACHMENT A

## SANPETE WATER CONSERVANCY DISTRICT FINANCIAL DATA

1. 2010 AUDIT REPORT AND FINANCIAL STATEMENTS

Sanpete Water Conservancy District

# SANPETE COUNTY WATER CONSERVANCY DISTRICT

## FINANCIAL STATEMENTS

## DECEMBER 31, 2010

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*Kimball & Roberts*
*Certified Public Accountants*
*A Professional Corporation*
*Box 663*
*Richfield, Utah 84701*
*Phone 896-6488*

INDEPENDENT AUDITOR'S REPORT

Honorable Board Members
Sanpete County Water Conservancy District
P. O. Box 265
Mt. Pleasant, Utah 84647

We have audited the accompanying financial statements of the governmental activities of Sanpete County Water Conservancy District as of and for the year ended December 31, 2010, which collectively comprise the District's basic financial statements as listed in the table of contents. These financial statements are the responsibility of Sanpete County Water Conservancy District's management. Our responsibility is to express opinions on these financial statements based on our audit.

We conducted our audit in accordance with auditing standards generally accepted in the United States of America and the standards applicable to financial audits contained in *Government Auditing Standards* issued by the Comptroller General of the United States. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinions.

In our opinion, the financial statements referred to above, present fairly, in all material respects, the respective financial position of the government activities of Sanpete County Water Conservancy District as of December 31, 2010, and the respective changes in financial position thereof for the year then ended in conformity with accounting principles generally accepted in the United States of America.

In accordance with *Government Auditing Standards*, we have also issued our report dated January 12, 2011, on our consideration of Sanpete County Water Conservancy District's internal control over financial reporting and our tests of its compliance with certain provisions of laws, regulations, contracts and grant agreements, and other matters. The purpose of that report is to describe the scope of our testing of internal control over financial reporting and compliance and the results of that testing, and not to provide an opinion on the internal control over financial reporting or on compliance. That report is an integral part of an audit performed in accordance with *Government Auditing Standards* and should be considered in assessing the results of our audit.

The Management's Discussion and Analysis and budgetary comparison information on pages 4 through 7 and 25 through 26, respectively, are not a required part of the basic financial statements but are supplementary information required by accounting principles generally accepted in the United States of America. We have applied certain limited procedures, which consisted principally of inquiries of management regarding the methods of measurement and presentation of the required supplementary information. However, we did not audit the information and express no opinion on it.

Kimball & Roberts

KIMBALL & ROBERTS, P. C.
Certified Public Accountants

January 12, 2011
Richfield, Utah

**Sanpete County Water Conservancy District**
**Management's Discussion and Analysis**

This discussion and analysis of Sanpete County Water Conservancy District's (District) financial performance provides an overview of the District's financial activities for the year ending December 31, 2010. This report is in conjunction with the District's financial statements, which are part of this report.

The purpose of the Sanpete County Water Conservancy District is to develop water for Sanpete County.

**Financial Highlights:**

- The District has one depreciable asset, a water metering system. The District has expended $184,765 on the narrows dam project in 2010. This is in addition to previous years expenditures on this project of $3,739,974.
- At the close of the current year, the District reported ending net assets of $5,181,903 of which $1,198,958 was restricted for capital projects.
- The District does not have any full-time employees and expended 60% of revenues on operating expenditures leaving 40% of the funds for capital additions on the narrows project in upper Gooseberry east of Fairview, Utah.
- The District generates revenues through property tax assessments in Sanpete County. This year the District received $328,316 in property taxes and $37,860 in fee-in-lieu of taxes. It also earned $6,684 in unrestricted investment earnings (interest) on its idle funds. The District received a grant from the State of Utah for $150,000 for engineering work on several projects.

**Using This Annual Report**
This discussion and analysis is intended to serve as an introduction to Sanpete County Water Conservancy District's financial statements. The basic financial statements comprise three components: 1) government-wide financial statements, 2) fund financial statements, and 3) notes to the financial statements. This report also contains other supplementary information in addition to the basic financial statements themselves.

**Government-wide financial statements**
The government-wide financial statements are designed to provide readers with a broad overview of the District's finances, in a manner similar to a private-sector business.

The statement of net assets presents information on all of the District's assets and liabilities, with a difference between the two reported as net assets. Over time, increases and decreases in net assets may serve as a useful indicator of whether the financial position of the District is improving or deteriorating.

The statement of activities present information showing how the government's net assets changed during the most recent fiscal year. All changes in net assets are reported as soon as the underlying event giving rise to the change occurs, regardless of the timing of related cash flows. Thus, revenues and expenses are reported in this statement for some items that will only result in cash flows in future periods.

## Sanpete County Water Conservancy District
## Management's Discussion and Analysis (Continued)

**Governmental Funds:**
Governmental funds are used to account for essentially the same functions reported as governmental activities in the government-wide financial statements. However, unlike the government-wide financial statements, governmental fund financial statements focus on near-term inflows and outflows of spendable resources, as well as on balance of spendable resources available at the end of the year.

The district has two governmental funds, the general fund and the capital projects fund. The general fund at year end has unassigned fund balance of $86,475. The capital projects fund has a fund balance of $1,198,958, which is restricted for planned capital projects. The unassigned fund balance in the general fund is available for expenditures in future years budgets. Unassigned fund balance is 19% of total expenditures in the general fund.

**Reporting the District as a Whole**
The District realizes revenues from several sources; 1) property tax revenue, 2) fee-in-lieu taxes, 3) unrestricted investment earnings and 4) capital grants from the State of Utah.

**Contacting the District**
This financial report is designed to provide the citizens with a general overview of the District's finances and to show accountability for the money it receives. If you have questions about this report or need additional financial information, contact Secretary David R. Cox, 90 West Union Manti, UT 84642.

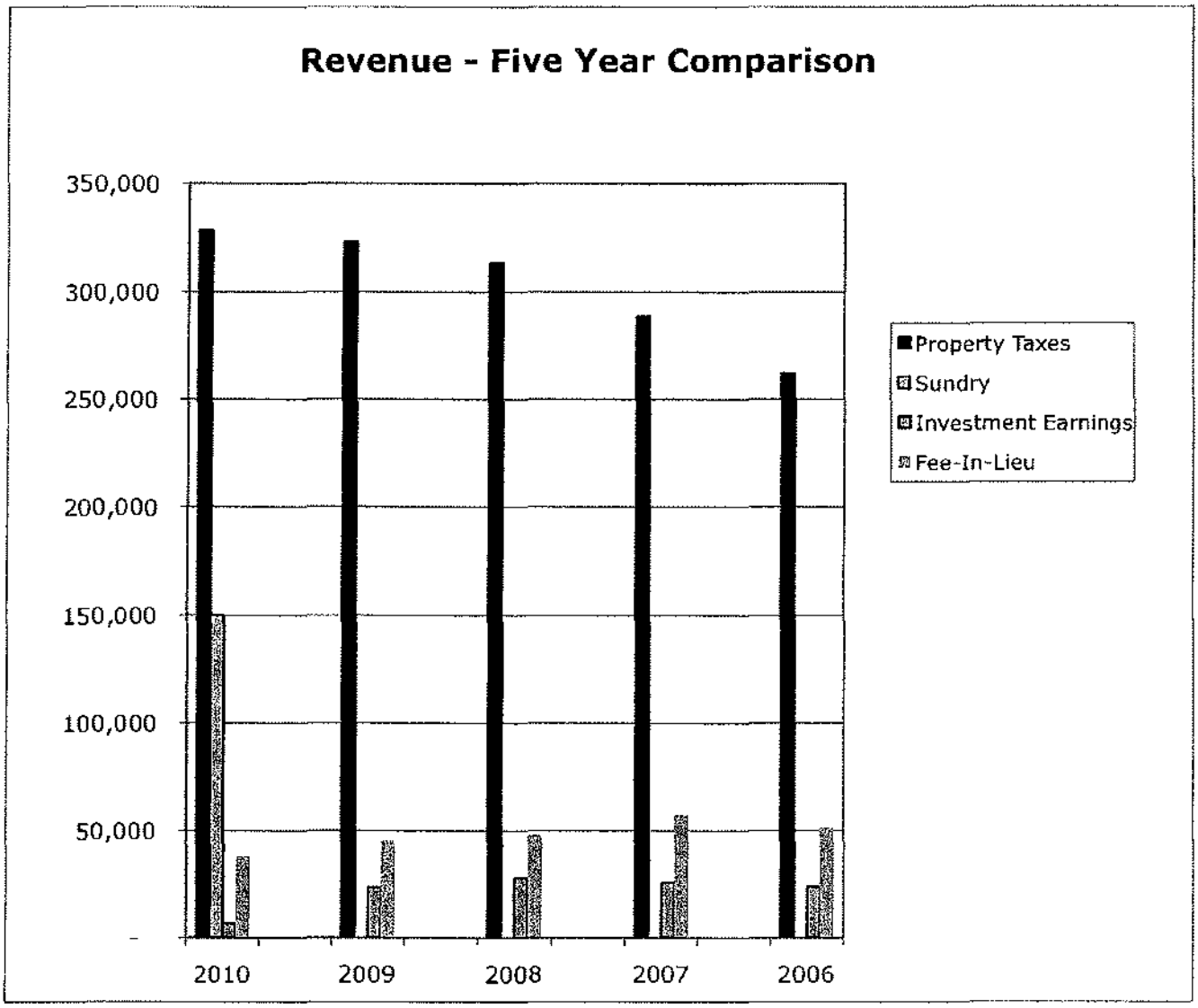
**Condensed Financial Statements:**
A comparative analysis is provided for 2010 and 2009.

| | 2010 | 2009 |
|---|---|---|
| **Assets:** | | |
| Current | 1,347,146 | 1,231,848 |
| Non-Current | 3,946,036 | 3,763,047 |
| Total Assets | 5,293,182 | 4,994,895 |
| **Liabilities:** | | |
| Current | 61,713 | - |
| Long-Term | 49,566 | 49,566 |
| Total Liabilities | 111,279 | 49,566 |
| **Net Assets:** | | |
| Invested in Capital Assets | 3,896,470 | 3,713,481 |
| Restricted | 1,198,958 | 748,958 |
| Unrestricted | 86,475 | 474,466 |
| Net Assets | 5,181,903 | 4,936,905 |

| | 2010 | 2009 |
|---|---|---|
| **Revenues:** | | |
| Property Taxes | 328,316 | 323,221 |
| Other Taxes | 37,860 | 45,123 |
| State Grant | 150,000 | 150,000 |
| Investment Earnings | 6,684 | 23,382 |
| Total Revenues | 522,860 | 541,726 |
| **Expenditures:** | | |
| Current | 277,862 | 192,683 |
| Total Expenditures | 277,862 | 192,683 |
| Change in Net Assets | 244,998 | 349,043 |
| Beginning Net Assets | 4,936,905 | 4,587,862 |
| Ending Net Assets | 5,181,903 | 4,936,905 |

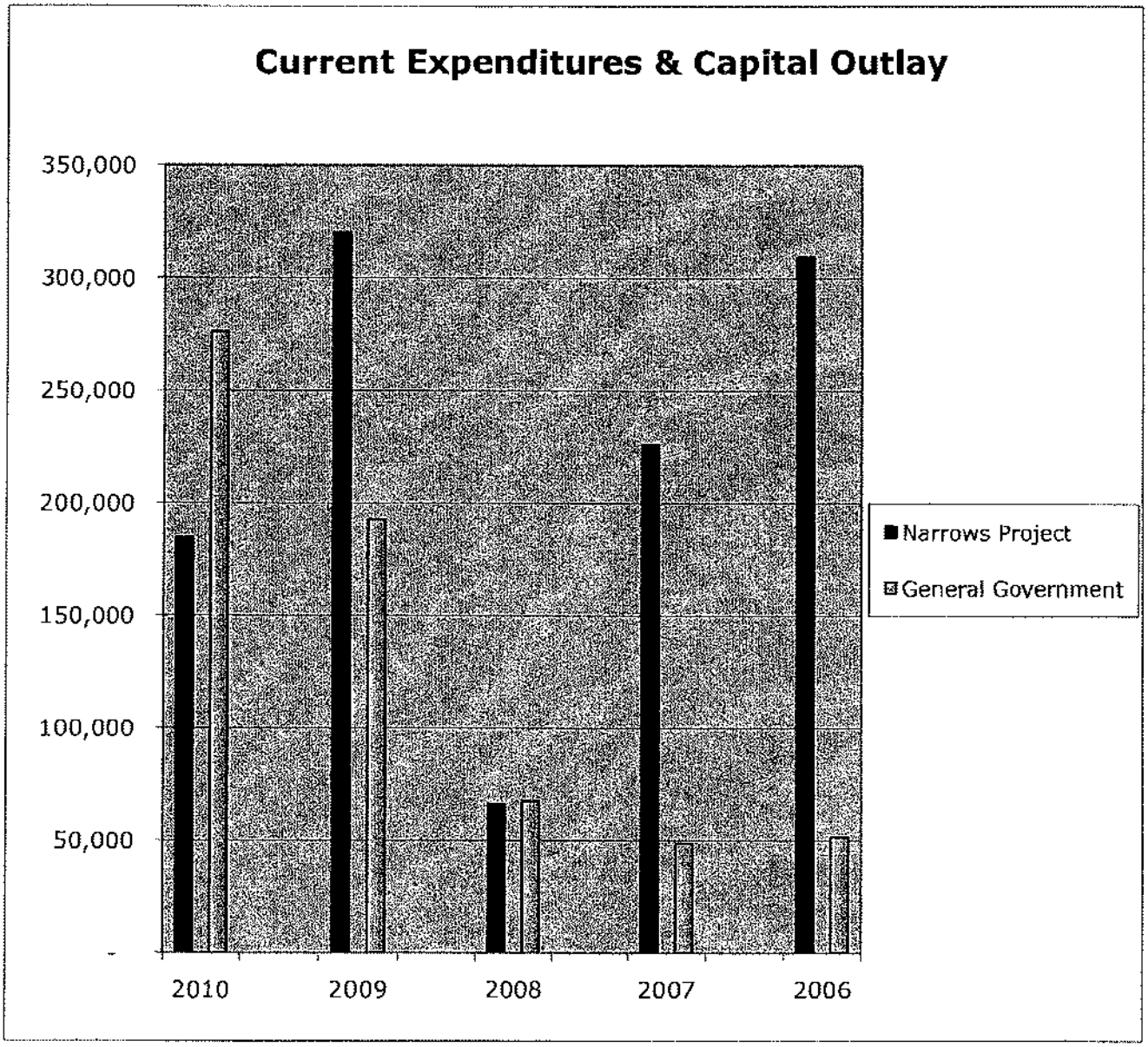
**Sanpete County Water Conservancy District**
**Revenue - Five Year Comparison**

| | 2010 | 2009 | 2008 | 2007 | 2006 |
|---|---|---|---|---|---|
| Property Taxes | 328,316 | 323,221 | 313,443 | 288,577 | 262,036 |
| Fee-In-Lieu | 37,860 | 45,123 | 47,762 | 57,234 | 51,437 |
| Sundry | 150,000 | 150,000 | - | - | - |
| Investment Earnings | 6,684 | 23,382 | 27,877 | 25,534 | 23,785 |
| Total | 522,860 | 541,726 | 389,082 | 371,345 | 337,258 |



**Sanpete County Water Conservancy District**
**Expenditures - Five Year Comparison**

| | 2010 | 2009 | 2008 | 2007 | 2006 |
|---|---|---|---|---|---|
| Narrows Project | 184,765 | 320,165 | 66,220 | 226,014 | 309,339 |
| General Government | 276,086 | 192,683 | 67,566 | 48,786 | 51,517 |
| Total | 460,851 | 512,848 | 133,786 | 274,800 | 360,856 |



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# BASIC FINANCIAL STATEMENTS

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**STATEMENT OF NET ASSETS**
**December 31, 2010**

| | Governmental Activities |
|---|---|
| **ASSETS** | |
| Current Assets: | |
| Cash and Investments | 359,332 |
| Accounts Receivable | 15,300 |
| Taxes Receivable | 972,514 |
| Total Current Assets | 1,347,146 |
| Noncurrent Assets: | |
| Capital Assets (Net of Accumulated Depreciation): | |
| Water Metering System | 21,297 |
| Construction-In-Progress | 3,924,739 |
| Total Noncurrent Assets | 3,946,036 |
| TOTAL ASSETS | 5,293,182 |
| **LIABILITIES** | |
| Current Liabilities: | |
| Accounts Payable | 61,713 |
| Noncurrent Liabilities: | |
| Note Payable - Due More Than One Year | 49,566 |
| TOTAL LIABILITIES | 111,279 |
| **NET ASSETS** | |
| Invested In Capital Assets, Net of Related Debt | 3,896,470 |
| Restricted for Capital Projects | 1,198,958 |
| Unrestricted | 86,475 |
| TOTAL NET ASSETS | 5,181,903 |
| TOTAL LIABILITIES AND NET ASSETS | 5,293,182 |

The notes to the financial statements are an integral part of this statement.

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**STATEMENT OF ACTIVITIES**
**For The Year Ended December 31, 2010**

| | | Program Revenues | | Net (Expense) Revenue and Changes in Net Assets |
|---|---|---|---|---|
| | Expenses | Charges for Services | Operating Grants/ Contributions | Governmental Activities |
| **Functions/Programs:** | | | | |
| Governmental Activities: | | | | |
| Water Conservancy Operations | 277,861 | - | 150,000 | (127,861) |
| TOTAL REVENUES | 277,861 | - | 150,000 | (127,861) |

| | |
|---|---|
| **General Revenues:** | |
| Property Taxes | 328,316 |
| Other Taxes | 37,860 |
| Unrestricted Investment Earnings | 6,684 |
| Total General Revenues | 372,860 |
| Changes in Net Assets | 244,999 |
| Net Assets - Beginning | 4,936,904 |
| Net Assets - Ending | 5,181,903 |

The notes to the financial statements are an integral part of this statement.

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**BALANCE SHEET**
**GOVERNMENTAL FUNDS**
**December 31, 2010**

| | General Fund | Capital Projects Fund | Total Governmental Funds |
|---|---|---|---|
| **ASSETS** | | | |
| Cash and Investments: | | | |
| Restricted | - | 359,332 | 359,332 |
| Accounts Receivable | 15,300 | - | 15,300 |
| Taxes Receivable | 972,514 | - | 972,514 |
| Due From Other Funds | - | 839,626 | 839,626 |
| TOTAL ASSETS | 987,814 | 1,198,958 | 2,186,772 |
| **LIABILITIES AND FUND EQUITY** | | | |
| Liabilities: | | | |
| Accounts Payable | 61,507 | - | 61,507 |
| Accrued Liabilities | 206 | - | 206 |
| Due To Other Funds | 839,626 | - | 839,626 |
| Total Liabilities | 901,339 | - | 901,339 |
| Fund Equity: | | | |
| Restricted For: | | | |
| Capital Projects | - | 1,198,958 | 1,198,958 |
| Unassigned | 86,475 | - | 86,475 |
| Total Fund Equity | 86,475 | 1,198,958 | 1,285,433 |
| TOTAL LIABILITIES AND FUND EQUITY | 987,814 | 1,198,958 | 2,186,772 |

The notes to the financial statements are an integral part of this statement.

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**BALANCE SHEET RECONCILIATION TO STATEMENT OF NET ASSETS**
**December 31, 2010**

| | | |
|---|---|---|
| Total Fund Balances - Governmental Fund Types | | 1,285,433 |
| Amounts reported for governmental activities in the statement of net assets are different because: | | |
| Capital assets used in governmental activities are not financial resources and, therefore, are not reported in the funds: | | |
| Water Metering System | 21,297 | |
| Construction-In-Progress | 3,924,739 | |
| Total (Net of Depreciation) | | 3,946,036 |
| Long-term liabilities, including bonds payable, are not due and payable in the current period and, therefore, are not reported in the funds: | | |
| Revenue Bonds Payable | | (49,566) |
| Net Assets of Government Activities | | 5,181,903 |

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**STATEMENT OF REVENUES, EXPENDITURES AND CHANGES IN FUND BALANCE**
**GOVERNMENTAL FUNDS**
**For The Year Ended December 31, 2010**

| | General Fund | Capital Projects Fund | Total Governmental Funds |
|---|---|---|---|
| **Revenues:** | | | |
| Property Taxes | 294,671 | - | 294,671 |
| Delinquent Property Taxes | 33,645 | - | 33,645 |
| Fee-In-Lieu | 37,860 | - | 37,860 |
| State Grant | 150,000 | - | 150,000 |
| Interest | 6,684 | - | 6,684 |
| Total Revenues | 522,860 | - | 522,860 |
| **Expenditures:** | | | |
| Current Expenditures: | | | |
| Engineering Fees | 169,656 | - | 169,656 |
| Engineering Fees - Narrows | 147,760 | - | 147,760 |
| Attorney Fees - Narrows | 37,005 | - | 37,005 |
| Cloud Seeding | 14,077 | - | 14,077 |
| Board of Directors Expense | 1,125 | - | 1,125 |
| Secretary Expenses | 1,500 | - | 1,500 |
| Insurance and Bonds | 232 | - | 232 |
| Reimbursements | 1,091 | - | 1,091 |
| Subscriptions | 250 | - | 250 |
| Advertising | 161 | - | 161 |
| Audit Reports | 11,000 | - | 11,000 |
| Public Relations | 76,832 | - | 76,832 |
| Other | 162 | - | 162 |
| Total Expenditures | 460,851 | - | 460,851 |
| Excess of Revenues Over (Under) Expenditures | 62,009 | - | 62,009 |
| **Other Financing Sources (Uses):** | | | |
| Transfers In (Out) | (450,000) | 450,000 | - |
| Net Change in Fund Balance | (387,991) | 450,000 | 62,009 |
| Fund Balance - Beginning | 474,466 | 748,958 | 1,223,424 |
| Fund Balance - Ending | 86,475 | 1,198,958 | 1,285,433 |

The notes to the financial statements are an integral part of this statement.

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**RECONCILIATION OF THE STATEMENT OF REVENUES, EXPENDITURES AND CHANGES IN FUND BALANCES OF GOVERNMENTAL FUNDS TO THE STATEMENT OF ACTIVITIES**
**For The Year Ended December 31, 2010**

Amounts reported for governmental activities in the statement of activities are different because:

| | | |
|---|---|---|
| Net Changes in Fund Balances - Total Governmental Funds | | 62,009 |
| Governmental funds report capital outlays as expenditures. However, in the statement of activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which capital outlays exceeded depreciation in the current period: | | |
| Capital Outlay | 184,765 | |
| Depreciation | (1,775) | |
| Total | | 182,990 |
| Changes In Net Assets of Governmental Activities | | 244,999 |

## NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

The Sanpete County Water Conservancy District was organized in 1961 for the purpose of developing water for the County.

### A. Reporting Entity

For financial reporting purposes, Sanpete County Water Conservancy District has included all funds. The District has also considered all potential component units for which it is financial accountable and that exclusion would cause the District's financial statements to be misleading or incomplete. The Governmental Accounting Standards Board has set forth criteria to be considered in determining financial accountability. These criteria include appointing a voting majority of an organization's governing body and (1) the ability of the District to impose its will on that organization or (2) the potential for the organization to provide specific financial benefits to, or impose specific financial burdens on the District.

As required by generally accepted accounting principles, these financial statements present Sanpete County Water Conservancy District, the reporting entity.

### B. Government-Wide and Fund Financial Statements

The Statement of Net Assets and the Statement of Activities display information about the District, the primary government, as a whole. Governmental activities, which normally are supported by taxes and intergovernmental revenues, are reported separately from business-type activities, which rely to a significant extent on fees and charges for support.

The statement of activities demonstrates the degree to which the direct expenses of a given function or segment are offset by program revenues. Direct expenses are those that are clearly identifiable with a specific function or segment. Program revenues include 1) charges to customers or applicants who purchase, use or directly benefit from goods, services or privileges provided by a given function or segment and 2) grants and contributions that are restricted to meeting the operational or capital requirements of a particular function or segment. Taxes and other items not properly included among program revenues are reported instead as general revenues.

Separate financial statements are provided for governmental funds and fiduciary funds, even through the latter are excluded from the government-wide financial statements. Major individual governmental funds are reported as separate columns in the fund financial statements.

### C. Measurement Focus, Basis of Accounting and Financial Statement Presentation

The government-wide financial statements are reported using the economic resources measurement focus and accrual. Revenues are recorded when earned and expenses are recorded when a liability is incurred, regardless of the timing of related cash flows. Grants and similar items are recognized as revenue as soon as all eligibility requirements imposed by the provider have been met.

**NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)**

Governmental fund financial statements are reported using the current financial resources measurement focus and the modified accrual basis of accounting. Revenues are recognized as soon as they are both measurable and available. Revenues are considered to be available when they are collectible within the current period or soon enough thereafter to pay liabilities of the current period. For this purpose, the government considers revenues to be available if they are collected within 60 days of the end of the current fiscal period. Expenditures generally are recorded when a liability is incurred, as under accrual accounting. However, debt service expenditures, as well as expenditures related to compensated absences and claims and judgments, are recorded only when payment is due.

State revenue sources and interest associated with the current fiscal period are considered to be susceptible to accrual and so have been recognized as revenues of the current fiscal period. All other revenues items are considered to be measurable and available only when cash is received by the government.

The government reports the following major governmental funds:

The General Fund is the government's primary operating fund. It accounts for all financial resources of the general government.

The Capital Projects Fund accounts for the acquisition of fixed assets or construction of major capital projects.

**D. Assets, Liabilities and Net Assets or Equity**

**Deposits and Investments:**

The government's cash and cash equivalents are considered to be cash on hand, demand deposits and short-term investments with original maturities of three months or less from the date of acquisition.

State statutes authorize the government to invest in obligations of the U. S. Treasury, commercial paper, corporate bonds, repurchase agreements and the State Treasurer's Investment Pool.

Investments for the government are reported at fair value. The State Treasurer's Investment Pool operates in accordance with appropriate state laws and regulations. The reported value of the pool is the same as the fair value of the pool shares.

## NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

**Capital Assets:**

Capital assets, which include property, plant, equipment, and infrastructure assets (e.g., roads, bridges, sidewalks and similar items), are reported in the applicable governmental activities column in the government-wide financial statements. Capital assets are defined by the government as assets with an initial, individual cost of more than $5,000 and an estimated useful life in excess of two years. Such assets are recorded at historical cost or estimated historical cost if purchased or constructed. Donated capital assets are recorded at estimated fair market value at date of donation.

The cost of normal maintenance and repairs that do not add to the value of the asset or materially extend assets lives are not capitalized.

Major outlays for capital assets and improvements are capitalized as projects are constructed.

Property, plant and equipment of the primary government is depreciated using the straight line method over the following estimated useful lives:

| | |
|---|---|
| Water Metering System | 25 Years |

**Long-Term Obligations:**

In the government-wide financial statements long-term debt and other long-term obligations are reported as liabilities in the applicable governmental activities statement of net assets.

In the fund financial statement, governmental fund types recognize bond premiums and discounts, as well as bond issuance costs, if any, during the current period. The face amount of debt issued is reported as other financing sources. Premiums received on debt issuances are reported as other financing sources while discounts on debt issuance are reported as other financing uses. Issuance costs, whether or not withheld from the actual debt proceeds received, are reported as debt service expenditures.

**Equity Classifications:**

Equity is classified in the government-wide financial statements as net assets and is displayed in three components:

a. Invested in capital assets, net of related debt - consists of capital assets including restricted capital assets, net of accumulated depreciation and reduced by the outstanding balances of any bonds, mortgages, notes, or other borrowings that are attributable to the acquisition, construction, or improvement of those assets.

**NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)**

b. Restricted net assets - consists of net assets with constraints placed on the use either by (1) external groups such as creditors, grantors, contributors, or laws or regulations of other governments; or (2) law through constitutional provisions or enabling legislation.

c. Unrestricted net assets - All other net assets that do not meet the definition of "restricted" or "invested in capital assets, net of related debt".

In the fund financial statements governmental fund equity is classified as fund balance. Fund balance is further classified as Nonspendable, Restricted, Committed, Assigned or Unassigned.

**Nonspendable fund balance** classification includes amounts that cannot be spent because they are either (a) not in spendable form, or (b) legally or contractually required to be maintained intact.

**Restricted fund balance** classification are restricted by enabling legislation. Also reported if, (a) externally imposed by creditors, grantors, contributors, or laws or regulations of other governments, or (b) imposed by law through constitutional provisions or enabling legislation.

**Committed fund balance** classification include those funds that can only be used for specific purposes pursuant to constraints imposed by formal action of the government's highest level of decision making authority.

**Assigned fund balance** classification include amounts that are constrained by the government's intent to be used for specific purposes, but are neither restricted nor committed. Also includes all remaining amounts that are reported in governmental funds, other than the general fund that are not classified as nonspendable, restricted nor committed or in the General Fund, that are intended to be used for specific purposes.

**Unassigned fund balance** classification is the residual classification for the General Fund. This classification represents fund balance that has not been assigned to other funds and that has not been restricted, committed, or assigned to specific purposes within the General Fund.

**E. Use of Estimates:**

The preparation of financial statements in conformity with generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

## NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

### F. Property Taxes

Property taxes are assessed and collected for the District by Sanpete County and remitted to the District shortly after collection. Property taxes become a lien on January 1 and are levied on the first Monday in August. Taxes are due and payable on November 1, and are delinquent after November 30. All dates are in the year of levy.

## NOTE 2 - BUDGETARY COMPLIANCE

Excess of Expenditures over Appropriations - The Fiscal Procedures Act requires expenditures be restricted to authorized budgets. The statement of revenues, expenditures and changes in fund balance, budget and actual, identifies the accounts which have overexpended budgeted amounts if any and, therefore, do not comply with appropriate fiscal procedures.

## NOTE 3 - DEPOSITS AND INVESTMENTS

### Deposits:

At year-end the carrying amount of the Districts deposits was $261,897 and the bank balances were $278,480. Of this amount $278,480 was covered by federal depository insurance. Utah State statutes do not require deposits to be collateralized, however, financial institutions must be approved by the State Money Management Council.

Cash and investments as of December 31, 2010, consist of the following:

| | Fair Value |
|---|---|
| Demand Deposits | 261,897 |
| Demand Deposits | 97,435 |
| Demand Deposits | 359,332 |

Cash and investments listed above are classified in the accompanying government-wide statement of net assets as follows:

| | |
|---|---|
| Governmental Activities - Restricted | 359,332 |
| Total Cash and Cash Equivalents | 359,332 |

The Utah Money Management Act (UMMA) established specific requirements regarding deposits of public funds by public treasurers. UMMA requires that District funds be deposited with a qualified depository which includes any depository institution which has been certified by the Utah State Commissioner of Financial Institutions as having met the requirements specified in UMMA Section 51, Chapter 7.

**NOTE 3 - DEPOSITS AND INVESTMENTS (CONTINUED)**

UMMA provides the formula for determining the amount of public funds which a qualified depository may hold in order to minimize risk of loss and also defines capital requirements which an institution must maintain to be eligible to accept public funds. UMMA lists the criteria for investments and specifies the assets which are eligible to be invested in, and for some investments, the amount of time to maturity.

UMMA enables the State Treasurer to operate the Public Treasurer's Investment Pool (PTIF). PTIF is managed by the Utah State Treasurer's investment staff and comes under the regulatory authority of the Utah Money Management Council. This council is comprised of a select group of financial professionals from units of local and state government and financial institutions doing business in the state. PTIF operations and portfolio composition is monitored at least semi-annually by Utah Money Management Council. PTIF is unrated by any nationally recognized statistical rating organizations. Deposits in PTIF are not insured or otherwise guaranteed by the State of Utah. Participants share proportionally in any realized gains or losses on investments which are recorded an amortized cost basis. The balance available for withdrawal is based on the accounting records maintained by PTIF. The fair value of the investment pool is approximately equal to the value of the pool shares.

**Custodial Credit Risk:**

Deposits - Custodial credit risk for deposits is the risk that in the event of a bank failure, the local government's deposits may not be recovered. The local government's policy for managing custodial credit risk is to adhere to the Money Management Act. The Act requires all deposits of the local government to be in a qualified depository, defined as any financial institution whose deposits are insured by an agency of the federal government and which has been certified by the Commissioner of Financial Institutions as meeting the requirements of the Act and adhering to the rules of the Utah Money Management Council. As of December 31, 2010, $0 of the local government's bank balances of $278,480 were uninsured and uncollateralized.

**Credit Risk:**

Credit risk is the risk that the counterparty of an investment will not fulfill its obligations. The local government's policy for limiting the credit risk of investments is to comply with the Money Management Act.

The local government is authorized to invest in the Utah Public Treasurer's Investment Fund (PTIF), an external pooled investment fund managed by the Utah State Treasurer and subject to the Act and Council requirements. The PTIF is not registered with the SEC as an investment company, and deposits in the PTIF are not insured or otherwise guaranteed by the State of Utah. The PTIF operates and reports to participants on an amortized cost basis. The income, gains and losses, net of administration fees, of the PTIF are allocated based upon the participants' average daily balances.

## NOTE 3 - DEPOSITS AND INVESTMENTS (CONTINUED)

For the year ended December 31, 2010, the local government has investments of $97,435 with the PTIF. The entire balance had a maturity less than one year. The PTIF pool has not been rated.

**Deposit and Investment Risk:**

The District maintains no investment policy containing any specific provisions intended to limit the District's exposure to interest rate risk, credit risk and concentration of credit risk other than that imposed by UMMA. The District's compliance with the provisions of UMMA addressed each of these risks.

**Interest Rate Risk:**

Interest rate risk is the risk that changes in interest rates of debt investments will adversely affect the fair value of an investment. The local government manages its exposure to declines in fair value by investments mainly in the PTIF and by adhering to the Money Management Act. The act requires that the remaining term to maturity of investments may not exceed the period of availability of the funds to be invested.

**Concentration of Credit Risk:**

Concentration of credit risk is the risk of loss attributed to the magnitude of a government's investments in a single issuer. The District deposits in two institutions, Far West Bank and Moroni Feed Credit Union.

## NOTE 4 - TAXES RECEIVABLES

Taxes receivable are funds held by Sanpete County due to Sanpete County Water Conservancy District at December 31, 2010.

## NOTE 5 - CONSTRUCTION IN PROGRESS

**Narrows:**

Construction in Progress - Narrows represents legal, engineering, and construction costs associated with the anticipated building of a dam in Upper Gooseberry, east of Fairview, Utah.

## NOTE 6 - CAPITAL ASSETS

Capital Assets activity for the year ended December 31, 2010, was as follows:

| | Beginning Balance | Additions | Deletions | Ending Balance |
|---|---|---|---|---|
| **Governmental Activities:** | | | | |
| Capital Assets Not Being Depreciated: | | | | |
| Construction-in-Progress | 3,739,974 | 184,765 | - | 3,924,739 |
| Capital Assets Being Depreciated: | | | | |
| Water Metering System | 44,372 | - | - | 44,372 |
| Less Accumulated Depreciation For: | | | | |
| Water Metering System | 21,300 | 1,775 | - | 23,075 |
| Total Capital Assets Being Depr. (Net) | 23,072 | (1,775) | - | 21,297 |
| Governmental Activities Capital Assets (Net) | 3,763,046 | 182,990 | - | 3,946,036 |

Depreciation was charged to functions of the Government as follows:

| | |
|---|---|
| General Fund | 1,775.00 |

## NOTE 7 - NOTE PAYABLE DIVISION OF WATER RESOURCES

On May 1, 1994, the State of Utah, Department of Natural Resources, Division of Water Resources, approved funding to provide financial assistance for completion of the final Environmental Impact Statement for the Narrows Project in Carbon and Sanpete Counties.

The State approved a $75,000 loan to be repaid when the Narrows Dam is constructed. At this time there are no terms set for repayment, nor has an interest rate been set. On November 21, 1994, the District received an advance from the State in the amount of $52,465, leaving an undisbursed approved amount of $22,535. Additional funds of $22,101 were advanced during 1995. The total amount of advanced funds at December 31, 1995 was $74,566. During 1996 the District repaid $25,000 leaving a balance due of $49,566. These funds are advanced upon submission of approved expenditures for the Environmental Impact Statement. The advanced funds of $49,566 are shown as a note payable at December 31, 2010.

**NOTE 7 - NOTE PAYABLE DIVISION OF WATER RESOURCES (CONTINUED)**

The following is statement of changes in the note payable:

| | Balance December 31, 2009 | Additions | Deletions | Balance December 31, 2010 |
|---|---|---|---|---|
| Note Payable - Division of Water Resources | 49,566 | - | - | 49,566 |

**NOTE 7 - TRANSFERS**

| Description | Transfers In | Transfers Out |
|---|---|---|
| General Fund | - | 450,000 |
| Capital Project Fund | 450,000 | - |
| Total | 450,000 | 450,000 |

Transfers were made for the following purposes:

* The General Fund transferred $450,000 to the Capital Project Fund for future Narrows Project costs.

# REQUIRED SUPPLEMENTARY INFORMATION "UNAUDITED"

## SANPETE COUNTY WATER CONSERVANCY DISTRICT
## NOTES TO REQUIRED SUPPLEMENTARY INFORMATION
## For The Year Ended December 31, 2010

**Budgetary Comparison Schedules:**

The Budgetary Comparison Schedules presented in this section of the report are for the District's General Fund.

**Budgeting and Budgetary Control:**

Budgets for the General Fund are legally required and are prepared and adopted on the modified accrual basis of accounting.

Original budgets represent the revenue estimates and spending authority authorized by the District's Board prior to the beginning of the year. Final budgets represent the original budget amounts plus any amendments made to the budget during the year by the Board through formal resolution. Final budgets do not include unexpended balances from the prior year because such balances automatically lapse to unreserved fund balance at the end of each year.

**Current Year Budgetary Compliance:**

For the year ended December 31, 2010, spending for General Fund of the District was within the approved budget.

**SANPETE COUNTY WATER CONSERVANCY DISTRICT**
**BUDGETARY COMPARISON SCHEDULE**
**GENERAL FUND**
**For The Year Ended December 31, 2010**

| | Budgeted Amounts | | | Variance with Final Budget |
|---|---|---|---|---|
| | Original | Final | Actual Amounts | Positive (Negative) |
| **Revenues:** | | | | |
| Property Taxes | 298,154 | 298,154 | 294,671 | (3,483) |
| Fee-In-Lieu | 54,000 | 54,000 | 37,860 | (16,140) |
| Delinquent Property Taxes | 23,000 | 23,000 | 33,645 | 10,645 |
| Interest | 16,000 | 16,000 | 6,684 | (9,316) |
| State Grant | 117,419 | 117,419 | 150,000 | 32,581 |
| Total Revenues | 508,573 | 508,573 | 522,860 | 14,287 |
| **Expenditures:** | | | | |
| Current: | | | | |
| Attorney Fees | 40,500 | 40,500 | 37,005 | 3,495 |
| Audit Fees | 3,700 | 11,000 | 11,000 | - |
| Engineering Fees | 100,000 | 170,000 | 169,656 | 344 |
| Engineering Fees - Narrows Project | 100,000 | 162,167 | 147,760 | 14,407 |
| Board of Directors Expenses | 2,200 | 2,200 | 1,125 | 1,075 |
| Secretary Expenses | 1,500 | 1,500 | 1,500 | - |
| Insurance and Bonds | 500 | 500 | 232 | 268 |
| Cloud Seeding | 16,000 | 16,000 | 14,077 | 1,923 |
| Payroll Taxes | 300 | 300 | - | 300 |
| Subscriptions | 250 | 250 | 250 | - |
| Advertising | 250 | 250 | 161 | 89 |
| Alternative Water Projects | 5,000 | 5,000 | - | 5,000 |
| Public Relations | 40,000 | 76,832 | 76,832 | - |
| Administrative Expenses | 18,000 | 18,000 | 1,091 | 16,909 |
| Construction and Labor | 178,323 | 2,024 | - | 2,024 |
| Other | 2,050 | 2,050 | 162 | 1,888 |
| Total Expenditures | 508,573 | 508,573 | 460,851 | 47,722 |
| Excess Revenues Over (Under) Expenditures | - | - | 62,009 | 62,009 |
| **Other Financing Sources (Uses):** | | | | |
| Transfers In (Out) | | | (450,000) | |
| Excess Revenues Over (Under) Expenditures After Transfers | | | (387,991) | |
| Fund Balance - Beginning of Year | | | 474,466 | |
| Fund Balance - End of Year | | | 86,475 | |

(This page contains no information and
is used to assist in formatting for easier reading)

# COMPLIANCE SECTION

(This page contains no information and
is used to assist in formatting for easier reading)

*Kimball & Roberts*
*Certified Public Accountants*
*A Professional Corporation*
*Box 663*
*Richfield, Utah 84701*
*Phone 896-6488*

## REPORT ON COMPLIANCE AND ON INTERNAL CONTROL OVER FINANCIAL REPORTING BASED ON AN AUDIT OF FINANCIAL STATEMENTS PERFORMED IN ACCORDANCE WITH *GOVERNMENT AUDITING STANDARDS*

Honorable Board Members
Sanpete County Water Conservancy District
P. O. Box 265
Mt. Pleasant, Utah 84647

We have audited the financial statements of the governmental activities of Sanpete County Water Conservancy District as and for the year ended December 31, 2010, which collectively comprise Sanpete County Water Conservancy District's basic financial statements and have issued our report thereon dated January 12, 2011. We conducted our audit in accordance with auditing standards generally accepted in the United States of America and the standards applicable to financial audits contained in *Government Auditing Standards*, issued by the Comptroller General of the United States.

### Internal Control Over Financial Reporting

In planning and performing our audit, we considered Sanpete County Water Conservancy District's internal control over financial reporting as a basis for designing our auditing procedures for the purpose of expressing our opinion on the financial statements, but not for the purpose of expressing an opinion on the effectiveness of Sanpete County Water Conservancy District's internal control over financial reporting. Accordingly, we do not express an opinion on the effectiveness of Sanpete County Water Conservancy District's internal control over financial reporting.

Our consideration of the internal control over financial reporting was for the limited purpose described in the preceding paragraph and would not necessarily identify all deficiencies in internal control over financial reporting that might be significant deficiencies or material weaknesses. However, as discussed below, we identified certain deficiencies in internal control over financial reporting that we consider to be significant deficiencies.

A control deficiency exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent or detect misstatements on a timely basis. A significant deficiency is a control deficiency or combination of control deficiencies, that adversely affects Sanpete County Water Conservancy District's ability to initiate, authorize, record, process, or report financial data reliably in accordance with generally accepted accounting principles such that there is more than a remote likelihood that a misstatement of Sanpete County Water Conservancy District's financial statements that is more than inconsequential will not be prevented or detected by Sanpete County Water Conservancy District's internal control. We consider the deficiencies described in the accompanying schedule of findings and recommendations to be significant deficiencies in internal control over financial reporting.

2010-1 Uncorrected Accounts
2010-2 Sufficient Accounting Experience and Expertise

A material weakness is a significant deficiency, or combination of significant deficiencies, that results in more than a remote likelihood that a material misstatement of the financial statements will not be prevented or detected by Sanpete County Water Conservancy District's internal control.

Our consideration of the internal control over financial reporting was for the limited purpose described in the first paragraph of this section and would not necessarily identify all deficiencies in internal control that might be significant deficiencies and, accordingly, would not necessarily disclose all significant deficiencies that are also considered to be material weaknesses. However, of the significant deficiencies described above, we consider item 2010-1 to be a material weakness.

Compliance and Other Matters

As part of obtaining reasonable assurance about whether Sanpete County Water Conservancy District's financial statements are free of material misstatement, we performed tests of its compliance with certain provisions of laws, regulations, contracts and grant agreements, noncompliance with which could have a direct and material effect on the determination of financial statement amounts. However, providing an opinion on compliance with those provisions was not an objective of our audit and, accordingly, we do not express such an opinion. The results of our tests disclosed no instances of noncompliance that are required to be reported under *Government Auditing Standards.*

We noted a certain matter that we reported to management of Sanpete County Water Conservancy District in a separate letter dated January 12, 2011.

The District's response to the findings identified in our audit is described in the accompanying schedule of findings and recommendations. We did not audit the District's response and, accordingly, we express no opinion on it.

This report is intended solely for the information and use of management, board members and others within the entity and is not intended to be and should not be used by anyone other than these specified parties.

Kimball & Roberts

KIMBALL & ROBERTS, P. C.
Certified Public Accountants

January 12, 2011
Richfield, Utah

*Kimball & Roberts*
*Certified Public Accountants*
*A Professional Corporation*
*Box 663*
*Richfield, Utah 84701*
*Phone 896-6488*

AUDITOR'S REPORT ON STATE LEGAL COMPLIANCE

Honorable Board Members
Sanpete County Water Conservancy District
P. O. Box 265
Mt. Pleasant, Utah 84647

We have audited the accompanying financial statements of the Governmental Activities of Sanpete County Water Conservancy District, for the year ended December 31, 2010, and have issued our report thereon dated January 12, 2011. The District received the following nonmajor grant, which is not required to be audited for specific compliance requirements: (However, this program was subject to testwork as part of the audit of Sanpete County Water Conservancy District's financial statements.)

Planning Grant (Department of Natural Resources)

Our audit included testwork on the District's compliance with the following general compliance requirements identified in the State of Utah Legal Compliance Audit Guide, including:

Public Debt
Cash Management
Purchasing Requirements
Budgetary Compliance
Truth in Taxation and Property Tax Limitations
Special Districts
Other General Issues

The District did not receive any major State grants during the year ending December 31, 2010.

The management of Sanpete County Water Conservancy District is responsible for the District's compliance with all compliance requirements identified above. Our responsibility is to express an opinion on compliance with those requirements based on our audit.

We conducted our audit in accordance with auditing standards generally accepted in the United States of America and *Government Auditing Standards*, issued by the Comptroller General of the United States. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether material noncompliance with the requirements referred to above occurred. An audit includes examining, on a test basis, evidence about the District's compliance with those requirements. We believe that our audit provides a reasonable basis for our opinion.

Our audit does not provide a legal determination on the District's compliance with these requirements.

The results of our audit procedures disclosed an immaterial instance of noncompliance with the requirements referred to above, which is described in a separate management letter. We considered this instance of noncompliance in forming our opinion on compliance, which is expressed in the following paragraph.

Honorable Board Members
Sanpete County Water Conservancy District

In our opinion, Sanpete County Water Conservancy District, complied, in all material respects, with the general compliance requirements identified above for the year ended December 31, 2010.

The District's written response to the finding identified in our audit is described in the accompanying management letter. We did not audit the District's response and, accordingly, we express no opinion on it.

This report is intended solely for the information and use of management of the District and is not intended to be and should not be used by anyone other than the specified parties. However, the report is a matter of public record and its distribution is not limited.

Kimball & Roberts

KIMBALL & ROBERTS, P. C.
Certified Public Accountants

January 12, 2011
Richfield, Utah

*Kimball & Roberts*
*Certified Public Accountants*
*A Professional Corporation*
*Box 663*
*Richfield, Utah 84701*
*Phone 896-6488*

## FINDINGS AND RECOMMENDATIONS

Honorable Board Members
Sanpete County Water Conservancy District
Mt. Pleasant, Utah 84647

During our audit of the financial statements of Sanpete County Water Conservancy District for the year ended December 31, 2010, we found circumstances that, if improved, would strengthen the District's accounting system and control over its assets. These items are discussed below for your consideration:

**Material Weakness Finding and Recommendation:**

2010-1 Uncorrected Accounts

Finding:

Sanpete County Water Conservancy District is not maintaining its own depreciation schedules nor recording depreciation properly. Statements on Auditing Standards #112 indicate that this control weakness is a material weakness in the District's internal control.

Recommendation:

We recommend that the District prepare appropriate depreciation schedules by the use of spreadsheets or depreciation software. The District's personnel should be properly trained on its use and application. Also, the District should properly record depreciation in its financial statements at least on an annual basis.

Sanpete County Water Conservancy District's Response:

Sanpete County Water Conservancy District plans to review and approve depreciation methods, estimated life of assets and related salvage values, if any.

**Significant Deficiency Finding and Recommendation:**

2010-2 Sufficient Accounting Experience and Expertise

Finding:

Statement on Auditing Standards #112 indicates that it is a significant deficiency in the District's internal controls when the District's personnel may not have sufficient experience or expertise to select and apply generally accepted accounting principles. The District's personnel may not have sufficient training or experience in the accounting field, specifically in the preparation of the District's financial statements and related notes to the financial statements.

Honorable Board Members
Sanpete County Water Conservancy District

Recommendation:

We would suggest that the District provide the training necessary for the present accounting personnel to properly prepare the financial statements and related notes to the financial statements. If the District believes that the cost of preparing the financial statements and related notes to the financial statement is prohibitive then the District should consider other alternatives to comply with Statement on Auditing Standards #112.

Sanpete County Water Conservancy District's Response:

The cost to prepare full disclosures and financial statements is prohibitive for our District. We will continue to prepare our financial statements and full disclosures as in the past years.

This report is intended solely for the information and use of management and District Board members and is not intended to be and should not be used by anyone other than these specified parties.

We thank you for the opportunity to perform the audit of the District this past fiscal year. We would like to express a special thanks to those who have given us assistance in this year's audit. If you have any questions throughout the year that we may help with, please give us a call. We look forward to a continued professional relationship with the District.

Respectfully submitted,

Kimball & Roberts

KIMBALL & ROBERTS, P. C.
Certified Public Accountants

January 12, 2011
Richfield, Utah

# SANPETE COUNTY WATER CONSERVANCY DISTRICT

## MANAGEMENT LETTER

## DECEMBER 31, 2010

*Kimball & Roberts*
*Certified Public Accountants*
*A Professional Corporation*
*Box 663*
*Richfield, Utah 84701*
*Phone 896-6488*

January 12, 2011

Honorable Board Members
Sanpete County Water Conservancy District
90 West Union Street
Manti, Utah 84642

During our audit of the funds of Sanpete County Water Conservancy District for the year ended December 31, 2010, we noted an area needing corrective action in order for the District to be in compliance with state laws and regulations. This item is discussed below for your consideration.

**COMPLIANCE:**

**Public Treasurer's Fidelity Bond**

Every public treasurer is required to secure a fidelity bond based on the previous year's budgeted gross revenues, which includes all funds collected or handled by the public treasurer.

**Finding:**

We noted that the present fidelity bond amount is less than the amount required by the Utah Money Management Council. The required fidelity bond is $40,000. The present fidelity bond is $22,000.

**Recommendation:**

We recommend that the fidelity bond be increased to $40,000.

**Response:**

The District will contact our insurance company and increase the fidelity bond coverage on the Treasurer to $40,000 as required.

We would like to thank Sanpete County Water Conservancy District's personnel for the cooperation and assistance given to us during the course of our examination.

Kimball & Roberts

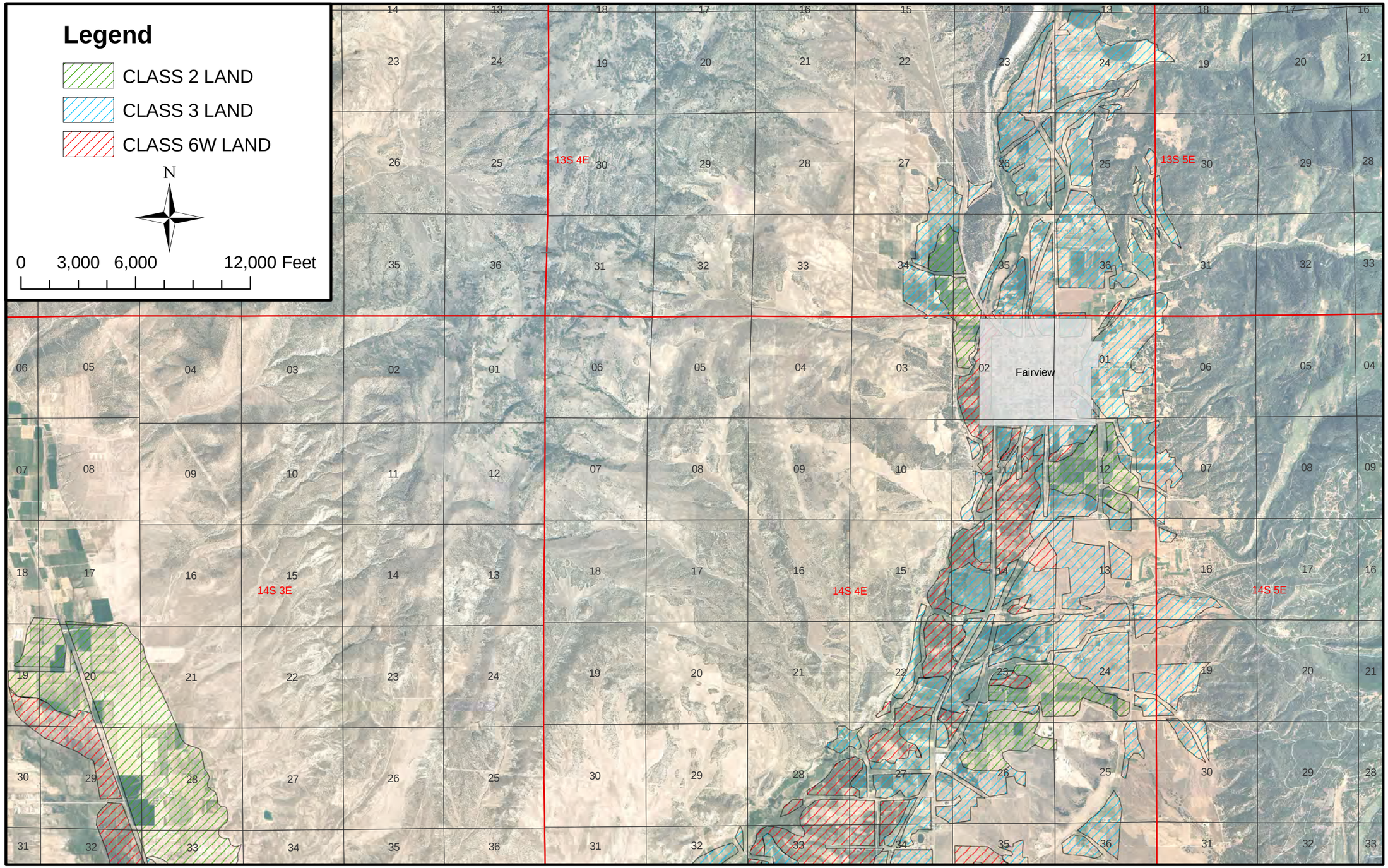
KIMBALL & ROBERTS
Certified Public Accountants

RGR/vl

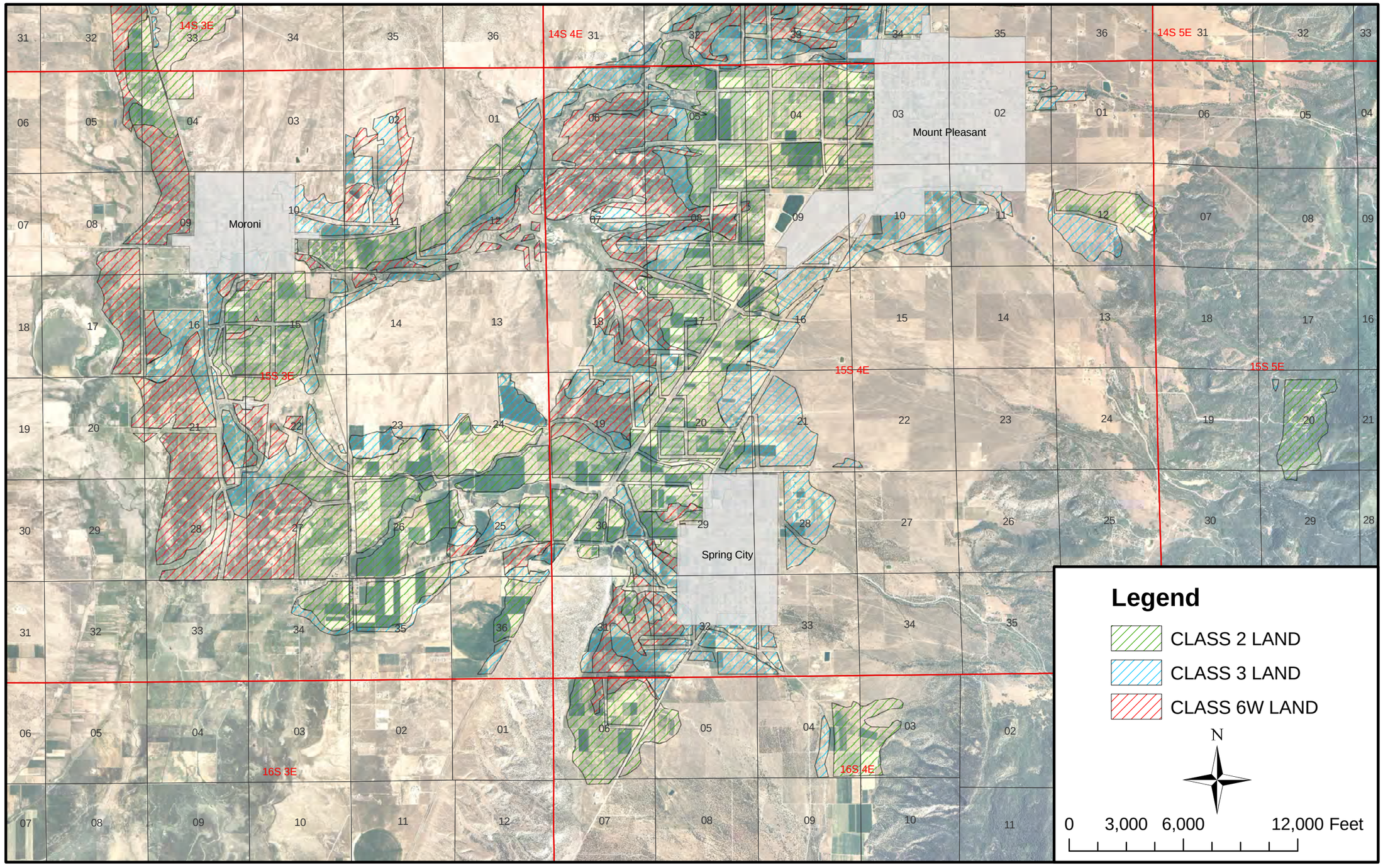
# ATTACHMENT B

LAND CLASSIFICATION
MAPS

Sanpete Water
Conservancy District




| | | | |
|---|---|---|---|
| | SANPETE WATER CONSERVANCY DISTRICT<br>NARROWS PROJECT | CLASSIFICATION OF PROJECT LANDS | FIGURE<br>1 of 2 |




| | | | |
|---|---|---|---|
| | SANPETE WATER CONSERVANCY DISTRICT<br>NARROWS PROJECT | CLASSIFICATION OF PROJECT LANDS | FIGURE<br>2 of 2 |

# ATTACHMENT C

## WATER SUPPLY

1. SUPPORTING DATA – TEMPERATURE, CONSUMPTIVE USE, AND EFFECTIVE PRECIPITATION

Sanpete Water Conservancy District

Table C-1
Average temperature data for Moroni, Utah
(degrees Farenheit)

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Daily Maximum | 35.8 | 41.6 | 51.0 | 61.3 | 71.3 | 82.0 | 89.5 | 87.1 | 79.2 | 66.7 | 50.1 | 38.6 |
| Average Daily Minimum | 10.1 | 15.1 | 22.4 | 28.6 | 35.9 | 42.3 | 49.4 | 47.9 | 39.5 | 30.5 | 21.2 | 12.8 |
| Average | 22.9 | 28.3 | 36.7 | 45.0 | 53.6 | 62.1 | 69.4 | 67.5 | 59.4 | 48.6 | 35.7 | 25.7 |

Table C-2
Monthly Precipitation at Ephraim, Utah
(inches)

| Year | Jan | Feb | March | April | May | June | July | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 0.57 | 2.02 | 0.82 | 0.58 | 0.79 | 0.40 | 0.36 | 0.23 | 1.00 | 1.16 | 1.00 | 0.05 | 8.98 |
| 1961 | 0.12 | 0.39 | 3.07 | 1.44 | 0.34 | 0.00 | 0.24 | 2.09 | 4.52 | 0.99 | 1.30 | 0.54 | 15.04 |
| 1962 | 0.77 | 3.03 | 0.83 | 0.58 | 0.72 | 0.04 | 0.35 | 0.05 | 0.49 | 0.44 | 0.28 | 0.67 | 8.25 |
| 1963 | 1.44 | 0.52 | 0.57 | 1.99 | 0.21 | 1.24 | 0.14 | 1.04 | 1.90 | 0.50 | 0.97 | 0.52 | 11.04 |
| 1964 | 0.59 | 0.24 | 1.26 | 1.90 | 2.17 | 1.00 | 0.35 | 0.25 | 0.53 | 0.13 | 1.14 | 1.99 | 11.55 |
| 1965 | 0.45 | 0.82 | 0.87 | 0.67 | 1.69 | 0.96 | 1.59 | 1.80 | 1.85 | 0.29 | 1.35 | 0.85 | 13.19 |
| 1966 | 0.22 | 0.64 | 0.11 | 0.28 | 0.88 | 0.40 | 0.48 | 1.38 | 0.71 | 1.49 | 0.43 | 3.26 | 10.28 |
| 1967 | 0.95 | 0.22 | 0.67 | 1.34 | 2.14 | 1.37 | 0.51 | 0.03 | 1.29 | 0.28 | 0.47 | 1.10 | 10.37 |
| 1968 | 0.12 | 1.92 | 0.57 | 2.72 | 0.32 | 0.53 | 1.19 | 1.78 | 0.14 | 1.10 | 0.32 | 0.44 | 11.15 |
| 1969 | 2.82 | 1.32 | 0.34 | 0.69 | 0.11 | 2.05 | 0.18 | 0.31 | 0.88 | 1.86 | 0.50 | 0.70 | 11.76 |
| 1970 | 0.92 | 0.14 | 1.46 | 0.87 | 0.27 | 2.62 | 1.25 | 0.50 | 0.71 | 1.18 | 1.11 | 0.55 | 11.58 |
| 1971 | 0.44 | 0.63 | 0.17 | 1.05 | 0.57 | 0.24 | 0.24 | 1.00 | 0.75 | 2.48 | 0.61 | 1.46 | 9.64 |
| 1972 | 0.16 | 0.17 | 0.11 | 0.92 | 0.44 | 0.66 | 0.43 | 1.05 | 1.83 | 2.35 | 1.12 | 0.55 | 9.79 |
| 1973 | 0.67 | 0.48 | 1.39 | 1.18 | 1.27 | 0.64 | 0.81 | | 0.52 | 0.53 | 1.33 | 1.21 | 10.03 |
| 1974 | 1.73 | 0.51 | 0.75 | 0.75 | 0.06 | 0.00 | 0.81 | 0.30 | 0.07 | 1.07 | 0.59 | 0.65 | 7.29 |
| 1975 | 0.50 | 0.43 | 2.31 | 0.92 | 2.20 | 1.32 | 0.14 | 0.25 | 0.10 | 0.77 | 0.92 | 0.35 | 10.21 |
| 1976 | 0.27 | 0.66 | 0.69 | 1.02 | 0.47 | 0.00 | 0.65 | 0.16 | 1.18 | 0.00 | 0.11 | 0.00 | 5.21 |
| 1977 | 0.39 | 0.25 | 0.69 | 0.06 | 1.09 | 0.24 | 1.70 | 1.04 | 0.62 | 1.28 | 0.81 | 1.11 | 9.28 |
| 1978 | 2.10 | 1.64 | 1.98 | 1.39 | 0.57 | 0.00 | 0.16 | 0.45 | 1.80 | 0.30 | 1.80 | 0.98 | 13.17 |
| 1979 | 1.50 | 1.15 | 1.87 | 0.87 | 1.72 | 0.08 | 0.52 | 0.59 | 0.15 | 1.06 | 1.17 | 0.33 | 11.01 |
| 1980 | 2.07 | 3.82 | 2.00 | 0.88 | 2.72 | 0.17 | 0.18 | 0.37 | 2.06 | 1.58 | 0.87 | 0.06 | 16.78 |
| 1981 | 0.30 | 0.25 | 1.74 | 0.68 | 2.75 | 0.18 | 0.95 | 0.63 | 1.55 | 2.66 | 0.35 | 1.10 | 13.14 |
| 1982 | 1.54 | 0.52 | 2.05 | 0.10 | 0.95 | 0.57 | 1.05 | 0.31 | 4.52 | 1.41 | 1.49 | 1.17 | 15.68 |
| 1983 | 2.02 | 1.47 | 2.52 | 1.59 | 1.61 | 0.21 | 0.72 | 1.52 | 1.44 | 1.12 | 3.07 | 2.60 | 19.89 |
| 1984 | 0.22 | 1.30 | 1.45 | 1.60 | 0.89 | 2.63 | 1.30 | 0.85 | 0.83 | 3.18 | 1.01 | 1.47 | 16.73 |
| 1985 | 0.64 | 0.62 | 1.44 | 1.90 | 1.06 | 0.97 | 1.81 | 0.01 | 0.52 | 1.91 | 2.75 | 1.06 | 14.69 |
| 1986 | 0.29 | 1.70 | 1.59 | 2.73 | 0.97 | 0.29 | 0.46 | 1.93 | 1.13 | 0.80 | 0.20 | 0.33 | 12.42 |
| 1987 | 0.62 | 0.96 | 1.80 | 0.38 | 1.36 | 0.54 | 2.06 | 0.78 | 0.42 | 1.45 | 0.59 | 1.13 | 12.09 |
| 1988 | 1.12 | 0.18 | 1.79 | 1.45 | 1.08 | 0.38 | 0.22 | 0.61 | 0.90 | 1.05 | 0.99 | 1.03 | 10.80 |
| 1989 | 0.78 | 0.57 | 1.39 | 0.65 | 0.46 | 0.72 | 0.67 | 1.15 | 1.22 | 0.98 | 0.63 | 0.41 | 9.63 |
| Average | 0.88 | 0.95 | 1.28 | 1.11 | 1.06 | 0.68 | 0.72 | 0.77 | 1.19 | 1.18 | 0.98 | 0.92 | 11.69 |

Table C-3
Narrows Project Consumptive Use Estimates 1/

| Month or Period | Midpoint of Period | Accum. Days to Midpoint | Percent of Growing Season | Mean Air Temp (t) | Daylight Hours % (p) | Cons. Use Factor (f) | Climatic Coeff. (kt) | Growth Stage Coeff. (kc) | Cons. Use Coeff. (k) | Monthly CU (inches) | Daily CU (in/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pasture** | | | | | | | | | | | |
| 15-Apr | | | | | | | | | | | |
| | 23-Apr | 8 | 6.0 | 47.3 | 4.47 | 2.11 | 0.50 | 0.87 | 0.44 | 0.93 | 0.058 |
| 01-May | | | | | | | | | | | |
| | 16-May | 32 | 23.7 | 53.6 | 10.01 | 5.37 | 0.61 | 0.90 | 0.55 | 2.96 | 0.096 |
| 01-Jun | | | | | | | | | | | |
| | 16-Jun | 62 | 46.6 | 62.1 | 10.09 | 6.27 | 0.76 | 0.92 | 0.70 | 4.38 | 0.146 |
| 01-Jul | | | | | | | | | | | |
| | 16-Jul | 93 | 69.5 | 69.4 | 10.22 | 7.09 | 0.89 | 0.93 | 0.82 | 5.85 | 0.189 |
| 01-Aug | | | | | | | | | | | |
| | 13-Aug | 121 | 90.6 | 67.4 | 8.00 | 5.39 | 0.85 | 0.91 | 0.78 | 4.18 | 0.167 |
| 26-Aug | | | | | | | | | | | |
| | | | | | | | | | **Season total =** | **18.30** | |
| **Small Grains** | | | | | | | | | | | |
| 15-Apr | | | | | | | | | | | |
| | 23-Apr | 8 | 6.1 | 47.3 | 4.47 | 2.11 | 0.50 | 0.37 | 0.19 | 0.39 | 0.025 |
| 01-May | | | | | | | | | | | |
| | 16-May | 31.5 | 24.0 | 53.6 | 10.01 | 5.37 | 0.61 | 0.80 | 0.49 | 2.63 | 0.085 |
| 01-Jun | | | | | | | | | | | |
| | 16-Jun | 62 | 47.3 | 62.1 | 10.09 | 6.27 | 0.76 | 1.29 | 0.98 | 6.15 | 0.205 |
| 01-Jul | | | | | | | | | | | |
| | 16-Jul | 92.5 | 70.6 | 69.4 | 10.22 | 7.09 | 0.89 | 1.02 | 0.90 | 6.41 | 0.207 |
| 01-Aug | | | | | | | | | | | |
| | 12-Aug | 119.5 | 91.2 | 67.3 | 7.39 | 4.97 | 0.85 | 0.26 | 0.22 | 1.10 | 0.048 |
| 24-Aug | | | | | | | | | | | |
| | | | | | | | | | **Season total =** | **16.69** | |

Table C-3 (continued)
Narrows Project Consumptive Use Estimates 1/

| Month or Period | Midpoint of Period | Accum. Days to Midpoint | Percent of Growing Season | Mean Air Temp (t) | Daylight Hours % (p) | Cons. Use Factor (f) | Climatic Coeff. (kt) | Growth Stage Coeff. (kc) | Cons. Use Coeff. (k) | Monthly CU (inches) | Daily CU (in/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hay** | | | | | | | | | | | |
| 15-Apr | | | | | | | | | | | |
| | 23-Apr | 8 | 6.0 | 47.3 | 4.47 | 2.11 | 0.50 | 0.87 | 0.44 | 0.93 | 0.058 |
| 01-May | | | | | | | | | | | |
| | 16-May | 31.5 | 23.7 | 53.6 | 10.01 | 5.37 | 0.61 | 0.90 | 0.55 | 2.96 | 0.096 |
| 01-Jun | | | | | | | | | | | |
| | 16-Jun | 62 | 46.6 | 62.1 | 10.09 | 6.27 | 0.76 | 0.92 | 0.70 | 4.38 | 0.146 |
| 01-Jul | | | | | | | | | | | |
| | 16-Jul | 92.5 | 69.5 | 69.4 | 10.22 | 7.09 | 0.89 | 0.93 | 0.82 | 5.85 | 0.189 |
| 01-Aug | | | | | | | | | | | |
| | 13-Aug | 120.5 | 90.6 | 67.4 | 8.00 | 5.39 | 0.85 | 0.91 | 0.78 | 4.18 | 0.167 |
| 26-Aug | | | | | | | | | | | |
| | | | | | | | | | **Season total =** | **18.30** | |
| **Alfalfa** | | | | | | | | | | | |
| 02-May | | | | | | | | | | | |
| | 17-May | 15 | 8.6 | 53.9 | 9.69 | 5.22 | 0.62 | 1.09 | 0.67 | 3.52 | 0.117 |
| 01-Jun | | | | | | | | | | | |
| | 16-Jun | 45 | 25.7 | 62.1 | 10.09 | 6.27 | 0.76 | 1.13 | 0.86 | 5.38 | 0.179 |
| 01-Jul | | | | | | | | | | | |
| | 16-Jul | 75.5 | 43.1 | 69.4 | 10.22 | 7.09 | 0.89 | 1.11 | 0.98 | 6.98 | 0.225 |
| 01-Aug | | | | | | | | | | | |
| | 16-Aug | 106.5 | 60.9 | 67.5 | 9.55 | 6.45 | 0.85 | 1.06 | 0.90 | 5.83 | 0.188 |
| 01-Sep | | | | | | | | | | | |
| | 16-Sep | 137 | 78.3 | 59.4 | 8.39 | 4.98 | 0.71 | 0.99 | 0.71 | 3.52 | 0.117 |
| 01-Oct | | | | | | | | | | | |
| | 12-Oct | 163.5 | 93.4 | 50.1 | 6.00 | 3.01 | 0.55 | 0.91 | 0.50 | 1.51 | 0.066 |
| 24-Oct | | | | | | | | | | | |
| | | | | | | | | | **Season total =** | **26.75** | |

1/ Weather data period of record: 1948-1990

Table C-4
Effective Precipitation for Group 1
(unit--inches)

| | APRIL | MAY | JUNE | JULY | AUG | SEP | OCT | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1959 | 0.27 | 0.25 | 0.24 | 0.06 | 0.53 | 0.66 | 0.24 | 2.24 |
| 1960 | 0.12 | 0.43 | 0.03 | 0.22 | 0.23 | 0.76 | 0.52 | 2.32 |
| 1961 | 0.27 | 0.13 | 0.00 | 0.49 | 1.41 | 1.16 | 0.51 | 3.96 |
| 1962 | 0.19 | 0.56 | 0.20 | 0.32 | 0.06 | 0.59 | 0.16 | 2.08 |
| 1963 | 0.45 | 0.17 | 0.58 | 0.28 | 0.49 | 0.73 | 0.04 | 2.73 |
| 1964 | 0.42 | 0.85 | 0.50 | 0.03 | 0.77 | 0.41 | 0.00 | 2.98 |
| 1965 | 0.00 | 0.68 | 0.38 | 0.50 | 0.94 | 1.03 | 0.00 | 3.53 |
| 1966 | 0.00 | 0.44 | 0.08 | 0.27 | 0.22 | 0.16 | 0.52 | 1.69 |
| 1967 | 0.08 | 1.02 | 1.08 | 0.48 | 0.13 | 0.69 | 0.05 | 3.52 |
| 1968 | 0.55 | 0.37 | 0.58 | 0.59 | 1.78 | 0.07 | 0.27 | 4.21 |
| 1969 | 0.05 | 0.00 | 0.83 | 0.52 | 0.17 | 0.44 | 0.52 | 2.52 |
| 1970 | 0.06 | 0.00 | 1.25 | 0.00 | 0.54 | 0.00 | 0.05 | 1.90 |
| 1971 | 0.30 | 0.52 | 0.34 | 0.05 | 0.88 | 0.28 | 0.52 | 2.87 |
| 1972 | 0.20 | 0.25 | 0.20 | 0.20 | 0.23 | 0.53 | 0.52 | 2.14 |
| 1973 | 0.47 | 0.95 | 0.39 | 1.00 | 0.00 | 0.29 | 0.00 | 3.10 |
| 1974 | 0.42 | 0.08 | 0.00 | 1.31 | 0.00 | 0.00 | 0.35 | 2.15 |
| 1975 | 0.00 | 1.29 | 0.46 | 0.44 | 0.15 | 0.37 | 0.00 | 2.71 |
| 1976 | 0.06 | 0.20 | 0.07 | 0.12 | 0.15 | 0.40 | 0.24 | 1.25 |
| 1977 | 0.00 | 0.82 | 0.00 | 0.81 | 0.76 | 0.29 | 0.40 | 3.08 |
| 1978 | 0.35 | 0.41 | 0.00 | 0.00 | 0.34 | 0.79 | 0.08 | 1.98 |
| 1979 | 0.00 | 0.60 | 0.00 | 0.35 | 0.53 | 0.00 | 0.29 | 1.77 |
| 1980 | 0.14 | 1.06 | 0.00 | 0.64 | 0.84 | 1.00 | 0.49 | 4.16 |
| 1981 | 0.03 | 1.02 | 0.00 | 0.83 | 1.18 | 0.81 | 0.52 | 4.39 |
| 1982 | 0.00 | 0.83 | 0.10 | 0.55 | 0.53 | 1.16 | 0.52 | 3.69 |
| 1983 | 0.37 | 0.56 | 0.01 | 0.44 | 1.43 | 1.16 | 0.35 | 4.32 |
| 1984 | 0.35 | 0.30 | 1.79 | 1.37 | 0.57 | 0.63 | 0.52 | 5.52 |
| 1985 | 0.39 | 0.67 | 0.52 | 1.59 | 0.00 | 0.37 | 0.52 | 4.06 |
| 1986 | 0.56 | 0.35 | 0.39 | 0.30 | 0.29 | 0.84 | 0.52 | 3.25 |
| 1987 | 0.00 | 0.83 | 0.15 | 0.74 | 0.57 | 0.18 | 0.46 | 2.92 |
| 1988 | 0.21 | 0.94 | 0.25 | 0.44 | 0.40 | 0.59 | 0.35 | 3.18 |
| 1989 | 0.16 | 0.30 | 0.55 | 0.29 | 0.83 | 0.64 | 0.32 | 3.08 |
| 1990 | 0.00 | 0.04 | 1.32 | 0.19 | 0.31 | 0.53 | 0.47 | 2.86 |

Table C-5
Effective Precipitation for Groups 2 and 3
(unit--inches)

| | APRIL | MAY | JUNE | JULY | AUG | SEP | OCT | |
|---|---|---|---|---|---|---|---|---|
| 1959 | 0.27 | 0.25 | 0.24 | 0.06 | 0.52 | 0.66 | 0.24 | 2.23 |
| 1960 | 0.12 | 0.43 | 0.03 | 0.22 | 0.23 | 0.77 | 0.56 | 2.35 |
| 1961 | 0.27 | 0.13 | 0.00 | 0.48 | 1.38 | 1.23 | 0.51 | 4.00 |
| 1962 | 0.19 | 0.56 | 0.19 | 0.31 | 0.06 | 0.59 | 0.16 | 2.07 |
| 1963 | 0.45 | 0.17 | 0.58 | 0.28 | 0.46 | 0.73 | 0.04 | 2.72 |
| 1964 | 0.42 | 0.84 | 0.50 | 0.03 | 0.76 | 0.41 | 0.00 | 2.96 |
| 1965 | 0.00 | 0.68 | 0.38 | 0.50 | 0.92 | 1.03 | 0.00 | 3.51 |
| 1966 | 0.00 | 0.44 | 0.08 | 0.27 | 0.22 | 0.16 | 0.56 | 1.73 |
| 1967 | 0.08 | 1.01 | 1.08 | 0.47 | 0.13 | 0.69 | 0.05 | 3.51 |
| 1968 | 0.48 | 0.37 | 0.58 | 0.58 | 1.75 | 0.07 | 0.27 | 4.11 |
| 1969 | 0.05 | 0.00 | 0.83 | 0.52 | 0.16 | 0.44 | 0.56 | 2.55 |
| 1970 | 0.06 | 0.00 | 1.25 | 0.00 | 0.53 | 0.00 | 0.05 | 1.89 |
| 1971 | 0.30 | 0.52 | 0.33 | 0.04 | 0.86 | 0.28 | 0.56 | 2.90 |
| 1972 | 0.20 | 0.25 | 0.20 | 0.20 | 0.23 | 0.53 | 0.56 | 2.18 |
| 1973 | 0.47 | 0.94 | 0.39 | 0.99 | 0.00 | 0.29 | 0.00 | 3.09 |
| 1974 | 0.41 | 0.07 | 0.00 | 1.30 | 0.00 | 0.00 | 0.35 | 2.14 |
| 1975 | 0.00 | 1.28 | 0.46 | 0.44 | 0.15 | 0.37 | 0.00 | 2.70 |
| 1976 | 0.06 | 0.20 | 0.07 | 0.12 | 0.15 | 0.41 | 0.24 | 1.24 |
| 1977 | 0.00 | 0.81 | 0.00 | 0.80 | 0.75 | 0.29 | 0.40 | 3.06 |
| 1978 | 0.35 | 0.41 | 0.00 | 0.00 | 0.34 | 0.80 | 0.08 | 1.97 |
| 1979 | 0.00 | 0.59 | 0.00 | 0.35 | 0.52 | 0.00 | 0.29 | 1.75 |
| 1980 | 0.14 | 1.05 | 0.00 | 0.63 | 0.83 | 1.01 | 0.49 | 4.15 |
| 1981 | 0.03 | 1.02 | 0.00 | 0.82 | 1.16 | 0.81 | 0.56 | 4.40 |
| 1982 | 0.00 | 0.83 | 0.10 | 0.54 | 0.52 | 1.23 | 0.56 | 3.78 |
| 1983 | 0.37 | 0.56 | 0.01 | 0.44 | 1.40 | 1.18 | 0.35 | 4.30 |
| 1984 | 0.35 | 0.30 | 1.79 | 1.35 | 0.56 | 0.63 | 0.56 | 5.53 |
| 1985 | 0.38 | 0.67 | 0.52 | 1.57 | 0.00 | 0.37 | 0.56 | 4.08 |
| 1986 | 0.48 | 0.35 | 0.39 | 0.29 | 0.29 | 0.85 | 0.53 | 3.18 |
| 1987 | 0.00 | 0.82 | 0.15 | 0.73 | 0.56 | 0.18 | 0.46 | 2.90 |
| 1988 | 0.21 | 0.93 | 0.25 | 0.44 | 0.39 | 0.60 | 0.35 | 3.16 |
| 1989 | 0.15 | 0.30 | 0.54 | 0.29 | 0.81 | 0.65 | 0.32 | 3.06 |
| 1990 | 0.00 | 0.04 | 1.32 | 0.19 | 0.30 | 0.53 | 0.47 | 2.85 |

# ATTACHMENT C

## WATER SUPPLY

2. GOOSEBERRY CREEK STREAMFLOW RECORDS AND NARROWS RESERVOIR SIMULATED OPERATION STUDY

Sanpete Water Conservancy District

**Table C-6**
**Recorded Flow of Gooseberry Creek Near Fairview**
**(Acre-Feet)**

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 155 | 131 | 56 | 49 | 46 | 117 | 336 | 2,970 | 951 | 431 | 188 | 105 | 5,535 |
| 1961 | 90 | 89 | 75 | 58 | 50 | 59 | 313 | 1,370 | 558 | 263 | 93 | 124 | 3,142 |
| 1962 | 95 | 89 | 66 | 61 | 93 | 81 | 678 | 4,850 | 2,410 | 845 | 538 | 266 | 10,072 |
| 1963 | 109 | 80 | 63 | 37 | 60 | 73 | 143 | 3,090 | 1,110 | 460 | 356 | 240 | 5,821 |
| 1964 | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] | NA[1] |
| 1965 | 118 | 93 | 73 | 61 | 59 | 64 | 189 | 3,070 | 3,300 | 751 | 617 | 531 | 8,926 |
| 1966 | 323 | 179 | 150 | 92 | 85 | 155 | 1,150 | 2,540 | 537 | 170 | 98 | 108 | 5,587 |
| 1967 | 95 | 93 | 89 | 72 | 62 | 77 | 87 | 3,020 | 2,650 | 522 | 239 | 144 | 7,150 |
| 1968 | 123 | 87 | 89 | 78 | 74 | 83 | 210 | 2,780 | 3,670 | 439 | 301 | 189 | 8,123 |
| 1969 | 160 | 122 | 98 | 105 | 98 | 102 | 526 | 5,900 | 1,340 | NA[1] | NA[1] | NA[1] | 8,451 |
| Total | 1,268 | 963 | 759 | 613 | 627 | 811 | 3,632 | 29,590 | 16,526 | 3,881 | 2,430 | 1,707 | 62,807 |
| Ave | 141 | 107 | 84 | 68 | 70 | 90 | 404 | 3,288 | 1,836 | 485 | 304 | 213 | 6,979 |

[1] NA = Not Available

**Table C-7**
**Natural Flow of Gooseberry Creek Near Fairview**
**(Acre-Feet)**

| | R=0.84 | R=0.77 | R=0.82 | R=0.61 | R=0.69 | R=0.78 | R=0.96 | R=0.99 | R=0.98 | R=0.85 | R=0.78 | R=0.98 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A=-4.87 | A=26.75 | A=0.54 | A=35.01 | A=35.79 | A=22.09 | A=-33.64 | A=520.55 | A=-232.51 | A=66.67 | A=72.35 | A=-7.26 | |
| | B=0.50 | B=0.34 | B=0.41 | B=0.19 | B=0.19 | B=0.30 | B=0.49 | B=0.46 | B=0.62 | B=0.37 | B=0.30 | B=0.53 | |
| **Year** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Total** |
| 1960 | 103 | 92 | 52 | 54 | 53 | 89 | 309 | 2,883 | 803 | 313 | 144 | 88 | 4,984 |
| 1961 | 99 | 99 | 80 | 62 | 60 | 73 | 289 | 1,688 | 313 | 209 | 119 | 122 | 3,212 |
| 1962 | 125 | 121 | 95 | 76 | 91 | 117 | 894 | 4,890 | 2,338 | 543 | 272 | 230 | 9,792 |
| 1963 | 132 | 106 | 63 | 53 | 59 | 66 | 123 | 3,338 | 1,185 | 351 | 245 | 203 | 5,925 |
| 1964 | 97 | 91 | 68 | 71 | 70 | 80 | 140 | 3,329 | 2,082 | 463 | 253 | 222 | 6,967 |
| 1965 | 114 | 90 | 108 | 87 | 80 | 91 | 268 | 3,313 | 3,430 | 586 | 393 | 452 | 9,012 |
| 1966 | 300 | 174 | 136 | 92 | 90 | 152 | 1,040 | 2,828 | 833 | 272 | 253 | 183 | 6,352 |
| 1967 | 240 | 129 | 110 | 76 | 73 | 104 | 365 | 3,599 | 2,862 | 471 | 257 | 192 | 8,479 |
| 1968 | 145 | 112 | 107 | 85 | 83 | 107 | 208 | 3,193 | 3,556 | 407 | 277 | 217 | 8,498 |
| 1969 | 191 | 131 | 102 | 76 | 74 | 105 | 652 | 6,425 | 1,901 | 459 | 239 | 219 | 10,573 |
| 1970 | 223 | 153 | 133 | 95 | 83 | 120 | 247 | 4,185 | 1,865 | 411 | 194 | 168 | 7,875 |
| 1971 | 182 | 145 | 179 | 128 | 79 | 109 | 356 | 3,286 | 1,399 | 346 | 188 | 159 | 6,556 |
| 1972 | 171 | 134 | 149 | 110 | 95 | 228 | 718 | 2,567 | 646 | 231 | 147 | 136 | 5,332 |
| 1973 | 176 | 142 | 126 | 91 | 85 | 147 | 374 | 4,280 | 2,054 | 394 | 192 | 185 | 8,246 |
| 1974 | 154 | 127 | 122 | 98 | 85 | 109 | 253 | 4,200 | 994 | 281 | 157 | 103 | 6,681 |
| 1975 | 132 | 116 | 94 | 84 | 78 | 95 | 125 | 2,782 | 5,465 | 677 | 251 | 176 | 10,074 |
| 1976 | 190 | 142 | 136 | 98 | 91 | 102 | 232 | 3,109 | 1,169 | 302 | 150 | 88 | 5,808 |
| 1977 | 98 | 87 | 55 | 63 | 64 | 73 | 297 | 1,010 | 167 | 161 | 111 | 56 | 2,243 |
| 1978 | 124 | 113 | 95 | 78 | 78 | 106 | 652 | 3,709 | 4,463 | 454 | 257 | 162 | 10,292 |
| 1979 | 23 | 122 | 79 | 71 | 68 | 80 | 255 | 3,736 | 2,150 | 329 | 188 | 114 | 7,215 |
| 1980 | 113 | 108 | 99 | 81 | 78 | 94 | 465 | 4,003 | 4,887 | 489 | 217 | 192 | 10,826 |
| 1981 | 160 | 129 | 106 | 82 | 78 | 123 | 747 | 2,470 | 1,182 | 263 | 155 | 122 | 5,615 |
| 1982 | 203 | 138 | 101 | 72 | 69 | 102 | 722 | 4,975 | 2,807 | 518 | 243 | 285 | 10,234 |
| 1983 | 422 | 268 | 211 | 118 | 108 | 173 | 318 | 2,880 | 8,769 | 1,186 | 341 | 328 | 15,122 |
| 1984 | 350 | 228 | 248 | 135 | 124 | 165 | 323 | 6,361 | 6,640 | 727 | 295 | 258 | 15,854 |
| 1985 | 304 | 198 | 211 | 127 | 107 | 143 | 1,470 | 5,787 | 1,791 | 454 | 220 | 180 | 10,993 |
| 1986 | 229 | 179 | 171 | 113 | 113 | 198 | 1,102 | 6,297 | 4,653 | 449 | 229 | 209 | 13,941 |
| 1987 | 235 | 173 | 124 | 69 | 65 | 90 | 896 | 2,397 | 728 | 265 | 162 | 117 | 5,322 |
| 1988 | 157 | 126 | 97 | 78 | 75 | 102 | 620 | 3,254 | 651 | 263 | 169 | 124 | 5,715 |
| 1989 | 132 | 134 | 116 | 88 | 78 | 130 | 1,121 | 2,392 | 502 | 258 | 152 | 130 | 5,233 |
| 1990 | 114 | 195 | 96 | 78 | 76 | 106 | 1,068 | 2,317 | 630 | 283 | 148 | 108 | 5,218 |
| 1991 | 132 | 122 | 100 | 81 | 81 | 104 | 448 | 3,563 | 2,240 | 389 | 211 | 205 | 7,678 |
| 1992 | 136 | 123 | 104 | 71 | 66 | 117 | 687 | 1,493 | 373 | 195 | 128 | 101 | 3,592 |
| 1993 | 215 | 149 | 131 | 95 | 95 | 194 | 940 | 5,580 | 2,304 | 431 | 216 | 186 | 10,538 |
| 1994 | 164 | 120 | 111 | 77 | 74 | 107 | 597 | 3,129 | 653 | 214 | 165 | 135 | 5,545 |
| 1995 | 197 | 125 | 127 | 91 | 86 | 162 | 514 | 4,089 | 6,259 | 879 | 324 | 232 | 13,085 |
| 1996 | 161 | 137 | 116 | 72 | 77 | 116 | 371 | 4,821 | 2,169 | 359 | 165 | 120 | 8,684 |
| 1997 | 126 | 142 | 122 | 88 | 87 | 137 | 579 | 6,979 | 2,724 | 374 | 187 | 210 | 11,754 |
| 1998 | 190 | 144 | 138 | 96 | 104 | 168 | 587 | 4,293 | 2,519 | 513 | 233 | 198 | 9,183 |
| 1999 | 178 | 141 | 74 | 57 | 68 | 105 | 282 | 3,478 | 2,582 | 422 | 274 | 240 | 7,902 |
| 2000 | 140 | 118 | 80 | 66 | 65 | 102 | 767 | 2,906 | 756 | 232 | 160 | 126 | 5,518 |
| 2001 | 135 | 107 | 38 | 43 | 50 | 109 | 854 | 3,333 | 415 | 203 | 153 | 95 | 5,536 |
| 2002 | 76 | 103 | 69 | 50 | 43 | 48 | 686 | 2,206 | 223 | 175 | 117 | 90 | 3,883 |
| Ave. | 177 | 137 | 119 | 87 | 81 | 116 | 519 | 3,639 | 2,409 | 418 | 216 | 181 | 8,099 |
| Total | 5,322 | 4,105 | 3,572 | 2,608 | 2,437 | 3,475 | 15,583 | 109,167 | 72,284 | 12,532 | 6,469 | 5,421 | 242,974 |

**Table C-8**
**Recorded Flow of Gooseberry Creek Near Scofield Utah**
(acre-feet)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1960** | 199 | 173 | 111 | 86 | 81 | 209 | 655 | 4,840 | 1,550 | 614 | 218 | 164 | 8,900 |
| **1961** | 195 | 201 | 188 | 135 | 122 | 157 | 619 | 2,250 | 788 | 347 | 143 | 234 | 5,379 |
| **1962** | 211 | 228 | 183 | 184 | 258 | 277 | 1,740 | 8,940 | 3,950 | 1,200 | 630 | 390 | 18,191 |
| **1963** | 264 | 223 | 144 | 87 | 110 | 131 | 233 | 5,680 | 2,090 | 710 | 543 | 377 | 10,592 |
| **1964** | 185 | 174 | 154 | 184 | 173 | 184 | 337 | 5,690 | 3,580 | 1,020 | 562 | 404 | 12,647 |
| **1965** | 225 | 174 | 251 | 260 | 219 | 215 | 592 | 5,660 | 5,650 | 1,330 | 1,030 | 837 | 16,443 |
| **1966** | 579 | 408 | 297 | 265 | 255 | 402 | 2,110 | 4,240 | 943 | 372 | 461 | 245 | 10,577 |
| **1967** | 360 | 209 | 201 | 154 | 139 | 184 | 339 | 5,740 | 4,780 | 1,010 | 512 | 320 | 13,948 |
| **1968** | 251 | 224 | 233 | 244 | 230 | 260 | 447 | 5,040 | 5,470 | 784 | 613 | 380 | 14,176 |
| **1969** | 352 | 272 | 210 | 179 | 166 | 235 | 1,330 | 12,050 | 2,590 | 938 | 459 | 368 | 19,149 |
| **1970** | 419 | 343 | 301 | 295 | 230 | 303 | 437 | 6,740 | 3,120 | 834 | 359 | 294 | 13,675 |
| **1971** | 325 | 307 | 401 | 454 | 202 | 255 | 744 | 5,230 | 2,270 | 659 | 343 | 280 | 11,470 |
| **1972** | 306 | 274 | 307 | 329 | 286 | 650 | 1,430 | 3,720 | 1,100 | 352 | 201 | 232 | 9,187 |
| **1973** | 290 | 276 | 233 | 215 | 194 | 263 | 497 | 7,300 | 3,430 | 803 | 352 | 309 | 14,162 |
| **1974** | 271 | 251 | 258 | 295 | 229 | 246 | 505 | 6,830 | 1,430 | 452 | 225 | 158 | 11,150 |
| **1975** | 208 | 200 | 164 | 184 | 167 | 184 | 201 | 3,250 | 8,840 | 1,540 | 539 | 308 | 15,785 |
| **1976** | 364 | 314 | 311 | 307 | 272 | 243 | 517 | 5,230 | 1,180 | 447 | 193 | 142 | 9,520 |
| **1977** | 187 | 160 | 117 | 130 | 132 | 158 | 648 | 791 | 583 | 231 | 120 | 112 | 3,369 |
| **1978** | 150 | 162 | 164 | 154 | 147 | 191 | 1,030 | 6,480 | 7,240 | 914 | 546 | 256 | 17,434 |
| **1979** | 40 | 261 | 173 | 172 | 156 | 172 | 476 | 6,280 | 3,050 | 609 | 327 | 200 | 11,916 |
| **1980** | 229 | 201 | 215 | 215 | 201 | 215 | 946 | 6,630 | 7,800 | 1,050 | 432 | 346 | 18,480 |
| **1981** | 309 | 282 | 237 | 226 | 205 | 317 | 1,510 | 3,650 | 1,590 | 437 | 237 | 213 | 9,213 |
| **1982** | 337 | 255 | 185 | 140 | 123 | 185 | 1,160 | 8,760 | 4,500 | 1,110 | 508 | 498 | 17,761 |
| **1983** | 830 | 691 | 500 | 427 | 374 | 491 | 638 | 4,530 | 14,210 | 2,950 | 861 | 599 | 27,101 |
| **1984** | 624 | 520 | 552 | 481 | 424 | 427 | 663 | 12,230 | 9,620 | 1,480 | 654 | 439 | 28,114 |
| **1985** | 561 | 458 | 464 | 440 | 338 | 366 | 3,010 | 10,350 | 2,400 | 914 | 434 | 314 | 20,049 |
| **1986** | 386 | 380 | 347 | 348 | 357 | 533 | 1,880 | 11,050 | 7,530 | 900 | 458 | 362 | 24,531 |
| **1987** | 448 | 398 | 271 | 150 | 126 | 183 | 1,740 | 3,150 | 915 | 461 | 259 | 204 | 8,305 |
| **1988** | 214 | 193 | 168 | 188 | 176 | 222 | 907 | 5,170 | 1,200 | 418 | 257 | 197 | 9,310 |
| **1989** | 231 | 278 | 248 | 241 | 186 | 318 | 2,180 | 3,060 | 950 | 436 | 217 | 221 | 8,566 |
| **1990** | 179 | 423 | 169 | 164 | 163 | 197 | 1,687 | 3,118 | 1,146 | 473 | 197 | 160 | 8,076 |
| **1991** | 204 | 114 | 177 | 179 | 172 | 196 | 323 | 5,395 | 3,540 | 687 | 386 | 338 | 11,713 |
| **1992** | 258 | 268 | 230 | 169 | 138 | 293 | 1,432 | 1,473 | 555 | 264 | 140 | 163 | 5,383 |
| **1993** | 245 | 157 | 145 | 185 | 209 | 350 | 903 | 9,882 | 3,671 | 786 | 374 | 242 | 17,148 |
| **1994** | 311 | 258 | 254 | 199 | 177 | 244 | 1,188 | 4,591 | 1,028 | 313 | 266 | 243 | 9,072 |
| **1995** | 328 | 227 | 246 | 245 | 223 | 406 | 826 | 6,629 | 10,217 | 2,118 | 773 | 393 | 22,629 |
| **1996** | 293 | 299 | 253 | 168 | 194 | 268 | 731 | 8,593 | 2,709 | 548 | 219 | 195 | 14,470 |
| **1997** | 225 | 301 | 263 | 256 | 245 | 350 | 1,158 | 12,951 | 4,425 | 761 | 354 | 384 | 21,674 |
| **1998** | 371 | 319 | 312 | 301 | 340 | 458 | 1,170 | 7,120 | 4,069 | 1,142 | 506 | 355 | 16,463 |
| **1999** | 333 | 309 | 151 | 88 | 141 | 236 | 539 | 5,794 | 4,176 | 859 | 626 | 435 | 13,687 |
| **2000** | 249 | 230 | 176 | 155 | 137 | 236 | 1,568 | 4,475 | 1,081 | 342 | 214 | 198 | 9,060 |
| **2001** | 231 | 192 | 56 | 14 | 50 | 242 | 1,503 | 5,236 | 832 | 303 | 228 | 153 | 9,040 |
| **2002** | 133 | 200 | 161 | 75 | 29 | 58 | 1,289 | 3,038 | 636 | 256 | 120 | 165 | 6,161 |
| Ave. | 300 | 274 | 237 | 218 | 198 | 272 | 1,019 | 6,020 | 3,545 | 795 | 398 | 298 | 13,574 |
| Total | 12,910 | 11,787 | 10,184 | 9,366 | 8,496 | 11,710 | 43,838 | 258,857 | 152,433 | 34,172 | 17,097 | 12,826 | 583,677 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Narrows Reservoir Operation | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| 1959 | OCT | 169 | 14 | 14 | 169 | 123 | 123 | 0 | 0 | | 78 | 9968 | 0 | 61 | 17 | 4422 | 94 | 14390 | 0 | 61 |
| | NOV | 143 | 12 | 12 | 143 | 119 | 119 | 0 | 0 | | 23 | 9969 | 0 | 59 | 5 | 4357 | 28 | 14326 | 0 | 59 |
| | DEC | 64 | 8 | 5 | 61 | 123 | 123 | 0 | 0 | | | 9907 | 0 | 61 | 0 | 4296 | | 14203 | 0 | 61 |
| 1960 | JAN | 55 | 6 | 4 | 53 | 123 | 123 | 0 | 0 | | | 9838 | 0 | 61 | 0 | 4235 | | 14072 | 0 | 61 |
| | FEB | 52 | 6 | 4 | 50 | 111 | 111 | 0 | 0 | | | 9777 | 0 | 55 | 0 | 4179 | | 13956 | 0 | 55 |
| | MAR | 132 | 15 | 11 | 128 | 123 | 123 | 0 | 0 | | | 9782 | 0 | 61 | 0 | 4118 | | 13899 | 0 | 61 |
| | APR | 383 | 47 | 31 | 367 | 0 | 0 | 0 | 0 | | | 10000 | 149 | 59 | 0 | 4207 | | 14207 | 0 | 59 |
| | MAY | 3318 | 348 | 269 | 3239 | 0 | 0 | 0 | 0 | | 173 | 10000 | 3066 | 361 | 36 | 4500 | 209 | 14500 | 2375 | 2737 |
| | JUN | 1063 | 112 | 86 | 1037 | 14 | 14 | 0 | 0 | | 210 | 10000 | 814 | 59 | 46 | 4500 | 256 | 14500 | 708 | 768 |
| | JUL | 475 | 44 | 38 | 469 | 2310 | 2310 | 0 | 0 | | 219 | 7940 | 0 | 61 | 48 | 4391 | 267 | 12331 | 0 | 61 |
| | AUG | 204 | 16 | 17 | 205 | 2351 | 2351 | 0 | 0 | | 168 | 5626 | 0 | 61 | 47 | 4282 | 215 | 9908 | 0 | 61 |
| | SEP | 117 | 12 | 9 | 114 | 3 | 3 | 0 | 0 | 55 | 105 | 5578 | 0 | 59 | 40 | 4182 | 145 | 9760 | 0 | 114 |
| | TOTAL | 6175 | 640 | 500 | 6035 | 5400 | 5400 | 0 | 0 | 55 | 975 | | 4028 | 1023 | 239 | | 1214 | | 3083 | 4161 |
| | OCT | 109 | 19 | 9 | 99 | 123 | 123 | 0 | 0 | | 55 | 5498 | 0 | 61 | 21 | 4100 | 76 | 9598 | 0 | 61 |
| | NOV | 109 | 20 | 9 | 98 | 119 | 119 | 0 | 0 | | 16 | 5461 | 0 | 59 | 6 | 4035 | 22 | 9496 | 0 | 59 |
| | DEC | 94 | 19 | 8 | 83 | 123 | 123 | 0 | 0 | | | 5421 | 0 | 61 | 0 | 3973 | | 9394 | 0 | 61 |
| 1961 | JAN | 71 | 13 | 6 | 64 | 123 | 123 | 0 | 0 | | | 5361 | 0 | 61 | 0 | 3912 | | 9273 | 0 | 61 |
| | FEB | 62 | 12 | 5 | 55 | 111 | 111 | 0 | 0 | | | 5305 | 0 | 55 | 0 | 3856 | | 9162 | 0 | 55 |
| | MAR | 74 | 15 | 6 | 65 | 123 | 123 | 0 | 0 | | | 5247 | 0 | 61 | 0 | 3795 | | 9042 | 0 | 61 |
| | APR | 374 | 61 | 30 | 343 | 0 | 0 | 0 | 0 | | | 5591 | 0 | 59 | 0 | 3736 | | 9326 | 0 | 59 |
| | MAY | 1592 | 222 | 129 | 1499 | 0 | 0 | 0 | 0 | | 124 | 6966 | 0 | 361 | 42 | 3332 | 167 | 10297 | 0 | 361 |
| | JUN | 636 | 78 | 52 | 610 | 14 | 14 | 0 | 0 | | 170 | 7391 | 0 | 59 | 43 | 3229 | 213 | 10620 | 0 | 59 |
| | JUL | 297 | 34 | 24 | 287 | 2501 | 2501 | 0 | 0 | 226 | 184 | 4767 | 0 | 61 | 42 | 3126 | 226 | 7893 | 0 | 287 |
| | AUG | 107 | 14 | 9 | 102 | 2161 | 2161 | 0 | 0 | 41 | 126 | 2542 | 0 | 61 | 42 | 3023 | 167 | 5564 | 0 | 102 |
| | SEP | 147 | 23 | 12 | 136 | 3 | 3 | 0 | 0 | | 70 | 2605 | 0 | 59 | 34 | 2929 | 104 | 5534 | 0 | 59 |
| | TOTAL | 3672 | 530 | 297 | 3439 | 5400 | 5400 | 0 | 0 | 267 | 745 | | 0 | 1023 | 231 | | 976 | | 0 | 1290 |
| | OCT | 111 | 16 | 9 | 104 | 123 | 123 | 0 | 0 | | 38 | 2548 | 0 | 61 | 18 | 2850 | 55 | 5398 | 0 | 61 |
| | NOV | 106 | 17 | 9 | 98 | 119 | 119 | 0 | 0 | | 11 | 2516 | 0 | 59 | 5 | 2786 | 16 | 5301 | 0 | 59 |
| | DEC | 79 | 13 | 6 | 72 | 123 | 123 | 0 | 0 | | | 2465 | 0 | 61 | 0 | 2724 | | 5190 | 0 | 61 |
| 1962 | JAN | 75 | 14 | 6 | 67 | 123 | 123 | 0 | 0 | | | 2409 | 0 | 61 | 0 | 2663 | | 5072 | 0 | 61 |
| | FEB | 112 | 19 | 9 | 102 | 111 | 111 | 0 | 0 | | | 2401 | 0 | 55 | 0 | 2607 | | 5008 | 0 | 55 |
| | MAR | 101 | 20 | 8 | 89 | 123 | 123 | 0 | 0 | | | 2367 | 0 | 61 | 0 | 2546 | | 4913 | 0 | 61 |
| | APR | 806 | 128 | 65 | 743 | 0 | 0 | 0 | 0 | | | 3110 | 0 | 59 | 0 | 2487 | | 5597 | 0 | 59 |
| | MAY | 5507 | 657 | 446 | 5296 | 89 | 89 | 0 | 0 | | 91 | 8226 | 0 | 361 | 33 | 2092 | 124 | 10318 | 0 | 361 |
| | JUN | 2700 | 290 | 219 | 2629 | 14 | 14 | 0 | 0 | | 187 | 10000 | 653 | 59 | 26 | 2660 | 213 | 12660 | 0 | 59 |
| | JUL | 933 | 88 | 76 | 921 | 2226 | 2226 | 0 | 0 | | 219 | 8475 | 0 | 61 | 30 | 2568 | 249 | 11044 | 0 | 61 |
| | AUG | 584 | 46 | 47 | 585 | 2346 | 2346 | 0 | 0 | | 174 | 6541 | 0 | 61 | 28 | 2479 | 202 | 9019 | 0 | 61 |
| | SEP | 295 | 29 | 24 | 290 | 3 | 3 | 0 | 0 | | 114 | 6714 | 0 | 59 | 23 | 2396 | 138 | 9109 | 0 | 59 |
| | TOTAL | 11409 | 1337 | 924 | 10996 | 5400 | 5400 | 0 | 0 | 0 | 835 | | 653 | 1023 | 163 | | 998 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| 1959 | OCT | 30 | 92 | 244 | 336 | 305 | 262 | 1291 | 748 | | 2039 | 0 | 6520 | 0 | 2039 | 290 | 31 | 42 | 2402 |
| | NOV | 30 | 90 | 276 | 366 | 35 | 73 | | | 891 | 891 | 0 | 5956 | 0 | 891 | 345 | 40 | 53 | 1329 |
| | DEC | 50 | 111 | 278 | 389 | -78 | | | | 891 | 891 | 0 | 5376 | 0 | 891 | 224 | 40 | 54 | 1209 |
| 1960 | JAN | 33 | 94 | 283 | 377 | 726 | | | | 805 | 805 | 0 | 5674 | 0 | 805 | 266 | 54 | 73 | 1198 |
| | FEB | 31 | 86 | 264 | 350 | 777 | | | | 242 | 242 | 0 | 6560 | 0 | 242 | 372 | 30 | 40 | 684 |
| | MAR | 81 | 143 | 559 | 702 | 861 | | | | 249 | 249 | 0 | 7873 | 0 | 249 | 525 | 66 | 88 | 928 |
| | APR | 288 | 347 | 2165 | 2512 | 1580 | | 0 | 1620 | | 1620 | 0 | 10346 | 0 | 1620 | 2033 | 243 | 326 | 4222 |
| | MAY | 1601 | 4338 | 6700 | 11038 | 3069 | 625 | 0 | 5353 | | 5353 | 0 | 18475 | 0 | 5353 | 7993 | 436 | 585 | 14367 |
| | JUN | 513 | 1280 | 1830 | 3110 | 769 | 903 | 4370 | 4149 | | 8519 | 0 | 12932 | 0 | 8519 | 3844 | 425 | 570 | 13359 |
| | JUL | 145 | 206 | 536 | 742 | -269 | 843 | 7658 | 881 | | 8539 | 0 | 4023 | 0 | 8539 | 979 | 99 | 133 | 9751 |
| | AUG | 13 | 75 | 245 | 320 | -463 | 558 | 3009 | 0 | | 3009 | 0 | 313 | 0 | 3009 | 3 | 47 | 63 | 3122 |
| | SEP | 50 | 164 | 141 | 305 | 184 | 355 | 175 | 489 | | 664 | 216 | 0 | 0 | 448 | 136 | 0 | 0 | 583 |
| | TOTAL | 2865 | 7026 | 13521 | 20547 | 7497 | 3619 | 16502 | 13241 | 3078 | 32821 | 216 | | 0 | 32605 | 17010 | 1512 | 2027 | 53154 |
| | OCT | 96 | 158 | 245 | 403 | 554 | 185 | 0 | 428 | | 428 | 0 | 344 | 0 | 428 | 144 | 0 | 0 | 572 |
| | NOV | 103 | 163 | 415 | 578 | 81 | 56 | | | 636 | 636 | 0 | 310 | 0 | 636 | 327 | 13 | 18 | 994 |
| | DEC | 105 | 167 | 403 | 570 | 95 | | | | 686 | 686 | 0 | 289 | 0 | 686 | 201 | 20 | 27 | 934 |
| 1961 | JAN | 71 | 133 | 295 | 428 | -9 | | | | 301 | 301 | 0 | 407 | 0 | 301 | 475 | 0 | 0 | 777 |
| | FEB | 67 | 122 | 211 | 333 | 40 | | | | 243 | 243 | 0 | 537 | 0 | 243 | 438 | 2 | 3 | 687 |
| | MAR | 92 | 153 | 224 | 377 | 1185 | | | | 176 | 176 | 0 | 1924 | 0 | 176 | 527 | 42 | 56 | 802 |
| | APR | 276 | 335 | 501 | 836 | 1550 | | 0 | 450 | | 450 | 0 | 3860 | 0 | 450 | 1156 | 161 | 216 | 1983 |
| | MAY | 751 | 1112 | 1960 | 3072 | 693 | 501 | 0 | 4207 | | 4207 | 0 | 2917 | 0 | 4207 | 6929 | 79 | 106 | 11321 |
| | JUN | 178 | 238 | 572 | 810 | -281 | 582 | 2035 | 1079 | | 3114 | 250 | 0 | 0 | 2864 | 3827 | 10 | 13 | 6714 |
| | JUL | 60 | 347 | 205 | 552 | 37 | 523 | 1528 | 589 | | 2117 | 2050 | 0 | 0 | 67 | 847 | 5 | 6 | 924 |
| | AUG | 41 | 144 | 169 | 313 | 399 | 458 | 194 | 711 | | 905 | 651 | 0 | 0 | 254 | 0 | 12 | 16 | 282 |
| | SEP | 98 | 157 | 222 | 379 | 630 | 349 | 0 | 499 | | 499 | 0 | 162 | 0 | 499 | 76 | 28 | 38 | 640 |
| | TOTAL | 1940 | 3229 | 5422 | 8651 | 4975 | 2653 | 3756 | 7964 | 2042 | 13762 | 2951 | | 0 | 10811 | 14947 | 372 | 499 | 26629 |
| | OCT | 107 | 168 | 169 | 337 | 277 | 187 | 0 | 462 | | 462 | 0 | 127 | 0 | 462 | 112 | 2 | 3 | 579 |
| | NOV | 130 | 190 | 174 | 364 | 406 | 55 | | | 640 | 640 | 0 | 201 | 0 | 640 | 321 | 5 | 7 | 973 |
| | DEC | 111 | 172 | 134 | 306 | 495 | | | | 474 | 474 | 0 | 528 | 0 | 474 | 167 | 2 | 3 | 646 |
| 1962 | JAN | 117 | 178 | 123 | 301 | 224 | | | | 301 | 301 | 0 | 753 | 0 | 301 | 402 | 24 | 32 | 759 |
| | FEB | 156 | 211 | 125 | 336 | 786 | | | | 199 | 199 | 0 | 1676 | 0 | 199 | 140 | 35 | 47 | 421 |
| | MAR | 188 | 249 | 151 | 400 | 837 | | | | 375 | 375 | 0 | 2538 | 0 | 375 | 522 | 55 | 74 | 1026 |
| | APR | 997 | 1056 | 8180 | 9236 | 422 | | 0 | 62 | | 62 | 0 | 12134 | 0 | 62 | 7704 | 869 | 1165 | 9800 |
| | MAY | 3644 | 4005 | 13050 | 17055 | 5741 | 655 | 1200 | 0 | | 1200 | 0 | 33076 | 0 | 1200 | 14874 | 2030 | 2722 | 20826 |
| | JUN | 1321 | 1381 | 3830 | 5211 | 3304 | 1077 | 0 | 8949 | | 8949 | 0 | 31564 | 0 | 8949 | 3881 | 549 | 736 | 14115 |
| | JUL | 279 | 341 | 750 | 1091 | 985 | 1110 | 8297 | 2935 | | 11232 | 0 | 21299 | 0 | 11232 | 1074 | 91 | 122 | 12519 |
| | AUG | 45 | 106 | 302 | 408 | 774 | 863 | 8332 | 1706 | | 10038 | 0 | 11580 | 0 | 10038 | 303 | 18 | 24 | 10383 |
| | SEP | 100 | 160 | 339 | 499 | 602 | 544 | 4189 | 1331 | | 5520 | 0 | 6616 | 0 | 5520 | 361 | 13 | 17 | 5911 |
| | TOTAL | 7195 | 8218 | 27327 | 35545 | 14851 | 4490 | 22019 | 15444 | 1989 | 39452 | 0 | | 0 | 39452 | 29860 | 3693 | 4953 | 77959 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 132 | 23 | 11 | 120 | 123 | 123 | 0 | 0 | | 62 | 6649 | 0 | 61 | 12 | 2323 | 73 | 8971 | 0 | 61 |
| | NOV | 99 | 19 | 8 | 88 | 119 | 119 | 0 | 0 | | 18 | 6600 | 0 | 59 | 3 | 2260 | 21 | 8859 | 0 | 59 |
| | DEC | 75 | 12 | 6 | 69 | 123 | 123 | 0 | 0 | | | 6546 | 0 | 61 | 0 | 2198 | | 8744 | 0 | 61 |
| 1963 | JAN | 44 | 7 | 4 | 41 | 123 | 123 | 0 | 0 | | | 6463 | 0 | 61 | 0 | 2137 | | 8600 | 0 | 61 |
| | FEB | 69 | 9 | 6 | 66 | 111 | 111 | 0 | 0 | | | 6418 | 0 | 55 | 0 | 2082 | | 8500 | 0 | 55 |
| | MAR | 84 | 11 | 7 | 80 | 123 | 123 | 0 | 0 | | | 6375 | 0 | 61 | 0 | 2020 | | 8395 | 0 | 61 |
| | APR | 163 | 20 | 13 | 156 | 0 | 0 | 0 | 0 | | | 6531 | 0 | 59 | 0 | 1961 | | 8492 | 0 | 59 |
| | MAY | 3576 | 486 | 290 | 3380 | 0 | 0 | 0 | 0 | | 136 | 9775 | 0 | 361 | 22 | 1577 | 158 | 11352 | 0 | 361 |
| | JUN | 1289 | 179 | 104 | 1214 | 72 | 72 | 0 | 0 | | 207 | 10000 | 710 | 59 | 18 | 2210 | 225 | 12210 | 0 | 59 |
| | JUL | 521 | 61 | 42 | 502 | 2310 | 2310 | 0 | 0 | | 219 | 7974 | 0 | 61 | 25 | 2123 | 244 | 10097 | 0 | 61 |
| | AUG | 402 | 46 | 33 | 389 | 2294 | 2294 | 0 | 0 | | 168 | 5900 | 0 | 61 | 24 | 2038 | 193 | 7938 | 0 | 61 |
| | SEP | 272 | 32 | 22 | 262 | 3 | 3 | 0 | 0 | 203 | 108 | 5849 | 0 | 59 | 20 | 1958 | 128 | 7807 | 0 | 262 |
| | TOTAL | 6726 | 905 | 545 | 6366 | 5400 | 5400 | 0 | 0 | 203 | 917 | | 710 | 1023 | 126 | | 1042 | | 0 | 1226 |
| | OCT | 110 | 11 | 9 | 108 | 123 | 123 | 0 | 0 | 47 | 57 | 5730 | 0 | 61 | 10 | 1886 | 67 | 7616 | 0 | 108 |
| | NOV | 106 | 11 | 9 | 104 | 119 | 119 | 0 | 0 | | 17 | 5698 | 0 | 59 | 3 | 1824 | 19 | 7522 | 0 | 59 |
| | DEC | 77 | 9 | 6 | 74 | 123 | 123 | 0 | 0 | | | 5649 | 0 | 61 | 0 | 1763 | | 7412 | 0 | 61 |
| 1964 | JAN | 91 | 11 | 7 | 87 | 123 | 123 | 0 | 0 | | | 5614 | 0 | 61 | 0 | 1701 | | 7315 | 0 | 61 |
| | FEB | 89 | 11 | 7 | 85 | 111 | 111 | 0 | 0 | | | 5588 | 0 | 55 | 0 | 1646 | | 7234 | 0 | 55 |
| | MAR | 97 | 11 | 8 | 94 | 123 | 123 | 0 | 0 | | | 5559 | 0 | 61 | 0 | 1585 | | 7143 | 0 | 61 |
| | APR | 200 | 21 | 16 | 195 | 0 | 0 | 0 | 0 | | | 5754 | 0 | 59 | 0 | 1525 | | 7279 | 0 | 59 |
| | MAY | 3588 | 349 | 291 | 3530 | 0 | 0 | 0 | 0 | | 126 | 9157 | 0 | 361 | 18 | 1146 | 144 | 10303 | 0 | 361 |
| | JUN | 2419 | 220 | 196 | 2395 | 14 | 14 | 0 | 0 | | 199 | 10000 | 1339 | 59 | 14 | 2411 | 213 | 12411 | 0 | 59 |
| | JUL | 688 | 63 | 56 | 681 | 2355 | 2355 | 0 | 0 | | 219 | 8107 | 0 | 61 | 28 | 2322 | 246 | 10430 | 0 | 61 |
| | AUG | 372 | 34 | 30 | 368 | 2307 | 2307 | 0 | 0 | | 170 | 5999 | 0 | 61 | 26 | 2235 | 196 | 8233 | 0 | 61 |
| | SEP | 268 | 25 | 22 | 265 | 3 | 3 | 0 | 0 | | 109 | 6152 | 0 | 59 | 22 | 2153 | 131 | 8306 | 0 | 59 |
| | TOTAL | 8105 | 776 | 657 | 7986 | 5400 | 5400 | 0 | 0 | 47 | 896 | | 1339 | 1023 | 121 | | 1017 | | 0 | 1070 |
| | OCT | 130 | 12 | 11 | 129 | 123 | 123 | 0 | 0 | 68 | 59 | 6031 | 0 | 61 | 11 | 2081 | 70 | 8112 | 0 | 129 |
| | NOV | 103 | 10 | 8 | 101 | 119 | 119 | 0 | 0 | | 17 | 5996 | 0 | 59 | 3 | 2018 | 20 | 8015 | 0 | 59 |
| | DEC | 87 | 14 | 7 | 80 | 123 | 123 | 0 | 0 | | | 5953 | 0 | 61 | 0 | 1957 | | 7910 | 0 | 61 |
| 1965 | JAN | 75 | 14 | 6 | 67 | 123 | 123 | 0 | 0 | | | 5897 | 0 | 61 | 0 | 1896 | | 7793 | 0 | 61 |
| | FEB | 71 | 12 | 6 | 65 | 111 | 111 | 0 | 0 | | | 5851 | 0 | 55 | 0 | 1840 | | 7691 | 0 | 55 |
| | MAR | 76 | 12 | 6 | 70 | 123 | 123 | 0 | 0 | | | 5798 | 0 | 61 | 0 | 1779 | | 7577 | 0 | 61 |
| | APR | 222 | 33 | 18 | 207 | 0 | 0 | 0 | 0 | | | 6005 | 0 | 59 | 0 | 1719 | | 7725 | 0 | 59 |
| | MAY | 3383 | 313 | 274 | 3344 | 0 | 0 | 0 | 0 | | 129 | 9220 | 0 | 361 | 20 | 1338 | 149 | 10558 | 0 | 361 |
| | JUN | 3613 | 313 | 293 | 3593 | 14 | 14 | 0 | 0 | | 200 | 10000 | 2599 | 59 | 16 | 3861 | 216 | 13861 | 0 | 59 |
| | JUL | 825 | 74 | 67 | 818 | 2325 | 2325 | 0 | 0 | | 219 | 8274 | 0 | 61 | 42 | 3758 | 261 | 12032 | 0 | 61 |
| | AUG | 674 | 57 | 55 | 672 | 2336 | 2336 | 0 | 0 | | 172 | 6437 | 0 | 61 | 40 | 3656 | 212 | 10093 | 0 | 61 |
| | SEP | 577 | 46 | 47 | 578 | 3 | 3 | 0 | 0 | | 113 | 6899 | 0 | 59 | 33 | 3563 | 147 | 10462 | 0 | 59 |
| | TOTAL | 9836 | 910 | 797 | 9723 | 5400 | 5400 | 0 | 0 | 68 | 909 | | 2599 | 1023 | 166 | | 1075 | | 0 | 1091 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 144 | 206 | 372 | 578 | 446 | 249 | 0 | 556 | | 556 | 0 | 6834 | 0 | 556 | 161 | 22 | 30 | 768 |
| | NOV | 135 | 194 | 378 | 572 | 108 | 74 | | | 613 | 613 | 0 | 6828 | 0 | 613 | 335 | 22 | 30 | 1000 |
| | DEC | 75 | 136 | 245 | 381 | 177 | | | | 921 | 921 | 0 | 6465 | 0 | 921 | 221 | 17 | 23 | 1181 |
| 1963 | JAN | 46 | 108 | 300 | 408 | -106 | | | | 281 | 281 | 0 | 6486 | 0 | 281 | 409 | 2 | 2 | 695 |
| | FEB | 44 | 100 | 441 | 541 | 944 | | | | 95 | 95 | 0 | 7876 | 0 | 95 | 259 | 12 | 16 | 382 |
| | MAR | 51 | 113 | 490 | 603 | 1562 | | | | 183 | 183 | 0 | 9857 | 0 | 183 | 522 | 116 | 156 | 976 |
| | APR | 77 | 136 | 1127 | 1263 | 1722 | | 0 | 1282 | | 1282 | 0 | 11560 | 0 | 1282 | 1760 | 182 | 244 | 3468 |
| | MAY | 2300 | 2662 | 7180 | 9842 | 3584 | 645 | 0 | 7478 | | 7478 | 0 | 16863 | 0 | 7478 | 7661 | 500 | 671 | 16309 |
| | JUN | 876 | 935 | 1920 | 2855 | 1757 | 877 | 1175 | 5767 | | 6942 | 0 | 13655 | 0 | 6942 | 3852 | 71 | 95 | 10960 |
| | JUL | 208 | 269 | 500 | 769 | 272 | 857 | 9780 | 1482 | | 11262 | 0 | 2577 | 0 | 11262 | 944 | 7 | 9 | 12221 |
| | AUG | 154 | 216 | 356 | 572 | 1016 | 523 | 2649 | 1915 | | 4564 | 923 | 0 | 0 | 3641 | 209 | 15 | 20 | 3885 |
| | SEP | 115 | 377 | 298 | 675 | 636 | 349 | 542 | 1311 | | 1853 | 891 | 0 | 0 | 962 | 211 | 19 | 25 | 1217 |
| | TOTAL | 4226 | 5452 | 13607 | 19059 | 12116 | 3575 | 14147 | 19790 | 2093 | 36030 | 1813 | | 0 | 34217 | 16543 | 984 | 1320 | 53064 |
| | OCT | 77 | 185 | 291 | 476 | 446 | 185 | 2515 | 922 | | 3437 | 2699 | 0 | 0 | 738 | 394 | 15 | 20 | 1167 |
| | NOV | 70 | 130 | 315 | 445 | 147 | 54 | | | 385 | 385 | 0 | 153 | 0 | 385 | 315 | 14 | 19 | 733 |
| | DEC | 80 | 141 | 225 | 366 | 2 | | | | 721 | 721 | 200 | 0 | 0 | 521 | 190 | 1 | 1 | 713 |
| 1964 | JAN | 97 | 158 | 123 | 281 | 536 | | | | 503 | 503 | 0 | 314 | 0 | 503 | 415 | 0 | 0 | 918 |
| | FEB | 88 | 143 | 115 | 258 | 262 | | | | 230 | 230 | 0 | 604 | 0 | 230 | 415 | 0 | 0 | 645 |
| | MAR | 90 | 152 | 123 | 275 | 1135 | | | | 242 | 242 | 0 | 1772 | 0 | 242 | 527 | 9 | 12 | 791 |
| | APR | 142 | 201 | 713 | 914 | 2798 | | 0 | 148 | | 148 | 0 | 5336 | 0 | 148 | 1504 | 305 | 409 | 2366 |
| | MAY | 2160 | 2522 | 9870 | 12392 | 5298 | 532 | 0 | 154 | | 154 | 0 | 22340 | 0 | 154 | 7350 | 877 | 1176 | 9557 |
| | JUN | 1185 | 1244 | 3910 | 5154 | 3187 | 959 | 0 | 6458 | | 6458 | 0 | 23264 | 0 | 6458 | 3851 | 428 | 574 | 11311 |
| | JUL | 339 | 401 | 790 | 1191 | -796 | 1013 | 10141 | 1014 | | 11155 | 0 | 11490 | 0 | 11155 | 1013 | 22 | 30 | 12219 |
| | AUG | 194 | 255 | 311 | 566 | -707 | 712 | 8589 | 166 | | 8755 | 0 | 1882 | 0 | 8755 | 408 | 0 | 0 | 9163 |
| | SEP | 139 | 199 | 234 | 433 | 706 | 386 | 5255 | 1344 | | 6599 | 3963 | 0 | 0 | 2636 | 355 | 0 | 0 | 2991 |
| | TOTAL | 4661 | 5731 | 17020 | 22751 | 13014 | 3841 | 26499 | 10207 | 2081 | 38787 | 6863 | | 0 | 31924 | 16737 | 1671 | 2241 | 52573 |
| | OCT | 96 | 226 | 280 | 506 | 583 | 185 | 1615 | 1088 | | 2703 | 1799 | 0 | 0 | 904 | 285 | 0 | 0 | 1189 |
| | NOV | 73 | 132 | 184 | 316 | 967 | 54 | | | 853 | 853 | 0 | 375 | 0 | 853 | 330 | 0 | 0 | 1183 |
| | DEC | 171 | 232 | 82 | 314 | 832 | | | | 565 | 565 | 0 | 957 | 0 | 565 | 210 | 0 | 0 | 775 |
| 1965 | JAN | 193 | 254 | 47 | 301 | 1986 | | | | 93 | 93 | 0 | 3151 | 0 | 93 | 399 | 19 | 25 | 536 |
| | FEB | 154 | 210 | 84 | 294 | 686 | | | | 89 | 89 | 0 | 4042 | 0 | 89 | 357 | 41 | 55 | 542 |
| | MAR | 145 | 206 | 414 | 620 | 770 | | | | 99 | 99 | 0 | 5333 | 0 | 99 | 527 | 82 | 110 | 818 |
| | APR | 385 | 444 | 1578 | 2022 | 2305 | | 0 | 175 | | 175 | 0 | 9485 | 0 | 175 | 2854 | 371 | 498 | 3898 |
| | MAY | 2316 | 2677 | 12430 | 15107 | 5789 | 610 | 231 | 0 | | 231 | 0 | 29541 | 0 | 231 | 8989 | 2180 | 2923 | 14323 |
| | JUN | 2057 | 2117 | 7690 | 9807 | 8640 | 1044 | 0 | 1314 | | 1314 | 0 | 45630 | 0 | 1314 | 3913 | 2130 | 2856 | 10213 |
| | JUL | 512 | 574 | 1660 | 2234 | 2540 | 1221 | 1196 | 5530 | | 6726 | 0 | 42457 | 0 | 6726 | 1117 | 792 | 1062 | 9697 |
| | AUG | 358 | 420 | 750 | 1170 | 2094 | 1049 | 1775 | 3874 | | 5649 | 0 | 39022 | 0 | 5649 | 391 | 262 | 351 | 6654 |
| | SEP | 259 | 319 | 473 | 792 | 1744 | 783 | 3962 | 3054 | | 7016 | 0 | 33758 | 0 | 7016 | 317 | 127 | 170 | 7630 |
| | TOTAL | 6720 | 7811 | 25672 | 33483 | 28936 | 4946 | 8779 | 15035 | 1699 | 25513 | 1799 | | 0 | 23714 | 19689 | 6004 | 8051 | 57458 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 446 | 123 | 36 | 359 | 123 | 123 | 0 | 0 | | 63 | 7073 | 0 | 61 | 17 | 3485 | 80 | 10558 | 0 | 61 |
| | NOV | 266 | 87 | 22 | 201 | 119 | 119 | 0 | 0 | | 19 | 7136 | 0 | 59 | 5 | 3421 | 24 | 10556 | 0 | 59 |
| | DEC | 213 | 63 | 17 | 167 | 123 | 123 | 0 | 0 | | | 7180 | 0 | 61 | 0 | 3359 | | 10539 | 0 | 61 |
| 1966 | JAN | 148 | 56 | 12 | 104 | 123 | 123 | 0 | 0 | | | 7161 | 0 | 61 | 0 | 3298 | | 10459 | 0 | 61 |
| | FEB | 139 | 54 | 11 | 96 | 111 | 111 | 0 | 0 | | | 7146 | 0 | 55 | 0 | 3242 | | 10389 | 0 | 55 |
| | MAR | 241 | 86 | 20 | 175 | 123 | 123 | 0 | 0 | | | 7198 | 0 | 61 | 0 | 3181 | | 10379 | 0 | 61 |
| | APR | 1600 | 450 | 130 | 1280 | 0 | 0 | 0 | 0 | | | 8477 | 0 | 59 | 0 | 3122 | | 11599 | 0 | 59 |
| | MAY | 3444 | 904 | 279 | 2819 | 0 | 0 | 0 | 0 | | 158 | 10000 | 1139 | 361 | 31 | 3868 | 188 | 13868 | 0 | 361 |
| | JUN | 738 | 201 | 60 | 597 | 1020 | 1020 | 0 | 0 | | 210 | 9367 | 0 | 59 | 40 | 3769 | 250 | 13135 | 0 | 59 |
| | JUL | 249 | 79 | 20 | 190 | 1808 | 1808 | 0 | 0 | | 211 | 7538 | 0 | 61 | 43 | 3664 | 254 | 11202 | 0 | 61 |
| | AUG | 196 | 98 | 16 | 114 | 1847 | 1847 | 0 | 0 | | 163 | 5642 | 0 | 61 | 41 | 3561 | 204 | 9204 | 0 | 61 |
| | SEP | 160 | 52 | 13 | 121 | 3 | 3 | 0 | 0 | | 105 | 5655 | 0 | 59 | 34 | 3468 | 139 | 9123 | 0 | 59 |
| | TOTAL | 7840 | 2253 | 635 | 6222 | 5400 | 5400 | 0 | 0 | 0 | 927 | | 1139 | 1023 | 211 | | 1138 | | 0 | 1023 |
| | OCT | 156 | 61 | 13 | 108 | 123 | 123 | 0 | 0 | | 56 | 5584 | 0 | 61 | 18 | 3389 | 74 | 8973 | 0 | 61 |
| | NOV | 129 | 36 | 10 | 103 | 119 | 119 | 0 | 0 | | 16 | 5552 | 0 | 59 | 5 | 3324 | 21 | 8877 | 0 | 59 |
| | DEC | 123 | 34 | 10 | 99 | 123 | 123 | 0 | 0 | | | 5528 | 0 | 61 | 0 | 3263 | | 8791 | 0 | 61 |
| 1967 | JAN | 98 | 26 | 8 | 80 | 123 | 123 | 0 | 0 | | | 5485 | 0 | 61 | 0 | 3202 | | 8687 | 0 | 61 |
| | FEB | 86 | 24 | 7 | 69 | 111 | 111 | 0 | 0 | | | 5443 | 0 | 55 | 0 | 3146 | | 8589 | 0 | 55 |
| | MAR | 108 | 31 | 9 | 86 | 123 | 123 | 0 | 0 | | | 5406 | 0 | 61 | 0 | 3085 | | 8491 | 0 | 61 |
| | APR | 145 | 58 | 12 | 99 | 0 | 0 | 0 | 0 | | | 5505 | 0 | 59 | 0 | 3025 | | 8530 | 0 | 59 |
| | MAY | 3998 | 978 | 324 | 3344 | 0 | 0 | 0 | 0 | | 123 | 8726 | 0 | 361 | 35 | 2629 | 158 | 11354 | 0 | 361 |
| | JUN | 3465 | 815 | 281 | 2931 | 14 | 14 | 0 | 0 | | 194 | 10000 | 1448 | 59 | 31 | 3987 | 225 | 13987 | 0 | 59 |
| | JUL | 694 | 172 | 56 | 578 | 1777 | 1777 | 0 | 0 | | 219 | 8583 | 0 | 61 | 43 | 3882 | 262 | 12465 | 0 | 61 |
| | AUG | 326 | 87 | 26 | 265 | 1811 | 1811 | 0 | 0 | | 175 | 6862 | 0 | 61 | 41 | 3780 | 216 | 10642 | 0 | 61 |
| | SEP | 199 | 55 | 16 | 160 | 1077 | 1077 | 0 | 0 | | 117 | 5828 | 0 | 59 | 34 | 3687 | 151 | 9515 | 0 | 59 |
| | TOTAL | 9527 | 2377 | 772 | 7922 | 5400 | 5400 | 0 | 0 | 0 | 901 | | 1448 | 1023 | 207 | | 1108 | | 0 | 1023 |
| | OCT | 156 | 33 | 13 | 136 | 123 | 123 | 0 | 0 | | 57 | 5784 | 0 | 61 | 19 | 3607 | 75 | 9391 | 0 | 61 |
| | NOV | 117 | 30 | 9 | 96 | 119 | 119 | 0 | 0 | | 17 | 5745 | 0 | 59 | 5 | 3542 | 22 | 9287 | 0 | 59 |
| | DEC | 120 | 31 | 10 | 99 | 123 | 123 | 0 | 0 | | | 5720 | 0 | 61 | 0 | 3481 | | 9201 | 0 | 61 |
| 1968 | JAN | 110 | 32 | 9 | 87 | 123 | 123 | 0 | 0 | | | 5684 | 0 | 61 | 0 | 3419 | | 9104 | 0 | 61 |
| | FEB | 104 | 30 | 8 | 82 | 111 | 111 | 0 | 0 | | | 5656 | 0 | 55 | 0 | 3364 | | 9020 | 0 | 55 |
| | MAR | 117 | 34 | 9 | 92 | 123 | 123 | 0 | 0 | | | 5625 | 0 | 61 | 0 | 3303 | | 8928 | 0 | 61 |
| | APR | 269 | 59 | 22 | 232 | 0 | 0 | 0 | 0 | | | 5857 | 0 | 59 | 0 | 3243 | | 9100 | 0 | 59 |
| | MAY | 3445 | 665 | 279 | 3059 | 0 | 0 | 0 | 0 | | 127 | 8788 | 0 | 361 | 37 | 2845 | 164 | 11634 | 0 | 361 |
| | JUN | 4392 | 722 | 356 | 4026 | 14 | 14 | 0 | 0 | | 195 | 10000 | 2606 | 59 | 33 | 4500 | 228 | 14500 | 858 | 917 |
| | JUL | 542 | 103 | 44 | 483 | 1878 | 1878 | 0 | 0 | | 219 | 8386 | 0 | 61 | 48 | 4391 | 267 | 12777 | 0 | 61 |
| | AUG | 382 | 81 | 31 | 332 | 1850 | 1850 | 0 | 0 | | 173 | 6694 | 0 | 61 | 46 | 4283 | 219 | 10978 | 0 | 61 |
| | SEP | 239 | 50 | 19 | 208 | 936 | 936 | 0 | 0 | | 116 | 5851 | 0 | 59 | 38 | 4186 | 154 | 10037 | 0 | 59 |
| | TOTAL | 9993 | 1870 | 809 | 8932 | 5400 | 5400 | 0 | 0 | 0 | 903 | | 2606 | 1023 | 226 | | 1129 | | 858 | 1881 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 220 | 281 | 481 | 762 | 721 | 400 | 1359 | 1781 | | 3140 | 0 | 31701 | 0 | 3140 | 484 | 135 | 181 | 3940 |
| | NOV | 207 | 267 | 502 | 769 | 248 | 116 | | | 828 | 828 | 0 | 31774 | 0 | 828 | 396 | 133 | 178 | 1535 |
| | DEC | 130 | 191 | 314 | 505 | 1354 | | | | 865 | 865 | 0 | 32769 | 0 | 865 | 322 | 111 | 149 | 1447 |
| 1966 | JAN | 161 | 222 | 220 | 442 | 754 | | | | 239 | 239 | 0 | 33726 | 0 | 239 | 211 | 106 | 142 | 698 |
| | FEB | 159 | 214 | 189 | 403 | 997 | | | | 141 | 141 | 0 | 34985 | 0 | 141 | 294 | 97 | 130 | 662 |
| | MAR | 227 | 289 | 768 | 1057 | 870 | | | | 140 | 140 | 0 | 36772 | 0 | 140 | 513 | 205 | 275 | 1133 |
| | APR | 830 | 890 | 3990 | 4880 | 2316 | | 0 | 516 | | 516 | 0 | 43452 | 0 | 516 | 3043 | 482 | 646 | 4687 |
| | MAY | 1421 | 1782 | 6040 | 7822 | 3911 | 955 | 0 | 7057 | | 7057 | 0 | 47174 | 0 | 7057 | 9218 | 673 | 902 | 17850 |
| | JUN | 346 | 406 | 1367 | 1773 | 1066 | 1179 | 3176 | 3376 | | 6552 | 0 | 42281 | 0 | 6552 | 3870 | 230 | 308 | 10961 |
| | JUL | 182 | 243 | 658 | 901 | -1030 | 1198 | 9582 | 0 | | 9582 | 0 | 31372 | 0 | 9582 | 1046 | 70 | 94 | 10792 |
| | AUG | 347 | 409 | 282 | 691 | -743 | 969 | 9076 | 0 | | 9076 | 0 | 21274 | 0 | 9076 | 414 | 32 | 43 | 9565 |
| | SEP | 124 | 183 | 233 | 416 | 277 | 657 | 4594 | 755 | | 5349 | 0 | 15962 | 0 | 5349 | 416 | 46 | 62 | 5873 |
| | TOTAL | 4355 | 5378 | 15044 | 20422 | 10741 | 5474 | 27787 | 13484 | 2213 | 43484 | 0 | | 0 | 43484 | 20227 | 2320 | 3111 | 69143 |
| | OCT | 252 | 314 | 387 | 701 | 380 | 319 | 799 | 1127 | | 1926 | 0 | 14798 | 0 | 1926 | 313 | 53 | 71 | 2363 |
| | NOV | 106 | 165 | 361 | 526 | 425 | 92 | | | 877 | 877 | 0 | 14780 | 0 | 877 | 349 | 44 | 59 | 1329 |
| | DEC | 102 | 163 | 398 | 561 | 1596 | | | | 795 | 795 | 0 | 16142 | 0 | 795 | 228 | 91 | 122 | 1236 |
| 1967 | JAN | 74 | 135 | 399 | 534 | 952 | | | | 105 | 105 | 0 | 17524 | 0 | 105 | 379 | 66 | 89 | 639 |
| | FEB | 70 | 125 | 361 | 486 | 762 | | | | 62 | 62 | 0 | 18710 | 0 | 62 | 339 | 65 | 87 | 553 |
| | MAR | 98 | 160 | 514 | 674 | 1347 | | | | 45 | 45 | 0 | 20686 | 0 | 45 | 522 | 106 | 142 | 815 |
| | APR | 240 | 300 | 1141 | 1441 | 1525 | | 0 | 805 | | 805 | 0 | 22846 | 0 | 805 | 2107 | 179 | 240 | 3331 |
| | MAY | 2396 | 2758 | 9330 | 12088 | 6471 | 798 | 0 | 2001 | | 2001 | 0 | 38606 | 0 | 2001 | 6390 | 768 | 1030 | 10189 |
| | JUN | 1849 | 1909 | 7250 | 9159 | 7313 | 1122 | 0 | 7910 | | 7910 | 0 | 46045 | 0 | 7910 | 5910 | 1100 | 1475 | 16395 |
| | JUL | 432 | 493 | 1620 | 2113 | 1148 | 1223 | 7377 | 3778 | | 11155 | 0 | 36928 | 0 | 11155 | 2220 | 365 | 489 | 14229 |
| | AUG | 247 | 308 | 598 | 906 | -1110 | 1013 | 8749 | 0 | | 8749 | 0 | 26962 | 0 | 8749 | 832 | 103 | 138 | 9822 |
| | SEP | 160 | 219 | 390 | 609 | -392 | 707 | 4530 | 318 | | 4848 | 0 | 21624 | 0 | 4848 | 464 | 76 | 102 | 5490 |
| | TOTAL | 6026 | 7049 | 22749 | 29798 | 20415 | 5273 | 21456 | 15938 | 1884 | 39278 | 0 | | 0 | 39278 | 20053 | 3016 | 4044 | 66391 |
| | OCT | 115 | 177 | 401 | 578 | 115 | 351 | 2272 | 767 | | 3039 | 0 | 18928 | 0 | 3039 | 461 | 67 | 90 | 3657 |
| | NOV | 128 | 187 | 379 | 566 | 544 | 99 | | | 821 | 821 | 0 | 19118 | 0 | 821 | 418 | 45 | 60 | 1344 |
| | DEC | 134 | 196 | 323 | 519 | 720 | | | | 921 | 921 | 0 | 19435 | 0 | 921 | 318 | 96 | 129 | 1464 |
| 1968 | JAN | 157 | 218 | 340 | 558 | 949 | | | | 333 | 333 | 0 | 20610 | 0 | 333 | 309 | 75 | 101 | 818 |
| | FEB | 148 | 203 | 385 | 588 | 690 | | | | 305 | 305 | 0 | 21583 | 0 | 305 | 330 | 67 | 90 | 792 |
| | MAR | 168 | 229 | 635 | 864 | 1218 | | | | 313 | 313 | 0 | 23352 | 0 | 313 | 745 | 94 | 126 | 1278 |
| | APR | 215 | 275 | 783 | 1058 | 2148 | | 0 | 278 | | 278 | 0 | 26279 | 0 | 278 | 2440 | 206 | 276 | 3200 |
| | MAY | 1981 | 2342 | 10650 | 12992 | 7909 | 833 | 0 | 0 | | 0 | 0 | 46349 | 0 | 0 | 14140 | 1530 | 2052 | 17722 |
| | JUN | 1444 | 2362 | 8240 | 10602 | 6361 | 1174 | 2966 | 8085 | | 11051 | 0 | 51086 | 0 | 11051 | 5100 | 1270 | 1703 | 19124 |
| | JUL | 301 | 362 | 1456 | 1818 | 1719 | 1255 | 9096 | 3959 | | 13055 | 0 | 40314 | 0 | 13055 | 1550 | 302 | 405 | 15312 |
| | AUG | 281 | 342 | 737 | 1079 | 1541 | 1036 | 2881 | 2891 | | 5772 | 0 | 36127 | 0 | 5772 | 746 | 166 | 223 | 6907 |
| | SEP | 172 | 231 | 495 | 726 | -422 | 767 | 10093 | 453 | | 10546 | 0 | 25118 | 0 | 10546 | 395 | 86 | 115 | 11142 |
| | TOTAL | 5244 | 7124 | 24824 | 31948 | 23494 | 5515 | 27307 | 16434 | 2693 | 46434 | 0 | | 0 | 46434 | 26952 | 4004 | 5369 | 82759 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 211 | 41 | 17 | 187 | 123 | 123 | 0 | 0 | | 57 | 5858 | 0 | 61 | 21 | 4104 | 78 | 9962 | 0 | 61 |
| | NOV | 153 | 31 | 12 | 134 | 119 | 119 | 0 | 0 | | 17 | 5857 | 0 | 59 | 6 | 4039 | 23 | 9896 | 0 | 59 |
| | DEC | 115 | 24 | 9 | 100 | 123 | 123 | 0 | 0 | | | 5834 | 0 | 61 | 0 | 3977 | | 9812 | 0 | 61 |
| 1969 | JAN | 93 | 21 | 8 | 80 | 123 | 123 | 0 | 0 | | | 5791 | 0 | 61 | 0 | 3916 | | 9707 | 0 | 61 |
| | FEB | 89 | 19 | 7 | 77 | 111 | 111 | 0 | 0 | | | 5757 | 0 | 55 | 0 | 3860 | | 9618 | 0 | 55 |
| | MAR | 121 | 27 | 10 | 104 | 123 | 123 | 0 | 0 | | | 5738 | 0 | 61 | 0 | 3799 | | 9537 | 0 | 61 |
| | APR | 747 | 153 | 61 | 655 | 0 | 0 | 0 | 0 | | | 6392 | 0 | 59 | 0 | 3740 | | 10132 | 0 | 59 |
| | MAY | 7139 | 1389 | 578 | 6328 | 0 | 0 | 0 | 0 | | 134 | 10000 | 2587 | 361 | 41 | 4500 | 175 | 14500 | 1424 | 1786 |
| | JUN | 1850 | 299 | 150 | 1701 | 14 | 14 | 0 | 0 | | 210 | 10000 | 1477 | 59 | 46 | 4500 | 256 | 14500 | 1372 | 1431 |
| | JUL | 667 | 108 | 54 | 613 | 1952 | 1952 | 0 | 0 | | 219 | 8442 | 0 | 61 | 48 | 4391 | 267 | 12833 | 0 | 61 |
| | AUG | 324 | 53 | 26 | 297 | 2042 | 2042 | 0 | 0 | | 174 | 6524 | 0 | 61 | 46 | 4284 | 219 | 10808 | 0 | 61 |
| | SEP | 255 | 42 | 21 | 234 | 671 | 671 | 0 | 0 | | 114 | 5973 | 0 | 59 | 38 | 4186 | 152 | 10159 | 0 | 59 |
| | TOTAL | 11764 | 2207 | 953 | 10510 | 5400 | 5400 | 0 | 0 | 0 | 924 | | 4064 | 1023 | 245 | | 1169 | | 2796 | 3819 |
| | OCT | 255 | 60 | 21 | 216 | 123 | 123 | 0 | 0 | | 58 | 6008 | 0 | 61 | 21 | 4104 | 78 | 10112 | 0 | 61 |
| | NOV | 189 | 49 | 15 | 155 | 119 | 119 | 0 | 0 | | 17 | 6027 | 0 | 59 | 6 | 4039 | 23 | 10066 | 0 | 59 |
| | DEC | 173 | 43 | 14 | 144 | 123 | 123 | 0 | 0 | | | 6048 | 0 | 61 | 0 | 3977 | | 10026 | 0 | 61 |
| 1970 | JAN | 134 | 42 | 11 | 103 | 123 | 123 | 0 | 0 | | | 6028 | 0 | 61 | 0 | 3916 | | 9944 | 0 | 61 |
| | FEB | 112 | 33 | 9 | 88 | 111 | 111 | 0 | 0 | | | 6005 | 0 | 55 | 0 | 3860 | | 9866 | 0 | 55 |
| | MAR | 152 | 43 | 12 | 121 | 123 | 123 | 0 | 0 | | | 6004 | 0 | 61 | 0 | 3799 | | 9803 | 0 | 61 |
| | APR | 268 | 62 | 22 | 228 | 0 | 0 | 0 | 0 | | | 6231 | 0 | 59 | 0 | 3740 | | 9971 | 0 | 59 |
| | MAY | 4385 | 960 | 355 | 3780 | 62 | 62 | 0 | 0 | | 132 | 9818 | 0 | 361 | 41 | 3337 | 173 | 13155 | 0 | 361 |
| | JUN | 2272 | 444 | 184 | 2012 | 14 | 14 | 0 | 0 | | 208 | 10000 | 1609 | 59 | 36 | 4500 | 244 | 14500 | 350 | 410 |
| | JUL | 613 | 119 | 50 | 544 | 1892 | 1892 | 0 | 0 | | 219 | 8433 | 0 | 61 | 48 | 4391 | 267 | 12824 | 0 | 61 |
| | AUG | 265 | 51 | 21 | 235 | 2017 | 2017 | 0 | 0 | | 174 | 6478 | 0 | 61 | 46 | 4284 | 219 | 10761 | 0 | 61 |
| | SEP | 206 | 42 | 17 | 181 | 694 | 694 | 0 | 0 | | 114 | 5851 | 0 | 59 | 38 | 4186 | 152 | 10037 | 0 | 59 |
| | TOTAL | 9024 | 1948 | 731 | 7807 | 5400 | 5400 | 0 | 0 | 0 | 920 | | 1609 | 1023 | 236 | | 1156 | | 350 | 1373 |
| | OCT | 199 | 45 | 16 | 170 | 123 | 123 | 0 | 0 | | 57 | 5841 | 0 | 61 | 21 | 4104 | 78 | 9945 | 0 | 61 |
| | NOV | 172 | 42 | 14 | 144 | 119 | 119 | 0 | 0 | | 17 | 5849 | 0 | 59 | 6 | 4038 | 23 | 9888 | 0 | 59 |
| | DEC | 233 | 55 | 19 | 197 | 123 | 123 | 0 | 0 | | | 5923 | 0 | 61 | 0 | 3977 | | 9900 | 0 | 61 |
| 1971 | JAN | 188 | 63 | 15 | 140 | 123 | 123 | 0 | 0 | | | 5940 | 0 | 61 | 0 | 3916 | | 9856 | 0 | 61 |
| | FEB | 102 | 28 | 8 | 82 | 111 | 111 | 0 | 0 | | | 5912 | 0 | 55 | 0 | 3860 | | 9772 | 0 | 55 |
| | MAR | 132 | 35 | 11 | 108 | 123 | 123 | 0 | 0 | | | 5896 | 0 | 61 | 0 | 3799 | | 9695 | 0 | 61 |
| | APR | 438 | 103 | 35 | 370 | 0 | 0 | 0 | 0 | | | 6267 | 0 | 59 | 0 | 3739 | | 10006 | 0 | 59 |
| | MAY | 3547 | 723 | 287 | 3111 | 0 | 0 | 0 | 0 | | 132 | 9246 | 0 | 361 | 41 | 3337 | 173 | 12583 | 0 | 361 |
| | JUN | 1659 | 314 | 134 | 1479 | 349 | 349 | 0 | 0 | | 201 | 10000 | 176 | 59 | 37 | 3416 | 238 | 13416 | 0 | 59 |
| | JUL | 496 | 91 | 40 | 445 | 1884 | 1884 | 0 | 0 | | 219 | 8342 | 0 | 61 | 38 | 3317 | 257 | 11659 | 0 | 61 |
| | AUG | 253 | 47 | 20 | 226 | 2140 | 2140 | 0 | 0 | | 173 | 6256 | 0 | 61 | 36 | 3219 | 209 | 9476 | 0 | 61 |
| | SEP | 195 | 39 | 16 | 172 | 305 | 305 | 0 | 0 | | 111 | 6012 | 0 | 59 | 30 | 3130 | 141 | 9142 | 0 | 59 |
| | TOTAL | 7614 | 1585 | 617 | 6646 | 5400 | 5400 | 0 | 0 | 0 | 909 | | 176 | 1023 | 209 | | 1118 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 165 | 226 | 499 | 725 | 711 | 367 | 1576 | 1562 | | 3138 | 0 | 23049 | 0 | 3138 | 409 | 101 | 135 | 3783 |
| | NOV | 138 | 197 | 525 | 722 | 1038 | 105 | | | 891 | 891 | 0 | 23813 | 0 | 891 | 377 | 98 | 131 | 1497 |
| | DEC | 110 | 171 | 300 | 471 | 954 | | | | 464 | 464 | 0 | 24774 | 0 | 464 | 149 | 74 | 99 | 786 |
| 1969 | JAN | 99 | 161 | 276 | 437 | 1339 | | | | 294 | 294 | 0 | 26255 | 0 | 294 | 123 | 87 | 117 | 621 |
| | FEB | 89 | 144 | 246 | 390 | 1569 | | | | 481 | 481 | 0 | 27734 | 0 | 481 | 106 | 83 | 111 | 781 |
| | MAR | 131 | 193 | 466 | 659 | 753 | | | | 921 | 921 | 0 | 28224 | 0 | 921 | 489 | 102 | 137 | 1649 |
| | APR | 675 | 735 | 4730 | 5465 | 5270 | | 0 | 3497 | | 3497 | 0 | 35462 | 0 | 3497 | 8330 | 771 | 1034 | 13632 |
| | MAY | 5722 | 7508 | 15730 | 23238 | 13209 | 907 | 4132 | 0 | | 4132 | 0 | 65700 | 1170 | 5302 | 12000 | 2770 | 3715 | 23786 |
| | JUN | 889 | 2320 | 3670 | 5990 | 4918 | 1294 | 2081 | 11178 | | 13259 | 0 | 62055 | 0 | 13259 | 2520 | 874 | 1172 | 17825 |
| | JUL | 325 | 386 | 1302 | 1688 | 490 | 1324 | 8496 | 2730 | | 11226 | 0 | 51684 | 0 | 11226 | 908 | 260 | 349 | 12743 |
| | AUG | 162 | 223 | 611 | 834 | -115 | 1101 | 7405 | 955 | | 8360 | 0 | 42942 | 0 | 8360 | 496 | 122 | 164 | 9142 |
| | SEP | 134 | 194 | 412 | 606 | -780 | 802 | 3259 | 0 | | 3259 | 0 | 38707 | 0 | 3259 | 329 | 83 | 111 | 3782 |
| | TOTAL | 8639 | 12458 | 28767 | 41225 | 29356 | 5900 | 26949 | 19922 | 3051 | 49922 | 0 | | 1170 | 51092 | 26236 | 5425 | 7275 | 90028 |
| | OCT | 203 | 265 | 489 | 754 | 804 | 415 | 0 | 800 | | 800 | 0 | 39050 | 0 | 800 | 444 | 126 | 169 | 1539 |
| | NOV | 188 | 247 | 356 | 603 | -11 | 122 | | | 60 | 60 | 0 | 39460 | 0 | 60 | 331 | 94 | 126 | 611 |
| | DEC | 157 | 218 | 344 | 562 | 155 | | | | 0 | 0 | 0 | 40177 | 0 | 0 | 329 | 92 | 123 | 544 |
| 1970 | JAN | 192 | 254 | 320 | 574 | 685 | | | | 0 | 0 | 0 | 41436 | 0 | 0 | 223 | 113 | 152 | 488 |
| | FEB | 142 | 197 | 325 | 522 | 1245 | | | | 0 | 0 | 0 | 43203 | 0 | 0 | 300 | 98 | 131 | 529 |
| | MAR | 182 | 243 | 556 | 799 | 161 | | | | 20 | 20 | 0 | 44143 | 0 | 20 | 414 | 146 | 196 | 776 |
| | APR | 209 | 269 | 863 | 1132 | 874 | | 0 | 1874 | | 1874 | 0 | 44275 | 0 | 1874 | 1110 | 191 | 256 | 3431 |
| | MAY | 2960 | 3321 | 11090 | 14411 | 19861 | 959 | 5941 | 8958 | | 14900 | 0 | 62688 | 0 | 14900 | 7400 | 953 | 1278 | 24531 |
| | JUN | 1108 | 1518 | 5510 | 7028 | 1677 | 1273 | 393 | 10307 | | 10700 | 0 | 59421 | 0 | 10700 | 2560 | 552 | 740 | 14552 |
| | JUL | 290 | 352 | 1546 | 1898 | -502 | 1306 | 8706 | 1878 | | 10584 | 0 | 48926 | 0 | 10584 | 970 | 159 | 213 | 11926 |
| | AUG | 124 | 185 | 556 | 741 | -915 | 1086 | 9376 | 0 | | 9376 | 0 | 38290 | 0 | 9376 | 464 | 56 | 75 | 9971 |
| | SEP | 113 | 173 | 525 | 698 | -819 | 779 | 5504 | 0 | | 5504 | 0 | 31886 | 0 | 5504 | 323 | 53 | 71 | 5951 |
| | TOTAL | 5868 | 7241 | 22480 | 29721 | 23216 | 5941 | 29920 | 23818 | 80 | 53818 | 0 | | 0 | 53818 | 14868 | 2633 | 3531 | 74849 |
| | OCT | 155 | 216 | 410 | 626 | -735 | 394 | 1200 | 0 | | 1200 | 0 | 30183 | 0 | 1200 | 413 | 65 | 87 | 1765 |
| | NOV | 163 | 222 | 477 | 699 | -298 | 114 | | | 500 | 500 | 0 | 29970 | 0 | 500 | 349 | 55 | 74 | 978 |
| | DEC | 204 | 266 | 769 | 1035 | -170 | | | | 200 | 200 | 0 | 30635 | 0 | 200 | 398 | 79 | 106 | 783 |
| 1971 | JAN | 314 | 375 | 796 | 1171 | 150 | | | | 0 | 0 | 0 | 31956 | 0 | 0 | 328 | 86 | 115 | 529 |
| | FEB | 120 | 175 | 918 | 1093 | 1180 | | | | 0 | 0 | 0 | 34229 | 0 | 0 | 299 | 86 | 115 | 500 |
| | MAR | 147 | 209 | 1225 | 1434 | 720 | | | | 0 | 0 | 0 | 36383 | 0 | 0 | 925 | 132 | 177 | 1234 |
| | APR | 374 | 433 | 3866 | 4299 | 2727 | | 0 | 337 | | 337 | 0 | 43072 | 0 | 337 | 5250 | 270 | 362 | 6219 |
| | MAY | 2119 | 2480 | 11720 | 14200 | 3543 | 953 | 0 | 2600 | | 2600 | 0 | 57262 | 0 | 2600 | 8440 | 1040 | 1395 | 13475 |
| | JUN | 791 | 850 | 4330 | 5180 | 297 | 1239 | 2103 | 6897 | | 9000 | 0 | 52500 | 0 | 9000 | 2710 | 474 | 636 | 12820 |
| | JUL | 214 | 275 | 1081 | 1356 | -1740 | 1263 | 10770 | 0 | | 10770 | 0 | 40084 | 0 | 10770 | 774 | 79 | 106 | 11729 |
| | AUG | 117 | 178 | 502 | 680 | -770 | 1035 | 10005 | 75 | | 10080 | 0 | 28879 | 0 | 10080 | 391 | 19 | 25 | 10515 |
| | SEP | 108 | 168 | 323 | 491 | -603 | 721 | 4706 | 0 | | 4706 | 0 | 23340 | 0 | 4706 | 280 | 16 | 21 | 5023 |
| | TOTAL | 4824 | 5847 | 26417 | 32264 | 4301 | 5718 | 28784 | 9909 | 700 | 39393 | 0 | | 0 | 39393 | 20557 | 2401 | 3220 | 65571 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 194 | 53 | 16 | 157 | 123 | 123 | 0 | 0 | | 58 | 5988 | 0 | 61 | 16 | 3053 | 74 | 9040 | 0 | 61 |
| | NOV | 161 | 48 | 13 | 126 | 119 | 119 | 0 | 0 | | 17 | 5978 | 0 | 59 | 5 | 2989 | 22 | 8967 | 0 | 59 |
| | DEC | 182 | 53 | 15 | 144 | 123 | 123 | 0 | 0 | | | 5998 | 0 | 61 | 0 | 2927 | | 8926 | 0 | 61 |
| 1972 | JAN | 149 | 57 | 12 | 104 | 123 | 123 | 0 | 0 | | | 5980 | 0 | 61 | 0 | 2866 | | 8846 | 0 | 61 |
| | FEB | 133 | 50 | 11 | 94 | 111 | 111 | 0 | 0 | | | 5962 | 0 | 55 | 0 | 2811 | | 8773 | 0 | 55 |
| | MAR | 304 | 113 | 25 | 216 | 123 | 123 | 0 | 0 | | | 6055 | 0 | 61 | 0 | 2749 | | 8804 | 0 | 61 |
| | APR | 843 | 249 | 68 | 662 | 0 | 0 | 0 | 0 | | | 6717 | 0 | 59 | 0 | 2690 | | 9407 | 0 | 59 |
| | MAY | 2786 | 647 | 226 | 2365 | 0 | 0 | 0 | 0 | | 138 | 8944 | 0 | 361 | 30 | 2299 | 167 | 11243 | 0 | 361 |
| | JUN | 850 | 191 | 69 | 728 | 297 | 297 | 0 | 0 | | 197 | 9178 | 0 | 59 | 27 | 2212 | 224 | 11390 | 0 | 59 |
| | JUL | 302 | 61 | 24 | 265 | 1909 | 1909 | 0 | 0 | | 208 | 7326 | 0 | 61 | 27 | 2124 | 235 | 9450 | 0 | 61 |
| | AUG | 165 | 35 | 13 | 143 | 2469 | 2469 | 0 | 0 | | 160 | 4840 | 0 | 61 | 25 | 2037 | 185 | 6877 | 0 | 61 |
| | SEP | 163 | 40 | 13 | 136 | 3 | 3 | 0 | 0 | | 96 | 4877 | 0 | 59 | 21 | 1957 | 118 | 6834 | 0 | 59 |
| | TOTAL | 6232 | 1597 | 505 | 5140 | 5400 | 5400 | 0 | 0 | 0 | 874 | | 0 | 1023 | 150 | | 1025 | | 0 | 1023 |
| | OCT | 181 | 44 | 15 | 152 | 123 | 123 | 0 | 0 | | 51 | 4854 | 0 | 61 | 11 | 1885 | 62 | 6739 | 0 | 61 |
| | NOV | 159 | 42 | 13 | 130 | 119 | 119 | 0 | 0 | | 15 | 4850 | 0 | 59 | 3 | 1822 | 18 | 6672 | 0 | 59 |
| | DEC | 133 | 35 | 11 | 109 | 123 | 123 | 0 | 0 | | | 4836 | 0 | 61 | 0 | 1761 | | 6597 | 0 | 61 |
| 1973 | JAN | 107 | 33 | 9 | 83 | 123 | 123 | 0 | 0 | | | 4796 | 0 | 61 | 0 | 1699 | | 6495 | 0 | 61 |
| | FEB | 100 | 29 | 8 | 79 | 111 | 111 | 0 | 0 | | | 4764 | 0 | 55 | 0 | 1644 | | 6408 | 0 | 55 |
| | MAR | 136 | 40 | 11 | 107 | 123 | 123 | 0 | 0 | | | 4748 | 0 | 61 | 0 | 1583 | | 6330 | 0 | 61 |
| | APR | 304 | 76 | 25 | 253 | 0 | 0 | 0 | 0 | | | 5000 | 0 | 59 | 0 | 1523 | | 6524 | 0 | 59 |
| | MAY | 4726 | 1110 | 383 | 3999 | 0 | 0 | 0 | 0 | | 117 | 8883 | 0 | 361 | 19 | 1143 | 135 | 10026 | 0 | 361 |
| | JUN | 2514 | 522 | 204 | 2196 | 134 | 134 | 0 | 0 | | 196 | 10000 | 749 | 59 | 14 | 1818 | 210 | 11818 | 0 | 59 |
| | JUL | 597 | 122 | 48 | 523 | 1749 | 1749 | 0 | 0 | | 219 | 8555 | 0 | 61 | 21 | 1736 | 240 | 10291 | 0 | 61 |
| | AUG | 263 | 54 | 21 | 230 | 1826 | 1826 | 0 | 0 | | 175 | 6784 | 0 | 61 | 19 | 1655 | 195 | 8439 | 0 | 61 |
| | SEP | 219 | 47 | 18 | 190 | 969 | 969 | 0 | 0 | | 117 | 5888 | 0 | 59 | 16 | 1580 | 132 | 7468 | 0 | 59 |
| | TOTAL | 9439 | 2154 | 765 | 8050 | 5400 | 5400 | 0 | 0 | 0 | 890 | | 749 | 1023 | 103 | | 993 | | 0 | 1023 |
| | OCT | 177 | 55 | 14 | 136 | 123 | 123 | 0 | 0 | | 57 | 5844 | 0 | 61 | 8 | 1510 | 66 | 7354 | 0 | 61 |
| | NOV | 153 | 51 | 12 | 114 | 119 | 119 | 0 | 0 | | 17 | 5823 | 0 | 59 | 2 | 1448 | 19 | 7271 | 0 | 59 |
| | DEC | 155 | 52 | 13 | 116 | 123 | 123 | 0 | 0 | | | 5816 | 0 | 61 | 0 | 1387 | | 7202 | 0 | 61 |
| 1974 | JAN | 139 | 60 | 11 | 90 | 123 | 123 | 0 | 0 | | | 5783 | 0 | 61 | 0 | 1325 | | 7108 | 0 | 61 |
| | FEB | 116 | 47 | 9 | 78 | 111 | 111 | 0 | 0 | | | 5750 | 0 | 55 | 0 | 1270 | | 7020 | 0 | 55 |
| | MAR | 134 | 50 | 11 | 95 | 123 | 123 | 0 | 0 | | | 5722 | 0 | 61 | 0 | 1208 | | 6931 | 0 | 61 |
| | APR | 321 | 103 | 26 | 244 | 0 | 0 | 0 | 0 | | | 5966 | 0 | 59 | 0 | 1149 | | 7115 | 0 | 59 |
| | MAY | 4634 | 1388 | 375 | 3621 | 0 | 0 | 0 | 0 | | 129 | 9459 | 0 | 361 | 14 | 774 | 142 | 10233 | 0 | 361 |
| | JUN | 1119 | 291 | 91 | 919 | 922 | 922 | 0 | 0 | | 203 | 9252 | 0 | 59 | 9 | 705 | 212 | 9958 | 0 | 59 |
| | JUL | 377 | 92 | 31 | 316 | 1766 | 1766 | 0 | 0 | | 209 | 7592 | 0 | 61 | 9 | 635 | 218 | 8227 | 0 | 61 |
| | AUG | 185 | 46 | 15 | 154 | 1987 | 1987 | 0 | 0 | | 163 | 5595 | 0 | 61 | 8 | 566 | 171 | 6161 | 0 | 61 |
| | SEP | 109 | 32 | 9 | 86 | 3 | 3 | 0 | 0 | | 105 | 5574 | 0 | 59 | 6 | 501 | 110 | 6075 | 0 | 59 |
| | TOTAL | 7619 | 2267 | 617 | 5969 | 5400 | 5400 | 0 | 0 | 0 | 883 | | 0 | 1023 | 56 | | 939 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 149 | 211 | 395 | 606 | 177 | 359 | 0 | 686 | | 686 | 0 | 23077 | 0 | 686 | 421 | 16 | 21 | 1144 |
| | NOV | 148 | 207 | 480 | 687 | -77 | 105 | | | 56 | 56 | 0 | 23527 | 0 | 56 | 357 | 62 | 83 | 558 |
| | DEC | 163 | 225 | 327 | 552 | 66 | | | | 0 | 0 | 0 | 24144 | 0 | 0 | 378 | 74 | 99 | 551 |
| 1972 | JAN | 225 | 286 | 246 | 532 | 1625 | | | | 0 | 0 | 0 | 26302 | 0 | 0 | 297 | 46 | 62 | 405 |
| | FEB | 192 | 248 | 301 | 549 | 213 | | | | 0 | 0 | 0 | 27063 | 0 | 0 | 338 | 41 | 55 | 434 |
| | MAR | 434 | 496 | 1300 | 1796 | 1050 | | | | 0 | 0 | 0 | 29909 | 0 | 0 | 2650 | 141 | 189 | 2980 |
| | APR | 768 | 827 | 2440 | 3267 | 1314 | | 0 | 684 | | 684 | 0 | 33806 | 0 | 684 | 3670 | 191 | 256 | 4801 |
| | MAY | 1355 | 1717 | 6020 | 7737 | 2651 | 895 | 0 | 7389 | | 7389 | 0 | 35910 | 0 | 7389 | 4520 | 319 | 428 | 12656 |
| | JUN | 372 | 432 | 1590 | 2022 | 1353 | 1101 | 3514 | 4043 | | 7557 | 0 | 30626 | 0 | 7557 | 1420 | 178 | 239 | 9394 |
| | JUL | 87 | 148 | 462 | 610 | -589 | 1100 | 13773 | 225 | | 13998 | 0 | 15549 | 0 | 13998 | 424 | 15 | 20 | 14457 |
| | AUG | 58 | 119 | 319 | 438 | 775 | 781 | 8505 | 1295 | | 9800 | 0 | 6181 | 0 | 9800 | 216 | 3 | 4 | 10023 |
| | SEP | 96 | 155 | 352 | 507 | 730 | 462 | 3861 | 1314 | | 5175 | 0 | 1782 | 0 | 5175 | 267 | 4 | 6 | 5452 |
| | TOTAL | 4047 | 5070 | 14232 | 19302 | 9289 | 4804 | 29653 | 15636 | 56 | 45345 | 0 | | 0 | 45345 | 14958 | 1091 | 1462 | 62856 |
| | OCT | 138 | 200 | 474 | 674 | 1383 | 204 | 0 | 400 | | 400 | 0 | 3235 | 0 | 400 | 316 | 135 | 181 | 1032 |
| | NOV | 146 | 206 | 436 | 642 | 191 | 64 | | | 400 | 400 | 0 | 3603 | 0 | 400 | 239 | 64 | 86 | 789 |
| | DEC | 124 | 186 | 457 | 643 | 110 | | | | 400 | 400 | 0 | 3955 | 0 | 400 | 275 | 68 | 91 | 834 |
| 1973 | JAN | 132 | 194 | 565 | 759 | 120 | | | | 300 | 300 | 0 | 4534 | 0 | 300 | 308 | 68 | 91 | 767 |
| | FEB | 115 | 170 | 472 | 642 | 534 | | | | 300 | 300 | 0 | 5410 | 0 | 300 | 287 | 61 | 82 | 730 |
| | MAR | 156 | 217 | 479 | 696 | 958 | | | | 300 | 300 | 0 | 6765 | 0 | 300 | 506 | 99 | 133 | 1038 |
| | APR | 244 | 304 | 1153 | 1457 | 1509 | | 0 | 159 | | 159 | 0 | 9571 | 0 | 159 | 3240 | 395 | 530 | 4324 |
| | MAY | 3301 | 3663 | 21900 | 25563 | 8661 | 612 | 0 | 0 | | 0 | 0 | 43183 | 0 | 0 | 17700 | 4620 | 6195 | 28515 |
| | JUN | 1234 | 1294 | 5340 | 6634 | 15300 | 1154 | 5654 | 9165 | | 14819 | 0 | 49144 | 0 | 14819 | 4820 | 1490 | 1998 | 23127 |
| | JUL | 280 | 341 | 1087 | 1428 | 1137 | 1243 | 7032 | 3027 | | 10059 | 0 | 40407 | 0 | 10059 | 1180 | 345 | 463 | 12047 |
| | AUG | 122 | 183 | 509 | 692 | -196 | 1037 | 9312 | 665 | | 9977 | 0 | 29889 | 0 | 9977 | 504 | 154 | 207 | 10842 |
| | SEP | 119 | 179 | 343 | 522 | -289 | 728 | 6302 | 363 | | 6665 | 0 | 22729 | 0 | 6665 | 319 | 109 | 146 | 7239 |
| | TOTAL | 6112 | 7135 | 33215 | 40350 | 29418 | 5041 | 28300 | 13779 | 1700 | 43779 | 0 | | 0 | 43779 | 29694 | 7608 | 10202 | 91284 |
| | OCT | 135 | 196 | 443 | 639 | -153 | 356 | 1581 | 561 | | 2142 | 0 | 20717 | 0 | 2142 | 352 | 101 | 135 | 2730 |
| | NOV | 137 | 196 | 406 | 602 | 836 | 102 | | | 869 | 869 | 0 | 21184 | 0 | 869 | 309 | 89 | 119 | 1386 |
| | DEC | 142 | 204 | 357 | 561 | 657 | | | | 472 | 472 | 0 | 21930 | 0 | 472 | 320 | 92 | 123 | 1007 |
| 1974 | JAN | 205 | 266 | 320 | 586 | 1815 | | | | 430 | 430 | 0 | 23901 | 0 | 430 | 307 | 92 | 123 | 952 |
| | FEB | 151 | 206 | 326 | 532 | 334 | | | | 389 | 389 | 0 | 24378 | 0 | 389 | 242 | 86 | 115 | 832 |
| | MAR | 151 | 213 | 462 | 675 | 1202 | | | | 410 | 410 | 0 | 25844 | 0 | 410 | 644 | 119 | 160 | 1333 |
| | APR | 261 | 320 | 1335 | 1655 | 2425 | | 0 | 1765 | | 1765 | 0 | 28160 | 0 | 1765 | 3660 | 276 | 370 | 6071 |
| | MAY | 3209 | 3570 | 13000 | 16570 | 7023 | 850 | 0 | 6386 | | 6386 | 0 | 44517 | 0 | 6386 | 10680 | 810 | 1086 | 18962 |
| | JUN | 511 | 571 | 2160 | 2731 | 1208 | 1163 | 1651 | 4798 | | 6448 | 0 | 40845 | 0 | 6448 | 3200 | 144 | 193 | 9985 |
| | JUL | 136 | 198 | 868 | 1066 | -93 | 1188 | 9661 | 1227 | | 10888 | 0 | 29741 | 0 | 10888 | 739 | 55 | 74 | 11756 |
| | AUG | 71 | 132 | 420 | 552 | -645 | 955 | 9733 | 0 | | 9733 | 0 | 18961 | 0 | 9733 | 319 | 11 | 15 | 10078 |
| | SEP | 72 | 132 | 261 | 393 | 172 | 633 | 4804 | 591 | | 5395 | 0 | 13497 | 0 | 5395 | 161 | 7 | 9 | 5571 |
| | TOTAL | 5181 | 6204 | 20358 | 26562 | 14780 | 5247 | 27430 | 15327 | 2570 | 45327 | 0 | | 0 | 45327 | 20933 | 1882 | 2523 | 70665 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 135 | 36 | 11 | 110 | 123 | 123 | 0 | 0 | | 55 | 5506 | 0 | 61 | 3 | 436 | 58 | 5942 | 0 | 61 |
| | NOV | 125 | 34 | 10 | 101 | 119 | 119 | 0 | 0 | | 16 | 5472 | 0 | 59 | 1 | 376 | 17 | 5848 | 0 | 59 |
| | DEC | 92 | 28 | 7 | 71 | 123 | 123 | 0 | 0 | | | 5420 | 0 | 61 | 0 | 315 | | 5735 | 0 | 61 |
| 1975 | JAN | 98 | 32 | 8 | 74 | 123 | 123 | 0 | 0 | | | 5371 | 0 | 61 | 0 | 254 | | 5625 | 0 | 61 |
| | FEB | 93 | 29 | 8 | 72 | 111 | 111 | 0 | 0 | | | 5332 | 0 | 55 | 0 | 198 | | 5530 | 0 | 55 |
| | MAR | 105 | 32 | 9 | 82 | 123 | 123 | 0 | 0 | | | 5290 | 0 | 61 | 0 | 137 | | 5427 | 0 | 61 |
| | APR | 140 | 35 | 11 | 116 | 0 | 0 | 0 | 0 | | | 5406 | 0 | 59 | 0 | 77 | | 5484 | 0 | 59 |
| | MAY | 2518 | 560 | 204 | 2162 | 0 | 0 | 0 | 285 | | 122 | 7162 | 0 | 76 | 1 | 0 | 123 | 7162 | 0 | 361 |
| | JUN | 6523 | 1523 | 528 | 5528 | 304 | 304 | 0 | 59 | | 173 | 10000 | 2153 | 0 | 0 | 2153 | 173 | 12153 | 0 | 59 |
| | JUL | 1104 | 265 | 89 | 928 | 1799 | 1799 | 0 | 0 | | 219 | 8910 | 0 | 61 | 25 | 2067 | 244 | 10977 | 0 | 61 |
| | AUG | 393 | 93 | 32 | 332 | 1706 | 1706 | 0 | 0 | | 179 | 7357 | 0 | 61 | 22 | 1983 | 202 | 9340 | 0 | 61 |
| | SEP | 223 | 53 | 18 | 188 | 869 | 869 | 0 | 0 | | 122 | 6554 | 0 | 59 | 18 | 1906 | 140 | 8460 | 0 | 59 |
| | TOTAL | 11549 | 2720 | 935 | 9764 | 5400 | 5400 | 0 | 344 | 0 | 887 | | 2153 | 678 | 70 | | 957 | | 0 | 1023 |
| | OCT | 234 | 74 | 19 | 179 | 123 | 123 | 0 | 0 | | 61 | 6549 | 0 | 61 | 10 | 1835 | 70 | 8384 | 0 | 61 |
| | NOV | 183 | 64 | 15 | 134 | 119 | 119 | 0 | 0 | | 18 | 6546 | 0 | 59 | 3 | 1772 | 21 | 8319 | 0 | 59 |
| | DEC | 189 | 63 | 15 | 141 | 123 | 123 | 0 | 0 | | | 6564 | 0 | 61 | 0 | 1711 | | 8276 | 0 | 61 |
| 1976 | JAN | 144 | 62 | 12 | 94 | 123 | 123 | 0 | 0 | | | 6535 | 0 | 61 | 0 | 1650 | | 8185 | 0 | 61 |
| | FEB | 130 | 55 | 11 | 86 | 111 | 111 | 0 | 0 | | | 6510 | 0 | 55 | 0 | 1594 | | 8104 | 0 | 55 |
| | MAR | 132 | 49 | 11 | 94 | 123 | 123 | 0 | 0 | | | 6480 | 0 | 61 | 0 | 1533 | | 8013 | 0 | 61 |
| | APR | 328 | 105 | 27 | 250 | 0 | 0 | 0 | 0 | | | 6730 | 0 | 59 | 0 | 1474 | | 8203 | 0 | 59 |
| | MAY | 3708 | 1059 | 300 | 2949 | 0 | 0 | 0 | 0 | | 138 | 9541 | 0 | 361 | 17 | 1095 | 155 | 10637 | 0 | 361 |
| | JUN | 930 | 239 | 75 | 766 | 559 | 559 | 0 | 0 | | 204 | 9545 | 0 | 59 | 13 | 1023 | 217 | 10568 | 0 | 59 |
| | JUL | 374 | 91 | 30 | 313 | 1844 | 1844 | 0 | 0 | | 213 | 7801 | 0 | 61 | 13 | 949 | 226 | 8750 | 0 | 61 |
| | AUG | 162 | 39 | 13 | 136 | 2272 | 2272 | 0 | 0 | | 166 | 5498 | 0 | 61 | 11 | 876 | 177 | 6375 | 0 | 61 |
| | SEP | 96 | 29 | 8 | 75 | 3 | 3 | 0 | 0 | | 104 | 5467 | 0 | 59 | 9 | 808 | 113 | 6275 | 0 | 59 |
| | TOTAL | 6610 | 1929 | 535 | 5216 | 5400 | 5400 | 0 | 0 | 0 | 903 | | 0 | 1023 | 75 | | 979 | | 0 | 1023 |
| | OCT | 120 | 28 | 10 | 102 | 123 | 123 | 0 | 0 | | 55 | 5391 | 0 | 61 | 4 | 742 | 59 | 6133 | 0 | 61 |
| | NOV | 105 | 24 | 9 | 90 | 119 | 119 | 0 | 0 | | 16 | 5345 | 0 | 59 | 1 | 681 | 17 | 6027 | 0 | 59 |
| | DEC | 61 | 17 | 5 | 49 | 123 | 123 | 0 | 0 | | | 5271 | 0 | 61 | 0 | 620 | | 5891 | 0 | 61 |
| 1977 | JAN | 77 | 19 | 6 | 64 | 123 | 123 | 0 | 0 | | | 5213 | 0 | 61 | 0 | 559 | | 5771 | 0 | 61 |
| | FEB | 80 | 20 | 6 | 66 | 111 | 111 | 0 | 0 | | | 5168 | 0 | 55 | 0 | 503 | | 5671 | 0 | 55 |
| | MAR | 92 | 23 | 7 | 76 | 123 | 123 | 0 | 0 | | | 5122 | 0 | 61 | 0 | 442 | | 5563 | 0 | 61 |
| | APR | 388 | 96 | 31 | 323 | 0 | 0 | 0 | 0 | | | 5445 | 0 | 59 | 0 | 382 | | 5827 | 0 | 59 |
| | MAY | 1126 | 117 | 91 | 1100 | 0 | 0 | 0 | 0 | | 122 | 6423 | 0 | 361 | 5 | 16 | 127 | 6439 | 0 | 361 |
| | JUN | 461 | 86 | 37 | 412 | 14 | 14 | 0 | 43 | | 163 | 6615 | 0 | 16 | 0 | 0 | 163 | 6615 | 0 | 59 |
| | JUL | 216 | 34 | 17 | 199 | 2642 | 2642 | 0 | 61 | | 173 | 3939 | 0 | 0 | 0 | 0 | 173 | 3939 | 0 | 61 |
| | AUG | 108 | 18 | 9 | 99 | 2019 | 2019 | 0 | 61 | | 113 | 1844 | 0 | 0 | 0 | 0 | 113 | 1844 | 0 | 61 |
| | SEP | 68 | 17 | 6 | 57 | 3 | 3 | 0 | 59 | | 61 | 1777 | 0 | 0 | 0 | 0 | 61 | 1777 | 0 | 59 |
| | TOTAL | 2902 | 499 | 235 | 2638 | 5400 | 5400 | 0 | 226 | 0 | 703 | | 0 | 797 | 11 | | 714 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 98 | 159 | 347 | 506 | 639 | 302 | 6 | 1194 | | 1200 | 0 | 13140 | 0 | 1200 | 313 | 40 | 54 | 1607 |
| | NOV | 99 | 158 | 503 | 661 | 213 | 88 | | | 800 | 800 | 0 | 13125 | 0 | 800 | 308 | 48 | 64 | 1220 |
| | DEC | 93 | 154 | 404 | 558 | 432 | | | | 921 | 921 | 0 | 13194 | 0 | 921 | 206 | 31 | 42 | 1200 |
| 1975 | JAN | 110 | 171 | 409 | 580 | 507 | | | | 700 | 700 | 0 | 13582 | 0 | 700 | 238 | 25 | 34 | 997 |
| | FEB | 95 | 151 | 388 | 539 | 745 | | | | 600 | 600 | 0 | 14266 | 0 | 600 | 260 | 70 | 94 | 1024 |
| | MAR | 102 | 164 | 431 | 595 | 1585 | | | | 600 | 600 | 0 | 15846 | 0 | 600 | 409 | 80 | 107 | 1196 |
| | APR | 85 | 144 | 485 | 629 | 1014 | | 0 | 300 | | 300 | 0 | 17189 | 0 | 300 | 1260 | 154 | 207 | 1921 |
| | MAY | 1088 | 1449 | 7520 | 8969 | 6427 | 729 | 0 | 200 | | 200 | 0 | 31656 | 0 | 200 | 11590 | 1210 | 1623 | 14623 |
| | JUN | 3312 | 3371 | 17140 | 20511 | 12341 | 1064 | 4108 | 1320 | | 5428 | 0 | 58016 | 0 | 5428 | 9600 | 1870 | 2508 | 19406 |
| | JUL | 612 | 673 | 1650 | 2323 | 6642 | 1297 | 4568 | 9832 | | 14400 | 0 | 51284 | 0 | 14400 | 2500 | 508 | 681 | 18089 |
| | AUG | 207 | 269 | 691 | 960 | -235 | 1099 | 11102 | 995 | | 12097 | 0 | 38813 | 0 | 12097 | 908 | 111 | 149 | 13265 |
| | SEP | 120 | 179 | 583 | 762 | -107 | 782 | 6595 | 784 | | 7379 | 0 | 31307 | 0 | 7379 | 459 | 63 | 84 | 7985 |
| | TOTAL | 6021 | 7043 | 30551 | 37594 | 30203 | 5362 | 26379 | 14625 | 3621 | 44625 | 0 | | 0 | 44625 | 28051 | 4210 | 5646 | 82531 |
| | OCT | 185 | 246 | 554 | 800 | 5 | 392 | 1577 | 923 | | 2500 | 0 | 29221 | 0 | 2500 | 420 | 82 | 110 | 3112 |
| | NOV | 180 | 240 | 519 | 759 | 692 | 113 | | | 600 | 600 | 0 | 29958 | 0 | 600 | 390 | 87 | 117 | 1194 |
| | DEC | 170 | 231 | 550 | 781 | 339 | | | | 500 | 500 | 0 | 30578 | 0 | 500 | 418 | 92 | 123 | 1133 |
| 1976 | JAN | 213 | 275 | 554 | 829 | 139 | | | | 500 | 500 | 0 | 31046 | 0 | 500 | 410 | 95 | 127 | 1132 |
| | FEB | 186 | 242 | 533 | 775 | 395 | | | | 400 | 400 | 0 | 31816 | 0 | 400 | 302 | 113 | 152 | 967 |
| | MAR | 149 | 211 | 624 | 835 | 563 | | | | 430 | 430 | 0 | 32784 | 0 | 430 | 661 | 123 | 165 | 1379 |
| | APR | 267 | 327 | 1053 | 1380 | 2426 | | 0 | 496 | | 496 | 0 | 36093 | 0 | 496 | 2550 | 210 | 282 | 3538 |
| | MAY | 2281 | 2642 | 8740 | 11382 | 5186 | 911 | 0 | 5510 | | 5510 | 0 | 46240 | 0 | 5510 | 4960 | 743 | 996 | 12209 |
| | JUN | 414 | 473 | 1710 | 2183 | 1198 | 1173 | 4927 | 4088 | | 9015 | 0 | 39432 | 0 | 9015 | 1250 | 203 | 272 | 10740 |
| | JUL | 134 | 195 | 673 | 868 | 676 | 1177 | 10696 | 1796 | | 12492 | 0 | 27307 | 0 | 12492 | 353 | 53 | 71 | 12969 |
| | AUG | 57 | 118 | 421 | 539 | 1740 | 931 | 7907 | 2354 | | 10261 | 0 | 18395 | 0 | 10261 | 172 | 26 | 35 | 10494 |
| | SEP | 67 | 127 | 336 | 463 | 1086 | 627 | 2463 | 1564 | | 4027 | 0 | 15289 | 0 | 4027 | 151 | 26 | 35 | 4239 |
| | TOTAL | 4304 | 5326 | 16267 | 21593 | 14445 | 5326 | 27570 | 16731 | 2430 | 46731 | 0 | | 0 | 46731 | 12037 | 1853 | 2485 | 63106 |
| | OCT | 85 | 147 | 319 | 466 | 431 | 314 | 713 | 937 | | 1650 | 0 | 14221 | 0 | 1650 | 194 | 32 | 43 | 1919 |
| | NOV | 70 | 130 | 338 | 468 | 94 | 90 | | | 678 | 678 | 0 | 14014 | 0 | 678 | 170 | 32 | 43 | 923 |
| | DEC | 68 | 129 | 331 | 460 | -391 | | | | 557 | 557 | 0 | 13527 | 0 | 557 | 90 | 4 | 6 | 657 |
| 1977 | JAN | 66 | 127 | 213 | 340 | -343 | | | | 492 | 492 | 0 | 13032 | 0 | 492 | 39 | 0 | 0 | 532 |
| | FEB | 66 | 121 | 175 | 296 | 378 | | | | 393 | 393 | 0 | 13313 | 0 | 393 | 130 | 2 | 2 | 527 |
| | MAR | 82 | 143 | 191 | 334 | 1108 | | | | 357 | 357 | 0 | 14398 | 0 | 357 | 215 | 6 | 8 | 585 |
| | APR | 325 | 384 | 1072 | 1456 | 428 | | 0 | 1648 | | 1648 | 0 | 14634 | 0 | 1648 | 338 | 104 | 139 | 2229 |
| | MAY | -309 | 52 | 649 | 701 | 2752 | 693 | 2659 | 4192 | | 6851 | 0 | 10543 | 0 | 6851 | 269 | 73 | 98 | 7291 |
| | JUN | 171 | 230 | 273 | 503 | 656 | 761 | 1612 | 1512 | | 3124 | 0 | 7818 | 0 | 3124 | 116 | 8 | 10 | 3258 |
| | JUL | 32 | 93 | 189 | 282 | 742 | 732 | 2720 | 1162 | | 3882 | 0 | 4227 | 0 | 3882 | 29 | 2 | 3 | 3916 |
| | AUG | 21 | 83 | 130 | 213 | 1185 | 562 | 967 | 1435 | | 2402 | 0 | 2660 | 0 | 2402 | 1 | 1 | 1 | 2404 |
| | SEP | 55 | 115 | 95 | 210 | 322 | 400 | 780 | 529 | | 1309 | 0 | 1483 | 0 | 1309 | 7 | 0 | 0 | 1316 |
| | TOTAL | 731 | 1754 | 3975 | 5729 | 7362 | 3554 | 9450 | 11416 | 2477 | 23343 | 0 | | 0 | 23343 | 1598 | 263 | 353 | 25557 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 96 | 17 | 8 | 87 | 123 | 123 | 0 | 61 | | 32 | 1647 | 0 | 0 | 0 | 0 | 32 | 1647 | 0 | 61 |
| | NOV | 104 | 18 | 8 | 94 | 119 | 119 | 0 | 59 | | 9 | 1554 | 0 | 0 | 0 | 0 | 9 | 1554 | 0 | 59 |
| | DEC | 87 | 18 | 7 | 76 | 123 | 123 | 0 | 61 | | | 1445 | 0 | 0 | 0 | 0 | | 1445 | 0 | 61 |
| 1978 | JAN | 84 | 17 | 7 | 74 | 123 | 123 | 0 | 61 | | | 1335 | 0 | 0 | 0 | 0 | | 1335 | 0 | 61 |
| | FEB | 83 | 16 | 7 | 74 | 111 | 111 | 0 | 55 | | | 1242 | 0 | 0 | 0 | 0 | | 1242 | 0 | 55 |
| | MAR | 103 | 21 | 8 | 90 | 123 | 123 | 0 | 61 | | | 1148 | 0 | 0 | 0 | 0 | | 1148 | 0 | 61 |
| | APR | 582 | 114 | 47 | 515 | 0 | 0 | 0 | 59 | | | 1604 | 0 | 0 | 0 | 0 | | 1604 | 0 | 59 |
| | MAY | 4143 | 715 | 336 | 3764 | 0 | 0 | 0 | 361 | | 69 | 4937 | 0 | 0 | 0 | 0 | 69 | 4937 | 0 | 361 |
| | JUN | 5070 | 799 | 411 | 4682 | 537 | 537 | 0 | 59 | | 140 | 8882 | 0 | 0 | 0 | 0 | 140 | 8882 | 0 | 59 |
| | JUL | 649 | 101 | 53 | 601 | 1892 | 1892 | 0 | 61 | | 205 | 7325 | 0 | 0 | 0 | 0 | 205 | 7325 | 0 | 61 |
| | AUG | 378 | 60 | 31 | 349 | 1913 | 1913 | 0 | 61 | | 160 | 5539 | 0 | 0 | 0 | 0 | 160 | 5539 | 0 | 61 |
| | SEP | 171 | 28 | 14 | 157 | 336 | 336 | 0 | 59 | | 104 | 5196 | 0 | 0 | 0 | 0 | 104 | 5196 | 0 | 59 |
| | TOTAL | 11550 | 1924 | 936 | 10562 | 5400 | 5400 | 0 | 1023 | 0 | 719 | | 0 | 0 | 0 | | 719 | | 0 | 1023 |
| | OCT | 34 | 6 | 3 | 31 | 219 | 219 | 0 | 61 | | 53 | 4894 | 0 | 0 | 0 | 0 | 53 | 4894 | 0 | 61 |
| | NOV | 153 | 42 | 12 | 123 | 119 | 119 | 0 | 59 | | 15 | 4824 | 0 | 0 | 0 | 0 | 15 | 4824 | 0 | 59 |
| | DEC | 97 | 28 | 8 | 77 | 123 | 123 | 0 | 61 | | | 4716 | 0 | 0 | 0 | 0 | | 4716 | 0 | 61 |
| 1979 | JAN | 93 | 28 | 8 | 73 | 123 | 123 | 0 | 61 | | | 4604 | 0 | 0 | 0 | 0 | | 4604 | 0 | 61 |
| | FEB | 88 | 25 | 7 | 70 | 111 | 111 | 0 | 55 | | | 4508 | 0 | 0 | 0 | 0 | | 4508 | 0 | 55 |
| | MAR | 99 | 28 | 8 | 79 | 123 | 123 | 0 | 61 | | | 4403 | 0 | 0 | 0 | 0 | | 4403 | 0 | 61 |
| | APR | 294 | 76 | 24 | 242 | 0 | 0 | 0 | 59 | | | 4585 | 0 | 0 | 0 | 0 | | 4585 | 0 | 59 |
| | MAY | 4186 | 1006 | 339 | 3519 | 0 | 0 | 0 | 361 | | 111 | 7632 | 0 | 0 | 0 | 0 | 111 | 7632 | 0 | 361 |
| | JUN | 2256 | 489 | 183 | 1950 | 523 | 523 | 0 | 59 | | 180 | 8819 | 0 | 0 | 0 | 0 | 180 | 8819 | 0 | 59 |
| | JUL | 471 | 98 | 38 | 411 | 1825 | 1825 | 0 | 61 | | 204 | 7140 | 0 | 0 | 0 | 0 | 204 | 7140 | 0 | 61 |
| | AUG | 247 | 52 | 20 | 215 | 1883 | 1883 | 0 | 61 | | 158 | 5253 | 0 | 0 | 0 | 0 | 158 | 5253 | 0 | 61 |
| | SEP | 137 | 32 | 11 | 116 | 351 | 351 | 0 | 59 | | 101 | 4858 | 0 | 0 | 0 | 0 | 101 | 4858 | 0 | 59 |
| | TOTAL | 8155 | 1910 | 661 | 6906 | 5400 | 5400 | 0 | 1023 | 0 | 821 | | 0 | 0 | 0 | | 821 | | 0 | 1023 |
| | OCT | 139 | 22 | 11 | 128 | 123 | 123 | 0 | 61 | | 51 | 4750 | 0 | 0 | 0 | 0 | 51 | 4750 | 0 | 61 |
| | NOV | 120 | 19 | 10 | 111 | 119 | 119 | 0 | 59 | | 15 | 4668 | 0 | 0 | 0 | 0 | 15 | 4668 | 0 | 59 |
| | DEC | 116 | 21 | 9 | 104 | 123 | 123 | 0 | 61 | | | 4588 | 0 | 0 | 0 | 0 | | 4588 | 0 | 61 |
| 1980 | JAN | 104 | 21 | 8 | 91 | 123 | 123 | 0 | 61 | | | 4495 | 0 | 0 | 0 | 0 | | 4495 | 0 | 61 |
| | FEB | 99 | 19 | 8 | 88 | 111 | 111 | 0 | 55 | | | 4416 | 0 | 0 | 0 | 0 | | 4416 | 0 | 55 |
| | MAR | 112 | 21 | 9 | 100 | 123 | 123 | 0 | 61 | | | 4332 | 0 | 0 | 0 | 0 | | 4332 | 0 | 61 |
| | APR | 530 | 91 | 43 | 482 | 0 | 0 | 0 | 59 | | | 4754 | 0 | 0 | 0 | 0 | | 4754 | 0 | 59 |
| | MAY | 4179 | 640 | 338 | 3877 | 0 | 0 | 0 | 361 | | 113 | 8157 | 0 | 0 | 0 | 0 | 113 | 8157 | 0 | 361 |
| | JUN | 5391 | 753 | 437 | 5075 | 364 | 364 | 0 | 59 | | 187 | 10000 | 2622 | 0 | 0 | 2622 | 187 | 12622 | 0 | 59 |
| | JUL | 727 | 101 | 59 | 685 | 1827 | 1827 | 0 | 0 | | 219 | 8639 | 0 | 61 | 30 | 2531 | 249 | 11170 | 0 | 61 |
| | AUG | 302 | 42 | 24 | 284 | 1799 | 1799 | 0 | 0 | | 176 | 6948 | 0 | 61 | 28 | 2442 | 204 | 9390 | 0 | 61 |
| | SEP | 235 | 33 | 19 | 221 | 688 | 688 | 0 | 0 | | 118 | 6363 | 0 | 59 | 22 | 2360 | 141 | 8723 | 0 | 59 |
| | TOTAL | 12054 | 1783 | 976 | 11247 | 5400 | 5400 | 0 | 841 | 0 | 880 | | 2622 | 182 | 80 | | 959 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 63 | 125 | 178 | 303 | 714 | 201 | 73 | 1042 | | 1115 | 0 | 1184 | 0 | 1115 | 99 | 0 | 1 | 1215 |
| | NOV | 68 | 127 | 209 | 336 | 98 | 58 | | | 373 | 373 | 0 | 1187 | 0 | 373 | 161 | 1 | 1 | 536 |
| | DEC | 88 | 149 | 321 | 470 | -117 | | | | 368 | 368 | 0 | 1172 | 0 | 368 | 181 | 0 | 1 | 550 |
| 1978 | JAN | 80 | 142 | 338 | 480 | -124 | | | | 368 | 368 | 0 | 1160 | 0 | 368 | 184 | 0 | 0 | 552 |
| | FEB | 73 | 129 | 329 | 458 | -143 | | | | 333 | 333 | 0 | 1141 | 0 | 333 | 167 | 0 | 0 | 501 |
| | MAR | 101 | 162 | 889 | 1051 | 1475 | | | | 155 | 155 | 0 | 3512 | 0 | 155 | 926 | 16 | 21 | 1118 |
| | APR | 515 | 574 | 2030 | 2604 | 3340 | | 0 | 0 | | 0 | 0 | 9457 | 0 | 0 | 5650 | 170 | 228 | 6048 |
| | MAY | 2716 | 3078 | 14480 | 17558 | 4229 | 610 | 0 | 0 | | 0 | 0 | 30634 | 0 | 0 | 10710 | 669 | 897 | 12276 |
| | JUN | 2558 | 2618 | 9310 | 11928 | 5085 | 1054 | 0 | 8465 | | 8465 | 0 | 38127 | 0 | 8465 | 3500 | 341 | 457 | 12763 |
| | JUL | 313 | 375 | 1236 | 1611 | -92 | 1167 | 9342 | 2058 | | 11400 | 0 | 27078 | 0 | 11400 | 736 | 23 | 31 | 12190 |
| | AUG | 197 | 259 | 414 | 673 | -360 | 929 | 8050 | 600 | | 8650 | 0 | 17812 | 0 | 8650 | 303 | 7 | 9 | 8969 |
| | SEP | 99 | 159 | 383 | 542 | -465 | 621 | 4426 | 174 | | 4600 | 0 | 12667 | 0 | 4600 | 194 | 1 | 2 | 4797 |
| | TOTAL | 6872 | 7895 | 30117 | 38012 | 13639 | 4640 | 21892 | 12338 | 1597 | 35827 | 0 | | 0 | 35827 | 22811 | 1229 | 1649 | 61516 |
| | OCT | 9 | 71 | 348 | 419 | 361 | 297 | 491 | 749 | | 1240 | 0 | 11910 | 0 | 1240 | 223 | 1 | 1 | 1465 |
| | NOV | 138 | 197 | 304 | 501 | 674 | 86 | | | 218 | 218 | 0 | 12781 | 0 | 218 | 285 | 1 | 2 | 506 |
| | DEC | 96 | 158 | 220 | 378 | 1051 | | | | 244 | 244 | 0 | 13965 | 0 | 244 | 291 | 1 | 2 | 538 |
| 1979 | JAN | 99 | 161 | 33 | 194 | 1479 | | | | 184 | 184 | 0 | 15454 | 0 | 184 | 108 | 1 | 1 | 293 |
| | FEB | 86 | 141 | 55 | 196 | 1213 | | | | 424 | 424 | 0 | 16440 | 0 | 424 | 199 | 1 | 1 | 624 |
| | MAR | 93 | 154 | 248 | 402 | 1264 | | | | 184 | 184 | 0 | 17922 | 0 | 184 | 450 | 5 | 6 | 645 |
| | APR | 234 | 294 | 1214 | 1508 | 1604 | | 1800 | 3294 | | 5094 | 0 | 15940 | 0 | 5094 | 3390 | 157 | 211 | 8852 |
| | MAY | 2761 | 3122 | 14350 | 17472 | 5134 | 712 | 198 | 0 | | 198 | 0 | 37636 | 0 | 198 | 9820 | 1430 | 1918 | 13366 |
| | JUN | 1100 | 1160 | 5010 | 6170 | 7817 | 1115 | 386 | 12790 | | 13176 | 0 | 37331 | 0 | 13176 | 2980 | 611 | 819 | 17586 |
| | JUL | 198 | 259 | 1051 | 1310 | -296 | 1161 | 8611 | 1364 | | 9975 | 0 | 27209 | 0 | 9975 | 984 | 137 | 184 | 11280 |
| | AUG | 112 | 173 | 403 | 576 | 396 | 930 | 6312 | 1126 | | 7438 | 0 | 19813 | 0 | 7438 | 395 | 69 | 93 | 7995 |
| | SEP | 84 | 143 | 249 | 392 | -449 | 642 | 6815 | 0 | | 6815 | 0 | 12299 | 0 | 6815 | 171 | 18 | 24 | 7028 |
| | TOTAL | 5010 | 6033 | 23485 | 29518 | 20247 | 4943 | 24613 | 19323 | 1254 | 45190 | 0 | | 0 | 45190 | 19296 | 2431 | 3260 | 70177 |
| | OCT | 101 | 162 | 272 | 434 | 614 | 294 | 1070 | 1115 | | 2185 | 0 | 10868 | 0 | 2185 | 220 | 10 | 13 | 2428 |
| | NOV | 90 | 150 | 345 | 495 | 499 | 83 | | | 421 | 421 | 0 | 11357 | 0 | 421 | 269 | 9 | 12 | 711 |
| | DEC | 111 | 172 | 379 | 551 | 645 | | | | 439 | 439 | 0 | 12114 | 0 | 439 | 194 | 8 | 10 | 651 |
| 1980 | JAN | 124 | 185 | 370 | 555 | 1521 | | | | 406 | 406 | 0 | 13784 | 0 | 406 | 321 | 4 | 6 | 737 |
| | FEB | 113 | 168 | 365 | 533 | 1106 | | | | 372 | 372 | 0 | 15052 | 0 | 372 | 292 | 3 | 4 | 671 |
| | MAR | 115 | 176 | 381 | 557 | 1723 | | | | 921 | 921 | 0 | 16411 | 0 | 921 | 352 | 3 | 4 | 1279 |
| | APR | 464 | 523 | 3614 | 4137 | 1120 | | 0 | 5680 | | 5680 | 0 | 15988 | 0 | 5680 | 5010 | 385 | 516 | 11591 |
| | MAY | 2753 | 3114 | 22640 | 25754 | 5031 | 713 | 0 | 0 | | 0 | 0 | 46061 | 0 | 0 | 17070 | 3410 | 4573 | 25053 |
| | JUN | 2725 | 2785 | 11970 | 14755 | 6393 | 1172 | 8795 | 7482 | | 16277 | 0 | 49759 | 0 | 16277 | 4590 | 1520 | 2038 | 24425 |
| | JUL | 365 | 426 | 1610 | 2036 | 1810 | 1246 | 6990 | 4470 | | 11460 | 0 | 40899 | 0 | 11460 | 1540 | 249 | 334 | 13583 |
| | AUG | 148 | 209 | 648 | 857 | 103 | 1040 | 8808 | 1183 | | 9991 | 0 | 30829 | 0 | 9991 | 542 | 28 | 38 | 10599 |
| | SEP | 125 | 184 | 592 | 776 | 1088 | 735 | 1778 | 2026 | | 3804 | 0 | 28154 | 0 | 3804 | 695 | 18 | 24 | 4541 |
| | TOTAL | 7233 | 8255 | 43186 | 51441 | 21653 | 5284 | 27441 | 21956 | 2559 | 51956 | 0 | | 0 | 51956 | 31095 | 5646 | 7572 | 96269 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 196 | 55 | 16 | 157 | 123 | 123 | 0 | 0 | | 60 | 6337 | 0 | 61 | 12 | 2287 | 72 | 8624 | 0 | 61 |
| | NOV | 165 | 50 | 13 | 128 | 119 | 119 | 0 | 0 | | 18 | 6329 | 0 | 59 | 3 | 2224 | 21 | 8553 | 0 | 59 |
| | DEC | 138 | 42 | 11 | 107 | 123 | 123 | 0 | 0 | | | 6313 | 0 | 61 | 0 | 2162 | | 8475 | 0 | 61 |
| 1981 | JAN | 113 | 40 | 9 | 82 | 123 | 123 | 0 | 0 | | | 6272 | 0 | 61 | 0 | 2101 | | 8373 | 0 | 61 |
| | FEB | 106 | 36 | 9 | 79 | 111 | 111 | 0 | 0 | | | 6240 | 0 | 55 | 0 | 2046 | | 8285 | 0 | 55 |
| | MAR | 162 | 56 | 13 | 119 | 123 | 123 | 0 | 0 | | | 6236 | 0 | 61 | 0 | 1984 | | 8220 | 0 | 61 |
| | APR | 891 | 268 | 72 | 695 | 0 | 0 | 0 | 0 | | | 6931 | 0 | 59 | 0 | 1925 | | 8856 | 0 | 59 |
| | MAY | 2753 | 649 | 223 | 2327 | 0 | 0 | 0 | 0 | | 140 | 9118 | 0 | 361 | 21 | 1542 | 162 | 10660 | 0 | 361 |
| | JUN | 1214 | 283 | 98 | 1029 | 620 | 620 | 0 | 0 | | 199 | 9328 | 0 | 59 | 18 | 1464 | 217 | 10792 | 0 | 59 |
| | JUL | 361 | 78 | 29 | 312 | 1942 | 1942 | 0 | 0 | | 210 | 7488 | 0 | 61 | 18 | 1385 | 228 | 8872 | 0 | 61 |
| | AUG | 189 | 42 | 15 | 162 | 2113 | 2113 | 0 | 0 | | 162 | 5375 | 0 | 61 | 17 | 1307 | 179 | 6682 | 0 | 61 |
| | SEP | 149 | 38 | 12 | 123 | 3 | 3 | 0 | 0 | | 102 | 5393 | 0 | 59 | 13 | 1234 | 116 | 6627 | 0 | 59 |
| | TOTAL | 6437 | 1637 | 521 | 5321 | 5400 | 5400 | 0 | 0 | 0 | 891 | | 0 | 1023 | 103 | | 995 | | 0 | 1023 |
| | OCT | 205 | 44 | 17 | 178 | 123 | 123 | 0 | 0 | | 54 | 5393 | 0 | 61 | 7 | 1166 | 61 | 6559 | 0 | 61 |
| | NOV | 147 | 33 | 12 | 126 | 119 | 119 | 0 | 0 | | 16 | 5384 | 0 | 59 | 2 | 1104 | 18 | 6489 | 0 | 59 |
| | DEC | 101 | 24 | 8 | 85 | 123 | 123 | 0 | 0 | | | 5346 | 0 | 61 | 0 | 1043 | | 6389 | 0 | 61 |
| 1982 | JAN | 80 | 18 | 6 | 68 | 123 | 123 | 0 | 0 | | | 5292 | 0 | 61 | 0 | 982 | | 6274 | 0 | 61 |
| | FEB | 76 | 16 | 6 | 66 | 111 | 111 | 0 | 0 | | | 5247 | 0 | 55 | 0 | 926 | | 6173 | 0 | 55 |
| | MAR | 102 | 24 | 8 | 86 | 123 | 123 | 0 | 0 | | | 5210 | 0 | 61 | 0 | 865 | | 6075 | 0 | 61 |
| | APR | 664 | 152 | 54 | 566 | 0 | 0 | 0 | 0 | | | 5776 | 0 | 59 | 0 | 805 | | 6582 | 0 | 59 |
| | MAY | 5446 | 1150 | 441 | 4737 | 0 | 0 | 0 | 0 | | 126 | 10000 | 387 | 361 | 10 | 821 | 136 | 10821 | 0 | 361 |
| | JUN | 3227 | 591 | 261 | 2897 | 604 | 604 | 0 | 0 | | 210 | 10000 | 2083 | 59 | 9 | 2836 | 219 | 12836 | 0 | 59 |
| | JUL | 788 | 146 | 64 | 706 | 1749 | 1749 | 0 | 0 | | 219 | 8738 | 0 | 61 | 32 | 2742 | 251 | 11480 | 0 | 61 |
| | AUG | 360 | 67 | 29 | 322 | 1837 | 1837 | 0 | 0 | | 177 | 7045 | 0 | 61 | 30 | 2651 | 207 | 9697 | 0 | 61 |
| | SEP | 357 | 65 | 29 | 321 | 488 | 488 | 0 | 0 | | 119 | 6759 | 0 | 59 | 24 | 2568 | 143 | 9327 | 0 | 59 |
| | TOTAL | 11553 | 2330 | 936 | 10159 | 5400 | 5400 | 0 | 0 | 0 | 922 | | 2470 | 1023 | 114 | | 1035 | | 0 | 1023 |
| | OCT | 453 | 37 | 37 | 453 | 123 | 123 | 0 | 0 | | 62 | 7027 | 0 | 61 | 13 | 2494 | 74 | 9521 | 0 | 61 |
| | NOV | 322 | 31 | 26 | 317 | 119 | 119 | 0 | 0 | | 19 | 7207 | 0 | 59 | 4 | 2431 | 22 | 9638 | 0 | 59 |
| | DEC | 268 | 22 | 22 | 268 | 123 | 123 | 0 | 0 | | | 7351 | 0 | 61 | 0 | 2370 | | 9721 | 0 | 61 |
| 1983 | JAN | 167 | 19 | 14 | 162 | 123 | 123 | 0 | 0 | | | 7390 | 0 | 61 | 0 | 2308 | | 9698 | 0 | 61 |
| | FEB | 149 | 17 | 12 | 144 | 111 | 111 | 0 | 0 | | | 7423 | 0 | 55 | 0 | 2253 | | 9676 | 0 | 55 |
| | MAR | 213 | 22 | 17 | 208 | 123 | 123 | 0 | 0 | | | 7508 | 0 | 61 | 0 | 2191 | | 9700 | 0 | 61 |
| | APR | 350 | 29 | 28 | 349 | 0 | 0 | 0 | 0 | | | 7858 | 0 | 59 | 0 | 2132 | | 9989 | 0 | 59 |
| | MAY | 2961 | 203 | 240 | 2998 | 0 | 0 | 0 | 0 | | 151 | 10000 | 705 | 361 | 22 | 2453 | 173 | 12453 | 0 | 361 |
| | JUN | 9328 | 638 | 756 | 9446 | 979 | 979 | 0 | 0 | | 210 | 10000 | 8257 | 59 | 27 | 4500 | 237 | 14500 | 6123 | 6182 |
| | JUL | 1841 | 132 | 149 | 1858 | 1708 | 1708 | 0 | 0 | | 219 | 9931 | 0 | 61 | 48 | 4391 | 267 | 14322 | 0 | 61 |
| | AUG | 548 | 39 | 44 | 553 | 1189 | 1189 | 0 | 0 | | 191 | 9105 | 0 | 61 | 41 | 4288 | 232 | 13393 | 0 | 61 |
| | SEP | 399 | 27 | 32 | 404 | 801 | 801 | 0 | 0 | | 138 | 8569 | 0 | 59 | 33 | 4196 | 171 | 12765 | 0 | 59 |
| | TOTAL | 16999 | 1216 | 1377 | 17160 | 5400 | 5400 | 0 | 0 | 0 | 989 | | 8961 | 1023 | 187 | | 1176 | | 6123 | 7146 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 152 | 214 | 530 | 744 | 97 | 380 | 365 | 936 | | 1301 | 0 | 27313 | 0 | 1301 | 419 | 9 | 12 | 1741 |
| | NOV | 154 | 213 | 445 | 658 | 499 | 111 | | | 298 | 298 | 0 | 28061 | 0 | 298 | 330 | 8 | 11 | 647 |
| | DEC | 130 | 191 | 689 | 880 | 381 | | | | 307 | 307 | 0 | 29015 | 0 | 307 | 244 | 4 | 5 | 560 |
| 1981 | JAN | 144 | 205 | 381 | 586 | 500 | | | | 307 | 307 | 0 | 29795 | 0 | 307 | 298 | 3 | 3 | 611 |
| | FEB | 126 | 182 | 568 | 750 | 505 | | | | 278 | 278 | 0 | 30772 | 0 | 278 | 327 | 3 | 4 | 612 |
| | MAR | 198 | 259 | 743 | 1002 | 686 | | | | 446 | 446 | 0 | 32014 | 0 | 446 | 460 | 10 | 13 | 929 |
| | APR | 815 | 874 | 2510 | 3384 | 690 | | 0 | 1210 | | 1210 | 0 | 34878 | 0 | 1210 | 1770 | 159 | 213 | 3352 |
| | MAY | 1323 | 1684 | 3770 | 5454 | 3005 | 903 | 0 | 8910 | | 8910 | 0 | 33524 | 0 | 8910 | 1880 | 47 | 63 | 10900 |
| | JUN | 561 | 620 | 2690 | 3310 | -316 | 1081 | 4605 | 3964 | | 8569 | 0 | 26868 | 0 | 8569 | 1440 | 7 | 9 | 10024 |
| | JUL | 125 | 186 | 528 | 714 | 130 | 1059 | 9122 | 1095 | | 10217 | 0 | 16436 | 0 | 10217 | 468 | 3 | 4 | 10691 |
| | AUG | 75 | 136 | 283 | 419 | 1219 | 795 | 7030 | 1739 | | 8769 | 0 | 8511 | 0 | 8769 | 139 | 1 | 1 | 8910 |
| | SEP | 90 | 149 | 397 | 546 | -39 | 499 | 1476 | 571 | | 2047 | 0 | 6473 | 0 | 2047 | 168 | 1 | 2 | 2218 |
| | TOTAL | 3892 | 4914 | 13534 | 18448 | 7357 | 4828 | 22598 | 18425 | 1636 | 42659 | 0 | | 0 | 42659 | 7943 | 254 | 340 | 51196 |
| | OCT | 159 | 221 | 460 | 681 | 1364 | 248 | 0 | 672 | | 672 | 0 | 7597 | 0 | 672 | 404 | 2 | 2 | 1080 |
| | NOV | 129 | 188 | 403 | 591 | 858 | 76 | | | 300 | 300 | 0 | 8670 | 0 | 300 | 368 | 2 | 2 | 672 |
| | DEC | 100 | 161 | 419 | 580 | 696 | | | | 300 | 300 | 0 | 9647 | 0 | 300 | 121 | 3 | 3 | 427 |
| 1982 | JAN | 72 | 133 | 355 | 488 | 1605 | | | | 300 | 300 | 0 | 11440 | 0 | 300 | 103 | 3 | 3 | 409 |
| | FEB | 57 | 112 | 315 | 427 | 1262 | | | | 300 | 300 | 0 | 12829 | 0 | 300 | 116 | 3 | 3 | 422 |
| | MAR | 99 | 160 | 401 | 561 | 1314 | | | | 300 | 300 | 0 | 14404 | 0 | 300 | 579 | 3 | 4 | 886 |
| | APR | 594 | 654 | 2560 | 3214 | 2480 | | 0 | 300 | | 300 | 0 | 19798 | 0 | 300 | 5360 | 140 | 188 | 5988 |
| | MAY | 4023 | 4384 | 14400 | 18784 | 20575 | 763 | 0 | 0 | | 0 | 0 | 58394 | 0 | 0 | 19740 | 1950 | 2615 | 24305 |
| | JUN | 1603 | 1662 | 5440 | 7102 | 16848 | 1245 | 11151 | 11132 | | 22283 | 0 | 58815 | 0 | 22283 | 4960 | 737 | 988 | 28969 |
| | JUL | 404 | 466 | 1420 | 1886 | 4340 | 1302 | 6281 | 6870 | | 13151 | 0 | 50587 | 0 | 13151 | 1410 | 110 | 148 | 14819 |
| | AUG | 186 | 247 | 712 | 959 | 884 | 1095 | 7192 | 2104 | | 9296 | 0 | 42039 | 0 | 9296 | 668 | 14 | 19 | 9997 |
| | SEP | 177 | 236 | 642 | 878 | 983 | 798 | 3875 | 2123 | | 5998 | 0 | 37105 | 0 | 5998 | 486 | 22 | 30 | 6536 |
| | TOTAL | 7602 | 8625 | 27527 | 36152 | 53207 | 5527 | 28500 | 23200 | 1500 | 53200 | 0 | | 0 | 53200 | 34315 | 2987 | 4005 | 94508 |
| | OCT | 377 | 439 | 810 | 1249 | 1115 | 411 | 0 | 813 | | 813 | 0 | 38245 | 0 | 813 | 664 | 34 | 46 | 1557 |
| | NOV | 374 | 433 | 1019 | 1452 | 1320 | 122 | | | 298 | 298 | 0 | 40597 | 0 | 298 | 589 | 17 | 23 | 927 |
| | DEC | 232 | 294 | 610 | 904 | 374 | | | | 684 | 684 | 0 | 41191 | 0 | 684 | 486 | 8 | 10 | 1188 |
| 1983 | JAN | 265 | 327 | 557 | 884 | 1065 | | | | 921 | 921 | 0 | 42218 | 0 | 921 | 435 | 6 | 8 | 1371 |
| | FEB | 230 | 285 | 491 | 776 | 1495 | | | | 832 | 832 | 0 | 43658 | 0 | 832 | 289 | 6 | 8 | 1135 |
| | MAR | 283 | 344 | 679 | 1023 | 1430 | | | | 921 | 921 | 0 | 45190 | 0 | 921 | 573 | 27 | 36 | 1557 |
| | APR | 289 | 348 | 1452 | 1800 | 2653 | | 0 | 4743 | | 4743 | 0 | 44900 | 0 | 4743 | 3080 | 175 | 235 | 8233 |
| | MAY | 1532 | 1894 | 14190 | 16084 | 10536 | 962 | 0 | 0 | | 0 | 0 | 65700 | 4857 | 4857 | 21680 | 3570 | 4787 | 34895 |
| | JUN | 4764 | 10947 | 29310 | 40257 | 34952 | 1294 | 2812 | 0 | | 2812 | 0 | 65700 | 71104 | 73915 | 12440 | 4990 | 6692 | 98037 |
| | JUL | 1092 | 1153 | 3170 | 4323 | 12022 | 1350 | 8613 | 13867 | | 22480 | 0 | 58215 | 0 | 22480 | 2530 | 703 | 943 | 26656 |
| | AUG | 308 | 369 | 1449 | 1818 | 1779 | 1136 | 5853 | 4089 | | 9942 | 0 | 50734 | 0 | 9942 | 1400 | 277 | 371 | 11990 |
| | SEP | 195 | 254 | 1001 | 1255 | 1831 | 835 | 9067 | 3431 | | 12498 | 0 | 40488 | 0 | 12498 | 648 | 136 | 182 | 13464 |
| | TOTAL | 9941 | 17087 | 54738 | 71825 | 70572 | 6110 | 26344 | 26944 | 3656 | 56944 | 0 | | 75961 | 132905 | 44814 | 9949 | 13342 | 201009 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 361 | 62 | 29 | 328 | 123 | 123 | 0 | 0 | | 71 | 8704 | 0 | 61 | 18 | 4117 | 89 | 12820 | 0 | 61 |
| | NOV | 262 | 52 | 21 | 231 | 119 | 119 | 0 | 0 | | 21 | 8795 | 0 | 59 | 5 | 4052 | 26 | 12847 | 0 | 59 |
| | DEC | 313 | 55 | 25 | 283 | 123 | 123 | 0 | 0 | | | 8955 | 0 | 61 | 0 | 3991 | | 12946 | 0 | 61 |
| 1984 | JAN | 192 | 48 | 16 | 160 | 123 | 123 | 0 | 0 | | | 8992 | 0 | 61 | 0 | 3930 | | 12921 | 0 | 61 |
| | FEB | 171 | 42 | 14 | 143 | 111 | 111 | 0 | 0 | | | 9023 | 0 | 55 | 0 | 3874 | | 12898 | 0 | 55 |
| | MAR | 197 | 42 | 16 | 171 | 123 | 123 | 0 | 0 | | | 9071 | 0 | 61 | 0 | 3813 | | 12884 | 0 | 61 |
| | APR | 380 | 66 | 31 | 345 | 0 | 0 | 0 | 0 | | | 9416 | 0 | 59 | 0 | 3753 | | 13170 | 0 | 59 |
| | MAY | 7142 | 1215 | 579 | 6506 | 0 | 0 | 0 | 0 | | 167 | 10000 | 5754 | 361 | 34 | 4500 | 201 | 14500 | 4613 | 4974 |
| | JUN | 6656 | 956 | 539 | 6239 | 14 | 14 | 0 | 0 | | 210 | 10000 | 6016 | 59 | 46 | 4500 | 256 | 14500 | 5910 | 5970 |
| | JUL | 1002 | 147 | 81 | 936 | 2004 | 2004 | 0 | 0 | | 219 | 8714 | 0 | 61 | 48 | 4391 | 267 | 13104 | 0 | 61 |
| | AUG | 443 | 65 | 36 | 414 | 1794 | 1794 | 0 | 0 | | 177 | 7156 | 0 | 61 | 45 | 4284 | 222 | 11441 | 0 | 61 |
| | SEP | 304 | 44 | 25 | 285 | 866 | 866 | 0 | 0 | | 120 | 6454 | 0 | 59 | 37 | 4188 | 157 | 10642 | 0 | 59 |
| | TOTAL | 17423 | 2794 | 1411 | 16040 | 5400 | 5400 | 0 | 0 | 0 | 985 | | 11770 | 1023 | 232 | | 1218 | | 10523 | 11545 |
| | OCT | 333 | 71 | 27 | 289 | 123 | 123 | 0 | 0 | | 60 | 6560 | 0 | 61 | 20 | 4107 | 80 | 10667 | 0 | 61 |
| | NOV | 239 | 58 | 19 | 200 | 119 | 119 | 0 | 0 | | 18 | 6624 | 0 | 59 | 6 | 4042 | 24 | 10665 | 0 | 59 |
| | DEC | 268 | 58 | 22 | 232 | 123 | 123 | 0 | 0 | | | 6732 | 0 | 61 | 0 | 3980 | | 10712 | 0 | 61 |
| 1985 | JAN | 182 | 55 | 15 | 142 | 123 | 123 | 0 | 0 | | | 6751 | 0 | 61 | 0 | 3919 | | 10670 | 0 | 61 |
| | FEB | 146 | 43 | 12 | 115 | 111 | 111 | 0 | 0 | | | 6755 | 0 | 55 | 0 | 3863 | | 10618 | 0 | 55 |
| | MAR | 176 | 46 | 14 | 144 | 123 | 123 | 0 | 0 | | | 6776 | 0 | 61 | 0 | 3802 | | 10578 | 0 | 61 |
| | APR | 1675 | 379 | 136 | 1432 | 0 | 0 | 0 | 0 | | | 8208 | 0 | 59 | 0 | 3743 | | 11950 | 0 | 59 |
| | MAY | 6282 | 1303 | 509 | 5488 | 0 | 0 | 0 | 0 | | 155 | 10000 | 3541 | 361 | 37 | 4500 | 191 | 14500 | 2386 | 2747 |
| | JUN | 1733 | 302 | 140 | 1571 | 14 | 14 | 0 | 0 | | 210 | 10000 | 1348 | 59 | 46 | 4500 | 256 | 14500 | 1242 | 1302 |
| | JUL | 657 | 115 | 53 | 595 | 1468 | 1468 | 0 | 0 | | 219 | 8909 | 0 | 61 | 48 | 4391 | 267 | 13299 | 0 | 61 |
| | AUG | 311 | 55 | 25 | 281 | 1815 | 1815 | 0 | 0 | | 179 | 7196 | 0 | 61 | 44 | 4285 | 224 | 11481 | 0 | 61 |
| | SEP | 218 | 40 | 18 | 196 | 1382 | 1382 | 0 | 0 | | 121 | 5889 | 0 | 59 | 37 | 4189 | 158 | 10078 | 0 | 59 |
| | TOTAL | 12220 | 2525 | 990 | 10685 | 5400 | 5400 | 0 | 0 | 0 | 961 | | 4889 | 1023 | 237 | | 1199 | | 3628 | 4651 |
| | OCT | 231 | 46 | 19 | 204 | 123 | 123 | 0 | 0 | | 57 | 5912 | 0 | 61 | 21 | 4107 | 78 | 10019 | 0 | 61 |
| | NOV | 202 | 45 | 16 | 173 | 119 | 119 | 0 | 0 | | 17 | 5950 | 0 | 59 | 6 | 4041 | 23 | 9991 | 0 | 59 |
| | DEC | 196 | 41 | 16 | 171 | 123 | 123 | 0 | 0 | | | 5998 | 0 | 61 | 0 | 3980 | | 9978 | 0 | 61 |
| 1986 | JAN | 150 | 41 | 12 | 121 | 123 | 123 | 0 | 0 | | | 5996 | 0 | 61 | 0 | 3919 | | 9914 | 0 | 61 |
| | FEB | 151 | 42 | 12 | 121 | 111 | 111 | 0 | 0 | | | 6006 | 0 | 55 | 0 | 3863 | | 9869 | 0 | 55 |
| | MAR | 243 | 63 | 20 | 200 | 123 | 123 | 0 | 0 | | | 6083 | 0 | 61 | 0 | 3802 | | 9884 | 0 | 61 |
| | APR | 1050 | 224 | 85 | 911 | 0 | 0 | 0 | 0 | | | 6994 | 0 | 59 | 0 | 3742 | | 10736 | 0 | 59 |
| | MAY | 6624 | 1315 | 537 | 5846 | 0 | 0 | 0 | 0 | | 141 | 10000 | 2698 | 361 | 39 | 4500 | 180 | 14500 | 1540 | 1901 |
| | JUN | 5312 | 896 | 430 | 4846 | 14 | 14 | 0 | 0 | | 210 | 10000 | 4623 | 59 | 46 | 4500 | 256 | 14500 | 4517 | 4577 |
| | JUL | 644 | 107 | 52 | 589 | 1784 | 1784 | 0 | 0 | | 219 | 8587 | 0 | 61 | 48 | 4391 | 267 | 12977 | 0 | 61 |
| | AUG | 324 | 55 | 26 | 295 | 1865 | 1865 | 0 | 0 | | 175 | 6841 | 0 | 61 | 45 | 4284 | 221 | 11125 | 0 | 61 |
| | SEP | 252 | 43 | 20 | 229 | 1015 | 1015 | 0 | 0 | | 117 | 5938 | 0 | 59 | 38 | 4187 | 155 | 10125 | 0 | 59 |
| | TOTAL | 15379 | 2918 | 1246 | 13707 | 5400 | 5400 | 0 | 0 | 0 | 936 | | 7321 | 1023 | 243 | | 1179 | | 6057 | 7080 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 296 | 357 | 806 | 1163 | 1910 | 420 | 9180 | 3340 | | 12520 | 0 | 30621 | 0 | 12520 | 619 | 175 | 235 | 13549 |
| | NOV | 289 | 348 | 680 | 1028 | 2931 | 115 | | | 891 | 891 | 0 | 33575 | 0 | 891 | 470 | 125 | 168 | 1654 |
| | DEC | 269 | 330 | 628 | 958 | 2020 | | | | 0 | 0 | 0 | 36553 | 0 | 0 | 502 | 111 | 149 | 762 |
| 1984 | JAN | 321 | 383 | 619 | 1002 | 1200 | | | | 0 | 0 | 0 | 38755 | 0 | 0 | 472 | 91 | 122 | 685 |
| | FEB | 281 | 337 | 716 | 1053 | 460 | | | | 0 | 0 | 0 | 40268 | 0 | 0 | 568 | 115 | 154 | 837 |
| | MAR | 256 | 317 | 743 | 1060 | 3143 | | | | 921 | 921 | 0 | 43550 | 0 | 921 | 875 | 171 | 229 | 2196 |
| | APR | 318 | 378 | 2217 | 2595 | 1542 | | 0 | 4422 | | 4422 | 0 | 43265 | 0 | 4422 | 4530 | 528 | 708 | 10188 |
| | MAY | 5724 | 10698 | 27130 | 37828 | 25226 | 954 | 0 | 0 | | 0 | 0 | 65700 | 39665 | 39665 | 25560 | 3920 | 5257 | 74402 |
| | JUN | 3381 | 9350 | 12110 | 21460 | 35747 | 1294 | 3027 | 6746 | | 9773 | 0 | 65700 | 46141 | 55914 | 6560 | 1370 | 1837 | 65681 |
| | JUL | 544 | 605 | 2550 | 3155 | 7925 | 1350 | 5160 | 11955 | | 17115 | 0 | 58315 | 0 | 17115 | 2070 | 491 | 658 | 20334 |
| | AUG | 240 | 301 | 1026 | 1327 | 1706 | 1137 | 4360 | 3386 | | 7746 | 0 | 52466 | 0 | 7746 | 1300 | 246 | 330 | 9622 |
| | SEP | 154 | 214 | 811 | 1025 | 153 | 842 | 6462 | 1403 | | 7865 | 0 | 44938 | 0 | 7865 | 591 | 155 | 208 | 8819 |
| | TOTAL | 12074 | 23619 | 50036 | 73655 | 83965 | 6111 | 28188 | 31253 | 1812 | 61253 | 0 | | 85806 | 147059 | 44117 | 7498 | 10055 | 208729 |
| | OCT | 272 | 333 | 939 | 1272 | 1119 | 431 | 3363 | 2619 | | 5982 | 0 | 40916 | 0 | 5982 | 732 | 205 | 275 | 7194 |
| | NOV | 258 | 317 | 852 | 1169 | 1077 | 124 | | | 891 | 891 | 0 | 42148 | 0 | 891 | 517 | 167 | 224 | 1799 |
| | DEC | 232 | 294 | 716 | 1010 | 2412 | | | | 792 | 792 | 0 | 44778 | 0 | 792 | 396 | 131 | 176 | 1495 |
| 1985 | JAN | 298 | 360 | 560 | 920 | 1000 | | | | 0 | 0 | 0 | 46697 | 0 | 0 | 437 | 152 | 204 | 793 |
| | FEB | 223 | 279 | 350 | 629 | 1412 | | | | 0 | 0 | 0 | 48738 | 0 | 0 | 350 | 94 | 126 | 570 |
| | MAR | 222 | 283 | 954 | 1237 | 1572 | | | | 792 | 792 | 0 | 50755 | 0 | 792 | 1200 | 205 | 275 | 2472 |
| | APR | 1578 | 1638 | 5560 | 7198 | 4354 | | 0 | 6264 | | 6264 | 0 | 56042 | 0 | 6264 | 9660 | 294 | 394 | 16612 |
| | MAY | 4862 | 7609 | 13300 | 20909 | 17085 | 1017 | 0 | 1389 | | 1389 | 0 | 65700 | 25930 | 27319 | 10960 | 1630 | 2186 | 42095 |
| | JUN | 829 | 2130 | 2920 | 5050 | 8628 | 1294 | 2599 | 13948 | | 16548 | 0 | 61537 | 0 | 16548 | 2520 | 498 | 668 | 20233 |
| | JUL | 319 | 380 | 1106 | 1486 | 1643 | 1320 | 7213 | 3663 | | 10876 | 0 | 52470 | 0 | 10876 | 1020 | 181 | 243 | 12320 |
| | AUG | 153 | 214 | 576 | 790 | 293 | 1105 | 10838 | 1303 | | 12141 | 0 | 40307 | 0 | 12141 | 442 | 70 | 94 | 12747 |
| | SEP | 118 | 178 | 535 | 713 | 93 | 789 | 3511 | 942 | | 4453 | 0 | 35870 | 0 | 4453 | 379 | 90 | 121 | 5043 |
| | TOTAL | 9364 | 14015 | 28368 | 42383 | 40688 | 6080 | 27525 | 30128 | 2475 | 60128 | 0 | | 25930 | 86058 | 28613 | 3717 | 4984 | 123372 |
| | OCT | 182 | 244 | 654 | 898 | 1354 | 407 | 0 | 672 | | 672 | 0 | 37043 | 0 | 672 | 413 | 89 | 119 | 1293 |
| | NOV | 207 | 266 | 521 | 787 | 1525 | 121 | | | 300 | 300 | 0 | 38934 | 0 | 300 | 384 | 82 | 110 | 876 |
| | DEC | 176 | 238 | 434 | 672 | 1334 | | | | 615 | 615 | 0 | 40325 | 0 | 615 | 328 | 94 | 126 | 1163 |
| 1986 | JAN | 227 | 288 | 608 | 896 | 1359 | | | | 615 | 615 | 0 | 41965 | 0 | 615 | 329 | 72 | 97 | 1113 |
| | FEB | 236 | 291 | 597 | 888 | 1946 | | | | 300 | 300 | 0 | 44499 | 0 | 300 | 1130 | 151 | 202 | 1783 |
| | MAR | 333 | 395 | 2097 | 2492 | 2005 | | | | 921 | 921 | 0 | 48075 | 0 | 921 | 3380 | 340 | 456 | 5097 |
| | APR | 969 | 1028 | 6370 | 7398 | 5630 | | 0 | 2807 | | 2807 | 0 | 58296 | 0 | 2807 | 10050 | 1010 | 1354 | 15222 |
| | MAY | 5204 | 7106 | 17510 | 24616 | 16161 | 1028 | 0 | 0 | | 0 | 0 | 65700 | 32345 | 32345 | 14090 | 2560 | 3433 | 52428 |
| | JUN | 2684 | 7260 | 6640 | 13900 | 20110 | 1294 | 6062 | 9863 | | 15925 | 0 | 65700 | 16791 | 32717 | 4260 | 1160 | 1556 | 39692 |
| | JUL | 311 | 372 | 2010 | 2382 | 2210 | 1350 | 6787 | 5120 | | 11907 | 0 | 57035 | 0 | 11907 | 1440 | 282 | 378 | 14007 |
| | AUG | 163 | 224 | 902 | 1126 | 1106 | 1130 | 9308 | 2466 | | 11774 | 0 | 46364 | 0 | 11774 | 612 | 128 | 172 | 12686 |
| | SEP | 133 | 192 | 708 | 900 | 662 | 817 | 5093 | 1732 | | 6825 | 0 | 40285 | 0 | 6825 | 532 | 130 | 174 | 7661 |
| | TOTAL | 10824 | 17904 | 39051 | 56955 | 55403 | 6146 | 27249 | 22661 | 2751 | 52661 | 0 | | 49136 | 101797 | 36948 | 6098 | 8177 | 153021 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 296 | 111 | 24 | 209 | 123 | 123 | 0 | 0 | | 57 | 5967 | 0 | 61 | 21 | 4105 | 78 | 10072 | 0 | 61 |
| | NOV | 231 | 99 | 19 | 151 | 119 | 119 | 0 | 0 | | 17 | 5981 | 0 | 59 | 6 | 4040 | 23 | 10021 | 0 | 59 |
| | DEC | 170 | 67 | 14 | 117 | 123 | 123 | 0 | 0 | | | 5975 | 0 | 61 | 0 | 3978 | | 9953 | 0 | 61 |
| 1987 | JAN | 89 | 37 | 7 | 59 | 123 | 123 | 0 | 0 | | | 5911 | 0 | 61 | 0 | 3917 | | 9828 | 0 | 61 |
| | FEB | 81 | 31 | 7 | 57 | 111 | 111 | 0 | 0 | | | 5857 | 0 | 55 | 0 | 3861 | | 9718 | 0 | 55 |
| | MAR | 109 | 45 | 9 | 73 | 123 | 123 | 0 | 0 | | | 5807 | 0 | 61 | 0 | 3800 | | 9607 | 0 | 61 |
| | APR | 1083 | 433 | 88 | 738 | 0 | 0 | 0 | 0 | | | 6545 | 0 | 59 | 0 | 3741 | | 10285 | 0 | 59 |
| | MAY | 2577 | 783 | 209 | 2003 | 0 | 0 | 0 | 0 | | 136 | 8412 | 0 | 361 | 40 | 3339 | 176 | 11751 | 0 | 361 |
| | JUN | 757 | 227 | 61 | 591 | 850 | 850 | 0 | 0 | | 190 | 7963 | 0 | 59 | 39 | 3240 | 229 | 11203 | 0 | 59 |
| | JUL | 396 | 115 | 32 | 313 | 1796 | 1796 | 0 | 0 | | 192 | 6288 | 0 | 61 | 41 | 3138 | 233 | 9426 | 0 | 61 |
| | AUG | 215 | 64 | 17 | 168 | 2030 | 2030 | 0 | 0 | | 147 | 4280 | 0 | 61 | 39 | 3038 | 185 | 7318 | 0 | 61 |
| | SEP | 152 | 51 | 12 | 113 | 3 | 3 | 0 | 0 | | 90 | 4301 | 0 | 59 | 32 | 2947 | 122 | 7247 | 0 | 59 |
| | TOTAL | 6156 | 2063 | 499 | 4592 | 5400 | 5400 | 0 | 0 | 0 | 829 | | 0 | 1023 | 218 | | 1047 | | 0 | 1023 |
| | OCT | 144 | 47 | 12 | 109 | 123 | 123 | 0 | 0 | | 48 | 4238 | 0 | 61 | 16 | 2869 | 64 | 7107 | 0 | 61 |
| | NOV | 126 | 42 | 10 | 94 | 119 | 119 | 0 | 0 | | 14 | 4200 | 0 | 59 | 5 | 2805 | 19 | 7004 | 0 | 59 |
| | DEC | 99 | 37 | 8 | 70 | 123 | 123 | 0 | 0 | | | 4147 | 0 | 61 | 0 | 2743 | | 6890 | 0 | 61 |
| 1988 | JAN | 102 | 41 | 8 | 69 | 123 | 123 | 0 | 0 | | | 4093 | 0 | 61 | 0 | 2682 | | 6775 | 0 | 61 |
| | FEB | 98 | 39 | 8 | 67 | 111 | 111 | 0 | 0 | | | 4049 | 0 | 55 | 0 | 2627 | | 6675 | 0 | 55 |
| | MAR | 125 | 49 | 10 | 86 | 123 | 123 | 0 | 0 | | | 4012 | 0 | 61 | 0 | 2565 | | 6577 | 0 | 61 |
| | APR | 564 | 199 | 46 | 411 | 0 | 0 | 0 | 0 | | | 4423 | 0 | 59 | 0 | 2506 | | 6928 | 0 | 59 |
| | MAY | 3714 | 1132 | 301 | 2883 | 0 | 0 | 0 | 0 | | 109 | 7196 | 0 | 361 | 31 | 2113 | 140 | 9310 | 0 | 361 |
| | JUN | 958 | 263 | 78 | 773 | 657 | 657 | 0 | 0 | | 174 | 7139 | 0 | 59 | 28 | 2026 | 201 | 9165 | 0 | 59 |
| | JUL | 358 | 92 | 29 | 295 | 1804 | 1804 | 0 | 0 | | 180 | 5449 | 0 | 61 | 28 | 1937 | 208 | 7386 | 0 | 61 |
| | AUG | 209 | 56 | 17 | 170 | 2214 | 2214 | 0 | 0 | | 135 | 3270 | 0 | 61 | 26 | 1850 | 161 | 5119 | 0 | 61 |
| | SEP | 142 | 43 | 12 | 111 | 3 | 3 | 0 | 0 | | 79 | 3299 | 0 | 59 | 21 | 1769 | 99 | 5068 | 0 | 59 |
| | TOTAL | 6639 | 2040 | 538 | 5137 | 5400 | 5400 | 0 | 0 | 0 | 739 | | 0 | 1023 | 155 | | 893 | | 0 | 1023 |
| | OCT | 153 | 49 | 12 | 116 | 123 | 123 | 0 | 0 | | 42 | 3250 | 0 | 61 | 11 | 1697 | 53 | 4948 | 0 | 61 |
| | NOV | 167 | 59 | 14 | 122 | 119 | 119 | 0 | 0 | | 12 | 3241 | 0 | 59 | 3 | 1635 | 15 | 4876 | 0 | 59 |
| | DEC | 150 | 53 | 12 | 109 | 123 | 123 | 0 | 0 | | | 3227 | 0 | 61 | 0 | 1574 | | 4800 | 0 | 61 |
| 1989 | JAN | 121 | 51 | 10 | 80 | 123 | 123 | 0 | 0 | | | 3183 | 0 | 61 | 0 | 1512 | | 4696 | 0 | 61 |
| | FEB | 101 | 39 | 8 | 70 | 111 | 111 | 0 | 0 | | | 3143 | 0 | 55 | 0 | 1457 | | 4600 | 0 | 55 |
| | MAR | 166 | 67 | 13 | 112 | 123 | 123 | 0 | 0 | | | 3132 | 0 | 61 | 0 | 1395 | | 4528 | 0 | 61 |
| | APR | 1312 | 462 | 106 | 956 | 0 | 0 | 0 | 0 | | | 4088 | 0 | 59 | 0 | 1336 | | 5424 | 0 | 59 |
| | MAY | 2470 | 649 | 200 | 2021 | 0 | 0 | 0 | 0 | | 105 | 6005 | 0 | 361 | 17 | 957 | 122 | 6962 | 0 | 361 |
| | JUN | 763 | 202 | 62 | 623 | 735 | 735 | 0 | 0 | | 156 | 5737 | 0 | 59 | 14 | 884 | 170 | 6621 | 0 | 59 |
| | JUL | 368 | 92 | 29 | 305 | 1758 | 1758 | 0 | 0 | | 159 | 4125 | 0 | 61 | 14 | 809 | 173 | 4934 | 0 | 61 |
| | AUG | 180 | 46 | 15 | 149 | 2183 | 2183 | 0 | 0 | | 116 | 1974 | 0 | 61 | 12 | 736 | 128 | 2710 | 0 | 61 |
| | SEP | 161 | 47 | 13 | 127 | 3 | 3 | 0 | 0 | 68 | 63 | 1968 | 0 | 59 | 9 | 668 | 72 | 2635 | 0 | 127 |
| | TOTAL | 6112 | 1816 | 494 | 4790 | 5400 | 5400 | 0 | 0 | 68 | 653 | | 0 | 1023 | 79 | | 733 | | 0 | 1091 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 239 | 300 | 712 | 1012 | 1268 | 419 | 0 | 496 | | 496 | 0 | 41650 | 0 | 496 | 559 | 188 | 252 | 1495 |
| | NOV | 247 | 307 | 570 | 877 | 460 | 124 | | | 0 | 0 | 0 | 42863 | 0 | 0 | 438 | 82 | 110 | 630 |
| | DEC | 154 | 216 | 500 | 716 | 1029 | | | | 0 | 0 | 0 | 44607 | 0 | 0 | 359 | 46 | 62 | 467 |
| 1987 | JAN | 91 | 152 | 444 | 596 | 1506 | | | | 0 | 0 | 0 | 46710 | 0 | 0 | 344 | 52 | 70 | 466 |
| | FEB | 69 | 125 | 340 | 465 | 1334 | | | | 0 | 0 | 0 | 48509 | 0 | 0 | 302 | 48 | 64 | 414 |
| | MAR | 110 | 172 | 454 | 626 | 1763 | | | | 0 | 0 | 0 | 50897 | 0 | 0 | 723 | 113 | 152 | 988 |
| | APR | 1002 | 1062 | 2400 | 3462 | 2361 | | 0 | 1101 | | 1101 | 0 | 55619 | 0 | 1101 | 2760 | 841 | 1128 | 5830 |
| | MAY | 1147 | 1509 | 3720 | 5229 | 2811 | 1015 | 0 | 7535 | | 7535 | 0 | 55108 | 0 | 7535 | 2740 | 665 | 892 | 11832 |
| | JUN | 324 | 383 | 915 | 1298 | 887 | 1226 | 4771 | 2717 | | 7488 | 0 | 48579 | 0 | 7488 | 942 | 416 | 558 | 9404 |
| | JUL | 148 | 209 | 481 | 690 | 1429 | 1239 | 6868 | 2371 | | 9239 | 0 | 40220 | 0 | 9239 | 466 | 172 | 231 | 10108 |
| | AUG | 91 | 152 | 318 | 470 | 246 | 1035 | 5762 | 823 | | 6585 | 0 | 33316 | 0 | 6585 | 290 | 94 | 126 | 7095 |
| | SEP | 91 | 150 | 258 | 408 | 135 | 751 | 4034 | 597 | | 4631 | 0 | 28478 | 0 | 4631 | 218 | 46 | 62 | 4957 |
| | TOTAL | 3713 | 4736 | 11112 | 15848 | 15230 | 5810 | 21434 | 15641 | 0 | 37075 | 0 | | 0 | 37075 | 10141 | 2763 | 3705 | 53684 |
| | OCT | 105 | 167 | 342 | 509 | 357 | 382 | 696 | 913 | | 1609 | 0 | 27353 | 0 | 1609 | 245 | 83 | 111 | 2048 |
| | NOV | 99 | 158 | 371 | 529 | 656 | 111 | | | 0 | 0 | 0 | 28427 | 0 | 0 | 238 | 128 | 172 | 538 |
| | DEC | 98 | 159 | 332 | 491 | 1200 | | | | 0 | 0 | 0 | 30118 | 0 | 0 | 249 | 76 | 102 | 427 |
| 1988 | JAN | 119 | 180 | 306 | 486 | 1406 | | | | 0 | 0 | 0 | 32010 | 0 | 0 | 285 | 66 | 89 | 440 |
| | FEB | 109 | 165 | 320 | 485 | 704 | | | | 0 | 0 | 0 | 33199 | 0 | 0 | 286 | 57 | 76 | 419 |
| | MAR | 136 | 197 | 458 | 655 | 1320 | | | | 0 | 0 | 0 | 35174 | 0 | 0 | 614 | 171 | 229 | 1014 |
| | APR | 496 | 556 | 9043 | 9599 | -4850 | | 0 | 0 | | 0 | 0 | 39923 | 0 | 0 | 3070 | 548 | 735 | 4353 |
| | MAY | 2287 | 2649 | 4980 | 7629 | 4967 | 935 | 0 | 4895 | | 4895 | 0 | 46688 | 0 | 4895 | 4050 | 982 | 1317 | 11244 |
| | JUN | 427 | 487 | 1800 | 2287 | 1271 | 1176 | 4899 | 4271 | | 9170 | 0 | 39900 | 0 | 9170 | 1170 | 313 | 420 | 11073 |
| | JUL | 123 | 184 | 612 | 796 | 57 | 1181 | 9920 | 1087 | | 11007 | 0 | 28565 | 0 | 11007 | 489 | 121 | 162 | 11779 |
| | AUG | 87 | 148 | 395 | 543 | -267 | 944 | 7531 | 385 | | 7916 | 0 | 19982 | 0 | 7916 | 181 | 47 | 63 | 8207 |
| | SEP | 86 | 146 | 454 | 600 | -204 | 644 | 3391 | 447 | | 3838 | 0 | 15895 | 0 | 3838 | 160 | 33 | 44 | 4075 |
| | TOTAL | 4173 | 5196 | 19413 | 24609 | 6616 | 5372 | 26438 | 11997 | 0 | 38435 | 0 | | 0 | 38435 | 11037 | 2625 | 3520 | 55617 |
| | OCT | 115 | 176 | 283 | 459 | 108 | 318 | 126 | 622 | | 748 | 0 | 15396 | 0 | 748 | 211 | 49 | 66 | 1074 |
| | NOV | 156 | 216 | 252 | 468 | 357 | 93 | | | 276 | 276 | 0 | 15852 | 0 | 276 | 196 | 52 | 70 | 594 |
| | DEC | 139 | 200 | 344 | 544 | 1032 | | | | 124 | 124 | 0 | 17305 | 0 | 124 | 181 | 59 | 79 | 443 |
| 1989 | JAN | 161 | 223 | 209 | 432 | 974 | | | | 124 | 124 | 0 | 18586 | 0 | 124 | 141 | 63 | 84 | 412 |
| | FEB | 116 | 171 | 181 | 352 | 1245 | | | | 112 | 112 | 0 | 20071 | 0 | 112 | 177 | 81 | 109 | 479 |
| | MAR | 206 | 267 | 203 | 470 | 2403 | | | | 124 | 124 | 0 | 22820 | 0 | 124 | 810 | 151 | 202 | 1287 |
| | APR | 1224 | 1283 | 2440 | 3723 | 2127 | | 0 | 3947 | | 3947 | 0 | 24723 | 0 | 3947 | 2950 | 201 | 270 | 7368 |
| | MAY | 1039 | 1400 | 4280 | 5680 | 1460 | 817 | 995 | 8800 | | 9795 | 0 | 21251 | 0 | 9795 | 1610 | 108 | 145 | 11658 |
| | JUN | 327 | 387 | 800 | 1187 | 1181 | 944 | 5061 | 2931 | | 7992 | 0 | 14683 | 0 | 7992 | 549 | 38 | 51 | 8630 |
| | JUL | 131 | 192 | 237 | 429 | -508 | 877 | 8844 | 165 | | 9009 | 0 | 4718 | 0 | 9009 | 209 | 14 | 19 | 9251 |
| | AUG | 68 | 130 | 367 | 497 | 443 | 574 | 4138 | 1027 | | 5165 | 80 | 0 | 0 | 5085 | 121 | 4 | 6 | 5216 |
| | SEP | 94 | 221 | 451 | 672 | -242 | 349 | 2357 | 430 | | 2787 | 2706 | 0 | 0 | 81 | 114 | 7 | 10 | 213 |
| | TOTAL | 3776 | 4866 | 10047 | 14913 | 10580 | 3971 | 21521 | 17922 | 760 | 40203 | 2786 | | 0 | 37417 | 7269 | 828 | 1110 | 46623 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 132 | 59 | 11 | 83 | 123 | 123 | 0 | 0 | | 33 | 1894 | 0 | 61 | 4 | 602 | 38 | 2496 | 0 | 61 |
| | NOV | 230 | 72 | 19 | 178 | 119 | 119 | 0 | 0 | | 10 | 1943 | 0 | 59 | 1 | 541 | 11 | 2485 | 0 | 59 |
| | DEC | 114 | 64 | 9 | 60 | 123 | 123 | 0 | 0 | | | 1880 | 0 | 61 | 0 | 480 | | 2360 | 0 | 61 |
| 1990 | JAN | 101 | 62 | 8 | 47 | 123 | 123 | 0 | 0 | | | 1804 | 0 | 61 | 0 | 419 | | 2222 | 0 | 61 |
| | FEB | 97 | 48 | 8 | 57 | 111 | 111 | 0 | 0 | | | 1749 | 0 | 55 | 0 | 363 | | 2113 | 0 | 55 |
| | MAR | 128 | 82 | 10 | 56 | 123 | 123 | 0 | 0 | | | 1683 | 0 | 61 | 0 | 302 | | 1984 | 0 | 61 |
| | APR | 1120 | 561 | 91 | 650 | 0 | 0 | 0 | 0 | | | 2332 | 0 | 59 | 0 | 242 | | 2575 | 0 | 59 |
| | MAY | 2564 | 787 | 208 | 1985 | 0 | 0 | 0 | 0 | | 80 | 4237 | 0 | 61 | 3 | 177 | 84 | 4414 | 0 | 61 |
| | JUN | 913 | 244 | 74 | 742 | 657 | 657 | 0 | 0 | | 129 | 4193 | 0 | 59 | 3 | 115 | 132 | 4309 | 0 | 59 |
| | JUL | 401 | 112 | 32 | 321 | 1804 | 1647 | 157 | 0 | | 134 | 2734 | 0 | 61 | 2 | 52 | 136 | 2785 | 0 | 61 |
| | AUG | 174 | 56 | 14 | 133 | 2214 | 0 | 2214 | 10 | 72 | 95 | 2689 | 0 | 51 | 1 | 0 | 96 | 2689 | 0 | 133 |
| | SEP | 127 | 57 | 10 | 80 | 3 | 0 | 3 | 59 | 21 | 72 | 2617 | 0 | 0 | 0 | 0 | 72 | 2617 | 0 | 80 |
| | TOTAL | 6100 | 2204 | 499 | 4390 | 5400 | 3026 | 2374 | 70 | 93 | 553 | | 0 | 653 | 15 | | 567 | | 0 | 816 |
| | OCT | 150 | 70 | 12 | 93 | 123 | 123 | 0 | 61 | 32 | 38 | 2455 | 0 | 0 | 0 | 0 | 38 | 2455 | 0 | 93 |
| | NOV | 165 | 165 | 13 | 13 | 119 | 119 | 0 | 59 | | 11 | 2280 | 0 | 0 | 0 | 0 | 11 | 2280 | 0 | 59 |
| | DEC | 120 | 66 | 10 | 63 | 123 | 123 | 0 | 61 | | | 2158 | 0 | 0 | 0 | 0 | | 2158 | 0 | 61 |
| 1991 | JAN | 106 | 64 | 9 | 50 | 123 | 123 | 0 | 61 | | | 2024 | 0 | 0 | 0 | 0 | | 2024 | 0 | 61 |
| | FEB | 104 | 64 | 8 | 49 | 111 | 111 | 0 | 55 | | | 1907 | 0 | 0 | 0 | 0 | | 1907 | 0 | 55 |
| | MAR | 125 | 77 | 10 | 59 | 123 | 123 | 0 | 61 | | | 1781 | 0 | 0 | 0 | 0 | | 1781 | 0 | 61 |
| | APR | 660 | 660 | 53 | 53 | 0 | 0 | 0 | 59 | | | 1775 | 0 | 0 | 0 | 0 | | 1775 | 0 | 59 |
| | MAY | 3864 | 1220 | 313 | 2958 | 0 | 0 | 0 | 361 | | 72 | 4299 | 0 | 0 | 0 | 0 | 72 | 4299 | 0 | 361 |
| | JUN | 2537 | 448 | 206 | 2294 | 735 | 735 | 0 | 59 | | 130 | 5670 | 0 | 0 | 0 | 0 | 130 | 5670 | 0 | 59 |
| | JUL | 567 | 185 | 46 | 428 | 1758 | 1758 | 0 | 61 | | 158 | 4120 | 0 | 0 | 0 | 0 | 158 | 4120 | 0 | 61 |
| | AUG | 296 | 77 | 24 | 243 | 2183 | 2183 | 0 | 61 | | 116 | 2002 | 0 | 0 | 0 | 0 | 116 | 2002 | 0 | 61 |
| | SEP | 249 | 62 | 20 | 207 | 3 | 3 | 0 | 59 | | 63 | 2084 | 0 | 0 | 0 | 0 | 63 | 2084 | 0 | 59 |
| | TOTAL | 8944 | 3159 | 718 | 6509 | 5400 | 5400 | 0 | 1023 | 32 | 588 | | 0 | 0 | 0 | | 588 | | 0 | 1055 |
| | OCT | 154 | 24 | 13 | 143 | 123 | 123 | 0 | 61 | 82 | 34 | 1926 | 0 | 0 | 0 | 0 | 34 | 1926 | 0 | 143 |
| | NOV | 145 | 14 | 12 | 143 | 119 | 119 | 0 | 59 | | 10 | 1880 | 0 | 0 | 0 | 0 | 10 | 1880 | 0 | 59 |
| | DEC | 124 | 21 | 10 | 113 | 123 | 123 | 0 | 61 | | | 1809 | 0 | 0 | 0 | 0 | | 1809 | 0 | 61 |
| 1992 | JAN | 90 | 21 | 7 | 76 | 123 | 123 | 0 | 61 | | | 1700 | 0 | 0 | 0 | 0 | | 1700 | 0 | 61 |
| | FEB | 82 | 20 | 7 | 68 | 111 | 111 | 0 | 55 | | | 1601 | 0 | 0 | 0 | 0 | | 1601 | 0 | 55 |
| | MAR | 141 | 23 | 11 | 129 | 123 | 123 | 0 | 61 | | | 1546 | 0 | 0 | 0 | 0 | | 1546 | 0 | 61 |
| | APR | 741 | 38 | 60 | 763 | 0 | 0 | 0 | 59 | | | 2250 | 0 | 0 | 0 | 0 | | 2250 | 0 | 59 |
| | MAY | 1705 | 641 | 138 | 1201 | 0 | 0 | 0 | 61 | | 79 | 3311 | 0 | 0 | 0 | 0 | 79 | 3311 | 0 | 61 |
| | JUN | 654 | 421 | 53 | 286 | 735 | 611 | 124 | 59 | | 114 | 2812 | 0 | 0 | 0 | 0 | 114 | 2812 | 0 | 59 |
| | JUL | 263 | 82 | 21 | 203 | 1758 | 0 | 1758 | 61 | 142 | 110 | 2701 | 0 | 0 | 0 | 0 | 110 | 2701 | 0 | 203 |
| | AUG | 136 | 46 | 11 | 101 | 2183 | 0 | 2183 | 61 | 40 | 94 | 2606 | 0 | 0 | 0 | 0 | 94 | 2606 | 0 | 101 |
| | SEP | 118 | 40 | 10 | 87 | 3 | 0 | 3 | 59 | | 71 | 2563 | 0 | 0 | 0 | 0 | 71 | 2563 | 0 | 59 |
| | TOTAL | 4351 | 1392 | 352 | 3311 | 5400 | 1333 | 4067 | 723 | 264 | 512 | | 0 | 0 | 0 | | 512 | | 0 | 987 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 95 | 157 | 250 | 407 | -429 | 185 | 1224 | 0 | | 1224 | 1224 | -207 | 0 | 0 | 162 | 54 | 73 | 290 |
| | NOV | 245 | 305 | 291 | 596 | 209 | 54 | | | 179 | 179 | 0 | 365 | 0 | 179 | 136 | 25 | 34 | 375 |
| | DEC | 110 | 171 | 304 | 475 | 238 | | | | 191 | 191 | 0 | 887 | 0 | 191 | 152 | 19 | 26 | 389 |
| 1990 | JAN | 117 | 178 | 259 | 438 | 301 | | | | 204 | 204 | 0 | 1421 | 0 | 204 | 153 | 23 | 31 | 411 |
| | FEB | 106 | 162 | 149 | 311 | 459 | | | | 51 | 51 | 0 | 2140 | 0 | 51 | 130 | 21 | 28 | 229 |
| | MAR | 141 | 202 | 187 | 389 | 882 | | | | 176 | 176 | 0 | 3235 | 0 | 176 | 372 | 58 | 78 | 684 |
| | APR | 1037 | 1097 | 3193 | 4290 | 4305 | | 0 | 2195 | | 2195 | 0 | 9635 | 0 | 2195 | 3190 | 972 | 1303 | 7661 |
| | MAY | 1134 | 1195 | 5452 | 6647 | 1286 | 613 | 0 | 7638 | | 7638 | 0 | 9317 | 0 | 7638 | 2270 | 551 | 739 | 11198 |
| | JUN | 404 | 463 | 1754 | 2217 | 736 | 735 | 1511 | 3636 | | 5147 | 0 | 6387 | 0 | 5147 | 725 | 320 | 429 | 6622 |
| | JUL | 151 | 213 | 727 | 940 | 456 | 698 | 6431 | 1656 | | 8087 | 1001 | 0 | 0 | 7086 | 328 | 121 | 162 | 7697 |
| | AUG | 64 | 198 | 358 | 556 | 14 | 458 | 3085 | 569 | | 3654 | 3542 | 0 | 0 | 112 | 161 | 52 | 70 | 395 |
| | SEP | 80 | 160 | 296 | 456 | 221 | 349 | 618 | 677 | | 1295 | 967 | 0 | 0 | 328 | 133 | 28 | 38 | 527 |
| | TOTAL | 3685 | 4501 | 13220 | 17721 | 8677 | 3091 | 12870 | 16370 | 801 | 30041 | 6734 | | 0 | 23307 | 7912 | 2246 | 3012 | 36477 |
| | OCT | 112 | 205 | 305 | 510 | -177 | 185 | 57 | 332 | | 389 | 241 | 0 | 0 | 148 | 147 | 50 | 67 | 411 |
| | NOV | 101 | 160 | 287 | 447 | -25 | 54 | | | 141 | 141 | 0 | 226 | 0 | 141 | 123 | 66 | 89 | 419 |
| | DEC | 114 | 176 | 282 | 457 | -345 | | | | 114 | 114 | 0 | 225 | 0 | 114 | 120 | 37 | 49 | 320 |
| 1991 | JAN | 129 | 190 | 362 | 552 | 351 | | | | 432 | 432 | 0 | 696 | 0 | 432 | 109 | 25 | 34 | 600 |
| | FEB | 123 | 179 | 377 | 556 | 192 | | | | 111 | 111 | 0 | 1333 | 0 | 111 | 112 | 22 | 30 | 275 |
| | MAR | 137 | 199 | 430 | 629 | 884 | | | | 40 | 40 | 0 | 2805 | 0 | 40 | 168 | 47 | 63 | 318 |
| | APR | 270 | 329 | 1787 | 2116 | 2210 | | 0 | 1170 | | 1170 | 0 | 5961 | 0 | 1170 | 1200 | 214 | 287 | 2871 |
| | MAY | 2438 | 2799 | 6625 | 9424 | 5335 | 544 | 0 | 5929 | | 5929 | 0 | 14246 | 0 | 5929 | 4270 | 1035 | 1388 | 12623 |
| | JUN | 1246 | 1305 | 3920 | 5225 | 4728 | 832 | 0 | 6286 | | 6286 | 0 | 17081 | 0 | 6286 | 2890 | 773 | 1037 | 10986 |
| | JUL | 260 | 321 | 1123 | 1444 | -624 | 919 | 8194 | 1186 | | 9380 | 0 | 7601 | 0 | 9380 | 791 | 196 | 262 | 10629 |
| | AUG | 144 | 205 | 471 | 676 | 220 | 636 | 5968 | 1077 | | 7045 | 0 | 815 | 0 | 7045 | 341 | 89 | 119 | 7593 |
| | SEP | 131 | 191 | 361 | 552 | 328 | 365 | 2779 | 1027 | | 3806 | 2476 | 0 | 0 | 1330 | 218 | 45 | 60 | 1654 |
| | TOTAL | 5203 | 6258 | 16328 | 22586 | 13076 | 3537 | 16998 | 17007 | 838 | 34843 | 2717 | | 0 | 32126 | 10489 | 2599 | 3485 | 48699 |
| | OCT | 115 | 259 | 67 | 326 | -286 | 185 | 2421 | 39 | | 2460 | 2460 | -145 | 0 | 0 | 183 | 42 | 57 | 282 |
| | NOV | 126 | 185 | 434 | 619 | 595 | 54 | | | 301 | 301 | 0 | 713 | 0 | 301 | 197 | 52 | 70 | 620 |
| | DEC | 118 | 179 | 344 | 523 | 353 | | | | 307 | 307 | 0 | 1282 | 0 | 307 | 186 | 61 | 81 | 635 |
| 1992 | JAN | 93 | 154 | 291 | 446 | 657 | | | | 307 | 307 | 0 | 2077 | 0 | 307 | 185 | 83 | 111 | 686 |
| | FEB | 70 | 125 | 271 | 397 | 529 | | | | 288 | 288 | 0 | 2715 | 0 | 288 | 191 | 87 | 117 | 684 |
| | MAR | 163 | 225 | 539 | 764 | 1098 | | | | 40 | 40 | 0 | 4537 | 0 | 40 | 641 | 119 | 160 | 961 |
| | APR | 669 | 728 | 2118 | 2847 | 834 | | 0 | 2594 | | 2594 | 0 | 5624 | 0 | 2594 | 1130 | 77 | 103 | 3904 |
| | MAY | 272 | 333 | 1867 | 2200 | 285 | 537 | 3230 | 3625 | | 6855 | 0 | 716 | 0 | 6855 | 834 | 56 | 75 | 7820 |
| | JUN | 270 | 329 | 715 | 1044 | -961 | 522 | 4644 | 309 | | 4953 | 4676 | 0 | 0 | 277 | 384 | 27 | 36 | 723 |
| | JUL | 61 | 265 | 425 | 690 | 102 | 523 | 1093 | 791 | | 1884 | 1616 | 0 | 0 | 268 | 163 | 11 | 15 | 457 |
| | AUG | 39 | 141 | 126 | 267 | 99 | 458 | 585 | 365 | | 950 | 950 | -92 | 0 | 0 | 43 | 1 | 2 | 46 |
| | SEP | 76 | 136 | 196 | 331 | 402 | 347 | 0 | 506 | | 506 | 212 | 0 | 0 | 294 | 83 | 5 | 7 | 390 |
| | TOTAL | 2072 | 3059 | 7393 | 10451 | 3707 | 2626 | 11973 | 8229 | 1243 | 21445 | 9913 | | 0 | 11532 | 4220 | 622 | 834 | 17209 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 235 | 195 | 19 | 59 | 123 | 123 | 0 | 61 | | 37 | 2401 | 0 | 0 | 0 | 0 | 37 | 2401 | 0 | 61 |
| | NOV | 203 | 203 | 14 | 14 | 119 | 119 | 0 | 59 | | 11 | 2226 | 0 | 0 | 0 | 0 | 11 | 2226 | 0 | 59 |
| | DEC | 174 | 174 | 13 | 13 | 123 | 123 | 0 | 61 | | | 2054 | 0 | 0 | 0 | 0 | | 2054 | 0 | 61 |
| 1993 | JAN | 128 | 128 | 10 | 10 | 123 | 123 | 0 | 61 | | | 1880 | 0 | 0 | 0 | 0 | | 1880 | 0 | 61 |
| | FEB | 127 | 104 | 10 | 32 | 111 | 111 | 0 | 55 | | | 1746 | 0 | 0 | 0 | 0 | | 1746 | 0 | 55 |
| | MAR | 234 | 222 | 19 | 32 | 123 | 123 | 0 | 61 | | | 1593 | 0 | 0 | 0 | 0 | | 1593 | 0 | 61 |
| | APR | 1085 | 1085 | 88 | 88 | 0 | 0 | 0 | 59 | | | 1622 | 0 | 0 | 0 | 0 | | 1622 | 0 | 59 |
| | MAY | 5968 | 1116 | 483 | 5335 | 0 | 0 | 0 | 361 | | 70 | 6526 | 0 | 0 | 0 | 0 | 70 | 6526 | 0 | 361 |
| | JUN | 2602 | 421 | 211 | 2392 | 735 | 735 | 0 | 59 | | 164 | 7960 | 0 | 0 | 0 | 0 | 164 | 7960 | 0 | 59 |
| | JUL | 632 | 200 | 51 | 483 | 1758 | 1758 | 0 | 61 | | 192 | 6432 | 0 | 0 | 0 | 0 | 192 | 6432 | 0 | 61 |
| | AUG | 305 | 106 | 25 | 224 | 2183 | 2183 | 0 | 61 | | 149 | 4263 | 0 | 0 | 0 | 0 | 149 | 4263 | 0 | 61 |
| | SEP | 226 | 124 | 18 | 120 | 3 | 3 | 0 | 59 | | 90 | 4231 | 0 | 0 | 0 | 0 | 90 | 4231 | 0 | 59 |
| | TOTAL | 11920 | 4079 | 962 | 8802 | 5400 | 5400 | 0 | 1023 | 0 | 712 | | 0 | 0 | 0 | | 712 | | 0 | 1023 |
| | OCT | 183 | 27 | 15 | 171 | 123 | 123 | 0 | 61 | | 48 | 4170 | 0 | 0 | 0 | 0 | 48 | 4170 | 0 | 61 |
| | NOV | 142 | 17 | 12 | 136 | 119 | 119 | 0 | 59 | | 14 | 4114 | 0 | 0 | 0 | 0 | 14 | 4114 | 0 | 59 |
| | DEC | 134 | 16 | 11 | 129 | 123 | 123 | 0 | 61 | | | 4058 | 0 | 0 | 0 | 0 | | 4058 | 0 | 61 |
| 1994 | JAN | 99 | 20 | 8 | 86 | 123 | 123 | 0 | 61 | | | 3960 | 0 | 0 | 0 | 0 | | 3960 | 0 | 61 |
| | FEB | 94 | 23 | 8 | 79 | 111 | 111 | 0 | 55 | | | 3872 | 0 | 0 | 0 | 0 | | 3872 | 0 | 55 |
| | MAR | 129 | 38 | 10 | 101 | 123 | 123 | 0 | 61 | | | 3789 | 0 | 0 | 0 | 0 | | 3789 | 0 | 61 |
| | APR | 652 | 99 | 53 | 606 | 0 | 0 | 0 | 59 | | | 4335 | 0 | 0 | 0 | 0 | | 4335 | 0 | 59 |
| | MAY | 3411 | 1079 | 276 | 2609 | 0 | 0 | 0 | 361 | | 108 | 6475 | 0 | 0 | 0 | 0 | 108 | 6475 | 0 | 361 |
| | JUN | 936 | 401 | 76 | 611 | 735 | 735 | 0 | 59 | | 163 | 6129 | 0 | 0 | 0 | 0 | 163 | 6129 | 0 | 59 |
| | JUL | 294 | 86 | 24 | 232 | 1758 | 1758 | 0 | 61 | | 165 | 4376 | 0 | 0 | 0 | 0 | 165 | 4376 | 0 | 61 |
| | AUG | 206 | 41 | 17 | 182 | 2183 | 2183 | 0 | 61 | | 120 | 2193 | 0 | 0 | 0 | 0 | 120 | 2193 | 0 | 61 |
| | SEP | 162 | 26 | 13 | 148 | 3 | 3 | 0 | 59 | | 66 | 2214 | 0 | 0 | 0 | 0 | 66 | 2214 | 0 | 59 |
| | TOTAL | 6439 | 1872 | 522 | 5089 | 5400 | 5400 | 0 | 1023 | 0 | 683 | | 0 | 0 | 0 | | 683 | | 0 | 1023 |
| | OCT | 217 | 76 | 18 | 158 | 123 | 123 | 0 | 61 | | 35 | 2152 | 0 | 0 | 0 | 0 | 35 | 2152 | 0 | 61 |
| | NOV | 148 | 64 | 12 | 97 | 119 | 119 | 0 | 59 | | 10 | 2060 | 0 | 0 | 0 | 0 | 10 | 2060 | 0 | 59 |
| | DEC | 154 | 62 | 12 | 104 | 123 | 123 | 0 | 61 | | | 1980 | 0 | 0 | 0 | 0 | | 1980 | 0 | 61 |
| 1995 | JAN | 121 | 49 | 10 | 82 | 123 | 123 | 0 | 61 | | | 1878 | 0 | 0 | 0 | 0 | | 1878 | 0 | 61 |
| | FEB | 113 | 44 | 9 | 78 | 111 | 111 | 0 | 55 | | | 1790 | 0 | 0 | 0 | 0 | | 1790 | 0 | 55 |
| | MAR | 196 | 60 | 16 | 152 | 123 | 123 | 0 | 61 | | | 1757 | 0 | 0 | 0 | 0 | | 1757 | 0 | 61 |
| | APR | 570 | 292 | 46 | 324 | 0 | 0 | 0 | 59 | | | 2021 | 0 | 0 | 0 | 0 | | 2021 | 0 | 59 |
| | MAY | 4413 | 1129 | 357 | 3642 | 0 | 0 | 0 | 361 | | 76 | 5226 | 0 | 0 | 0 | 0 | 76 | 5226 | 0 | 361 |
| | JUN | 6590 | 253 | 534 | 6871 | 735 | 735 | 0 | 59 | | 145 | 10000 | 1158 | 0 | 0 | 1158 | 145 | 11158 | 0 | 59 |
| | JUL | 1329 | 77 | 108 | 1360 | 1758 | 1758 | 0 | 0 | | 219 | 9383 | 0 | 61 | 14 | 1083 | 233 | 10466 | 0 | 61 |
| | AUG | 513 | 65 | 42 | 489 | 2183 | 2183 | 0 | 0 | | 185 | 7504 | 0 | 61 | 12 | 1010 | 196 | 8514 | 0 | 61 |
| | SEP | 284 | 60 | 23 | 247 | 3 | 3 | 0 | 0 | | 124 | 7625 | 0 | 59 | 9 | 941 | 133 | 8566 | 0 | 59 |
| | TOTAL | 14646 | 2230 | 1186 | 13602 | 5400 | 5400 | 0 | 841 | 0 | 793 | | 1158 | 182 | 35 | | 828 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 186 | 247 | 224 | 471 | 162 | 185 | 0 | 422 | | 422 | 0 | 26 | 0 | 422 | 147 | 0 | 0 | 569 |
| | NOV | 143 | 202 | 212 | 414 | 753 | 55 | | | 232 | 232 | 0 | 906 | 0 | 232 | 272 | 0 | 0 | 504 |
| | DEC | 132 | 193 | 245 | 438 | 571 | | | | 335 | 335 | 0 | 1580 | 0 | 335 | 207 | 0 | 0 | 542 |
| 1993 | JAN | 175 | 236 | 217 | 453 | 804 | | | | 309 | 309 | 0 | 2527 | 0 | 309 | 187 | 16 | 22 | 534 |
| | FEB | 177 | 232 | 156 | 388 | 996 | | | | 279 | 279 | 0 | 3631 | 0 | 279 | 176 | 37 | 50 | 543 |
| | MAR | 318 | 380 | 399 | 779 | 1457 | | | | 177 | 177 | 0 | 5690 | 0 | 177 | 853 | 75 | 101 | 1205 |
| | APR | 815 | 874 | 1301 | 2175 | 3597 | | 0 | 0 | | 0 | 0 | 11463 | 0 | 0 | 5251 | 366 | 490 | 6107 |
| | MAY | 4547 | 4908 | 17739 | 22647 | 8265 | 644 | 0 | 0 | | 0 | 0 | 41731 | 0 | 0 | 14915 | 1935 | 2595 | 19446 |
| | JUN | 1279 | 1339 | 4942 | 6281 | 4842 | 1144 | 0 | 4642 | | 4642 | 0 | 47068 | 0 | 4642 | 3748 | 557 | 747 | 9695 |
| | JUL | 302 | 364 | 1123 | 1487 | 221 | 1230 | 8913 | 2130 | | 11043 | 0 | 36503 | 0 | 11043 | 970 | 193 | 259 | 12465 |
| | AUG | 150 | 211 | 541 | 752 | 1069 | 1010 | 6594 | 1984 | | 8578 | 0 | 28736 | 0 | 8578 | 465 | 74 | 100 | 9217 |
| | SEP | 121 | 181 | 307 | 487 | 132 | 720 | 4834 | 680 | | 5514 | 0 | 23122 | 0 | 5514 | 260 | 51 | 68 | 5893 |
| | TOTAL | 8345 | 9368 | 27405 | 36773 | 22868 | 4988 | 20341 | 9858 | 1332 | 31531 | 0 | | 0 | 31531 | 27451 | 3305 | 4432 | 66720 |
| | OCT | 140 | 201 | 365 | 566 | 365 | 358 | 63 | 1040 | | 1103 | 0 | 22591 | 0 | 1103 | 330 | 34 | 46 | 1513 |
| | NOV | 122 | 181 | 211 | 392 | 474 | 105 | | | 373 | 373 | 0 | 22980 | 0 | 373 | 308 | 40 | 53 | 773 |
| | DEC | 125 | 187 | 275 | 462 | 1141 | | | | 307 | 307 | 0 | 24277 | 0 | 307 | 295 | 34 | 46 | 681 |
| 1994 | JAN | 113 | 174 | 325 | 499 | 472 | | | | 307 | 307 | 0 | 24940 | 0 | 307 | 202 | 59 | 79 | 646 |
| | FEB | 99 | 154 | 998 | 1152 | 495 | | | | 273 | 273 | 0 | 26314 | 0 | 273 | 237 | 41 | 54 | 606 |
| | MAR | 143 | 204 | 1536 | 1740 | -315 | | | | 53 | 53 | 0 | 27686 | 0 | 53 | 712 | 72 | 96 | 934 |
| | APR | 582 | 641 | 2228 | 2869 | 799 | | 0 | 2548 | | 2548 | 0 | 28806 | 0 | 2548 | 1538 | 255 | 342 | 4684 |
| | MAY | 1983 | 2344 | 4002 | 6346 | 3458 | 856 | 0 | 8436 | | 8436 | 0 | 29318 | 0 | 8436 | 1743 | 548 | 735 | 11462 |
| | JUN | 416 | 476 | 962 | 1438 | 780 | 1041 | 6988 | 2769 | | 9758 | 0 | 20737 | 0 | 9758 | 606 | 518 | 695 | 11576 |
| | JUL | 81 | 143 | 344 | 487 | -573 | 977 | 10821 | 84 | | 10905 | 0 | 8768 | 0 | 10905 | 163 | 126 | 169 | 11363 |
| | AUG | 85 | 146 | 207 | 353 | 293 | 660 | 7044 | 766 | | 7810 | 0 | 944 | 0 | 7810 | 88 | 77 | 103 | 8079 |
| | SEP | 95 | 154 | 97 | 251 | -126 | 367 | 2129 | 214 | | 2343 | 1642 | 0 | 0 | 701 | 83 | 12 | 16 | 810 |
| | TOTAL | 3983 | 5006 | 11549 | 16554 | 7263 | 4365 | 27046 | 15857 | 1313 | 44217 | 1642 | | 0 | 42574 | 6306 | 1814 | 2433 | 53128 |
| | OCT | 170 | 231 | 236 | 467 | 831 | 185 | 0 | 599 | | 599 | 0 | 513 | 0 | 599 | 204 | 0 | 0 | 804 |
| | NOV | 130 | 190 | 235 | 424 | 629 | 56 | | | 649 | 649 | 0 | 861 | 0 | 649 | 189 | 5 | 7 | 850 |
| | DEC | 142 | 203 | 260 | 463 | 692 | | | | 307 | 307 | 0 | 1709 | 0 | 307 | 222 | 0 | 0 | 528 |
| 1995 | JAN | 163 | 224 | 276 | 501 | 934 | | | | 180 | 180 | 0 | 2963 | 0 | 180 | 210 | 9 | 13 | 411 |
| | FEB | 144 | 200 | 359 | 559 | 642 | | | | 111 | 111 | 0 | 4054 | 0 | 111 | 278 | 36 | 48 | 473 |
| | MAR | 254 | 316 | 1196 | 1511 | 2408 | | | | 123 | 123 | 0 | 7850 | 0 | 123 | 822 | 76 | 102 | 1123 |
| | APR | 502 | 561 | 2816 | 3377 | 1571 | | 0 | 331 | | 331 | 0 | 12467 | 0 | 331 | 2578 | 224 | 301 | 3434 |
| | MAY | 2987 | 3349 | 12337 | 15686 | 5292 | 660 | 0 | 123 | | 123 | 0 | 32663 | 0 | 123 | 12030 | 1171 | 1570 | 14894 |
| | JUN | 3346 | 3405 | 14731 | 18137 | 6522 | 1074 | 6336 | 6036 | | 12372 | 0 | 43876 | 0 | 12372 | 6653 | 1400 | 1878 | 22303 |
| | JUL | 758 | 819 | 2289 | 3109 | 6431 | 1209 | 9600 | 10838 | | 20438 | 0 | 31768 | 0 | 20438 | 1792 | 536 | 719 | 23485 |
| | AUG | 285 | 346 | 657 | 1003 | 2068 | 973 | 7816 | 3499 | | 11315 | 0 | 22552 | 0 | 11315 | 749 | 63 | 84 | 12210 |
| | SEP | 146 | 205 | 528 | 733 | 442 | 669 | 4879 | 1363 | | 6242 | 0 | 16817 | 0 | 6242 | 496 | 100 | 133 | 6971 |
| | TOTAL | 9027 | 10050 | 35920 | 45970 | 28461 | 4826 | 28631 | 22788 | 1369 | 52788 | 0 | | 0 | 52788 | 26224 | 3620 | 4854 | 87486 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 179 | 37 | 15 | 156 | 123 | 123 | 0 | 0 | | 66 | 7592 | 0 | 61 | 5 | 875 | 71 | 8467 | 0 | 61 |
| | NOV | 162 | 26 | 13 | 149 | 119 | 119 | 0 | 0 | | 19 | 7603 | 0 | 59 | 1 | 814 | 21 | 8417 | 0 | 59 |
| | DEC | 140 | 28 | 11 | 123 | 123 | 123 | 0 | 0 | | | 7603 | 0 | 61 | 0 | 753 | | 8356 | 0 | 61 |
| 1996 | JAN | 92 | 28 | 7 | 71 | 123 | 123 | 0 | 0 | | | 7551 | 0 | 61 | 0 | 692 | | 8243 | 0 | 61 |
| | FEB | 99 | 25 | 8 | 82 | 111 | 111 | 0 | 0 | | | 7522 | 0 | 55 | 0 | 636 | | 8158 | 0 | 55 |
| | MAR | 140 | 46 | 11 | 105 | 123 | 123 | 0 | 0 | | | 7504 | 0 | 61 | 0 | 575 | | 8079 | 0 | 61 |
| | APR | 427 | 94 | 35 | 367 | 0 | 0 | 0 | 0 | | | 7872 | 0 | 59 | 0 | 515 | | 8387 | 0 | 59 |
| | MAY | 5177 | 756 | 419 | 4840 | 0 | 0 | 0 | 0 | | 151 | 10000 | 2561 | 361 | 6 | 2709 | 157 | 12709 | 0 | 361 |
| | JUN | 2465 | 1165 | 200 | 1500 | 735 | 735 | 0 | 0 | | 210 | 10000 | 556 | 59 | 29 | 3176 | 239 | 13176 | 0 | 59 |
| | JUL | 519 | 242 | 42 | 319 | 1758 | 1758 | 0 | 0 | | 219 | 8343 | 0 | 61 | 35 | 3079 | 254 | 11422 | 0 | 61 |
| | AUG | 206 | 88 | 17 | 134 | 2183 | 2183 | 0 | 0 | | 173 | 6121 | 0 | 61 | 34 | 2984 | 206 | 9105 | 0 | 61 |
| | SEP | 142 | 45 | 11 | 109 | 3 | 3 | 0 | 0 | | 110 | 6117 | 0 | 59 | 28 | 2896 | 138 | 9013 | 0 | 59 |
| | TOTAL | 9748 | 2581 | 790 | 7957 | 5400 | 5400 | 0 | 0 | 0 | 948 | | 3116 | 1023 | 138 | | 1086 | | 0 | 1023 |
| | OCT | 144 | 37 | 12 | 119 | 123 | 123 | 0 | 0 | | 58 | 6055 | 0 | 61 | 15 | 2820 | 73 | 8875 | 0 | 61 |
| | NOV | 167 | 38 | 14 | 143 | 119 | 119 | 0 | 0 | | 17 | 6062 | 0 | 59 | 4 | 2757 | 21 | 8818 | 0 | 59 |
| | DEC | 147 | 32 | 12 | 127 | 123 | 123 | 0 | 0 | | | 6066 | 0 | 61 | 0 | 2695 | | 8761 | 0 | 61 |
| 1997 | JAN | 116 | 21 | 9 | 104 | 123 | 123 | 0 | 0 | | | 6047 | 0 | 61 | 0 | 2634 | | 8681 | 0 | 61 |
| | FEB | 114 | 25 | 9 | 98 | 111 | 111 | 0 | 0 | | | 6034 | 0 | 55 | 0 | 2579 | | 8613 | 0 | 55 |
| | MAR | 166 | 34 | 13 | 145 | 123 | 123 | 0 | 0 | | | 6057 | 0 | 61 | 0 | 2517 | | 8574 | 0 | 61 |
| | APR | 634 | 93 | 51 | 593 | 0 | 0 | 0 | 0 | | | 6650 | 0 | 59 | 0 | 2458 | | 9108 | 0 | 59 |
| | MAY | 7428 | 1089 | 602 | 6941 | 0 | 0 | 0 | 0 | | 137 | 10000 | 3454 | 361 | 27 | 4500 | 164 | 14500 | 1023 | 1384 |
| | JUN | 3025 | 343 | 245 | 2927 | 735 | 735 | 0 | 0 | | 210 | 10000 | 1982 | 59 | 46 | 4500 | 256 | 14500 | 1877 | 1936 |
| | JUL | 543 | 69 | 44 | 517 | 1758 | 1758 | 0 | 0 | | 219 | 8541 | 0 | 61 | 48 | 4391 | 267 | 12931 | 0 | 61 |
| | AUG | 248 | 28 | 20 | 241 | 2183 | 2183 | 0 | 0 | | 175 | 6423 | 0 | 61 | 45 | 4284 | 220 | 10707 | 0 | 61 |
| | SEP | 255 | 25 | 21 | 251 | 3 | 3 | 0 | 0 | | 113 | 6558 | 0 | 59 | 39 | 4186 | 152 | 10744 | 0 | 59 |
| | TOTAL | 12987 | 1833 | 1052 | 12206 | 5400 | 5400 | 0 | 0 | 0 | 929 | | 5436 | 1023 | 224 | | 1153 | | 2900 | 3922 |
| | OCT | 210 | 19 | 17 | 208 | 123 | 123 | 0 | 0 | | 61 | 6582 | 0 | 61 | 20 | 4105 | 81 | 10687 | 0 | 61 |
| | NOV | 170 | 25 | 14 | 158 | 119 | 119 | 0 | 0 | | 18 | 6604 | 0 | 59 | 6 | 4040 | 24 | 10643 | 0 | 59 |
| | DEC | 168 | 22 | 14 | 160 | 123 | 123 | 0 | 0 | | | 6640 | 0 | 61 | 0 | 3978 | | 10619 | 0 | 61 |
| 1998 | JAN | 130 | 21 | 10 | 119 | 123 | 123 | 0 | 0 | | | 6636 | 0 | 61 | 0 | 3917 | | 10553 | 0 | 61 |
| | FEB | 140 | 20 | 11 | 131 | 111 | 111 | 0 | 0 | | | 6656 | 0 | 55 | 0 | 3861 | | 10517 | 0 | 55 |
| | MAR | 204 | 29 | 16 | 191 | 123 | 123 | 0 | 0 | | | 6724 | 0 | 61 | 0 | 3800 | | 10524 | 0 | 61 |
| | APR | 642 | 97 | 52 | 597 | 0 | 0 | 0 | 0 | | | 7321 | 0 | 59 | 0 | 3741 | | 11062 | 0 | 59 |
| | MAY | 4626 | 1081 | 375 | 3919 | 0 | 0 | 0 | 0 | | 145 | 10000 | 1096 | 361 | 39 | 4436 | 183 | 14436 | 0 | 361 |
| | JUN | 2818 | 370 | 228 | 2677 | 735 | 735 | 0 | 0 | | 210 | 10000 | 1733 | 59 | 45 | 4500 | 255 | 14500 | 1564 | 1624 |
| | JUL | 759 | 64 | 61 | 756 | 1758 | 1758 | 0 | 0 | | 219 | 8780 | 0 | 61 | 48 | 4391 | 267 | 13171 | 0 | 61 |
| | AUG | 337 | 30 | 27 | 335 | 2183 | 2183 | 0 | 0 | | 178 | 6754 | 0 | 61 | 45 | 4285 | 222 | 11039 | 0 | 61 |
| | SEP | 240 | 32 | 19 | 228 | 3 | 3 | 0 | 0 | | 116 | 6863 | 0 | 59 | 38 | 4187 | 154 | 11050 | 0 | 59 |
| | TOTAL | 10443 | 1810 | 846 | 9479 | 5400 | 5400 | 0 | 0 | 0 | 946 | | 2829 | 1023 | 240 | | 1186 | | 1564 | 2587 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 137 | 198 | 560 | 758 | -184 | 324 | 2919 | 669 | | 3587 | 0 | 13479 | 0 | 3587 | 479 | 118 | 158 | 4342 |
| | NOV | 150 | 209 | 473 | 682 | 760 | 89 | | | 770 | 770 | 0 | 14063 | 0 | 770 | 444 | 97 | 130 | 1441 |
| | DEC | 130 | 192 | 379 | 570 | 1075 | | | | 614 | 614 | 0 | 15095 | 0 | 614 | 404 | 18 | 24 | 1060 |
| 1996 | JAN | 97 | 158 | 513 | 672 | 780 | | | | 351 | 351 | 0 | 16195 | 0 | 351 | 233 | 23 | 30 | 638 |
| | FEB | 112 | 168 | 518 | 686 | 1255 | | | | 832 | 832 | 0 | 17304 | 0 | 832 | 281 | 51 | 68 | 1232 |
| | MAR | 162 | 224 | 948 | 1171 | 793 | | | | 921 | 921 | 0 | 18347 | 0 | 921 | 589 | 86 | 115 | 1712 |
| | APR | 363 | 423 | 3505 | 3927 | 2031 | | 0 | 6267 | | 6267 | 0 | 18039 | 0 | 6267 | 4604 | 565 | 758 | 12193 |
| | MAY | 3753 | 4115 | 13626 | 17741 | 7269 | 740 | 1571 | 0 | | 1571 | 0 | 40738 | 0 | 1571 | 11110 | 1819 | 2439 | 16939 |
| | JUN | 1209 | 1268 | 3291 | 4559 | 4271 | 1138 | 0 | 8138 | | 8138 | 0 | 40293 | 0 | 8138 | 2412 | 537 | 719 | 11805 |
| | JUL | 228 | 290 | 895 | 1185 | 1132 | 1184 | 8831 | 2574 | | 11405 | 0 | 30021 | 0 | 11405 | 804 | 126 | 169 | 12504 |
| | AUG | 85 | 146 | 438 | 584 | -75 | 957 | 10221 | 582 | | 10803 | 0 | 18769 | 0 | 10803 | 296 | 74 | 99 | 11273 |
| | SEP | 86 | 146 | 399 | 545 | 316 | 631 | 2971 | 910 | | 3881 | 0 | 15118 | 0 | 3881 | 267 | 29 | 38 | 4215 |
| | TOTAL | 6513 | 7536 | 25544 | 33080 | 19425 | 5063 | 26512 | 19140 | 3488 | 49140 | 0 | | 0 | 49140 | 21924 | 3541 | 4749 | 79353 |
| | OCT | 106 | 168 | 444 | 612 | 438 | 313 | 457 | 1107 | | 1564 | 0 | 14290 | 0 | 1564 | 327 | 33 | 44 | 1969 |
| | NOV | 157 | 217 | 484 | 700 | 1057 | 91 | | | 495 | 495 | 0 | 15462 | 0 | 495 | 325 | 72 | 96 | 988 |
| | DEC | 136 | 198 | 325 | 522 | 1394 | | | | 0 | 0 | 0 | 17378 | 0 | 0 | 263 | 0 | 0 | 263 |
| 1997 | JAN | 152 | 213 | 322 | 535 | 1617 | | | | 0 | 0 | 0 | 19530 | 0 | 0 | 261 | 26 | 34 | 321 |
| | FEB | 147 | 202 | 381 | 583 | 1249 | | | | 644 | 644 | 0 | 20719 | 0 | 644 | 229 | 38 | 51 | 961 |
| | MAR | 204 | 266 | 638 | 904 | 2067 | | | | 921 | 921 | 0 | 22769 | 0 | 921 | 1983 | 120 | 161 | 3185 |
| | APR | 565 | 624 | 2988 | 3612 | 5065 | | 0 | 0 | | 0 | 0 | 31446 | 0 | 0 | 6890 | 428 | 574 | 7892 |
| | MAY | 6011 | 7395 | 15468 | 22862 | 13889 | 878 | 192 | 0 | | 192 | 0 | 65700 | 1428 | 1620 | 16450 | 2275 | 3050 | 23395 |
| | JUN | 1499 | 3435 | 4247 | 7682 | 6951 | 1294 | 3101 | 11444 | | 14545 | 0 | 64494 | 0 | 14545 | 3754 | 917 | 1230 | 20447 |
| | JUL | 244 | 305 | 1062 | 1367 | 1256 | 1341 | 9027 | 3079 | | 12106 | 0 | 53671 | 0 | 12106 | 1271 | 281 | 377 | 14034 |
| | AUG | 113 | 174 | 770 | 944 | 566 | 1111 | 4033 | 1690 | | 5722 | 0 | 48347 | 0 | 5722 | 675 | 77 | 104 | 6579 |
| | SEP | 134 | 193 | 709 | 902 | 2180 | 825 | 5122 | 3273 | | 8395 | 0 | 42209 | 0 | 8395 | 560 | 93 | 125 | 9173 |
| | TOTAL | 9467 | 13390 | 27837 | 41227 | 37728 | 5853 | 21932 | 20593 | 2060 | 44584 | 0 | | 1428 | 46012 | 32987 | 4360 | 5847 | 89206 |
| | OCT | 164 | 225 | 580 | 805 | 1038 | 424 | 5931 | 1989 | | 7920 | 0 | 35707 | 0 | 7920 | 471 | 256 | 343 | 8990 |
| | NOV | 161 | 220 | 501 | 721 | 667 | 120 | | | 0 | 0 | 0 | 36976 | 0 | 0 | 391 | 38 | 51 | 480 |
| | DEC | 153 | 214 | 344 | 559 | 597 | | | | 0 | 0 | 0 | 38131 | 0 | 0 | 239 | 30 | 41 | 309 |
| 1998 | JAN | 182 | 243 | 331 | 575 | 1484 | | | | 0 | 0 | 0 | 40190 | 0 | 0 | 206 | 46 | 62 | 314 |
| | FEB | 209 | 264 | 453 | 717 | 493 | | | | 0 | 0 | 0 | 41400 | 0 | 0 | 232 | 37 | 49 | 318 |
| | MAR | 267 | 328 | 696 | 1024 | 1738 | | | | 921 | 921 | 0 | 43242 | 0 | 921 | 1172 | 98 | 131 | 2323 |
| | APR | 573 | 632 | 2020 | 2652 | 1817 | | 1209 | 5007 | | 6216 | 0 | 41495 | 0 | 6216 | 4384 | 572 | 766 | 11937 |
| | MAY | 3201 | 3562 | 11417 | 14979 | 9227 | 944 | 22 | 0 | | 22 | 0 | 64735 | 0 | 22 | 13504 | 1839 | 2466 | 17831 |
| | JUN | 1392 | 3016 | 6683 | 9698 | 5502 | 1287 | 1297 | 11985 | | 13282 | 0 | 65367 | 0 | 13282 | 3249 | 910 | 1221 | 18662 |
| | JUL | 385 | 447 | 2609 | 3055 | 551 | 1348 | 7346 | 4301 | | 11646 | 0 | 55979 | 0 | 11646 | 1191 | 161 | 216 | 13214 |
| | AUG | 171 | 232 | 691 | 923 | 1751 | 1124 | 8487 | 2948 | | 11435 | 0 | 46094 | 0 | 11435 | 570 | 72 | 97 | 12173 |
| | SEP | 128 | 187 | 447 | 634 | 667 | 816 | 4788 | 1469 | | 6257 | 0 | 40322 | 0 | 6257 | 400 | 66 | 89 | 6811 |
| | TOTAL | 6984 | 9571 | 26771 | 36342 | 25532 | 6062 | 29079 | 27698 | 921 | 57698 | 0 | | 0 | 57698 | 26007 | 4125 | 5532 | 93363 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 197 | 33 | 16 | 180 | 123 | 123 | 0 | 0 | | 62 | 6858 | 0 | 61 | 20 | 4106 | 82 | 10964 | 0 | 61 |
| | NOV | 167 | 28 | 14 | 152 | 119 | 119 | 0 | 0 | | 18 | 6872 | 0 | 59 | 6 | 4041 | 24 | 10914 | 0 | 59 |
| | DEC | 85 | 28 | 7 | 64 | 123 | 123 | 0 | 0 | | | 6813 | 0 | 61 | 0 | 3980 | | 10793 | 0 | 61 |
| 1999 | JAN | 67 | 27 | 5 | 46 | 123 | 123 | 0 | 0 | | | 6736 | 0 | 61 | 0 | 3919 | | 10655 | 0 | 61 |
| | FEB | 85 | 30 | 7 | 62 | 111 | 111 | 0 | 0 | | | 6687 | 0 | 55 | 0 | 3863 | | 10550 | 0 | 55 |
| | MAR | 127 | 41 | 10 | 96 | 123 | 123 | 0 | 0 | | | 6660 | 0 | 61 | 0 | 3802 | | 10462 | 0 | 61 |
| | APR | 339 | 105 | 27 | 262 | 0 | 0 | 0 | 0 | | | 6922 | 0 | 59 | 0 | 3742 | | 10665 | 0 | 59 |
| | MAY | 3776 | 636 | 306 | 3446 | 0 | 0 | 0 | 0 | | 140 | 10000 | 228 | 361 | 39 | 3569 | 180 | 13569 | 0 | 361 |
| | JUN | 2882 | 363 | 233 | 2751 | 735 | 735 | 0 | 0 | | 210 | 10000 | 1807 | 59 | 38 | 4500 | 247 | 14500 | 779 | 839 |
| | JUL | 618 | 102 | 50 | 566 | 1758 | 1758 | 0 | 0 | | 219 | 8589 | 0 | 61 | 48 | 4391 | 267 | 12980 | 0 | 61 |
| | AUG | 416 | 45 | 34 | 404 | 2183 | 2183 | 0 | 0 | | 176 | 6635 | 0 | 61 | 45 | 4284 | 221 | 10919 | 0 | 61 |
| | SEP | 293 | 32 | 24 | 285 | 3 | 3 | 0 | 0 | | 115 | 6803 | 0 | 59 | 38 | 4187 | 153 | 10989 | 0 | 59 |
| | TOTAL | 9052 | 1471 | 733 | 8315 | 5400 | 5400 | 0 | 0 | 0 | 940 | | 2035 | 1023 | 234 | | 1174 | | 779 | 1802 |
| | OCT | 158 | 41 | 13 | 130 | 123 | 123 | 0 | 0 | | 62 | 6748 | 0 | 61 | 20 | 4106 | 82 | 10853 | 0 | 61 |
| | NOV | 139 | 38 | 11 | 112 | 119 | 119 | 0 | 0 | | 18 | 6723 | 0 | 59 | 6 | 4040 | 24 | 10763 | 0 | 59 |
| | DEC | 94 | 19 | 8 | 83 | 123 | 123 | 0 | 0 | | | 6682 | 0 | 61 | 0 | 3979 | | 10661 | 0 | 61 |
| 2000 | JAN | 82 | 11 | 7 | 78 | 123 | 123 | 0 | 0 | | | 6638 | 0 | 61 | 0 | 3918 | | 10555 | 0 | 61 |
| | FEB | 80 | 17 | 7 | 70 | 111 | 111 | 0 | 0 | | | 6596 | 0 | 55 | 0 | 3862 | | 10458 | 0 | 55 |
| | MAR | 123 | 29 | 10 | 104 | 123 | 123 | 0 | 0 | | | 6577 | 0 | 61 | 0 | 3801 | | 10378 | 0 | 61 |
| | APR | 821 | 66 | 67 | 821 | 0 | 0 | 0 | 0 | | | 7398 | 0 | 59 | 0 | 3741 | | 11140 | 0 | 59 |
| | MAY | 3179 | 711 | 257 | 2725 | 0 | 0 | 0 | 0 | | 146 | 9977 | 0 | 361 | 38 | 3342 | 184 | 13319 | 0 | 361 |
| | JUN | 1040 | 513 | 84 | 611 | 735 | 735 | 0 | 0 | | 209 | 9644 | 0 | 59 | 36 | 3247 | 245 | 12891 | 0 | 59 |
| | JUL | 322 | 106 | 26 | 242 | 1758 | 1758 | 0 | 0 | | 214 | 7914 | 0 | 61 | 37 | 3148 | 251 | 11063 | 0 | 61 |
| | AUG | 196 | 77 | 16 | 135 | 2183 | 2183 | 0 | 0 | | 167 | 5699 | 0 | 61 | 35 | 3052 | 203 | 8751 | 0 | 61 |
| | SEP | 150 | 53 | 12 | 108 | 3 | 3 | 0 | 0 | | 106 | 5700 | 0 | 59 | 30 | 2963 | 135 | 8662 | 0 | 59 |
| | TOTAL | 6383 | 1681 | 517 | 5220 | 5400 | 5400 | 0 | 0 | 0 | 923 | | 0 | 1023 | 201 | | 1124 | | 0 | 1023 |
| | OCT | 153 | 49 | 12 | 117 | 123 | 123 | 0 | 0 | | 56 | 5637 | 0 | 61 | 15 | 2886 | 71 | 8524 | 0 | 61 |
| | NOV | 127 | 45 | 10 | 92 | 119 | 119 | 0 | 0 | | 16 | 5594 | 0 | 59 | 4 | 2822 | 21 | 8416 | 0 | 59 |
| | DEC | 38 | 35 | 3 | 7 | 123 | 123 | 0 | 0 | | | 5478 | 0 | 61 | 0 | 2761 | | 8239 | 0 | 61 |
| 2001 | JAN | 46 | 30 | 4 | 19 | 123 | 123 | 0 | 0 | | | 5374 | 0 | 61 | 0 | 2700 | | 8073 | 0 | 61 |
| | FEB | 58 | 27 | 5 | 36 | 111 | 111 | 0 | 0 | | | 5299 | 0 | 55 | 0 | 2644 | | 7943 | 0 | 55 |
| | MAR | 131 | 46 | 11 | 96 | 123 | 123 | 0 | 0 | | | 5271 | 0 | 61 | 0 | 2583 | | 7854 | 0 | 61 |
| | APR | 907 | 308 | 73 | 672 | 0 | 0 | 0 | 0 | | | 5944 | 0 | 59 | 0 | 2523 | | 8467 | 0 | 59 |
| | MAY | 3624 | 879 | 294 | 3039 | 0 | 0 | 0 | 0 | | 128 | 8854 | 0 | 361 | 29 | 2133 | 158 | 10987 | 0 | 361 |
| | JUN | 696 | 212 | 56 | 540 | 735 | 735 | 0 | 0 | | 196 | 8464 | 0 | 59 | 25 | 2048 | 221 | 10512 | 0 | 59 |
| | JUL | 277 | 67 | 22 | 232 | 1758 | 1758 | 0 | 0 | | 199 | 6739 | 0 | 61 | 26 | 1960 | 225 | 8700 | 0 | 61 |
| | AUG | 184 | 42 | 15 | 157 | 2183 | 2183 | 0 | 0 | | 153 | 4561 | 0 | 61 | 24 | 1875 | 177 | 6436 | 0 | 61 |
| | SEP | 110 | 39 | 9 | 80 | 3 | 3 | 0 | 0 | | 93 | 4545 | 0 | 59 | 20 | 1796 | 113 | 6341 | 0 | 59 |
| | TOTAL | 6353 | 1780 | 515 | 5087 | 5400 | 5400 | 0 | 0 | 0 | 841 | | 0 | 1023 | 144 | | 986 | | 0 | 1023 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 153 | 214 | 435 | 649 | 106 | 419 | 4176 | 873 | | 5049 | 0 | 35608 | 0 | 5049 | 482 | 159 | 214 | 5904 |
| | NOV | 157 | 216 | 552 | 769 | 984 | 119 | | | 198 | 198 | 0 | 37044 | 0 | 198 | 386 | 63 | 85 | 732 |
| | DEC | 87 | 148 | 462 | 610 | 536 | | | | 307 | 307 | 0 | 37883 | 0 | 307 | 260 | 22 | 30 | 619 |
| 1999 | JAN | 42 | 103 | 428 | 531 | 614 | | | | 307 | 307 | 0 | 38722 | 0 | 307 | 257 | 63 | 85 | 712 |
| | FEB | 79 | 134 | 96 | 230 | 842 | | | | 277 | 277 | 0 | 39517 | 0 | 277 | 182 | 45 | 60 | 564 |
| | MAR | 140 | 201 | 439 | 640 | 2596 | | | | 426 | 426 | 0 | 42327 | 0 | 426 | 816 | 76 | 102 | 1419 |
| | APR | 278 | 337 | 1326 | 1663 | 1555 | | 0 | 1980 | | 1980 | 0 | 43565 | 0 | 1980 | 1241 | 223 | 299 | 3743 |
| | MAY | 2349 | 2710 | 8323 | 11033 | 7953 | 955 | 0 | 1967 | | 1967 | 0 | 59628 | 0 | 1967 | 5929 | 366 | 490 | 8753 |
| | JUN | 1424 | 2263 | 4378 | 6641 | 5024 | 1253 | 22 | 12988 | | 13010 | 0 | 57030 | 0 | 13010 | 2982 | 769 | 1031 | 17791 |
| | JUL | 293 | 355 | 1105 | 1460 | 1056 | 1291 | 8428 | 3020 | | 11447 | 0 | 46807 | 0 | 11447 | 755 | 158 | 212 | 12572 |
| | AUG | 222 | 283 | 559 | 842 | 1215 | 1075 | 5045 | 2400 | | 7445 | 0 | 40344 | 0 | 7445 | 398 | 77 | 103 | 8023 |
| | SEP | 150 | 209 | 421 | 630 | 636 | 790 | 4037 | 1491 | | 5528 | 0 | 35292 | 0 | 5528 | 284 | 67 | 90 | 5969 |
| | TOTAL | 5372 | 7175 | 18522 | 25696 | 23117 | 5902 | 21707 | 24720 | 1515 | 47941 | 0 | | 0 | 47941 | 13973 | 2088 | 2800 | 66802 |
| | OCT | 118 | 180 | 525 | 705 | -773 | 405 | 6026 | 0 | | 6026 | 0 | 28792 | 0 | 6026 | 253 | 124 | 166 | 6570 |
| | NOV | 118 | 177 | 625 | 802 | -796 | 113 | | | 789 | 789 | 0 | 27898 | 0 | 789 | 234 | 102 | 136 | 1260 |
| | DEC | 93 | 155 | 505 | 660 | 476 | | | | 309 | 309 | 0 | 28724 | 0 | 309 | 254 | 0 | 0 | 563 |
| 2000 | JAN | 76 | 138 | 563 | 701 | 1082 | | | | 309 | 309 | 0 | 30198 | 0 | 309 | 197 | 9 | 13 | 528 |
| | FEB | 67 | 123 | 529 | 652 | 1435 | | | | 20 | 20 | 0 | 32265 | 0 | 20 | 147 | 39 | 52 | 257 |
| | MAR | 133 | 194 | 543 | 737 | 954 | | | | 0 | 0 | 0 | 33957 | 0 | 0 | 602 | 68 | 91 | 762 |
| | APR | 747 | 806 | 2406 | 3212 | 1278 | | 0 | 1054 | | 1054 | 0 | 37393 | 0 | 1054 | 2447 | 271 | 364 | 4136 |
| | MAY | 1750 | 2111 | 4610 | 6721 | 4279 | 920 | 0 | 7789 | | 7789 | 0 | 39684 | 0 | 7789 | 2449 | 629 | 843 | 11711 |
| | JUN | 470 | 529 | 1325 | 1854 | 1263 | 1130 | 5746 | 3669 | | 9415 | 0 | 32256 | 0 | 9415 | 731 | 576 | 772 | 11494 |
| | JUL | 100 | 161 | 517 | 679 | 645 | 1116 | 8765 | 1504 | | 10269 | 0 | 22194 | 0 | 10269 | 221 | 62 | 82 | 10634 |
| | AUG | 79 | 140 | 346 | 486 | 63 | 874 | 7185 | 623 | | 7808 | 0 | 14061 | 0 | 7808 | 125 | 76 | 103 | 8112 |
| | SEP | 89 | 149 | 355 | 504 | 233 | 577 | 851 | 786 | | 1637 | 0 | 12584 | 0 | 1637 | 130 | 4 | 5 | 1776 |
| | TOTAL | 3840 | 4863 | 12850 | 17713 | 10139 | 5134 | 28573 | 15426 | 1427 | 45426 | 0 | | 0 | 45426 | 7790 | 1960 | 2628 | 57804 |
| | OCT | 114 | 176 | 395 | 570 | 757 | 296 | 0 | 659 | | 659 | 0 | 12957 | 0 | 659 | 243 | 11 | 14 | 927 |
| | NOV | 100 | 160 | 450 | 609 | 962 | 88 | | | 579 | 579 | 0 | 13862 | 0 | 579 | 188 | 48 | 64 | 878 |
| | DEC | 49 | 111 | 346 | 456 | 339 | | | | 309 | 309 | 0 | 14348 | 0 | 309 | 176 | 32 | 42 | 559 |
| 2001 | JAN | 0 | 61 | 227 | 288 | 2754 | | | | 309 | 309 | 0 | 17081 | 0 | 309 | 202 | 18 | 24 | 554 |
| | FEB | 14 | 70 | 305 | 375 | 773 | | | | 279 | 279 | 0 | 17950 | 0 | 279 | 209 | 37 | 49 | 575 |
| | MAR | 147 | 208 | 457 | 666 | 1573 | | | | 0 | 0 | 0 | 20189 | 0 | 0 | 773 | 76 | 102 | 952 |
| | APR | 830 | 890 | 1859 | 2749 | 2125 | | 0 | 80 | | 80 | 0 | 24983 | 0 | 80 | 2429 | 267 | 358 | 3134 |
| | MAY | 2197 | 2558 | 5383 | 7941 | 3698 | 820 | 0 | 4594 | | 4594 | 0 | 31209 | 0 | 4594 | 3149 | 639 | 857 | 9239 |
| | JUN | 292 | 351 | 1259 | 1610 | 740 | 1060 | 5673 | 2831 | | 8504 | 0 | 23995 | 0 | 8504 | 843 | 509 | 682 | 10538 |
| | JUL | 70 | 132 | 459 | 590 | 759 | 1023 | 7143 | 1520 | | 8663 | 0 | 15659 | 0 | 8663 | 386 | 26 | 35 | 9111 |
| | AUG | 71 | 132 | 306 | 439 | 1560 | 783 | 5266 | 2095 | | 7361 | 0 | 9514 | 0 | 7361 | 265 | 78 | 104 | 7808 |
| | SEP | 73 | 132 | 213 | 345 | 481 | 514 | 3253 | 847 | | 4100 | 0 | 5726 | 0 | 4100 | 134 | 35 | 47 | 4316 |
| | TOTAL | 3959 | 4981 | 11659 | 16640 | 16523 | 4584 | 21335 | 12625 | 1477 | 35437 | 0 | | 0 | 35437 | 8997 | 1775 | 2380 | 48589 |

Water Supply Pool Capacity (acre-feet) = 10000
Min. Streamflow Pool Capacity (acre-feet) = 4500

Table C-9

Future With Narrows Project
Simulated Operation Study
(Unit--acre-feet)

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Narrows Reservoir Operation | | | | | | | | | | | | | | | | | | |
| Year | Month | Natural Flow Gooseberry Creek Nr. Fairview | Diversion by Cottonwood-Gooseberry | Other Inflow to Narrows Reservoir | Net Inflow to Narrows Reservoir | Project Irrigation Demand | Project Irrigation Release | Project Irrigation Shortage | Release from Wtr Sply Pool for Min. Streamflow | Bypass of Direct Flow Rights | Evaporation (Water Supply Pool) | End of Month Contents (Water Supply Pool) | Inflow to Min. Streamflow Pool | Fishery Release to Gooseberry Creek | Evaporation (Min. Streamflow Pool) | End of Month Contents (Min. Streamflow Pool) | Evaporation | Total End of Month Contents | Spills | Stream Flow Below Narrows Dam |
| | OCT | 92 | 28 | 7 | 72 | 123 | 123 | 0 | 0 | | 50 | 4445 | 0 | 61 | 10 | 1724 | 60 | 6169 | 0 | 61 |
| | NOV | 121 | 23 | 10 | 108 | 119 | 119 | 0 | 0 | | 14 | 4420 | 0 | 59 | 3 | 1662 | 17 | 6082 | 0 | 59 |
| | DEC | 79 | 7 | 6 | 79 | 123 | 123 | 0 | 0 | | | 4376 | 0 | 61 | 0 | 1600 | | 5976 | 0 | 61 |
| 2002 | JAN | 56 | 2 | 5 | 59 | 123 | 123 | 0 | 0 | | | 4311 | 0 | 61 | 0 | 1539 | | 5851 | 0 | 61 |
| | FEB | 46 | 6 | 4 | 44 | 111 | 111 | 0 | 0 | | | 4244 | 0 | 55 | 0 | 1484 | | 5728 | 0 | 55 |
| | MAR | 58 | 29 | 5 | 34 | 123 | 123 | 0 | 0 | | | 4155 | 0 | 61 | 0 | 1422 | | 5577 | 0 | 61 |
| | APR | 740 | 179 | 60 | 621 | 0 | 0 | 0 | 0 | | | 4776 | 0 | 59 | 0 | 1363 | | 6138 | 0 | 59 |
| | MAY | 2448 | 625 | 198 | 2021 | 0 | 0 | 0 | 0 | | 114 | 6683 | 0 | 361 | 17 | 984 | 131 | 7668 | 0 | 361 |
| | JUN | 503 | 99 | 41 | 444 | 735 | 735 | 0 | 0 | | 166 | 6226 | 0 | 59 | 14 | 911 | 180 | 7138 | 0 | 59 |
| | JUL | 232 | 36 | 19 | 215 | 1758 | 1758 | 0 | 0 | | 167 | 4517 | 0 | 61 | 14 | 836 | 180 | 5353 | 0 | 61 |
| | AUG | 114 | 27 | 9 | 95 | 2183 | 2183 | 0 | 0 | | 122 | 2307 | 0 | 61 | 12 | 763 | 134 | 3070 | 0 | 61 |
| | SEP | 104 | 18 | 8 | 94 | 3 | 3 | 0 | 0 | | 67 | 2332 | 0 | 59 | 9 | 694 | 76 | 3026 | 0 | 59 |
| | TOTAL | 4593 | 1079 | 372 | 3886 | 5400 | 5400 | 0 | 0 | 0 | 700 | | 0 | 1023 | 79 | | 778 | | 0 | 1023 |
| | AVERAGE | 9039 | 1875 | 732 | 7896 | 5400 | 5250 | 150 | 190 | 26 | 844 | 6036 | 1765 | 819 | 135 | 2200 | 979 | 8236 | 899 | 1933 |

Table C-9

Future With Narrows Project
Simulated Operation Study

| A | B | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Scofield Reservoir Operation | | | | | | | | | | | | | | |
| Year | Month | Reach Gains Between Dam Site and Gooseberry nr. Scofield | Stream Flow at Gooseberry Nr. Scofield | Reach Gains Above Fish Creek Above Reservoir | Stream Flow at Fish Creek Above Reservoir | Other Inflow to Scofield Reservoir | Evaporation | Irrigation Season Demand on Storage | Direct Flow Rights Releases | Non-Irrigation Season Demand on Storage | Total Demand on Storage | Shortage | End of Month Contents | Spills | Total Flow in Price River below Scofield Dam | White River | Beaver Creek | Lower Fish Creek Below Scofield Gains | Price River Above PRWID Treatment Plant |
| | OCT | 61 | 122 | 332 | 454 | 855 | 241 | 2373 | 1321 | | 3693 | 0 | 3101 | 0 | 3693 | 185 | 23 | 31 | 3932 |
| | NOV | 92 | 152 | 245 | 397 | 1702 | 64 | | | 709 | 709 | 0 | 4427 | 0 | 709 | 201 | 65 | 87 | 1061 |
| | DEC | 82 | 144 | 166 | 309 | 605 | | | | 309 | 309 | 0 | 5032 | 0 | 309 | 174 | 16 | 22 | 522 |
| 2002 | JAN | 16 | 78 | 189 | 267 | 720 | | | | 309 | 309 | 0 | 5710 | 0 | 309 | 183 | 16 | 21 | 530 |
| | FEB | 0 | 55 | 162 | 217 | 3732 | | | | 279 | 279 | 0 | 9380 | 0 | 279 | 184 | 35 | 47 | 545 |
| | MAR | 25 | 86 | 350 | 437 | 1676 | | | | 210 | 210 | 0 | 11283 | 0 | 210 | 296 | 65 | 88 | 659 |
| | APR | 668 | 727 | 1764 | 2492 | 1491 | | 0 | 1012 | | 1012 | 0 | 14253 | 0 | 1012 | 1378 | 196 | 263 | 2850 |
| | MAY | 1017 | 1378 | 3836 | 5215 | 2838 | 688 | 3133 | 9167 | | 12299 | 0 | 9319 | 0 | 12299 | 1099 | 406 | 545 | 14349 |
| | JUN | 192 | 251 | 1111 | 1362 | 1206 | 735 | 4503 | 2952 | | 7455 | 0 | 3696 | 0 | 7455 | 372 | 441 | 592 | 8861 |
| | JUL | 41 | 103 | 286 | 389 | -290 | 629 | 938 | 252 | | 1190 | 0 | 1976 | 0 | 1190 | 87 | 32 | 43 | 1352 |
| | AUG | 25 | 86 | 173 | 259 | 1657 | 508 | 444 | 1951 | | 2395 | 0 | 990 | 0 | 2395 | 10 | 77 | 104 | 2586 |
| | SEP | 70 | 130 | 277 | 407 | 1637 | 368 | 0 | 1350 | | 1350 | 0 | 1316 | 0 | 1350 | 53 | 5 | 7 | 1415 |
| | TOTAL | 2290 | 3312 | 8891 | 12203 | 17829 | 3233 | 11390 | 18004 | 1816 | 31210 | 0 | | 0 | 31210 | 4222 | 1379 | 1849 | 38660 |
| | AVERAGE | 5679 | 7612 | 22231 | 29843 | 21672 | 4892 | 22903 | 17414 | 1769 | 42085 | 871 | 24124 | 5568 | 46783 | 19718 | 3033 | 4067 | 73600 |

Average June 30 Contents = 36115

**Narrows Project**
**Future With Narrows Project Operation Study**
**Explanation of Columns**

## Introduction

The Future With Project operation study is intended to show the flows of Gooseberry and Fish Creeks and the Price River below Scofield Dam and the operation of Scofield Reservoir under the future with Narrows Project conditions.

The study is based on historical hydrologic data from the 1960 through 2002 period and relies on information in the Future Without Project Operation Study, the Scofield Reservoir Historical Operation Study, and the Scofield Reservoir Demand Study.

## Column Explanation

**Column**

A Year - data in the study is grouped according to water years with the water year beginning in October.

B Month - monthly values are provided for each year of the study.

C Natural Flow of Gooseberry Creek Near Fairview - the calculated natural flow of Gooseberry Creek at the USGS gaging station "Gooseberry Creek Near Fairview, Utah" (Sta. No. 09309800). Equal to Column C of the Future Without Project operation study.

D Diversion by Cottonwood-Gooseberry - the amount of Column C that was stored in Fairview Lakes or diverted through the Fairview Tunnel or Fairview Ditch as described under Column C, item 3. Equal to Column D of the Future Without Project operation study.

E Other Inflow to Narrows Reservoir - inflow to the reservoir below the "Gooseberry Creek Near Fairview, Utah" gage. Equal to Column F of the Future Without Project operation study.

F Net Inflow to Narrows Reservoir - Column C plus Column E minus Column D.

G Project Irrigation Demand - based on the remaining demand after existing supplies with a maximum release through Narrows Tunnel of 50 cfs. The 1984 Compromise Agreement limits this release to 5,400 acre-feet per year.

H Project Irrigation Release - equal to Column G provided there is sufficient water from Narrows Reservoir and inflow, otherwise it is limited to Narrows Reservoir contents plus inflow.

I Project Irrigation Shortage - Column G minus Column H.

**Column Explanation (continued)**

**Column**

J Release from Water Supply Pool for Minimum Streamflow - when there is insufficient water in the minimum streamflow pool, a minimum release of 1 cfs for fish habitat plus 300 acre-feet per year supplemental release for fish and channel maintenance is made from the water supply pool in Narrows Reservoir. The 300 acre-feet release is assumed to occur each year in May.

K Bypass of Direct Flow Rights - the amount of inflow bypassed for downstream direct flow rights when there is insufficient storage in Scofield Reservoir to satisfy those demands. These bypasses only occur when Scofield Reservoir is empty and there are unmet direct flow rights demands. The direct flow demands were identified in the Scofield Reservoir Demand Study, Column Q.

L Evaporation (Water Supply Pool) - the amount of Narrows Reservoir evaporation attributable to the water stored in the inactive and water supply pools. These calculated evaporation losses from Narrows Reservoir are based on the following evaporation rates: October - 0.17 ft., November - 0.05 ft., May - 0.38 ft., June - 0.46 ft., July - 0.48 ft., August - 0.42 ft., September - 0.32 ft. Evaporation losses in the remaining months were assumed to be zero due to ice cover on the reservoir.

M End of Month Contents (Water Supply Pool) - equal to the previous month's water supply pool content plus Column F minus Columns H, J, K, and L and is limited to a maximum of 10,000 acre-feet in accordance with the water rights agreement.

N Inflow to Minimum Streamflow Pool - when the calculated value of Column M exceeds 10,000 acre-feet, the excess is assumed to flow into the minimum streamflow pool where it can be stored for that purpose.

O Fishery Release to Gooseberry Creek - a minimum release of 1 cfs for fish habitat plus 300 acre-feet per year supplemental release for fish and channel maintenance is made from the minimum streamflow pool in Narrows Reservoir. If there is insufficient water in the minimum streamflow pool, the release will be made from the water supply pool. The 300 acre-feet release is assumed to occur in May of each year.

P Evaporation (Minimum Streamflow Pool) - the amount of Narrows Reservoir evaporation attributable to the water stored in the minimum streamflow pool.

Q End of Month Contents (Minimum Streamflow Pool) - equal to the previous month's minimum streamflow pool content plus Column N minus Columns O and P and is limited to a maximum of 4,500 acre-feet in accordance with the water rights agreement.

R Evaporation - the total evaporation from Narrows Reservoir. equal to Column L plus Column P.

**Column Explanation (continued)**

**Column**

S Total End of Month Contents - Column M plus Column Q.

T Spills - occur when the results of Column Q exceed the minimum streamflow pool capacity of 4,500 acre-feet, in which case the spill is equal to the calculated value of Column Q minus 4,500.

U Stream Flow Below Narrows Dam - equal to the sum of Columns J, K, O, and T.

V Reach Gains Between Dam Site and Gooseberry Near Scofield - equal to Column H of Future Without Project operation study.

W Stream Flow at Gooseberry Near Scofield - Column U plus Column V.

X Reach Gains Above Fish Creek Above Reservoir - Column J of Future Without Project operation study.

Y Stream Flow at Fish Creek Above Reservoir - Column W plus Column X.

Z Other Inflow to Scofield Reservoir - Column L of Future Without Project operation study.

AA Evaporation - calculated evaporation losses from Scofield Reservoir based on the following evaporation rates: October - 0.17 ft., November - 0.05 ft., May - 0.38 ft., June - 0.46 ft., July - 0.48 ft., August - 0.42 ft., September - 0.32 ft. Evaporation losses in the remaining months were assumed to be zero due to ice cover on the reservoir.

AB Irrigation Season Demand on Storage - Column AE from the Scofield Reservoir Demand Study.

AC Direct Flow Rights Releases - Column AC from the Scofield Reservoir Demand Study.

AD Non-Irrigation season Demand on Storage - Column AD from the Scofield Reservoir Demand Study.

AE Total Demand on Storage - the sum of Columns AB, AC, and AD.

AF Shortage - the amount of unsatisfied demand from Columns AB, AC, and AD due to insufficient storage.

AG End of Month Contents - equal to the previous month's active content plus Columns Y and Z minus Columns AA and AE plus Column AF minus Column AI. Limited to a maximum of 65,700 acre-feet in accordance with the reservoir active capacity and water rights.

**Column Explanation (continued)**

**Column**

AH Spills - occur when the results of Column AG exceed the maximum active content of 65,700 acre-feet, in which case the spill is equal to the calculated value of Column AG minus 65,700.

AI Total Flow in Price River Below Scofield Dam - equal to Column AE minus Column AF plus Column AH and represents the flow in the Price River below Scofield Dam under the Future With Narrows Project condition.

AI Total Flow in Price River Below Scofield Dam - equal to Column AE minus Column AF plus Column AH and represents the flow in the Price River below Scofield Dam under the Future With Narrows Project condition.

AJ White River - equal to Column E from the Scofield Reservoir Demand Study.

AK Beaver Creek - equal to Column H from the Scofield Reservoir Demand Study.

AL Lower Fish Creek Below Scofield Gains - equal to Column I from the Scofield Reservoir Demand Study.

AM Price River Above PRIWID Treatment Plant - equal to the sum of Columns U, V, W, and X.

# ATTACHMENT C

## WATER SUPPLY

3. EXISTING WATER SUPPLIES FOR GROUPS 1,2 AND 3 LANDS
   PROJECT WATER DELIVERIES FOR GROUPS 1,2,AND 3 LANDS

Sanpete Water Conservancy District

TABLE C-10
TOTAL EXISTING WATER SUPPLY FOR
GROUP 1 LANDS
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 906 | 863 | 892 | 936 | 904 | 1,257 | 1,183 | 2,846 | 4,135 | 1,847 | 954 | 877 | 17,600 |
| 1961 | 850 | 906 | 959 | 859 | 663 | 751 | 719 | 1,982 | 2,829 | 1,257 | 972 | 1,087 | 13,834 |
| 1962 | 905 | 1,062 | 951 | 902 | 870 | 982 | 1,800 | 4,002 | 7,722 | 4,254 | 1,840 | 1,343 | 26,633 |
| 1963 | 1,057 | 1,129 | 1,002 | 988 | 854 | 994 | 829 | 2,229 | 3,586 | 2,114 | 1,783 | 1,202 | 17,767 |
| 1964 | 893 | 891 | 921 | 902 | 806 | 919 | 817 | 2,464 | 6,001 | 2,804 | 1,512 | 1,233 | 20,163 |
| 1965 | 796 | 852 | 840 | 968 | 781 | 869 | 1,488 | 14,427 | 16,570 | 3,960 | 1,929 | 1,549 | 45,029 |
| 1966 | 1,104 | 1,131 | 1,157 | 1,112 | 951 | 1,461 | 5,686 | 10,324 | 2,563 | 1,227 | 713 | 785 | 28,214 |
| 1967 | 1,020 | 1,005 | 987 | 960 | 872 | 1,178 | 1,439 | 12,268 | 13,869 | 3,680 | 1,610 | 1,237 | 40,125 |
| 1968 | 931 | 957 | 928 | 865 | 945 | 1,202 | 1,390 | 15,125 | 18,021 | 3,594 | 2,404 | 1,263 | 47,625 |
| 1969 | 1,143 | 1,225 | 1,230 | 1,234 | 880 | 952 | 6,593 | 31,007 | 7,094 | 3,828 | 2,233 | 1,425 | 58,844 |
| 1970 | 1,193 | 1,284 | 1,209 | 1,159 | 1,088 | 1,265 | 1,075 | 15,117 | 10,068 | 4,346 | 1,944 | 1,010 | 40,758 |
| 1971 | 868 | 1,071 | 1,083 | 1,071 | 918 | 1,089 | 3,008 | 16,098 | 8,175 | 3,289 | 1,841 | 1,249 | 39,760 |
| 1972 | 1,081 | 1,045 | 1,110 | 1,112 | 924 | 1,687 | 2,416 | 8,561 | 3,536 | 2,028 | 921 | 792 | 25,213 |
| 1973 | 801 | 838 | 954 | 880 | 762 | 969 | 1,342 | 23,580 | 11,236 | 4,109 | 2,216 | 1,122 | 48,809 |
| 1974 | 898 | 878 | 799 | 865 | 723 | 1,052 | 1,290 | 17,467 | 5,318 | 2,692 | 1,536 | 742 | 34,260 |
| 1975 | 680 | 804 | 861 | 804 | 691 | 832 | 784 | 10,227 | 24,720 | 5,716 | 2,808 | 2,103 | 51,030 |
| 1976 | 1,343 | 1,164 | 1,143 | 1,132 | 989 | 1,008 | 1,437 | 12,206 | 3,980 | 2,601 | 1,254 | 778 | 29,035 |
| 1977 | 735 | 813 | 780 | 628 | 677 | 787 | 1,208 | 1,699 | 2,215 | 892 | 572 | 631 | 11,637 |
| 1978 | 548 | 685 | 814 | 831 | 696 | 1,132 | 3,070 | 20,371 | 21,672 | 4,247 | 2,237 | 1,703 | 58,006 |
| 1979 | 1,083 | 1,198 | 1,276 | 1,275 | 1,043 | 1,089 | 1,890 | 17,568 | 8,107 | 3,619 | 2,011 | 1,079 | 41,238 |
| 1980 | 758 | 953 | 1,069 | 1,078 | 912 | 869 | 2,149 | 18,133 | 24,435 | 7,177 | 3,360 | 2,624 | 63,517 |
| 1981 | 1,565 | 1,204 | 676 | 981 | 951 | 1,121 | 3,628 | 10,187 | 5,631 | 2,848 | 1,478 | 1,159 | 31,429 |
| 1982 | 1,109 | 1,238 | 995 | 914 | 1,022 | 1,411 | 3,896 | 28,774 | 17,270 | 4,988 | 2,490 | 1,582 | 65,689 |
| 1983 | 1,977 | 2,322 | 1,768 | 1,705 | 1,459 | 2,247 | 3,200 | 24,117 | 44,459 | 12,197 | 4,994 | 2,850 | 103,295 |
| 1984 | 2,133 | 1,783 | 1,808 | 1,677 | 1,491 | 1,599 | 3,037 | 39,353 | 22,126 | 6,328 | 3,403 | 2,636 | 87,374 |
| 1985 | 1,705 | 1,696 | 1,593 | 1,472 | 1,140 | 1,649 | 9,883 | 26,315 | 6,344 | 4,284 | 2,570 | 1,801 | 60,452 |
| 1986 | 1,362 | 1,271 | 1,304 | 1,323 | 1,271 | 3,393 | 8,166 | 33,418 | 20,232 | 4,058 | 2,667 | 1,872 | 80,337 |
| 1987 | 1,537 | 1,682 | 1,982 | 1,787 | 1,524 | 1,825 | 4,737 | 10,907 | 4,907 | 3,061 | 2,101 | 1,358 | 37,408 |
| 1988 | 854 | 1,011 | 894 | 901 | 801 | 1,013 | 2,350 | 11,574 | 4,014 | 2,986 | 1,676 | 1,297 | 29,371 |
| 1989 | 921 | 1,039 | 854 | 750 | 691 | 952 | 2,450 | 2,560 | 432 | 1,185 | 572 | 98 | 12,504 |
| AVERAGE | 1,092 | 1,133 | 1,095 | 1,069 | 943 | 1,252 | 2,765 | 14,830 | 11,042 | 3,707 | 1,953 | 1,350 | 42,232 |

TABLE C-11
FLOW AT OAK CREEK NEAR FAIRVIEW, UTAH
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 150 | 130 | 133 | 137 | 139 | 200 | 246 | 643 | 706 | 217 | 148 | 119 | 2,968 |
| 1961 | 140 | 136 | 143 | 126 | 102 | 119 | 149 | 445 | 454 | 165 | 148 | 143 | 2,270 |
| 1962 | 148 | 160 | 141 | 132 | 134 | 156 | 373 | 910 | 1,338 | 537 | 230 | 178 | 4,437 |
| 1963 | 174 | 170 | 149 | 145 | 131 | 158 | 172 | 511 | 652 | 246 | 210 | 154 | 2,872 |
| 1964 | 148 | 134 | 137 | 132 | 124 | 146 | 171 | 571 | 1,120 | 345 | 186 | 157 | 3,371 |
| 1965 | 131 | 128 | 125 | 142 | 120 | 138 | 310 | 3,420 | 3,170 | 439 | 241 | 188 | 8,552 |
| 1966 | 181 | 170 | 172 | 163 | 146 | 232 | 1,190 | 2,420 | 493 | 178 | 110 | 110 | 5,565 |
| 1967 | 169 | 151 | 147 | 141 | 134 | 187 | 301 | 2,910 | 2,690 | 532 | 252 | 173 | 7,787 |
| 1968 | 154 | 144 | 138 | 127 | 145 | 191 | 291 | 3,580 | 3,450 | 383 | 249 | 165 | 9,017 |
| 1969 | 189 | 184 | 183 | 181 | 135 | 151 | 1,380 | 7,280 | 1,220 | 419 | 239 | 176 | 11,737 |
| 1970 | 198 | 193 | 180 | 170 | 167 | 201 | 225 | 3,590 | 1,870 | 478 | 188 | 133 | 7,593 |
| 1971 | 143 | 161 | 161 | 157 | 141 | 173 | 630 | 3,810 | 1,500 | 329 | 192 | 163 | 7,560 |
| 1972 | 178 | 157 | 165 | 163 | 142 | 268 | 506 | 1,990 | 534 | 160 | 108 | 104 | 4,475 |
| 1973 | 133 | 126 | 142 | 129 | 117 | 154 | 281 | 5,570 | 2,120 | 413 | 192 | 145 | 9,522 |
| 1974 | 149 | 132 | 119 | 127 | 111 | 167 | 270 | 4,120 | 887 | 226 | 115 | 93 | 6,516 |
| 1975 | 113 | 121 | 128 | 118 | 106 | 132 | 164 | 2,430 | 4,760 | 692 | 261 | 206 | 9,231 |
| 1976 | 223 | 175 | 170 | 166 | 152 | 160 | 301 | 2,870 | 598 | 226 | 123 | 105 | 5,269 |
| 1977 | 122 | 122 | 116 | 92 | 104 | 125 | 253 | 395 | 323 | 121 | 86 | 84 | 1,943 |
| 1978 | 91 | 103 | 121 | 122 | 107 | 180 | 643 | 4,840 | 4,170 | 472 | 212 | 182 | 11,243 |
| 1979 | 180 | 180 | 190 | 187 | 160 | 173 | 396 | 4,140 | 1,550 | 375 | 171 | 113 | 7,815 |
| 1980 | 126 | 143 | 159 | 158 | 140 | 138 | 450 | 4,290 | 4,740 | 853 | 367 | 361 | 11,925 |
| 1981 | 260 | 181 | 111 | 144 | 146 | 178 | 760 | 2,410 | 1,070 | 287 | 130 | 110 | 5,787 |
| 1982 | 184 | 186 | 148 | 134 | 157 | 224 | 816 | 6,810 | 3,210 | 509 | 235 | 212 | 12,825 |
| 1983 | 328 | 349 | 263 | 250 | 224 | 357 | 670 | 5,730 | 8,680 | 1,760 | 643 | 389 | 19,643 |
| 1984 | 354 | 268 | 269 | 246 | 229 | 254 | 636 | 9,350 | 4,170 | 800 | 368 | 274 | 17,218 |
| 1985 | 283 | 255 | 237 | 216 | 175 | 262 | 2,070 | 6,220 | 1,090 | 490 | 247 | 206 | 11,751 |
| 1986 | 226 | 191 | 194 | 194 | 195 | 539 | 1,710 | 7,940 | 3,760 | 472 | 275 | 231 | 15,927 |
| 1987 | 255 | 253 | 295 | 262 | 234 | 290 | 992 | 2,570 | 856 | 301 | 213 | 170 | 6,691 |
| 1988 | 142 | 152 | 133 | 132 | 123 | 161 | 492 | 2,750 | 639 | 280 | 179 | 156 | 5,339 |
| 1989 | 153 | 156 | 127 | 110 | 106 | 151 | 513 | 608 | | | | | 1,924 |
| AVERAGE | 181 | 170 | 163 | 157 | 145 | 199 | 579 | 3,504 | 2,132 | 438 | 218 | 172 | 7,959 |

TABLE C-12
TOTAL FLOW IN COTTONWOOD CREEK
(INCLUDES NATURAL FLOW AND IMPORTS THROUGH FAIRVIEW TUNNEL)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 80 | 85 | 84 | 91 | 86 | 129 | 185 | 495 | 830 | 544 | 100 | 77 | 2,786 |
| 1961 | 75 | 89 | 90 | 84 | 63 | 77 | 112 | 342 | 733 | 290 | 107 | 92 | 2,154 |
| 1962 | 79 | 104 | 90 | 88 | 83 | 101 | 281 | 749 | 1541 | 851 | 505 | 150 | 4,622 |
| 1963 | 93 | 111 | 95 | 96 | 81 | 102 | 130 | 393 | 595 | 564 | 553 | 177 | 2,990 |
| 1964 | 79 | 88 | 87 | 88 | 77 | 94 | 129 | 450 | 897 | 577 | 439 | 214 | 3,219 |
| 1965 | 70 | 84 | 79 | 94 | 74 | 89 | 234 | 2630 | 2478 | 673 | 488 | 275 | 7,268 |
| 1966 | 97 | 111 | 109 | 108 | 90 | 150 | 897 | 1861 | 363 | 117 | 69 | 71 | 4,043 |
| 1967 | 90 | 99 | 93 | 93 | 83 | 121 | 227 | 2238 | 1978 | 348 | 158 | 111 | 5,639 |
| 1968 | 82 | 94 | 88 | 84 | 90 | 123 | 219 | 2765 | 2758 | 1152 | 975 | 199 | 8,629 |
| 1969 | 101 | 120 | 116 | 120 | 84 | 98 | 1040 | 5702 | 1503 | 1090 | 862 | 290 | 11,126 |
| 1970 | 106 | 126 | 114 | 113 | 103 | 130 | 170 | 2760 | 1837 | 1198 | 859 | 128 | 7,644 |
| 1971 | 77 | 105 | 102 | 104 | 87 | 112 | 475 | 2930 | 1303 | 1109 | 719 | 148 | 7,271 |
| 1972 | 95 | 103 | 105 | 108 | 88 | 173 | 381 | 1530 | 1045 | 970 | 287 | 79 | 4,964 |
| 1973 | 71 | 82 | 90 | 86 | 72 | 99 | 212 | 4283 | 1855 | 1320 | 1081 | 142 | 9,393 |
| 1974 | 80 | 86 | 75 | 84 | 69 | 108 | 204 | 3168 | 1282 | 1178 | 847 | 104 | 7,285 |
| 1975 | 61 | 79 | 81 | 78 | 66 | 85 | 124 | 1868 | 3806 | 1445 | 1263 | 710 | 9,666 |
| 1976 | 119 | 114 | 108 | 110 | 94 | 103 | 227 | 2207 | 1164 | 1088 | 523 | 67 | 5,924 |
| 1977 | 65 | 80 | 74 | 61 | 64 | 81 | 191 | 304 | 747 | 98 | 65 | 60 | 1,890 |
| 1978 | 49 | 67 | 77 | 81 | 66 | 116 | 485 | 3722 | 3066 | 1194 | 994 | 477 | 10,394 |
| 1979 | 96 | 118 | 120 | 124 | 99 | 112 | 298 | 3183 | 1140 | 1208 | 1002 | 305 | 7,805 |
| 1980 | 67 | 94 | 101 | 105 | 87 | 89 | 339 | 3299 | 3485 | 1519 | 1222 | 232 | 10,639 |
| 1981 | 139 | 118 | 0.1 | 95 | 90 | 115 | 573 | 1853 | 787 | 1015 | 711 | 406 | 5,902 |
| 1982 | 99 | 122 | 94 | 89 | 97 | 145 | 615 | 5236 | 2912 | 1383 | 1095 | 136 | 12,023 |
| 1983 | 176 | 228 | 167 | 166 | 139 | 231 | 505 | 4406 | 6382 | 1652 | 1235 | 250 | 15,537 |
| 1984 | 190 | 175 | 171 | 163 | 142 | 164 | 479 | 7189 | 3756 | 1280 | 1228 | 789 | 15,726 |
| 1985 | 152 | 167 | 150 | 143 | 108 | 169 | 1560 | 4783 | 1404 | 1209 | 1129 | 429 | 11,403 |
| 1986 | 121 | 125 | 123 | 129 | 121 | 348 | 1289 | 6105 | 3795 | 1319 | 1088 | 386 | 14,949 |
| 1987 | 137 | 165 | 187 | 174 | 145 | 187 | 748 | 1976 | 1049 | 1193 | 859 | 226 | 7,046 |
| 1988 | 76 | 99 | 84 | 88 | 76 | 104 | 371 | 2115 | 1046 | 1169 | 625 | 255 | 6,108 |
| 1989 | 82 | 102 | 81 | 73 | 66 | 98 | 387 | 467 | 338 | 1040 | 549 | 61 | 3,344 |
| AVERAGE | 97 | 111 | 101 | 104 | 90 | 128 | 436 | 2,700 | 1,863 | 993 | 721 | 235 | 7,580 |

TABLE C-13
FLOW IN SPRING CREEK
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 10 | 15 | 13 | 16 | 14 | 28 | 88 | 269 | 223 | 29 | 18 | 9 | 732 |
| 1961 | 9 | 16 | 14 | 14 | 10 | 17 | 53 | 186 | 144 | 22 | 17 | 11 | 513 |
| 1962 | 10 | 19 | 14 | 15 | 13 | 22 | 134 | 381 | 423 | 73 | 27 | 13 | 1,144 |
| 1963 | 11 | 20 | 14 | 17 | 13 | 22 | 62 | 214 | 206 | 33 | 25 | 12 | 649 |
| 1964 | 10 | 16 | 13 | 15 | 12 | 21 | 61 | 239 | 354 | 47 | 22 | 12 | 822 |
| 1965 | 9 | 15 | 12 | 16 | 12 | 19 | 111 | 1,432 | 1,003 | 60 | 29 | 14 | 2,732 |
| 1966 | 12 | 20 | 17 | 19 | 15 | 33 | 428 | 1,013 | 156 | 24 | 13 | 8 | 1,758 |
| 1967 | 11 | 18 | 14 | 16 | 13 | 26 | 108 | 1,218 | 851 | 72 | 30 | 13 | 2,390 |
| 1968 | 10 | 17 | 13 | 15 | 15 | 27 | 105 | 1,499 | 1,091 | 52 | 29 | 12 | 2,885 |
| 1969 | 12 | 22 | 18 | 21 | 14 | 21 | 496 | 3,047 | 386 | 57 | 28 | 13 | 4,135 |
| 1970 | 13 | 23 | 17 | 19 | 17 | 28 | 81 | 1,503 | 592 | 65 | 22 | 10 | 2,390 |
| 1971 | 9 | 19 | 16 | 18 | 14 | 24 | 226 | 1,595 | 474 | 45 | 23 | 12 | 2,475 |
| 1972 | 12 | 19 | 16 | 19 | 14 | 38 | 182 | 833 | 169 | 22 | 13 | 8 | 1,345 |
| 1973 | 9 | 15 | 14 | 15 | 12 | 22 | 101 | 2,332 | 671 | 56 | 23 | 11 | 3,281 |
| 1974 | 10 | 16 | 11 | 15 | 11 | 24 | 97 | 1,725 | 281 | 31 | 14 | 7 | 2,242 |
| 1975 | 7 | 14 | 12 | 13 | 11 | 19 | 59 | 1,017 | 1,506 | 94 | 31 | 15 | 2,798 |
| 1976 | 15 | 21 | 16 | 19 | 15 | 23 | 108 | 1,201 | 189 | 31 | 15 | 8 | 1,661 |
| 1977 | 8 | 15 | 11 | 11 | 10 | 18 | 91 | 165 | 102 | 16 | 10 | 6 | 463 |
| 1978 | 6 | 12 | 12 | 14 | 11 | 25 | 231 | 2,026 | 1,319 | 64 | 25 | 14 | 3,759 |
| 1979 | 12 | 21 | 18 | 21 | 16 | 24 | 142 | 1,733 | 490 | 51 | 20 | 8 | 2,556 |
| 1980 | 8 | 17 | 15 | 18 | 14 | 19 | 162 | 1,796 | 1,499 | 116 | 43 | 27 | 3,734 |
| 1981 | 17 | 22 | 11 | 16 | 15 | 25 | 273 | 1,009 | 338 | 39 | 15 | 8 | 1,788 |
| 1982 | 12 | 22 | 14 | 15 | 16 | 32 | 293 | 2,851 | 1,015 | 69 | 28 | 16 | 4,383 |
| 1983 | 22 | 42 | 25 | 29 | 22 | 50 | 241 | 2,399 | 2,746 | 239 | 76 | 29 | 5,920 |
| 1984 | 23 | 32 | 26 | 28 | 23 | 36 | 229 | 3,914 | 1,319 | 109 | 44 | 20 | 5,803 |
| 1985 | 19 | 30 | 23 | 25 | 18 | 37 | 744 | 2,604 | 345 | 67 | 29 | 15 | 3,956 |
| 1986 | 15 | 23 | 19 | 22 | 20 | 76 | 615 | 3,324 | 1,189 | 64 | 33 | 17 | 5,417 |
| 1987 | 17 | 30 | 28 | 30 | 23 | 41 | 357 | 1,076 | 271 | 41 | 25 | 13 | 1,952 |
| 1988 | 9 | 18 | 13 | 15 | 12 | 23 | 177 | 1,151 | 202 | 38 | 21 | 12 | 1,691 |
| 1989 | 10 | 19 | 12 | 13 | 11 | 21 | 184 | 255 | - | - | - | - | 525 |
| AVERAGE | 12 | 20 | 16 | 18 | 15 | 28 | 208 | 1,467 | 652 | 58 | 25 | 12 | 2,530 |

TABLE C-14
FLOW IN BIRCH CREEK
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 118 | 120 | 122 | 130 | 124 | 178 | 207 | 518 | 605 | 198 | 131 | 114 | 2,565 |
| 1961 | 111 | 126 | 131 | 119 | 91 | 106 | 125 | 358 | 388 | 150 | 130 | 137 | 1,972 |
| 1962 | 117 | 148 | 130 | 125 | 119 | 139 | 314 | 733 | 1,145 | 489 | 203 | 170 | 3,832 |
| 1963 | 138 | 157 | 137 | 137 | 117 | 141 | 145 | 412 | 558 | 224 | 186 | 147 | 2,499 |
| 1964 | 117 | 124 | 126 | 125 | 110 | 130 | 144 | 460 | 958 | 314 | 164 | 150 | 2,922 |
| 1965 | 104 | 119 | 115 | 134 | 107 | 123 | 261 | 2,754 | 2,713 | 400 | 213 | 179 | 7,222 |
| 1966 | 143 | 158 | 158 | 154 | 130 | 207 | 1,001 | 1,949 | 422 | 162 | 97 | 105 | 4,686 |
| 1967 | 134 | 140 | 135 | 133 | 119 | 167 | 253 | 2,343 | 2,302 | 485 | 222 | 165 | 6,598 |
| 1968 | 122 | 133 | 127 | 120 | 129 | 170 | 245 | 2,883 | 2,953 | 349 | 220 | 157 | 7,608 |
| 1969 | 150 | 171 | 168 | 171 | 120 | 135 | 1,161 | 5,862 | 1,044 | 382 | 211 | 168 | 9,743 |
| 1970 | 157 | 179 | 165 | 161 | 149 | 179 | 189 | 2,891 | 1,600 | 435 | 166 | 127 | 6,398 |
| 1971 | 113 | 149 | 148 | 149 | 126 | 154 | 530 | 3,068 | 1,284 | 300 | 170 | 155 | 6,346 |
| 1972 | 141 | 145 | 152 | 154 | 126 | 239 | 426 | 1,602 | 457 | 146 | 95 | 99 | 3,782 |
| 1973 | 105 | 117 | 130 | 122 | 104 | 137 | 236 | 4,485 | 1,814 | 376 | 170 | 138 | 7,934 |
| 1974 | 118 | 122 | 109 | 120 | 99 | 149 | 227 | 3,317 | 759 | 206 | 102 | 89 | 5,417 |
| 1975 | 89 | 112 | 118 | 112 | 94 | 118 | 138 | 1,957 | 4,074 | 630 | 230 | 196 | 7,868 |
| 1976 | 176 | 162 | 156 | 157 | 135 | 143 | 253 | 2,311 | 512 | 206 | 109 | 100 | 4,420 |
| 1977 | 97 | 113 | 107 | 87 | 93 | 111 | 213 | 318 | 276 | 110 | 76 | 80 | 1,681 |
| 1978 | 72 | 95 | 111 | 115 | 95 | 160 | 541 | 3,897 | 3,569 | 430 | 187 | 174 | 9,446 |
| 1979 | 142 | 167 | 174 | 177 | 143 | 154 | 333 | 3,333 | 1,327 | 342 | 151 | 108 | 6,551 |
| 1980 | 100 | 133 | 146 | 150 | 125 | 123 | 379 | 3,454 | 4,057 | 777 | 324 | 344 | 10,112 |
| 1981 | 206 | 168 | 102 | 136 | 130 | 159 | 639 | 1,941 | 916 | 261 | 115 | 105 | 4,878 |
| 1982 | 146 | 172 | 136 | 127 | 140 | 200 | 687 | 5,483 | 2,747 | 464 | 207 | 202 | 10,711 |
| 1983 | 260 | 323 | 241 | 237 | 200 | 318 | 564 | 4,614 | 7,429 | 1,604 | 568 | 371 | 16,729 |
| 1984 | 280 | 248 | 247 | 233 | 204 | 226 | 535 | 7,529 | 3,569 | 729 | 325 | 261 | 14,386 |
| 1985 | 224 | 236 | 218 | 204 | 156 | 234 | 1,741 | 5,008 | 933 | 446 | 218 | 196 | 9,814 |
| 1986 | 179 | 177 | 178 | 184 | 174 | 480 | 1,439 | 6,393 | 3,218 | 430 | 243 | 220 | 13,315 |
| 1987 | 202 | 234 | 271 | 248 | 208 | 258 | 835 | 2,069 | 733 | 274 | 188 | 162 | 5,682 |
| 1988 | 112 | 141 | 122 | 125 | 110 | 143 | 414 | 2,214 | 547 | 255 | 158 | 149 | 4,490 |
| 1989 | 121 | 145 | 117 | 104 | 94 | 135 | 432 | 490 | - | - | - | - | 1,638 |
| AVERAGE | 143 | 158 | 150 | 148 | 129 | 177 | 487 | 2,822 | 1,764 | 386 | 186 | 159 | 6,708 |

TABLE C-15
FLOW IN COVE CREEK
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 56 | 61 | 60 | 65 | 61 | 95 | 154 | 423 | 422 | 104 | 67 | 54 | 1,622 |
| 1961 | 52 | 64 | 64 | 60 | 45 | 57 | 93 | 292 | 271 | 79 | 67 | 64 | 1,208 |
| 1962 | 55 | 75 | 64 | 63 | 59 | 74 | 233 | 598 | 800 | 257 | 104 | 80 | 2,462 |
| 1963 | 65 | 80 | 67 | 69 | 58 | 75 | 108 | 336 | 390 | 118 | 95 | 69 | 1,530 |
| 1964 | 55 | 63 | 62 | 63 | 55 | 69 | 107 | 375 | 669 | 165 | 84 | 70 | 1,837 |
| 1965 | 49 | 60 | 56 | 68 | 53 | 66 | 194 | 2,247 | 1,894 | 210 | 109 | 84 | 5,090 |
| 1966 | 68 | 80 | 78 | 78 | 65 | 110 | 744 | 1,590 | 295 | 85 | 50 | 49 | 3,292 |
| 1967 | 63 | 71 | 66 | 67 | 59 | 89 | 188 | 1,912 | 1,607 | 255 | 114 | 77 | 4,568 |
| 1968 | 58 | 68 | 62 | 60 | 64 | 91 | 182 | 2,352 | 2,062 | 183 | 113 | 74 | 5,369 |
| 1969 | 71 | 87 | 82 | 86 | 60 | 72 | 863 | 4,784 | 729 | 201 | 108 | 79 | 7,222 |
| 1970 | 74 | 91 | 81 | 81 | 74 | 95 | 141 | 2,359 | 1,117 | 229 | 85 | 60 | 4,487 |
| 1971 | 54 | 76 | 73 | 75 | 62 | 82 | 394 | 2,504 | 896 | 158 | 87 | 73 | 4,534 |
| 1972 | 67 | 74 | 74 | 78 | 63 | 127 | 316 | 1,308 | 319 | 77 | 49 | 47 | 2,599 |
| 1973 | 50 | 59 | 64 | 61 | 52 | 73 | 176 | 3,660 | 1,267 | 198 | 87 | 65 | 5,812 |
| 1974 | 56 | 62 | 54 | 60 | 49 | 79 | 169 | 2,707 | 530 | 108 | 52 | 42 | 3,968 |
| 1975 | 42 | 57 | 58 | 56 | 47 | 63 | 103 | 1,597 | 2,844 | 331 | 118 | 92 | 5,408 |
| 1976 | 84 | 83 | 77 | 79 | 67 | 76 | 188 | 1,886 | 357 | 108 | 56 | 47 | 3,108 |
| 1977 | 46 | 58 | 52 | 44 | 46 | 59 | 158 | 260 | 193 | 58 | 39 | 38 | 1,051 |
| 1978 | 34 | 49 | 55 | 58 | 47 | 85 | 402 | 3,180 | 2,492 | 226 | 96 | 82 | 6,806 |
| 1979 | 67 | 85 | 86 | 89 | 71 | 82 | 248 | 2,720 | 926 | 180 | 78 | 51 | 4,683 |
| 1980 | 47 | 68 | 72 | 75 | 62 | 66 | 281 | 2,819 | 2,832 | 408 | 166 | 162 | 7,058 |
| 1981 | 97 | 85 | 50 | 69 | 65 | 85 | 475 | 1,584 | 639 | 137 | 59 | 49 | 3,394 |
| 1982 | 69 | 88 | 67 | 64 | 69 | 106 | 510 | 4,475 | 1,918 | 244 | 107 | 95 | 7,812 |
| 1983 | 123 | 165 | 119 | 119 | 99 | 169 | 419 | 3,765 | 5,187 | 843 | 291 | 174 | 11,473 |
| 1984 | 133 | 127 | 121 | 117 | 101 | 121 | 398 | 6,144 | 2,492 | 383 | 167 | 123 | 10,427 |
| 1985 | 106 | 120 | 107 | 103 | 77 | 124 | 1,295 | 4,087 | 651 | 235 | 112 | 92 | 7,109 |
| 1986 | 85 | 90 | 87 | 92 | 86 | 256 | 1,070 | 5,217 | 2,247 | 226 | 125 | 103 | 9,684 |
| 1987 | 96 | 119 | 133 | 125 | 104 | 138 | 620 | 1,689 | 512 | 144 | 97 | 76 | 3,853 |
| 1988 | 53 | 72 | 60 | 63 | 54 | 76 | 308 | 1,807 | 382 | 134 | 81 | 70 | 3,160 |
| 1989 | 57 | 74 | 57 | 52 | 47 | 72 | 321 | 400 | - | - | - | - | 1,080 |
| AVERAGE | 68 | 80 | 74 | 75 | 64 | 94 | 362 | 2,303 | 1,231 | 203 | 95 | 75 | 4,724 |

TABLE C-16
FLOW IN PLEASANT CREEK
(NATURAL FLOW PLUS IMPORTS FROM CANDLAND DITCH AND COAL FORK DITCH)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 492 | 452 | 480 | 497 | 480 | 627 | 303 | 498 | 1,349 | 755 | 490 | 504 | 6,927 |
| 1961 | 463 | 475 | 517 | 456 | 352 | 375 | 187 | 359 | 839 | 551 | 503 | 640 | 5,717 |
| 1962 | 496 | 556 | 512 | 479 | 462 | 490 | 465 | 631 | 2,475 | 2,047 | 771 | 752 | 10,136 |
| 1963 | 576 | 591 | 540 | 524 | 454 | 496 | 212 | 363 | 1,185 | 929 | 714 | 643 | 7,227 |
| 1964 | 484 | 466 | 496 | 479 | 428 | 459 | 205 | 369 | 2,003 | 1,356 | 617 | 630 | 7,992 |
| 1965 | 433 | 446 | 453 | 514 | 415 | 434 | 378 | 1,944 | 5,312 | 2,178 | 849 | 809 | 14,165 |
| 1966 | 603 | 592 | 623 | 590 | 505 | 729 | 1,426 | 1,491 | 834 | 661 | 374 | 442 | 8,870 |
| 1967 | 553 | 526 | 532 | 510 | 464 | 588 | 362 | 1,647 | 4,441 | 1,988 | 834 | 698 | 13,143 |
| 1968 | 505 | 501 | 500 | 459 | 502 | 600 | 348 | 2,046 | 5,707 | 1,475 | 818 | 656 | 14,117 |
| 1969 | 620 | 641 | 663 | 655 | 467 | 475 | 1,653 | 4,332 | 2,212 | 1,679 | 785 | 699 | 14,881 |
| 1970 | 645 | 672 | 652 | 615 | 578 | 632 | 269 | 2,014 | 3,052 | 1,941 | 624 | 552 | 12,246 |
| 1971 | 472 | 561 | 583 | 568 | 488 | 544 | 753 | 2,191 | 2,718 | 1,348 | 650 | 698 | 11,574 |
| 1972 | 588 | 547 | 598 | 590 | 491 | 842 | 605 | 1,298 | 1,012 | 653 | 369 | 455 | 8,048 |
| 1973 | 433 | 439 | 514 | 467 | 405 | 484 | 336 | 3,250 | 3,509 | 1,746 | 663 | 621 | 12,867 |
| 1974 | 485 | 460 | 431 | 459 | 384 | 525 | 323 | 2,430 | 1,579 | 943 | 406 | 407 | 8,832 |
| 1975 | 368 | 421 | 464 | 427 | 367 | 415 | 196 | 1,358 | 7,730 | 2,524 | 905 | 884 | 16,059 |
| 1976 | 726 | 609 | 616 | 601 | 526 | 503 | 360 | 1,731 | 1,160 | 942 | 428 | 451 | 8,653 |
| 1977 | 397 | 425 | 420 | 333 | 360 | 393 | 302 | 257 | 574 | 489 | 296 | 363 | 4,609 |
| 1978 | 296 | 359 | 438 | 441 | 370 | 566 | 768 | 2,706 | 7,056 | 1,861 | 723 | 774 | 16,358 |
| 1979 | 586 | 627 | 688 | 677 | 554 | 544 | 473 | 2,459 | 2,674 | 1,463 | 589 | 494 | 11,828 |
| 1980 | 410 | 498 | 576 | 572 | 484 | 434 | 538 | 2,475 | 7,822 | 3,504 | 1,238 | 1,498 | 20,049 |
| 1981 | 846 | 630 | 402 | 521 | 505 | 559 | 908 | 1,390 | 1,881 | 1,109 | 448 | 481 | 9,680 |
| 1982 | 599 | 648 | 536 | 485 | 543 | 704 | 975 | 3,919 | 5,468 | 2,319 | 818 | 921 | 17,935 |
| 1983 | 1,068 | 1,215 | 953 | 904 | 775 | 1,122 | 801 | 3,203 | 14,035 | 6,099 | 2,181 | 1,637 | 33,993 |
| 1984 | 1,153 | 933 | 974 | 890 | 792 | 798 | 760 | 5,227 | 6,820 | 3,027 | 1,271 | 1,169 | 23,814 |
| 1985 | 921 | 888 | 858 | 781 | 606 | 823 | 2,473 | 3,613 | 1,921 | 1,837 | 835 | 863 | 16,419 |
| 1986 | 736 | 665 | 703 | 702 | 675 | 1,694 | 2,043 | 4,439 | 6,023 | 1,547 | 903 | 915 | 21,045 |
| 1987 | 830 | 881 | 1,068 | 948 | 810 | 911 | 1,185 | 1,527 | 1,486 | 1,108 | 719 | 711 | 12,184 |
| 1988 | 462 | 529 | 482 | 478 | 426 | 506 | 588 | 1,537 | 1,198 | 1,110 | 612 | 655 | 8,583 |
| 1989 | 498 | 543 | 460 | 398 | 367 | 475 | 613 | 340 | 94 | 145 | 23 | 37 | 3,993 |
| AVERAGE | 591 | 593 | 591 | 567 | 501 | 625 | 694 | 2,035 | 3,472 | 1,644 | 715 | 702 | 12,731 |

TABLE C-17
TOTAL EXISTING WATER SUPPLY FOR
GROUP 2 LANDS
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 1,330 | 1,215 | 1,283 | 1,323 | 1,280 | 1,661 | 682 | 2,004 | 4,936 | 1,968 | 1,300 | 1,324 | 20,306 |
| 1961 | 1,271 | 1,297 | 1,396 | 1,225 | 950 | 1,004 | 426 | 1,536 | 3,094 | 1,437 | 1,375 | 1,672 | 16,683 |
| 1962 | 1,391 | 1,518 | 1,384 | 1,285 | 1,241 | 1,302 | 1,054 | 2,051 | 8,277 | 5,416 | 2,067 | 1,976 | 28,962 |
| 1963 | 1,575 | 1,624 | 1,475 | 1,413 | 1,219 | 1,319 | 479 | 1,241 | 4,085 | 2,447 | 1,940 | 1,692 | 20,509 |
| 1964 | 1,298 | 1,259 | 1,342 | 1,285 | 1,145 | 1,205 | 455 | 1,002 | 6,429 | 3,594 | 1,639 | 1,667 | 22,320 |
| 1965 | 1,178 | 1,224 | 1,227 | 1,387 | 1,118 | 1,155 | 846 | 3,216 | 14,416 | 5,895 | 2,393 | 2,122 | 36,177 |
| 1966 | 1,669 | 1,578 | 1,649 | 1,549 | 1,329 | 1,899 | 3,154 | 3,496 | 2,679 | 1,732 | 1,017 | 1,167 | 22,918 |
| 1967 | 1,478 | 1,401 | 1,413 | 1,350 | 1,228 | 1,540 | 801 | 2,666 | 11,739 | 5,247 | 2,209 | 1,843 | 32,915 |
| 1968 | 1,353 | 1,370 | 1,349 | 1,208 | 1,320 | 1,563 | 767 | 3,491 | 15,028 | 3,900 | 2,147 | 1,736 | 35,232 |
| 1969 | 1,665 | 1,718 | 1,746 | 1,720 | 1,229 | 1,236 | 3,653 | 8,908 | 7,215 | 4,459 | 2,061 | 1,847 | 37,457 |
| 1970 | 1,708 | 1,762 | 1,717 | 1,614 | 1,521 | 1,645 | 595 | 3,108 | 8,003 | 5,164 | 1,657 | 1,453 | 29,947 |
| 1971 | 1,281 | 1,470 | 1,536 | 1,491 | 1,283 | 1,417 | 1,662 | 3,853 | 8,757 | 3,583 | 1,762 | 1,831 | 29,926 |
| 1972 | 1,604 | 1,434 | 1,574 | 1,549 | 1,293 | 2,195 | 1,335 | 3,634 | 3,772 | 1,725 | 1,011 | 1,190 | 22,316 |
| 1973 | 1,145 | 1,151 | 1,355 | 1,226 | 1,065 | 1,261 | 741 | 6,129 | 9,424 | 4,661 | 1,832 | 1,630 | 31,620 |
| 1974 | 1,283 | 1,206 | 1,135 | 1,207 | 1,011 | 1,367 | 712 | 4,810 | 5,126 | 2,505 | 1,146 | 1,066 | 22,574 |
| 1975 | 973 | 1,105 | 1,221 | 1,121 | 965 | 1,081 | 432 | 2,055 | 19,371 | 6,648 | 2,511 | 2,319 | 39,802 |
| 1976 | 1,919 | 1,598 | 1,622 | 1,576 | 1,383 | 1,310 | 794 | 3,755 | 4,390 | 2,503 | 1,194 | 1,182 | 23,226 |
| 1977 | 1,051 | 1,114 | 1,107 | 875 | 947 | 1,023 | 668 | 710 | 2,140 | 1,288 | 816 | 952 | 12,691 |
| 1978 | 783 | 940 | 1,154 | 1,159 | 974 | 1,474 | 1,696 | 4,088 | 19,394 | 4,937 | 1,976 | 2,031 | 40,606 |
| 1979 | 1,549 | 1,643 | 1,812 | 1,776 | 1,457 | 1,417 | 1,045 | 5,017 | 7,911 | 3,874 | 1,626 | 1,294 | 30,421 |
| 1980 | 1,084 | 1,306 | 1,516 | 1,501 | 1,274 | 1,130 | 1,186 | 4,421 | 20,327 | 9,346 | 3,343 | 3,942 | 50,376 |
| 1981 | 2,237 | 1,653 | 1,059 | 1,368 | 1,329 | 1,457 | 2,005 | 2,482 | 5,891 | 2,930 | 1,240 | 1,260 | 24,911 |
| 1982 | 1,585 | 1,699 | 1,413 | 1,274 | 1,430 | 1,834 | 2,152 | 6,928 | 15,333 | 6,235 | 2,280 | 2,412 | 44,575 |
| 1983 | 2,823 | 3,187 | 2,509 | 2,375 | 2,039 | 2,923 | 1,768 | 4,839 | 34,449 | 16,007 | 5,916 | 4,303 | 83,138 |
| 1984 | 3,046 | 2,447 | 2,566 | 2,336 | 2,084 | 2,080 | 1,678 | 7,893 | 17,422 | 8,010 | 3,511 | 3,066 | 56,139 |
| 1985 | 2,436 | 2,328 | 2,261 | 2,052 | 1,592 | 2,145 | 5,458 | 6,680 | 6,036 | 4,850 | 2,261 | 2,270 | 40,369 |
| 1986 | 1,945 | 1,743 | 1,850 | 1,842 | 1,775 | 4,413 | 4,509 | 6,703 | 14,704 | 4,041 | 2,367 | 2,421 | 48,313 |
| 1987 | 2,194 | 2,311 | 2,814 | 2,489 | 2,131 | 2,373 | 2,616 | 3,116 | 4,648 | 2,912 | 1,945 | 1,870 | 31,419 |
| 1988 | 1,222 | 1,388 | 1,269 | 1,253 | 1,119 | 1,319 | 1,298 | 2,325 | 4,317 | 2,940 | 1,678 | 1,721 | 21,849 |
| 1989 | 1,317 | 1,424 | 1,213 | 1,045 | 965 | 1,236 | 1,354 | 518 | 1,223 | 406 | 128 | 88 | 10,917 |
| AVERAGE | 1,580 | 1,570 | 1,566 | 1,496 | 1,323 | 1,633 | 1,534 | 3,756 | 9,685 | 4,355 | 1,945 | 1,845 | 32,287 |

TABLE C-18
TOTAL FLOW IN TWIN CREEK
(NATURAL FLOW PLUS IMPORTS FROM TWIN CREEK TUNNEL)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 239 | 219 | 235 | 242 | 234 | 302 | 115 | 144 | 640 | 345 | 237 | 232 | 3,184 |
| 1961 | 223 | 231 | 252 | 222 | 171 | 181 | 70 | 103 | 460 | 261 | 238 | 279 | 2,691 |
| 1962 | 236 | 270 | 250 | 233 | 225 | 236 | 175 | 171 | 1,080 | 964 | 369 | 346 | 4,555 |
| 1963 | 278 | 287 | 264 | 255 | 221 | 239 | 81 | 96 | 598 | 427 | 338 | 301 | 3,385 |
| 1964 | 236 | 226 | 242 | 233 | 209 | 221 | 80 | 90 | 923 | 632 | 297 | 306 | 3,695 |
| 1965 | 209 | 216 | 221 | 250 | 202 | 209 | 146 | 459 | 2,333 | 1,019 | 392 | 366 | 6,022 |
| 1966 | 289 | 287 | 304 | 287 | 246 | 351 | 559 | 379 | 484 | 298 | 177 | 214 | 3,875 |
| 1967 | 270 | 255 | 260 | 248 | 226 | 283 | 141 | 386 | 1,998 | 936 | 403 | 337 | 5,743 |
| 1968 | 246 | 244 | 244 | 224 | 245 | 289 | 137 | 487 | 2,523 | 689 | 397 | 321 | 6,046 |
| 1969 | 302 | 311 | 324 | 319 | 228 | 229 | 648 | 1,086 | 995 | 786 | 381 | 342 | 5,951 |
| 1970 | 316 | 326 | 318 | 299 | 282 | 304 | 106 | 476 | 1,430 | 911 | 301 | 259 | 5,328 |
| 1971 | 228 | 272 | 285 | 276 | 238 | 262 | 296 | 525 | 1,191 | 627 | 309 | 317 | 4,826 |
| 1972 | 284 | 266 | 292 | 287 | 240 | 406 | 238 | 346 | 518 | 293 | 174 | 202 | 3,546 |
| 1973 | 212 | 213 | 251 | 227 | 197 | 233 | 132 | 796 | 1,605 | 817 | 310 | 282 | 5,275 |
| 1974 | 238 | 223 | 210 | 224 | 187 | 253 | 127 | 599 | 761 | 432 | 187 | 181 | 3,622 |
| 1975 | 180 | 205 | 226 | 208 | 179 | 200 | 77 | 322 | 3,419 | 1,195 | 422 | 401 | 7,034 |
| 1976 | 356 | 296 | 301 | 292 | 256 | 242 | 141 | 433 | 564 | 432 | 200 | 204 | 3,717 |
| 1977 | 195 | 206 | 205 | 162 | 175 | 189 | 119 | 60 | 367 | 215 | 139 | 163 | 2,195 |
| 1978 | 145 | 174 | 214 | 215 | 181 | 273 | 302 | 642 | 3,028 | 874 | 342 | 354 | 6,744 |
| 1979 | 287 | 304 | 336 | 329 | 270 | 262 | 186 | 611 | 1,218 | 683 | 276 | 220 | 4,982 |
| 1980 | 201 | 242 | 281 | 278 | 236 | 209 | 211 | 596 | 3,412 | 1,660 | 589 | 702 | 8,617 |
| 1981 | 415 | 306 | 196 | 253 | 246 | 270 | 357 | 330 | 887 | 513 | 210 | 214 | 4,197 |
| 1982 | 294 | 315 | 262 | 236 | 265 | 339 | 383 | 949 | 2,366 | 1,089 | 381 | 412 | 7,291 |
| 1983 | 524 | 590 | 465 | 440 | 378 | 541 | 315 | 760 | 6,113 | 2,921 | 1,033 | 757 | 14,837 |
| 1984 | 565 | 453 | 476 | 433 | 386 | 385 | 299 | 1,240 | 3,015 | 1,436 | 595 | 533 | 9,816 |
| 1985 | 452 | 431 | 419 | 380 | 295 | 397 | 972 | 882 | 901 | 864 | 397 | 401 | 6,791 |
| 1986 | 361 | 323 | 343 | 341 | 329 | 816 | 803 | 1,053 | 2,726 | 747 | 438 | 449 | 8,729 |
| 1987 | 407 | 428 | 522 | 461 | 395 | 439 | 466 | 375 | 737 | 514 | 342 | 331 | 5,417 |
| 1988 | 227 | 257 | 235 | 232 | 207 | 244 | 231 | 365 | 591 | 513 | 289 | 303 | 3,694 |
| 1989 | 244 | 264 | 225 | 194 | 179 | 229 | 241 | 81 | 148 | 48 | 4 | 0 | 1,857 |
| AVERAGE | 289 | 288 | 289 | 276 | 244 | 301 | 272 | 495 | 1,568 | 771 | 339 | 324 | 5,455 |

TABLE C-19
TOTAL FLOW IN CEDAR CREEK
(INCLUDES NATURAL FLOW AND IMPORTS FROM BLACK CANYON DITCH AND CEDAR CREEK TUNNEL)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 256 | 234 | 244 | 252 | 244 | 314 | 118 | 362 | 932 | 377 | 243 | 263 | 3,839 |
| 1961 | 247 | 253 | 267 | 235 | 183 | 191 | 75 | 282 | 540 | 271 | 254 | 346 | 3,144 |
| 1962 | 275 | 296 | 265 | 246 | 238 | 247 | 184 | 349 | 1595 | 1047 | 385 | 393 | 5,520 |
| 1963 | 306 | 318 | 284 | 272 | 234 | 250 | 83 | 215 | 733 | 474 | 360 | 333 | 3,862 |
| 1964 | 248 | 243 | 257 | 246 | 219 | 227 | 77 | 160 | 1190 | 699 | 306 | 319 | 4,191 |
| 1965 | 228 | 240 | 235 | 267 | 215 | 219 | 145 | 377 | 2615 | 1178 | 438 | 428 | 6,585 |
| 1966 | 327 | 302 | 312 | 292 | 251 | 356 | 530 | 520 | 423 | 336 | 188 | 223 | 4,060 |
| 1967 | 282 | 268 | 268 | 256 | 233 | 290 | 135 | 307 | 2077 | 1011 | 413 | 354 | 5,894 |
| 1968 | 259 | 267 | 258 | 228 | 249 | 293 | 128 | 421 | 2688 | 756 | 403 | 330 | 6,280 |
| 1969 | 319 | 330 | 330 | 324 | 232 | 232 | 613 | 1229 | 1360 | 869 | 387 | 350 | 6,575 |
| 1970 | 324 | 332 | 324 | 304 | 287 | 309 | 100 | 339 | 1370 | 1007 | 310 | 285 | 5,291 |
| 1971 | 248 | 277 | 290 | 281 | 242 | 266 | 278 | 476 | 1669 | 701 | 327 | 368 | 5,423 |
| 1972 | 311 | 270 | 297 | 292 | 244 | 412 | 223 | 585 | 688 | 339 | 187 | 243 | 4,091 |
| 1973 | 217 | 217 | 256 | 231 | 201 | 237 | 124 | 798 | 1657 | 915 | 338 | 328 | 5,519 |
| 1974 | 243 | 227 | 214 | 227 | 191 | 256 | 119 | 648 | 928 | 492 | 209 | 218 | 3,972 |
| 1975 | 184 | 208 | 231 | 211 | 182 | 203 | 72 | 219 | 3406 | 1275 | 462 | 467 | 7,120 |
| 1976 | 363 | 301 | 306 | 297 | 261 | 246 | 133 | 536 | 826 | 492 | 219 | 238 | 4,218 |
| 1977 | 199 | 210 | 209 | 165 | 179 | 192 | 112 | 115 | 336 | 254 | 150 | 193 | 2,314 |
| 1978 | 148 | 177 | 218 | 218 | 184 | 276 | 284 | 435 | 3584 | 959 | 366 | 406 | 7,255 |
| 1979 | 293 | 309 | 342 | 335 | 275 | 266 | 175 | 689 | 1440 | 752 | 300 | 264 | 5,440 |
| 1980 | 205 | 246 | 286 | 283 | 240 | 212 | 199 | 553 | 3654 | 1823 | 622 | 774 | 9,097 |
| 1981 | 423 | 311 | 200 | 258 | 251 | 273 | 336 | 311 | 1068 | 569 | 228 | 257 | 4,485 |
| 1982 | 300 | 320 | 267 | 240 | 270 | 344 | 360 | 859 | 2836 | 1234 | 419 | 490 | 7,939 |
| 1983 | 534 | 600 | 474 | 448 | 385 | 548 | 296 | 515 | 6082 | 3040 | 1098 | 854 | 14,874 |
| 1984 | 576 | 461 | 484 | 440 | 393 | 390 | 281 | 841 | 3085 | 1545 | 647 | 614 | 9,757 |
| 1985 | 461 | 438 | 427 | 387 | 300 | 402 | 914 | 857 | 1099 | 935 | 420 | 449 | 7,089 |
| 1986 | 368 | 328 | 349 | 347 | 335 | 828 | 755 | 714 | 2516 | 759 | 445 | 458 | 8,202 |
| 1987 | 415 | 435 | 531 | 469 | 402 | 445 | 438 | 429 | 816 | 561 | 361 | 369 | 5,671 |
| 1988 | 231 | 261 | 240 | 236 | 211 | 247 | 217 | 247 | 795 | 573 | 310 | 341 | 3,909 |
| 1989 | 249 | 268 | 229 | 197 | 182 | 232 | 227 | 55 | 198 | 93 | 19 | 32 | 1,981 |
| AVERAGE | 301 | 298 | 296 | 283 | 250 | 307 | 258 | 481 | 1,740 | 845 | 360 | 366 | 5,787 |

TABLE C-20
TOTAL FLOW IN OAK CREEK NEAR SPRING CITY
(INCLUDES NATURAL FLOW AND IMPORTS FROM SPRING CITY TUNNEL)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 334 | 298 | 310 | 319 | 309 | 403 | 167 | 963 | 1,817 | 488 | 318 | 341 | 6,067 |
| 1961 | 332 | 326 | 346 | 300 | 235 | 248 | 111 | 756 | 1,011 | 343 | 381 | 461 | 4,850 |
| 1962 | 384 | 382 | 343 | 314 | 303 | 318 | 267 | 897 | 2,990 | 1,414 | 534 | 510 | 8,656 |
| 1963 | 407 | 413 | 372 | 349 | 298 | 322 | 118 | 558 | 1,341 | 639 | 528 | 427 | 5,772 |
| 1964 | 319 | 312 | 333 | 314 | 277 | 287 | 102 | 396 | 2,123 | 957 | 407 | 401 | 6,228 |
| 1965 | 302 | 311 | 306 | 343 | 274 | 283 | 200 | 706 | 4,025 | 1,742 | 740 | 560 | 9,792 |
| 1966 | 446 | 382 | 393 | 365 | 313 | 446 | 702 | 1,223 | 668 | 448 | 277 | 281 | 5,944 |
| 1967 | 360 | 339 | 338 | 322 | 293 | 366 | 180 | 559 | 3,041 | 1,354 | 541 | 446 | 8,139 |
| 1968 | 332 | 345 | 333 | 284 | 311 | 367 | 169 | 812 | 3,966 | 1,025 | 507 | 412 | 8,863 |
| 1969 | 411 | 420 | 411 | 405 | 289 | 290 | 811 | 2,719 | 2,479 | 1,197 | 486 | 437 | 10,355 |
| 1970 | 405 | 415 | 405 | 380 | 358 | 386 | 131 | 578 | 1,920 | 1,396 | 410 | 366 | 7,150 |
| 1971 | 326 | 346 | 362 | 351 | 302 | 333 | 366 | 946 | 3,039 | 974 | 474 | 480 | 8,299 |
| 1972 | 413 | 337 | 371 | 365 | 304 | 515 | 294 | 1,455 | 1,329 | 471 | 282 | 320 | 6,456 |
| 1973 | 270 | 271 | 319 | 289 | 251 | 296 | 163 | 1,675 | 2,450 | 1,286 | 530 | 428 | 8,228 |
| 1974 | 303 | 284 | 268 | 284 | 238 | 321 | 157 | 1,403 | 1,642 | 689 | 356 | 287 | 6,232 |
| 1975 | 230 | 260 | 288 | 264 | 227 | 254 | 95 | 360 | 4,674 | 1,688 | 738 | 610 | 9,688 |
| 1976 | 453 | 376 | 382 | 371 | 326 | 308 | 175 | 1,218 | 1,634 | 688 | 355 | 311 | 6,597 |
| 1977 | 248 | 262 | 261 | 206 | 223 | 240 | 147 | 285 | 594 | 351 | 233 | 253 | 3,303 |
| 1978 | 185 | 221 | 272 | 273 | 229 | 346 | 373 | 717 | 5,675 | 1,314 | 548 | 528 | 10,681 |
| 1979 | 366 | 387 | 427 | 418 | 343 | 333 | 230 | 1,519 | 2,392 | 1,026 | 467 | 348 | 8,256 |
| 1980 | 256 | 307 | 357 | 353 | 300 | 265 | 261 | 1,114 | 5,345 | 2,538 | 889 | 992 | 12,977 |
| 1981 | 528 | 389 | 250 | 322 | 313 | 342 | 441 | 626 | 1,847 | 773 | 358 | 339 | 6,528 |
| 1982 | 374 | 400 | 333 | 300 | 337 | 431 | 474 | 1,712 | 4,569 | 1,779 | 679 | 644 | 12,032 |
| 1983 | 666 | 750 | 591 | 559 | 480 | 686 | 389 | 849 | 8,183 | 3,923 | 1,607 | 1,104 | 19,787 |
| 1984 | 719 | 576 | 605 | 550 | 491 | 488 | 369 | 1,385 | 4,360 | 2,079 | 1,017 | 800 | 13,439 |
| 1985 | 575 | 548 | 533 | 483 | 375 | 504 | 1,201 | 1,773 | 1,910 | 1,254 | 606 | 579 | 10,341 |
| 1986 | 459 | 410 | 436 | 434 | 418 | 1,036 | 992 | 1,176 | 3,232 | 949 | 556 | 572 | 10,670 |
| 1987 | 518 | 544 | 663 | 586 | 502 | 557 | 576 | 945 | 1,375 | 746 | 519 | 476 | 8,007 |
| 1988 | 288 | 327 | 299 | 295 | 264 | 310 | 286 | 407 | 1,517 | 787 | 470 | 440 | 5,690 |
| 1989 | 311 | 335 | 286 | 246 | 227 | 290 | 298 | 90 | 521 | 169 | 99 | 55 | 2,927 |
| AVERAGE | 384 | 376 | 373 | 355 | 314 | 386 | 342 | 994 | 2,722 | 1,150 | 530 | 474 | 8,398 |

TABLE C-21
TOTAL FLOW IN CANAL CREEK
(INCLUDES NATURAL FLOW AND IMPORTS FROM HORSESHOE TUNNEL)
(ACRE-FEET)

| YEAR | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 501 | 464 | 494 | 510 | 493 | 642 | 282 | 535 | 1,547 | 758 | 502 | 488 | 7,216 |
| 1961 | 469 | 487 | 531 | 468 | 361 | 384 | 170 | 395 | 1,083 | 562 | 502 | 586 | 5,998 |
| 1962 | 496 | 570 | 526 | 492 | 475 | 501 | 428 | 634 | 2,612 | 1,991 | 779 | 727 | 10,231 |
| 1963 | 584 | 606 | 555 | 537 | 466 | 508 | 197 | 372 | 1,413 | 907 | 714 | 631 | 7,490 |
| 1964 | 495 | 478 | 510 | 492 | 440 | 470 | 196 | 356 | 2,193 | 1,306 | 629 | 641 | 8,206 |
| 1965 | 439 | 457 | 465 | 527 | 427 | 444 | 355 | 1,674 | 5,443 | 1,956 | 823 | 768 | 13,778 |
| 1966 | 607 | 607 | 640 | 605 | 519 | 746 | 1,363 | 1,374 | 1,104 | 650 | 375 | 449 | 9,039 |
| 1967 | 566 | 539 | 547 | 524 | 476 | 601 | 345 | 1,414 | 4,623 | 1,946 | 852 | 706 | 13,139 |
| 1968 | 516 | 514 | 514 | 472 | 515 | 614 | 333 | 1,771 | 5,851 | 1,430 | 840 | 673 | 14,043 |
| 1969 | 633 | 657 | 681 | 672 | 480 | 485 | 1,581 | 3,874 | 2,381 | 1,607 | 807 | 718 | 14,576 |
| 1970 | 663 | 689 | 670 | 631 | 594 | 646 | 258 | 1,715 | 3,283 | 1,850 | 636 | 543 | 12,178 |
| 1971 | 479 | 575 | 599 | 583 | 501 | 556 | 722 | 1,906 | 2,858 | 1,281 | 652 | 666 | 11,378 |
| 1972 | 596 | 561 | 614 | 605 | 505 | 862 | 580 | 1,248 | 1,237 | 622 | 368 | 425 | 8,223 |
| 1973 | 446 | 450 | 529 | 479 | 416 | 495 | 322 | 2,860 | 3,712 | 1,643 | 654 | 592 | 12,598 |
| 1974 | 499 | 472 | 443 | 472 | 395 | 537 | 309 | 2,160 | 1,795 | 892 | 394 | 380 | 8,748 |
| 1975 | 379 | 432 | 476 | 438 | 377 | 424 | 188 | 1,154 | 7,872 | 2,490 | 889 | 841 | 15,960 |
| 1976 | 747 | 625 | 633 | 616 | 540 | 514 | 345 | 1,568 | 1,366 | 891 | 420 | 429 | 8,694 |
| 1977 | 409 | 436 | 432 | 342 | 370 | 402 | 290 | 250 | 843 | 468 | 294 | 343 | 4,879 |
| 1978 | 305 | 368 | 450 | 453 | 380 | 579 | 737 | 2,294 | 7,107 | 1,790 | 720 | 743 | 15,926 |
| 1979 | 603 | 643 | 707 | 694 | 569 | 556 | 454 | 2,198 | 2,861 | 1,413 | 583 | 462 | 11,743 |
| 1980 | 422 | 511 | 592 | 587 | 498 | 444 | 515 | 2,158 | 7,916 | 3,325 | 1,243 | 1,474 | 19,685 |
| 1981 | 871 | 647 | 413 | 535 | 519 | 572 | 871 | 1,215 | 2,089 | 1,075 | 444 | 450 | 9,701 |
| 1982 | 617 | 664 | 551 | 498 | 558 | 720 | 935 | 3,408 | 5,562 | 2,133 | 801 | 866 | 17,313 |
| 1983 | 1,099 | 1,247 | 979 | 928 | 796 | 1,148 | 768 | 2,715 | 14,071 | 6,123 | 2,178 | 1,588 | 33,640 |
| 1984 | 1,186 | 957 | 1,001 | 913 | 814 | 817 | 729 | 4,427 | 6,962 | 2,950 | 1,252 | 1,119 | 23,127 |
| 1985 | 948 | 911 | 882 | 802 | 622 | 842 | 2,371 | 3,168 | 2,126 | 1,797 | 838 | 841 | 16,148 |
| 1986 | 757 | 682 | 722 | 720 | 693 | 1,733 | 1,959 | 3,760 | 6,230 | 1,586 | 928 | 942 | 20,712 |
| 1987 | 854 | 904 | 1,098 | 973 | 832 | 932 | 1,136 | 1,367 | 1,720 | 1,091 | 723 | 694 | 12,324 |
| 1988 | 476 | 543 | 495 | 490 | 437 | 518 | 564 | 1,306 | 1,414 | 1,067 | 609 | 637 | 8,556 |
| 1989 | 513 | 557 | 473 | 408 | 377 | 485 | 588 | 292 | 356 | 96 | 6 | 1 | 4,152 |
| AVERAGE | 606 | 608 | 607 | 582 | 515 | 639 | 663 | 1,786 | 3,654 | 1,590 | 715 | 681 | 12,647 |

Table C-22
Total Historical Diversions for
Group 3 Lands
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | 1,612 | 3,957 | 3,156 | 2,043 | 1,614 | 1,630 | 1,029 | 15,041 |
| 1961 | 1,114 | 1,927 | 1,681 | 1,587 | 1,495 | 1,877 | 711 | 10,392 |
| 1962 | 3,022 | 6,226 | 5,397 | 4,487 | 3,890 | 3,248 | 1,930 | 28,199 |
| 1963 | 2,170 | 4,427 | 4,660 | 3,069 | 2,362 | 2,172 | 1,385 | 20,245 |
| 1964 | 2,591 | 4,948 | 5,004 | 4,288 | 3,185 | 2,506 | 1,654 | 24,175 |
| 1965 | 3,107 | 4,500 | 5,469 | 5,075 | 4,421 | 4,433 | 1,984 | 28,988 |
| 1966 | 2,146 | 4,570 | 3,942 | 2,964 | 2,685 | 2,345 | 1,370 | 20,021 |
| 1967 | 2,817 | 4,005 | 5,511 | 4,676 | 3,999 | 3,478 | 1,798 | 26,283 |
| 1968 | 3,026 | 4,507 | 4,900 | 4,844 | 4,570 | 4,456 | 1,932 | 28,234 |
| 1969 | 3,113 | 4,712 | 4,673 | 5,036 | 4,886 | 4,642 | 1,988 | 29,050 |
| 1970 | 2,921 | 4,638 | 4,518 | 4,576 | 4,465 | 4,273 | 1,865 | 27,255 |
| 1971 | 2,302 | 4,628 | 4,539 | 4,752 | 4,084 | 3,713 | 1,534 | 25,553 |
| 1972 | 1,921 | 3,276 | 3,336 | 2,284 | 2,056 | 1,949 | 993 | 15,815 |
| 1973 | 2,421 | 5,003 | 4,842 | 4,671 | 4,320 | 3,724 | 1,861 | 26,842 |
| 1974 | 2,331 | 4,710 | 4,500 | 4,039 | 3,723 | 3,077 | 1,801 | 24,179 |
| 1975 | 2,141 | 4,767 | 4,467 | 4,399 | 4,251 | 3,764 | 1,883 | 25,672 |
| 1976 | 1,971 | 4,429 | 4,085 | 2,976 | 2,817 | 2,370 | 1,235 | 19,881 |
| 1977 | 3,562 | 3,131 | 1,967 | 1,521 | 1,473 | 1,435 | 772 | 13,860 |
| 1978 | 2,433 | 4,731 | 4,619 | 4,407 | 4,212 | 3,569 | 1,838 | 25,808 |
| 1979 | 2,420 | 5,083 | 4,643 | 4,398 | 4,099 | 3,678 | 1,839 | 26,161 |
| 1980 | 2,460 | 5,083 | 4,919 | 4,891 | 4,495 | 4,181 | 2,091 | 28,119 |
| 1981 | 2,348 | 4,185 | 4,035 | 3,622 | 3,252 | 2,979 | 1,503 | 21,924 |
| 1982 | 2,460 | 4,771 | 4,379 | 4,711 | 4,250 | 4,199 | 2,065 | 26,835 |
| 1983 | 1,900 | 3,967 | 3,839 | 3,967 | 3,967 | 3,839 | 1,899 | 23,378 |
| 1984 | 3,892 | 6,937 | 6,690 | 6,004 | 5,391 | 4,939 | 2,492 | 36,345 |
| 1985 | 3,153 | 5,621 | 5,420 | 4,865 | 4,368 | 4,002 | 2,019 | 29,448 |
| 1986 | 3,718 | 6,626 | 6,390 | 5,735 | 5,150 | 4,718 | 2,380 | 34,717 |
| 1987 | 2,470 | 4,402 | 4,245 | 3,810 | 3,421 | 3,134 | 1,581 | 23,064 |
| 1988 | 4,386 | 4,625 | 4,587 | 3,399 | 2,627 | 2,542 | 1,321 | 23,488 |
| 1989 | 1,831 | 4,201 | 3,243 | 2,860 | 2,182 | 1,811 | 1,026 | 17,154 |
| Total | 77,757 | 138,593 | 133,655 | 119,956 | 107,707 | 98,681 | 49,778 | 726,126 |
| Average | 2,592 | 4,620 | 4,455 | 3,999 | 3,590 | 3,289 | 1,659 | 24,204 |

Table C-23
Historical Diversions
Meadow Ditch
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 196 | 106 | 42 | 19 | 18 | N/A | 381 |
| 1961 | N/A | 26 | 15 | 15 | 12 | 14 | N/A | 82 |
| 1962 | N/A | 205 | 154 | 88 | 51 | 38 | N/A | 535 |
| 1963 | N/A | 138 | 136 | 69 | 40 | 15 | N/A | 398 |
| 1964 | N/A | 151 | 196 | 66 | 36 | 15 | N/A | 464 |
| 1965 | N/A | 195 | 278 | 200 | 104 | 78 | N/A | 855 |
| 1966 | N/A | 158 | 113 | 70 | 57 | 34 | N/A | 430 |
| 1967 | N/A | 152 | 201 | 133 | 93 | 60 | N/A | 639 |
| 1968 | N/A | 140 | 135 | 78 | 78 | 90 | N/A | 520 |
| 1969 | N/A | 140 | 100 | 104 | 106 | 100 | N/A | 551 |
| 1970 | N/A | 102 | 99 | 102 | 102 | 99 | N/A | 505 |
| 1971 | 51 | 99 | 96 | 99 | 77 | 72 | 22 | 516 |
| 1972 | 53 | 90 | 95 | 37 | 20 | 16 | 8 | 320 |
| 1973 | 50 | 102 | 99 | 102 | 99 | 86 | 42 | 580 |
| 1974 | 50 | 102 | 80 | 60 | 52 | 48 | 24 | 415 |
| 1975 | 50 | 102 | 100 | 75 | 51 | 45 | 23 | 446 |
| 1976 | 44 | 99 | 102 | 67 | 47 | 33 | 15 | 407 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 50 | 102 | 99 | 96 | 82 | 70 | 32 | 531 |
| 1979 | 50 | 102 | 99 | 99 | 83 | 72 | 36 | 541 |
| 1980 | 50 | 102 | 99 | 102 | 94 | 81 | 41 | 569 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 50 | 102 | 99 | 102 | 96 | 89 | 45 | 583 |
| 1983 | 50 | 102 | 99 | 102 | 102 | 99 | 49 | 604 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 50 | 102 | 94 | 26 | N/A | N/A | N/A | 272 |
| 1989 | 43 | 88 | 77 | 67 | 16 | N/A | N/A | 292 |
| 1990 | 49 | 100 | 89 | 58 | 31 | N/A | N/A | 327 |

N/A - Data not available

Table C-24
Historical Diversions
Sheep Ditch 1/
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 56 | 16 | 0 | 0 | 0 | N/A | 72 |
| 1961 | N/A | 0 | 0 | 0 | 0 | 0 | N/A | 0 |
| 1962 | N/A | 149 | 108 | 87 | 83 | 76 | N/A | 503 |
| 1963 | N/A | 57 | 90 | 84 | 64 | 68 | N/A | 363 |
| 1964 | N/A | 54 | 96 | 89 | 76 | 30 | N/A | 345 |
| 1965 | N/A | 60 | 224 | 114 | 70 | 54 | N/A | 522 |
| 1966 | N/A | 112 | 90 | 0 | 0 | 0 | N/A | 202 |
| 1967 | N/A | 42 | 117 | 101 | 62 | 45 | N/A | 367 |
| 1968 | N/A | 28 | 124 | 118 | 65 | 60 | N/A | 395 |
| 1969 | N/A | 0 | 0 | 0 | 0 | 0 | N/A | 0 |
| 1970 | N/A | 93 | 90 | 93 | 93 | 90 | N/A | 459 |

1/ After 1970 this water was transferred to the Brady Ditch
N/A - Data not available.

Table C-25
Historical Diversions
Mower Ditch
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 75 | 106 | 65 | 42 | 43 | N/A | 331 |
| 1961 | N/A | 71 | 92 | 84 | 49 | 47 | N/A | 343 |
| 1962 | N/A | 187 | 114 | 84 | 82 | 73 | N/A | 540 |
| 1963 | N/A | 125 | 125 | 84 | 64 | 66 | N/A | 463 |
| 1964 | N/A | 140 | 134 | 108 | 76 | 60 | N/A | 518 |
| 1965 | N/A | 91 | 222 | 144 | 145 | 118 | N/A | 720 |
| 1966 | N/A | 171 | 217 | 93 | 93 | 75 | N/A | 648 |
| 1967 | N/A | 150 | 222 | 180 | 128 | 60 | N/A | 740 |
| 1968 | N/A | 160 | 150 | 155 | 124 | 150 | N/A | 739 |
| 1969 | N/A | 144 | 129 | 148 | 142 | 142 | N/A | 705 |
| 1970 | N/A | 136 | 132 | 136 | 136 | 132 | N/A | 673 |
| 1971 | 66 | 136 | 132 | 136 | 124 | 124 | 51 | 770 |
| 1972 | 66 | 117 | 119 | 87 | 87 | 81 | 42 | 599 |
| 1973 | 66 | 136 | 132 | 136 | 130 | 126 | 63 | 790 |
| 1974 | 66 | 136 | 126 | 109 | 105 | 106 | 0 | 649 |
| 1975 | 60 | 136 | 132 | 136 | 136 | 132 | 66 | 799 |
| 1976 | 56 | 132 | 136 | 105 | 94 | 97 | 50 | 670 |
| 1977 | 96 | 72 | 47 | 48 | 48 | 46 | 23 | 380 |
| 1978 | 66 | 136 | 132 | 134 | 124 | 119 | 59 | 771 |
| 1979 | 66 | 136 | 132 | 132 | 132 | 119 | 59 | 777 |
| 1980 | 66 | 136 | 132 | 136 | 136 | 132 | 66 | 805 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 66 | 136 | 132 | 136 | 136 | 132 | 66 | 805 |
| 1983 | 66 | 136 | 132 | 136 | 136 | 132 | 66 | 805 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 132 | 133 | 131 | 108 | 82 | 79 | 40 | 705 |
| 1989 | 58 | 118 | 100 | 91 | 74 | 61 | 26 | 528 |
| 1990 | 67 | 133 | 118 | 79 | 53 | 54 | 32 | 535 |

N/A - Data not available

Table C-26
Historical Diversions
Brady Ditch
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 183 | 141 | 120 | 76 | 69 | N/A | 589 |
| 1961 | N/A | 87 | 89 | 89 | 73 | 74 | N/A | 411 |
| 1962 | N/A | 300 | 262 | 229 | 195 | 137 | N/A | 1,124 |
| 1963 | N/A | 206 | 255 | 137 | 109 | 101 | N/A | 806 |
| 1964 | N/A | 307 | 283 | 228 | 146 | 120 | N/A | 1,084 |
| 1965 | N/A | 240 | 338 | 296 | 248 | 171 | N/A | 1,293 |
| 1966 | N/A | 274 | 227 | 135 | 135 | 132 | N/A | 903 |
| 1967 | N/A | 196 | 300 | 276 | 210 | 102 | N/A | 1,084 |
| 1968 | N/A | 217 | 240 | 28 | 217 | 236 | N/A | 938 |
| 1969 | N/A | 149 | 80 | 145 | 175 | 180 | N/A | 729 |
| 1970 | N/A | 159 | 154 | 159 | 159 | 154 | N/A | 786 |
| 1971 | 77 | 159 | 154 | 159 | 149 | 149 | 51 | 898 |
| 1972 | 77 | 133 | 143 | 106 | 83 | 78 | 39 | 659 |
| 1973 | 77 | 159 | 154 | 159 | 149 | 144 | 72 | 915 |
| 1974 | 77 | 159 | 146 | 126 | 121 | 119 | 93 | 841 |
| 1975 | 105 | 217 | 210 | 217 | 217 | 210 | 105 | 1,281 |
| 1976 | 91 | 210 | 210 | 157 | 148 | 126 | 63 | 1,004 |
| 1977 | 158 | 184 | 96 | 88 | 88 | 85 | 43 | 742 |
| 1978 | 114 | 236 | 228 | 236 | 236 | 205 | 103 | 1,357 |
| 1979 | 114 | 236 | 228 | 236 | 228 | 205 | 103 | 1,350 |
| 1980 | 114 | 236 | 228 | 236 | 236 | 228 | 114 | 1,391 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 114 | 236 | 228 | 236 | 236 | 228 | 114 | 1,391 |
| 1983 | 94 | 236 | 228 | 236 | 236 | 228 | 94 | 1,351 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 228 | 230 | 229 | 186 | 141 | 137 | 68 | 1,220 |
| 1989 | 99 | 202 | 178 | 158 | 128 | 101 | 44 | 908 |
| 1990 | 113 | 230 | 204 | 134 | 92 | 97 | 53 | 924 |

N/A - Data not available

Table C-27
Historical Diversions
Graveyard Ditch
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 107 | 101 | 66 | 63 | 50 | N/A | 388 |
| 1961 | N/A | 49 | 47 | 49 | 41 | 38 | N/A | 223 |
| 1962 | N/A | 173 | 158 | 120 | 87 | 73 | N/A | 610 |
| 1963 | N/A | 190 | 106 | 67 | 59 | 54 | N/A | 474 |
| 1964 | N/A | 288 | 130 | 91 | 61 | 45 | N/A | 614 |
| 1965 | N/A | 170 | 218 | 142 | 124 | 84 | N/A | 738 |
| 1966 | N/A | 0 | 85 | 93 | 48 | 0 | N/A | 226 |
| 1967 | N/A | 94 | 142 | 153 | 118 | 90 | N/A | 597 |
| 1968 | N/A | 0 | 88 | 109 | 109 | 180 | N/A | 485 |
| 1969 | N/A | 117 | 140 | 139 | 124 | 120 | N/A | 640 |
| 1970 | N/A | 109 | 105 | 109 | 109 | 105 | N/A | 536 |
| 1971 | 52 | 109 | 105 | 109 | 102 | 102 | 53 | 631 |
| 1972 | 53 | 88 | 98 | 55 | 52 | 47 | 24 | 417 |
| 1973 | 52 | 109 | 105 | 109 | 102 | 99 | 50 | 625 |
| 1974 | 52 | 109 | 105 | 108 | 105 | 101 | 51 | 630 |
| 1975 | 51 | 109 | 105 | 109 | 109 | 105 | 54 | 640 |
| 1976 | 47 | 102 | 102 | 76 | 71 | 60 | 30 | 489 |
| 1977 | 68 | 57 | 37 | 38 | 38 | 37 | 18 | 293 |
| 1978 | 53 | 109 | 105 | 109 | 109 | 95 | 47 | 626 |
| 1979 | 53 | 109 | 105 | 107 | 105 | 95 | 47 | 621 |
| 1980 | 53 | 109 | 105 | 109 | 109 | 105 | 53 | 641 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 53 | 109 | 105 | 109 | 109 | 105 | 53 | 641 |
| 1983 | 53 | 109 | 105 | 109 | 109 | 105 | 53 | 641 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 105 | 106 | 98 | 86 | 65 | 63 | 32 | 555 |
| 1989 | 46 | 94 | 82 | 71 | 57 | 49 | 20 | 418 |
| 1990 | 52 | 106 | 94 | 69 | 43 | 44 | 25 | 433 |

N/A - Data not available

Table C-28
Historical Diversions
San Pitch Ditch Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 155 | 134 | 92 | 80 | 64 | N/A | 525 |
| 1961 | N/A | 58 | 116 | 64 | 58 | 57 | N/A | 352 |
| 1962 | N/A | 212 | 194 | 160 | 141 | 138 | N/A | 845 |
| 1963 | N/A | 152 | 151 | 108 | 91 | 138 | N/A | 640 |
| 1964 | N/A | 252 | 154 | 129 | 90 | 60 | N/A | 685 |
| 1965 | N/A | 158 | 240 | 78 | 164 | 136 | N/A | 776 |
| 1966 | N/A | 205 | 133 | 83 | 93 | 120 | N/A | 634 |
| 1967 | N/A | 117 | 168 | 154 | 118 | 111 | N/A | 668 |
| 1968 | N/A | 200 | 180 | 186 | 179 | 150 | N/A | 895 |
| 1969 | N/A | 161 | 180 | 185 | 163 | 153 | N/A | 842 |
| 1970 | N/A | 158 | 153 | 158 | 158 | 153 | N/A | 780 |
| 1971 | 77 | 158 | 153 | 158 | 149 | 147 | 77 | 918 |
| 1972 | 77 | 135 | 143 | 87 | 79 | 75 | 39 | 634 |
| 1973 | 77 | 158 | 153 | 158 | 155 | 150 | 75 | 926 |
| 1974 | 77 | 158 | 153 | 157 | 155 | 149 | 75 | 923 |
| 1975 | 69 | 158 | 153 | 158 | 158 | 153 | 77 | 926 |
| 1976 | 64 | 138 | 138 | 103 | 117 | 106 | 41 | 707 |
| 1977 | 98 | 82 | 54 | 56 | 56 | 54 | 27 | 427 |
| 1978 | 77 | 158 | 153 | 158 | 158 | 138 | 69 | 911 |
| 1979 | 77 | 158 | 153 | 156 | 153 | 138 | 69 | 904 |
| 1980 | 77 | 158 | 153 | 158 | 158 | 153 | 77 | 933 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 77 | 158 | 153 | 158 | 158 | 153 | 77 | 933 |
| 1983 | 77 | 158 | 153 | 158 | 158 | 153 | 77 | 933 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 153 | 154 | 152 | 126 | 95 | 92 | 46 | 817 |
| 1989 | 67 | 136 | 119 | 106 | 84 | 70 | 29 | 611 |
| 1990 | 77 | 155 | 141 | 89 | 62 | 65 | 36 | 624 |

N/A - Data not available.

Table C-29
Historical Diversions
Miner & Turpin Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 87 | 94 | 97 | 97 | 94 | N/A | 468 |
| 1961 | N/A | 97 | 94 | 97 | 97 | 94 | N/A | 477 |
| 1962 | N/A | 97 | 94 | 97 | 97 | 94 | N/A | 477 |
| 1963 | N/A | 59 | 94 | 97 | 97 | 66 | N/A | 412 |
| 1964 | N/A | 50 | 94 | 97 | 97 | 94 | N/A | 430 |
| 1965 | N/A | 43 | 75 | 97 | 97 | 94 | N/A | 405 |
| 1966 | N/A | 97 | 94 | 97 | 97 | 94 | N/A | 477 |
| 1967 | N/A | 97 | 94 | 97 | 97 | 94 | N/A | 477 |
| 1968 | N/A | 41 | 94 | 97 | 97 | 94 | N/A | 421 |
| 1969 | N/A | 97 | 93 | 97 | 97 | 93 | N/A | 475 |
| 1970 | N/A | 97 | 94 | 97 | 97 | 94 | N/A | 477 |
| 1971 | 47 | 97 | 94 | 97 | 97 | 94 | 39 | 563 |
| 1972 | 47 | 94 | 85 | 64 | 53 | 46 | 24 | 413 |
| 1973 | 47 | 97 | 94 | 97 | 97 | 94 | 47 | 571 |
| 1974 | 47 | 97 | 94 | 95 | 97 | 94 | 47 | 569 |
| 1975 | 42 | 97 | 94 | 97 | 97 | 94 | 47 | 566 |
| 1976 | 43 | 94 | 94 | 70 | 66 | 56 | 28 | 450 |
| 1977 | 75 | 64 | 41 | 43 | 43 | 42 | 21 | 330 |
| 1978 | 47 | 97 | 94 | 97 | 97 | 84 | 42 | 557 |
| 1979 | 47 | 97 | 94 | 95 | 94 | 84 | 42 | 552 |
| 1980 | 47 | 97 | 94 | 97 | 97 | 94 | 47 | 571 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 47 | 97 | 94 | 97 | 97 | 94 | 47 | 571 |
| 1983 | 47 | 97 | 94 | 97 | 97 | 94 | 47 | 571 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 94 | 94 | 93 | 77 | 58 | 56 | 28 | 500 |
| 1989 | 41 | 84 | 73 | 65 | 52 | 43 | 18 | 376 |
| 1990 | 46 | 94 | 87 | 55 | 38 | 40 | 22 | 383 |

N/A - Data not available.

Table C-30
Historical Diversions
M&M Ditch Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 749 | 648 | 396 | 322 | 276 | N/A | 2,390 |
| 1961 | N/A | 239 | 212 | 250 | 229 | 303 | N/A | 1,232 |
| 1962 | N/A | 1,388 | 1,040 | 858 | 707 | 627 | N/A | 4,619 |
| 1963 | N/A | 691 | 789 | 543 | 403 | 288 | N/A | 2,713 |
| 1964 | N/A | 908 | 793 | 787 | 646 | 480 | N/A | 3,615 |
| 1965 | N/A | 992 | 1,172 | 930 | 680 | 1,020 | N/A | 4,794 |
| 1966 | N/A | 798 | 537 | 538 | 478 | 420 | N/A | 2,771 |
| 1967 | N/A | 752 | 1,434 | 870 | 854 | 780 | N/A | 4,690 |
| 1968 | N/A | 914 | 900 | 930 | 868 | 840 | N/A | 4,452 |
| 1969 | N/A | 918 | 911 | 916 | 875 | 870 | N/A | 4,490 |
| 1970 | N/A | 820 | 793 | 820 | 820 | 793 | N/A | 4,045 |
| 1971 | 397 | 820 | 793 | 820 | 820 | 793 | 325 | 4,767 |
| 1972 | 339 | 616 | 683 | 471 | 429 | 407 | 209 | 3,154 |
| 1973 | 397 | 820 | 793 | 820 | 820 | 793 | 397 | 4,839 |
| 1974 | 397 | 805 | 793 | 820 | 739 | 638 | 397 | 4,588 |
| 1975 | 338 | 805 | 793 | 805 | 805 | 793 | 397 | 4,735 |
| 1976 | 365 | 793 | 793 | 538 | 528 | 476 | 238 | 3,731 |
| 1977 | 494 | 466 | 280 | 286 | 286 | 276 | 138 | 2,226 |
| 1978 | 300 | 655 | 793 | 820 | 820 | 610 | 357 | 4,354 |
| 1979 | 397 | 820 | 793 | 809 | 795 | 714 | 357 | 4,684 |
| 1980 | 397 | 820 | 793 | 820 | 820 | 793 | 397 | 4,838 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 397 | 820 | 793 | 820 | 820 | 793 | 397 | 4,838 |
| 1983 | 397 | 820 | 793 | 820 | 820 | 793 | 397 | 4,838 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 793 | 798 | 786 | 650 | 492 | 476 | 238 | 4,233 |
| 1989 | 359 | 751 | 617 | 548 | 457 | 366 | 153 | 3,252 |
| 1990 | 681 | 801 | 711 | 527 | 381 | 392 | 221 | 3,714 |

N/A - Data not available.

Table C-31
Historical Diversions
Olsen & Seely Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1961 | N/A | 58 | 60 | 62 | 62 | 60 | N/A | 302 |
| 1962 | N/A | 48 | 60 | 62 | 62 | 60 | N/A | 292 |
| 1963 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1964 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1965 | N/A | 62 | 60 | 62 | 42 | 62 | N/A | 288 |
| 1966 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1967 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1968 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1969 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1970 | N/A | 62 | 60 | 62 | 62 | 60 | N/A | 306 |
| 1971 | 30 | 62 | 60 | 62 | 62 | 60 | 24 | 360 |
| 1972 | 30 | 62 | 60 | 62 | 62 | 60 | 30 | 366 |
| 1973 | 30 | 62 | 60 | 62 | 62 | 60 | 30 | 366 |
| 1974 | 30 | 62 | 60 | 62 | 54 | 49 | 29 | 345 |
| 1975 | 26 | 62 | 60 | 62 | 62 | 60 | 30 | 362 |
| 1976 | 26 | 57 | 57 | 42 | 39 | 33 | 17 | 270 |
| 1977 | 39 | 35 | 21 | 22 | 22 | 21 | 10 | 170 |
| 1978 | 30 | 62 | 60 | 62 | 62 | 54 | 27 | 357 |
| 1979 | 30 | 62 | 60 | 61 | 60 | 54 | 27 | 354 |
| 1980 | 30 | 62 | 60 | 62 | 62 | 60 | 30 | 366 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 30 | 62 | 60 | 62 | 62 | 60 | 30 | 366 |
| 1983 | 30 | 62 | 60 | 62 | 62 | 60 | 30 | 366 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 60 | 61 | 60 | 49 | 37 | 36 | 18 | 321 |
| 1989 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1990 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

N/A - Data not available.

Table C-32
Historical Diversions
Frandsen McArthur Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 396 | 324 | 203 | 137 | 189 | N/A | 1,251 |
| 1961 | N/A | 215 | 194 | 188 | 195 | 290 | N/A | 1,082 |
| 1962 | N/A | 499 | 445 | 390 | 311 | 281 | N/A | 1,925 |
| 1963 | N/A | 394 | 368 | 270 | 227 | 226 | N/A | 1,484 |
| 1964 | N/A | 403 | 390 | 383 | 306 | 282 | N/A | 1,764 |
| 1965 | N/A | 337 | 471 | 470 | 396 | 390 | N/A | 2,064 |
| 1966 | N/A | 381 | 370 | 269 | 248 | 90 | N/A | 1,357 |
| 1967 | N/A | 397 | 387 | 403 | 381 | 360 | N/A | 1,928 |
| 1968 | N/A | 413 | 420 | 414 | 403 | 390 | N/A | 2,040 |
| 1969 | N/A | 426 | 445 | 457 | 450 | 414 | N/A | 2,192 |
| 1970 | N/A | 403 | 390 | 403 | 403 | 390 | N/A | 1,989 |
| 1971 | 195 | 403 | 390 | 403 | 403 | 390 | 160 | 2,344 |
| 1972 | 135 | 308 | 340 | 225 | 201 | 191 | 98 | 1,498 |
| 1973 | 195 | 403 | 390 | 403 | 403 | 390 | 195 | 2,379 |
| 1974 | 195 | 403 | 390 | 403 | 363 | 291 | 195 | 2,240 |
| 1975 | 165 | 403 | 390 | 403 | 403 | 390 | 195 | 2,349 |
| 1976 | 179 | 390 | 390 | 301 | 276 | 134 | 117 | 1,788 |
| 1977 | 258 | 266 | 196 | 136 | 136 | 132 | 66 | 1,190 |
| 1978 | 195 | 403 | 390 | 403 | 403 | 360 | 177 | 2,331 |
| 1979 | 195 | 403 | 390 | 398 | 371 | 351 | 176 | 2,283 |
| 1980 | 195 | 403 | 390 | 403 | 403 | 390 | 195 | 2,379 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 195 | 403 | 390 | 403 | 403 | 390 | 195 | 2,379 |
| 1983 | 195 | 403 | 390 | 403 | 403 | 390 | 195 | 2,379 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 390 | 394 | 378 | 320 | 242 | 234 | 117 | 2,074 |
| 1989 | 161 | 384 | 306 | 229 | 214 | 179 | 76 | 1,547 |
| 1990 | 335 | 394 | 337 | 227 | 147 | 161 | 92 | 1,692 |

N/A - Data not available.

Table C-33
Historical Diversions
Moroni Irrigation City Ditch
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 534 | 468 | 307 | 211 | 254 | N/A | 1,774 |
| 1961 | N/A | 304 | 229 | 246 | 250 | 326 | N/A | 1,355 |
| 1962 | N/A | 722 | 782 | 591 | 506 | 454 | N/A | 3,055 |
| 1963 | N/A | 571 | 553 | 396 | 305 | 328 | N/A | 2,153 |
| 1964 | N/A | 696 | 558 | 572 | 427 | 360 | N/A | 2,613 |
| 1965 | N/A | 564 | 308 | 696 | 620 | 580 | N/A | 2,768 |
| 1966 | N/A | 577 | 518 | 419 | 341 | 351 | N/A | 2,206 |
| 1967 | N/A | 581 | 716 | 620 | 594 | 480 | N/A | 2,991 |
| 1968 | N/A | 684 | 620 | 620 | 620 | 600 | N/A | 3,144 |
| 1969 | N/A | 631 | 586 | 645 | 651 | 600 | N/A | 3,113 |
| 1970 | N/A | 620 | 600 | 620 | 620 | 600 | N/A | 3,060 |
| 1971 | 300 | 620 | 600 | 620 | 620 | 600 | 247 | 3,607 |
| 1972 | 183 | 474 | 516 | 347 | 310 | 297 | 150 | 2,278 |
| 1973 | 300 | 620 | 600 | 620 | 620 | 600 | 300 | 3,660 |
| 1974 | 300 | 620 | 600 | 620 | 578 | 480 | 300 | 3,498 |
| 1975 | 255 | 620 | 600 | 620 | 620 | 600 | 300 | 3,615 |
| 1976 | 276 | 600 | 600 | 448 | 422 | 360 | 180 | 2,886 |
| 1977 | 504 | 448 | 320 | 210 | 204 | 198 | 100 | 1,984 |
| 1978 | 300 | 620 | 600 | 620 | 620 | 550 | 270 | 3,580 |
| 1979 | 300 | 620 | 600 | 612 | 603 | 540 | 270 | 3,545 |
| 1980 | 300 | 620 | 600 | 620 | 620 | 600 | 300 | 3,660 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 300 | 620 | 600 | 620 | 620 | 600 | 300 | 3,660 |
| 1983 | 300 | 620 | 600 | 620 | 620 | 600 | 300 | 3,660 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 600 | 606 | 595 | 492 | 372 | 360 | 180 | 3,205 |
| 1989 | 262 | 595 | 472 | 430 | 329 | 277 | 116 | 2,481 |
| 1990 | 515 | 606 | 538 | 353 | 234 | 204 | 141 | 2,590 |

N/A - Data not available.

Table C-34
Historical Diversions
Moroni Irrigation Spring Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 259 | 212 | 145 | 101 | 105 | N/A | 822 |
| 1961 | N/A | 155 | 124 | 113 | 107 | 141 | N/A | 639 |
| 1962 | N/A | 246 | 247 | 223 | 237 | 187 | N/A | 1,141 |
| 1963 | N/A | 275 | 253 | 169 | 140 | 135 | N/A | 971 |
| 1964 | N/A | 264 | 270 | 257 | 161 | 120 | N/A | 1,072 |
| 1965 | N/A | 234 | 290 | 298 | 258 | 240 | N/A | 1,320 |
| 1966 | N/A | 270 | 242 | 155 | 142 | 146 | N/A | 955 |
| 1967 | N/A | 212 | 270 | 198 | 146 | 150 | N/A | 976 |
| 1968 | N/A | 279 | 270 | 279 | 279 | 270 | N/A | 1,377 |
| 1969 | N/A | 227 | 279 | 308 | 248 | 270 | N/A | 1,332 |
| 1970 | N/A | 279 | 270 | 279 | 279 | 270 | N/A | 1,377 |
| 1971 | 135 | 279 | 270 | 279 | 279 | 270 | 112 | 1,624 |
| 1972 | 135 | 222 | 223 | 154 | 142 | 134 | 69 | 1,079 |
| 1973 | 135 | 279 | 270 | 279 | 279 | 270 | 135 | 1,647 |
| 1974 | 135 | 279 | 270 | 279 | 249 | 222 | 135 | 1,568 |
| 1975 | 114 | 279 | 270 | 279 | 279 | 270 | 135 | 1,626 |
| 1976 | 124 | 270 | 270 | 202 | 180 | 162 | 93 | 1,301 |
| 1977 | 226 | 188 | 142 | 92 | 80 | 78 | 40 | 846 |
| 1978 | 135 | 279 | 270 | 279 | 279 | 205 | 123 | 1,570 |
| 1979 | 135 | 279 | 270 | 275 | 271 | 243 | 122 | 1,595 |
| 1980 | 135 | 279 | 270 | 279 | 279 | 270 | 135 | 1,647 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 135 | 279 | 270 | 279 | 279 | 270 | 135 | 1,647 |
| 1983 | 135 | 279 | 270 | 279 | 279 | 270 | 135 | 1,647 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 270 | 273 | 268 | 221 | 167 | 162 | 81 | 1,442 |
| 1989 | 118 | 268 | 212 | 193 | 147 | 125 | 52 | 1,116 |
| 1990 | 232 | 273 | 241 | 155 | 105 | 110 | 64 | 1,179 |

N/A - Data not available.

Table C-35
Historical Diversions
Moroni Irrigation Canal Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 874 | 661 | 392 | 358 | 361 | N/A | 2,645 |
| 1961 | N/A | 420 | 328 | 263 | 281 | 381 | N/A | 1,672 |
| 1962 | N/A | 1,104 | 1,004 | 828 | 775 | 575 | N/A | 4,285 |
| 1963 | N/A | 654 | 852 | 548 | 433 | 448 | N/A | 2,935 |
| 1964 | N/A | 628 | 892 | 851 | 586 | 480 | N/A | 3,437 |
| 1965 | N/A | 813 | 946 | 809 | 821 | 806 | N/A | 4,195 |
| 1966 | N/A | 836 | 770 | 518 | 465 | 468 | N/A | 3,057 |
| 1967 | N/A | 708 | 822 | 874 | 704 | 558 | N/A | 3,666 |
| 1968 | N/A | 750 | 900 | 930 | 930 | 840 | N/A | 4,350 |
| 1969 | N/A | 946 | 890 | 941 | 899 | 921 | N/A | 4,596 |
| 1970 | N/A | 942 | 912 | 942 | 942 | 912 | N/A | 4,651 |
| 1971 | 456 | 942 | 912 | 942 | 942 | 912 | 375 | 5,482 |
| 1972 | 427 | 718 | 770 | 528 | 476 | 455 | 232 | 3,605 |
| 1973 | 456 | 942 | 912 | 942 | 942 | 912 | 456 | 5,563 |
| 1974 | 456 | 942 | 912 | 942 | 868 | 780 | 456 | 5,356 |
| 1975 | 387 | 942 | 912 | 942 | 942 | 912 | 456 | 5,494 |
| 1976 | 420 | 912 | 912 | 681 | 641 | 547 | 274 | 4,387 |
| 1977 | 766 | 764 | 484 | 306 | 286 | 270 | 136 | 3,012 |
| 1978 | 458 | 946 | 915 | 946 | 946 | 839 | 412 | 5,460 |
| 1979 | 458 | 946 | 951 | 954 | 917 | 823 | 412 | 5,459 |
| 1980 | 458 | 946 | 915 | 946 | 946 | 915 | 458 | 5,582 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 458 | 946 | 915 | 946 | 946 | 915 | 458 | 5,582 |
| 1983 | 458 | 946 | 915 | 946 | 946 | 915 | 458 | 5,582 |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 912 | 921 | 904 | 748 | 565 | 547 | 274 | 4,872 |
| 1989 | 398 | 876 | 718 | 654 | 500 | 421 | 176 | 3,743 |
| 1990 | 783 | 921 | 833 | 596 | 345 | 371 | 234 | 4,083 |

N/A - Data not available.

Table C-36
Historical Diversions
Rock Dam Phillip Co.
(unit--acre-feet)

| | Apr | May | June | July | Aug | Sept | Oct | Total |
|---|---|---|---|---|---|---|---|---|
| 1960 | N/A | 224 | 86 | 56 | 46 | 47 | N/A | 459 |
| 1961 | N/A | 149 | 82 | 69 | 42 | 54 | N/A | 396 |
| 1962 | N/A | 897 | 736 | 671 | 557 | 436 | N/A | 3,297 |
| 1963 | N/A | 854 | 830 | 438 | 270 | 180 | N/A | 2,572 |
| 1964 | N/A | 745 | 954 | 568 | 416 | 300 | N/A | 2,983 |
| 1965 | N/A | 542 | 628 | 740 | 652 | 600 | N/A | 3,162 |
| 1966 | N/A | 630 | 487 | 434 | 428 | 355 | N/A | 2,334 |
| 1967 | N/A | 446 | 578 | 556 | 432 | 528 | N/A | 2,540 |
| 1968 | N/A | 620 | 720 | 839 | 540 | 496 | N/A | 3,215 |
| 1969 | N/A | 696 | 780 | 889 | 894 | 720 | N/A | 3,979 |
| 1970 | N/A | 657 | 666 | 596 | 484 | 421 | N/A | 2,824 |
| 1971 | 420 | 744 | 780 | 868 | 260 | N/A | N/A | 3,072 |
| 1972 | 300 | 220 | 60 | 62 | 62 | 60 | 30 | 794 |
| 1973 | 540 | 1,116 | 1,080 | 784 | 462 | N/A | N/A | 3,982 |
| 1974 | 450 | 837 | 771 | 258 | 239 | N/A | N/A | 2,555 |
| 1975 | 480 | 837 | 648 | 496 | 372 | N/A | N/A | 2,833 |
| 1976 | 236 | 632 | 280 | 186 | 186 | 180 | 90 | 1,790 |
| 1977 | 780 | 504 | 248 | 196 | 186 | 196 | 150 | 2,260 |
| 1978 | 610 | 928 | 780 | 448 | 278 | 240 | 120 | 3,404 |
| 1979 | 500 | 1,116 | 768 | 464 | 288 | 240 | 120 | 3,496 |
| 1980 | 540 | 1,116 | 1,080 | 924 | 536 | 360 | 180 | 4,736 |
| 1981 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1982 | 540 | 804 | 540 | 744 | 290 | 370 | 150 | 3,438 |
| 1983 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1984 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1985 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1986 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1987 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1988 | 600 | 752 | 800 | 310 | 310 | 300 | 200 | 3,272 |
| 1989 | 180 | 606 | 288 | 248 | 124 | 120 | 316 | 1,882 |
| 1990 | 543 | 811 | 423 | 185 | 185 | 179 | 407 | 2,730 |

N/A - Data not available.

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-59 | 394 | 906 | 394 | - | - | 360 | 1,327 | 360 | - | - |
| Nov-59 | - | - | - | - | - | - | - | - | - | - |
| Dec-59 | - | - | - | - | - | - | - | - | - | - |
| Jan-60 | - | - | - | - | - | - | - | - | - | - |
| Feb-60 | - | - | - | - | - | - | - | - | - | - |
| Mar-60 | - | - | - | - | - | - | - | - | - | - |
| Apr-60 | 604 | 631 | 604 | - | - | 401 | 363 | 363 | 38 | 28 |
| May-60 | 3,569 | 2,846 | 2,846 | 723 | 422 | 2,735 | 2,004 | 2,004 | 731 | 530 |
| Jun-60 | 6,358 | 4,136 | 4,136 | 2,222 | 1,297 | 5,026 | 4,936 | 4,936 | 90 | 65 |
| Jul-60 | 8,035 | 1,847 | 1,847 | 6,188 | 3,611 | 6,252 | 1,968 | 1,968 | 4,284 | 3,105 |
| Aug-60 | 5,903 | 954 | 954 | 4,949 | 2,888 | 4,420 | 1,299 | 1,299 | 3,121 | 2,262 |
| Sep-60 | 551 | 876 | 551 | - | - | 516 | 1,324 | 516 | - | - |
| Total | 25,414 | 12,196 | 11,332 | 14,082 | 8,217 | 19,710 | 13,221 | 11,446 | 8,264 | 5,990 |
| Oct-60 | - | 702 | - | - | - | - | 1,030 | - | - | - |
| Nov-60 | - | - | - | - | - | - | - | - | - | - |
| Dec-60 | - | - | - | - | - | - | - | - | - | - |
| Jan-61 | - | - | - | - | - | - | - | - | - | - |
| Feb-61 | - | - | - | - | - | - | - | - | - | - |
| Mar-61 | - | - | - | - | - | - | - | - | - | - |
| Apr-61 | 391 | 384 | 384 | 7 | 4 | 230 | 228 | 228 | 2 | 1 |
| May-61 | 3,993 | 1,984 | 1,984 | 2,009 | 1,172 | 3,073 | 1,536 | 1,536 | 1,537 | 1,114 |
| Jun-61 | 6,402 | 2,828 | 2,828 | 3,574 | 2,085 | 5,061 | 3,094 | 3,094 | 1,967 | 1,426 |
| Jul-61 | 7,666 | 1,258 | 1,258 | 6,408 | 3,739 | 5,959 | 1,438 | 1,438 | 4,521 | 3,277 |
| Aug-61 | 4,274 | 973 | 973 | 3,301 | 1,926 | 3,132 | 1,376 | 1,376 | 1,756 | 1,273 |
| Sep-61 | - | 1,087 | - | - | - | - | 1,671 | - | - | - |
| Total | 22,726 | 9,216 | 7,427 | 15,299 | 8,927 | 17,455 | 10,373 | 7,672 | 9,783 | 7,091 |
| Oct-61 | 19 | 658 | 19 | - | - | 58 | 984 | 58 | - | - |
| Nov-61 | - | - | - | - | - | - | - | - | - | - |
| Dec-61 | - | - | - | - | - | - | - | - | - | - |
| Jan-62 | - | - | - | - | - | - | - | - | - | - |
| Feb-62 | - | - | - | - | - | - | - | - | - | - |
| Mar-62 | - | - | - | - | - | - | - | - | - | - |
| Apr-62 | 508 | 961 | 508 | - | - | 324 | 562 | 324 | - | - |
| May-62 | 3,391 | 4,002 | 3,391 | - | - | 2,593 | 2,050 | 2,050 | 543 | 394 |
| Jun-62 | 6,131 | 7,722 | 6,131 | - | - | 4,844 | 8,277 | 4,844 | - | - |
| Jul-62 | 7,903 | 4,254 | 4,254 | 3,649 | 2,129 | 6,147 | 5,415 | 5,415 | 732 | 531 |
| Aug-62 | 6,136 | 1,840 | 1,840 | 4,296 | 2,507 | 4,604 | 2,067 | 2,067 | 2,537 | 1,839 |
| Sep-62 | 792 | 1,343 | 792 | - | - | 711 | 1,976 | 711 | - | - |
| Total | 24,880 | 20,780 | 16,935 | 7,945 | 4,636 | 19,281 | 21,331 | 15,469 | 3,812 | 2,763 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-62 | 495 | 701 | 495 | - | - | 441 | 1,077 | 441 | - | - |
| Nov-62 | - | - | - | - | - | - | - | - | - | - |
| Dec-62 | - | - | - | - | - | - | - | - | - | - |
| Jan-63 | - | - | - | - | - | - | - | - | - | - |
| Feb-63 | - | - | - | - | - | - | - | - | - | - |
| Mar-63 | - | - | - | - | - | - | - | - | - | - |
| Apr-63 | 144 | 442 | 144 | - | - | 33 | 255 | 33 | - | - |
| May-63 | 3,935 | 2,228 | 2,228 | 1,707 | 996 | 3,026 | 1,240 | 1,240 | 1,786 | 1,294 |
| Jun-63 | 5,602 | 3,585 | 3,585 | 2,017 | 1,177 | 4,421 | 4,086 | 4,086 | 335 | 243 |
| Jul-63 | 7,955 | 2,113 | 2,113 | 5,842 | 3,409 | 6,189 | 2,447 | 2,447 | 3,742 | 2,712 |
| Aug-63 | 5,546 | 1,782 | 1,782 | 3,764 | 2,196 | 4,138 | 1,940 | 1,940 | 2,198 | 1,593 |
| Sep-63 | 600 | 1,202 | 600 | - | - | 556 | 1,691 | 556 | - | - |
| Total | 24,277 | 12,053 | 10,947 | 13,330 | 7,778 | 18,804 | 12,736 | 10,743 | 8,061 | 5,843 |
| Oct-63 | 663 | 820 | 663 | - | - | 577 | 1,219 | 577 | - | - |
| Nov-63 | - | - | - | - | - | - | - | - | - | - |
| Dec-63 | - | - | - | - | - | - | - | - | - | - |
| Jan-64 | - | - | - | - | - | - | - | - | - | - |
| Feb-64 | - | - | - | - | - | - | - | - | - | - |
| Mar-64 | - | - | - | - | - | - | - | - | - | - |
| Apr-64 | 185 | 436 | 185 | - | - | 66 | 243 | 66 | - | - |
| May-64 | 2,999 | 2,466 | 2,466 | 533 | 311 | 2,280 | 1,002 | 1,002 | 1,278 | 926 |
| Jun-64 | 5,711 | 6,002 | 5,711 | - | - | 4,508 | 6,429 | 4,508 | - | - |
| Jul-64 | 8,295 | 2,803 | 2,803 | 5,492 | 3,205 | 6,459 | 3,593 | 3,593 | 2,866 | 2,077 |
| Aug-64 | 5,158 | 1,512 | 1,512 | 3,646 | 2,127 | 3,831 | 1,639 | 1,639 | 2,192 | 1,589 |
| Sep-64 | 1,038 | 1,233 | 1,038 | - | - | 909 | 1,666 | 909 | - | - |
| Total | 24,049 | 15,272 | 14,378 | 9,671 | 5,643 | 18,630 | 15,791 | 12,294 | 6,336 | 4,592 |
| Oct-64 | 721 | 691 | 691 | 30 | 18 | 623 | 1,004 | 623 | - | - |
| Nov-64 | - | - | - | - | - | - | - | - | - | - |
| Dec-64 | - | - | - | - | - | - | - | - | - | - |
| Jan-65 | - | - | - | - | - | - | - | - | - | - |
| Feb-65 | - | - | - | - | - | - | - | - | - | - |
| Mar-65 | - | - | - | - | - | - | - | - | - | - |
| Apr-65 | 770 | 793 | 770 | - | - | 534 | 451 | 451 | 83 | 60 |
| May-65 | 3,229 | 14,426 | 3,229 | - | - | 2,463 | 3,216 | 2,463 | - | - |
| Jun-65 | 5,879 | 16,570 | 5,879 | - | - | 4,643 | 14,416 | 4,643 | - | - |
| Jul-65 | 7,642 | 3,959 | 3,959 | 3,683 | 2,149 | 5,940 | 5,895 | 5,895 | 45 | 33 |
| Aug-65 | 4,920 | 1,929 | 1,929 | 2,991 | 1,745 | 3,643 | 2,393 | 2,393 | 1,250 | 906 |
| Sep-65 | 180 | 1,550 | 180 | - | - | 217 | 2,122 | 217 | - | - |
| Total | 23,341 | 39,918 | 16,637 | 6,704 | 3,912 | 18,063 | 29,497 | 16,685 | 1,378 | 999 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-65 | 721 | 616 | 616 | 105 | 61 | 623 | 912 | 623 | - | - |
| Nov-65 | - | - | - | - | - | - | - | - | - | - |
| Dec-65 | - | - | - | - | - | - | - | - | - | - |
| Jan-66 | - | - | - | - | - | - | - | - | - | - |
| Feb-66 | - | - | - | - | - | - | - | - | - | - |
| Mar-66 | - | - | - | - | - | - | - | - | - | - |
| Apr-66 | 770 | 3,033 | 770 | - | - | 534 | 1,682 | 534 | - | - |
| May-66 | 3,559 | 10,324 | 3,559 | - | - | 2,727 | 3,496 | 2,727 | - | - |
| Jun-66 | 6,288 | 2,562 | 2,562 | 3,726 | 2,174 | 4,970 | 2,678 | 2,678 | 2,292 | 1,661 |
| Jul-66 | 7,968 | 1,227 | 1,227 | 6,741 | 3,933 | 6,199 | 1,731 | 1,731 | 4,468 | 3,238 |
| Aug-66 | 5,915 | 713 | 713 | 5,202 | 3,035 | 4,430 | 1 | 1 | 4,429 | 3,210 |
| Sep-66 | 1,384 | 785 | 785 | 599 | 350 | 1,188 | 1,167 | 1,167 | 21 | 15 |
| Total | 26,605 | 19,260 | 10,232 | 16,373 | 9,554 | 20,671 | 11,667 | 9,461 | 11,210 | 8,125 |
| Oct-66 | - | 854 | - | - | - | - | 1,291 | - | - | - |
| Nov-66 | - | - | - | - | - | - | - | - | - | - |
| Dec-66 | - | - | - | - | - | - | - | - | - | - |
| Jan-67 | - | - | - | - | - | - | - | - | - | - |
| Feb-67 | - | - | - | - | - | - | - | - | - | - |
| Mar-67 | - | - | - | - | - | - | - | - | - | - |
| Apr-67 | 660 | 768 | 660 | - | - | 446 | 427 | 427 | 19 | 14 |
| May-67 | 2,760 | 12,268 | 2,760 | - | - | 2,089 | 2,666 | 2,089 | - | - |
| Jun-67 | 4,906 | 13,869 | 4,906 | - | - | 3,865 | 11,739 | 3,865 | - | - |
| Jul-67 | 7,678 | 3,680 | 3,680 | 3,998 | 2,333 | 5,968 | 5,247 | 5,247 | 721 | 523 |
| Aug-67 | 6,042 | 1,610 | 1,610 | 4,432 | 2,586 | 4,530 | 2,208 | 2,208 | 2,322 | 1,683 |
| Sep-67 | 649 | 1,237 | 649 | - | - | 596 | 1,842 | 596 | - | - |
| Total | 22,695 | 34,286 | 14,265 | 8,430 | 4,919 | 17,494 | 25,420 | 14,432 | 3,062 | 2,219 |
| Oct-67 | 654 | 790 | 654 | - | - | 570 | 1,145 | 570 | - | - |
| Nov-67 | - | - | - | - | - | - | - | - | - | - |
| Dec-67 | - | - | - | - | - | - | - | - | - | - |
| Jan-68 | - | - | - | - | - | - | - | - | - | - |
| Feb-68 | - | - | - | - | - | - | - | - | - | - |
| Mar-68 | - | - | - | - | - | - | - | - | - | - |
| Apr-68 | 14 | 741 | 14 | - | - | - | 409 | - | - | - |
| May-68 | 3,651 | 15,125 | 3,651 | - | - | 2,800 | 3,491 | 2,800 | - | - |
| Jun-68 | 5,602 | 18,020 | 5,602 | - | - | 4,421 | 15,028 | 4,421 | - | - |
| Jul-68 | 7,524 | 3,594 | 3,594 | 3,930 | 2,293 | 5,845 | 3,900 | 3,900 | 1,945 | 1,410 |
| Aug-68 | 3,754 | 2,404 | 2,404 | 1,350 | 788 | 2,721 | 2,148 | 2,148 | 573 | 415 |
| Sep-68 | 1,514 | 1,264 | 1,264 | 250 | 146 | 1,293 | 1,736 | 1,293 | - | - |
| Total | 22,713 | 41,938 | 17,183 | 5,530 | 3,227 | 17,650 | 27,857 | 15,132 | 2,518 | 1,825 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-68 | 342 | 721 | 342 | - | - | 318 | 1,047 | 318 | - | - |
| Nov-68 | - | - | - | - | - | - | - | - | - | - |
| Dec-68 | - | - | - | - | - | - | - | - | - | - |
| Jan-69 | - | - | - | - | - | - | - | - | - | - |
| Feb-69 | - | - | - | - | - | - | - | - | - | - |
| Mar-69 | - | - | - | - | - | - | - | - | - | - |
| Apr-69 | 707 | 3,516 | 707 | - | - | 469 | 1,948 | 469 | - | - |
| May-69 | 4,171 | 31,007 | 4,171 | - | - | 3,215 | 8,907 | 3,215 | - | - |
| Jun-69 | 5,250 | 7,094 | 5,250 | - | - | 4,139 | 7,214 | 4,139 | - | - |
| Jul-69 | 7,618 | 3,827 | 3,827 | 3,791 | 2,212 | 5,921 | 4,459 | 4,459 | 1,462 | 1,060 |
| Aug-69 | 5,990 | 2,233 | 2,233 | 3,757 | 2,192 | 4,489 | 2,060 | 2,060 | 2,429 | 1,761 |
| Sep-69 | 1,002 | 1,424 | 1,002 | - | - | 880 | 1,848 | 880 | - | - |
| Total | 25,080 | 49,822 | 17,532 | 7,548 | 4,404 | 19,431 | 27,483 | 15,540 | 3,891 | 2,820 |
| Oct-69 | - | 885 | - | - | - | - | 1,289 | - | - | - |
| Nov-69 | - | - | - | - | - | - | - | - | - | - |
| Dec-69 | - | - | - | - | - | - | - | - | - | - |
| Jan-70 | - | - | - | - | - | - | - | - | - | - |
| Feb-70 | - | - | - | - | - | - | - | - | - | - |
| Mar-70 | - | - | - | - | - | - | - | - | - | - |
| Apr-70 | 689 | 573 | 573 | 116 | 68 | 469 | 317 | 317 | 152 | 110 |
| May-70 | 4,171 | 15,117 | 4,171 | - | - | 3,215 | 3,108 | 3,108 | 107 | 78 |
| Jun-70 | 4,670 | 10,068 | 4,670 | - | - | 3,676 | 8,003 | 3,676 | - | - |
| Jul-70 | 8,341 | 4,346 | 4,346 | 3,995 | 2,331 | 6,496 | 5,164 | 5,164 | 1,332 | 965 |
| Aug-70 | 5,471 | 1,944 | 1,944 | 3,527 | 2,058 | 4,078 | 1,657 | 1,657 | 2,421 | 1,755 |
| Sep-70 | 1,607 | 1,010 | 1,010 | 597 | 348 | 1,368 | 1,453 | 1,368 | - | - |
| Total | 24,949 | 33,943 | 16,714 | 8,235 | 4,805 | 19,302 | 20,991 | 15,290 | 4,012 | 2,908 |
| Oct-70 | 654 | 924 | 654 | - | - | 570 | 1,323 | 570 | - | - |
| Nov-70 | - | - | - | - | - | - | - | - | - | - |
| Dec-70 | - | - | - | - | - | - | - | - | - | - |
| Jan-71 | - | - | - | - | - | - | - | - | - | - |
| Feb-71 | - | - | - | - | - | - | - | - | - | - |
| Mar-71 | - | - | - | - | - | - | - | - | - | - |
| Apr-71 | 352 | 1,604 | 352 | - | - | 199 | 886 | 199 | - | - |
| May-71 | 3,450 | 16,097 | 3,450 | - | - | 2,639 | 3,852 | 2,639 | - | - |
| Jun-71 | 5,937 | 8,175 | 5,937 | - | - | 4,689 | 8,756 | 4,689 | - | - |
| Jul-71 | 8,279 | 3,288 | 3,288 | 4,991 | 2,912 | 6,446 | 3,583 | 3,583 | 2,863 | 2,075 |
| Aug-71 | 5,008 | 1,840 | 1,840 | 3,168 | 1,849 | 3,713 | 1,762 | 1,762 | 1,951 | 1,414 |
| Sep-71 | 1,224 | 1,249 | 1,224 | - | - | 1,059 | 1,831 | 1,059 | - | - |
| Total | 24,904 | 33,177 | 16,745 | 8,159 | 4,761 | 19,315 | 21,993 | 14,501 | 4,814 | 3,489 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-71 | - | 672 | - | - | - | - | 992 | - | - | - |
| Nov-71 | - | - | - | - | - | - | - | - | - | - |
| Dec-71 | - | - | - | - | - | - | - | - | - | - |
| Jan-72 | - | - | - | - | - | - | - | - | - | - |
| Feb-72 | - | - | - | - | - | - | - | - | - | - |
| Mar-72 | - | - | - | - | - | - | - | - | - | - |
| Apr-72 | 487 | 1,289 | 487 | - | - | 307 | 712 | 307 | - | - |
| May-72 | 3,822 | 8,561 | 3,822 | - | - | 2,936 | 3,633 | 2,936 | - | - |
| Jun-72 | 6,118 | 3,536 | 3,536 | 2,582 | 1,507 | 4,834 | 3,772 | 3,772 | 1,062 | 770 |
| Jul-72 | 8,062 | 2,027 | 2,027 | 6,035 | 3,521 | 6,274 | 1,725 | 1,725 | 4,549 | 3,297 |
| Aug-72 | 5,903 | 921 | 921 | 4,982 | 2,907 | 4,420 | 1,012 | 1,012 | 3,408 | 2,470 |
| Sep-72 | 870 | 791 | 791 | 79 | 46 | 773 | 1,191 | 773 | - | - |
| Total | 25,262 | 17,797 | 11,584 | 13,678 | 7,981 | 19,544 | 13,037 | 10,525 | 9,019 | 6,537 |
| Oct-72 | - | 837 | - | - | - | - | 1,242 | - | - | - |
| Nov-72 | - | - | - | - | - | - | - | - | - | - |
| Dec-72 | - | - | - | - | - | - | - | - | - | - |
| Jan-73 | - | - | - | - | - | - | - | - | - | - |
| Feb-73 | - | - | - | - | - | - | - | - | - | - |
| Mar-73 | - | - | - | - | - | - | - | - | - | - |
| Apr-73 | 117 | 716 | 117 | - | - | 11 | 395 | 11 | - | - |
| May-73 | 2,857 | 23,579 | 2,857 | - | - | 2,166 | 6,130 | 2,166 | - | - |
| Jun-73 | 5,856 | 11,236 | 5,856 | - | - | 4,625 | 9,425 | 4,625 | - | - |
| Jul-73 | 6,956 | 4,110 | 4,110 | 2,846 | 1,661 | 5,394 | 4,661 | 4,661 | 733 | 531 |
| Aug-73 | 6,221 | 2,215 | 2,215 | 4,006 | 2,338 | 4,672 | 1,832 | 1,832 | 2,840 | 2,058 |
| Sep-73 | 1,205 | 1,123 | 1,123 | 82 | 48 | 1,044 | 1,630 | 1,044 | - | - |
| Total | 23,212 | 43,816 | 16,278 | 6,934 | 4,046 | 17,912 | 25,315 | 14,339 | 3,573 | 2,590 |
| Oct-73 | 721 | 620 | 620 | 101 | 59 | 623 | 886 | 623 | - | - |
| Nov-73 | - | - | - | - | - | - | - | - | - | - |
| Dec-73 | - | - | - | - | - | - | - | - | - | - |
| Jan-74 | - | - | - | - | - | - | - | - | - | - |
| Feb-74 | - | - | - | - | - | - | - | - | - | - |
| Mar-74 | - | - | - | - | - | - | - | - | - | - |
| Apr-74 | 195 | 688 | 195 | - | - | 73 | 380 | 73 | - | - |
| May-74 | 4,067 | 17,467 | 4,067 | - | - | 3,132 | 4,810 | 3,132 | - | - |
| Jun-74 | 6,402 | 5,318 | 5,318 | 1,084 | 633 | 5,061 | 5,126 | 5,061 | - | - |
| Jul-74 | 6,520 | 2,692 | 2,692 | 3,828 | 2,234 | 5,047 | 2,506 | 2,506 | 2,541 | 1,842 |
| Aug-74 | 6,221 | 1,535 | 1,535 | 4,686 | 2,734 | 4,672 | 1,147 | 1,147 | 3,525 | 2,555 |
| Sep-74 | 1,607 | 741 | 741 | 866 | 505 | 1,368 | 1,066 | 1,066 | 302 | 219 |
| Total | 25,733 | 29,061 | 15,168 | 10,565 | 6,165 | 19,976 | 15,921 | 13,608 | 6,368 | 4,616 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-74 | 240 | 695 | 240 | - | - | 236 | 993 | 236 | - | - |
| Nov-74 | - | - | - | - | - | - | - | - | - | - |
| Dec-74 | - | - | - | - | - | - | - | - | - | - |
| Jan-75 | - | - | - | - | - | - | - | - | - | - |
| Feb-75 | - | - | - | - | - | - | - | - | - | - |
| Mar-75 | - | - | - | - | - | - | - | - | - | - |
| Apr-75 | 770 | 418 | 418 | 352 | 205 | 534 | 231 | 231 | 303 | 220 |
| May-75 | 2,386 | 10,227 | 2,386 | - | - | 1,791 | 2,055 | 1,791 | - | - |
| Jun-75 | 5,766 | 24,720 | 5,766 | - | - | 4,552 | 19,370 | 4,552 | - | - |
| Jul-75 | 7,727 | 5,717 | 5,717 | 2,010 | 1,173 | 6,007 | 6,649 | 6,007 | - | - |
| Aug-75 | 6,016 | 2,809 | 2,809 | 3,207 | 1,871 | 4,509 | 2,511 | 2,511 | 1,998 | 1,448 |
| Sep-75 | 1,093 | 2,105 | 1,093 | - | - | 953 | 2,319 | 953 | - | - |
| Total | 23,998 | 46,691 | 18,429 | 5,569 | 3,250 | 18,582 | 34,128 | 16,281 | 2,301 | 1,668 |
| Oct-75 | 721 | 527 | 527 | 194 | 113 | 623 | 753 | 623 | - | - |
| Nov-75 | - | - | - | - | - | - | - | - | - | - |
| Dec-75 | - | - | - | - | - | - | - | - | - | - |
| Jan-76 | - | - | - | - | - | - | - | - | - | - |
| Feb-76 | - | - | - | - | - | - | - | - | - | - |
| Mar-76 | - | - | - | - | - | - | - | - | - | - |
| Apr-76 | 683 | 767 | 683 | - | - | 464 | 423 | 423 | 41 | 30 |
| May-76 | 3,889 | 12,206 | 3,889 | - | - | 2,990 | 3,756 | 2,990 | - | - |
| Jun-76 | 6,302 | 3,980 | 3,980 | 2,322 | 1,355 | 4,981 | 4,390 | 4,390 | 591 | 428 |
| Jul-76 | 8,175 | 2,601 | 2,601 | 5,574 | 3,252 | 6,363 | 2,503 | 2,503 | 3,860 | 2,798 |
| Aug-76 | 6,016 | 1,253 | 1,253 | 4,763 | 2,779 | 4,509 | 1,194 | 1,194 | 3,315 | 2,403 |
| Sep-76 | 1,047 | 778 | 778 | 269 | 157 | 916 | 1,182 | 916 | - | - |
| Total | 26,833 | 22,112 | 13,711 | 13,122 | 7,657 | 20,846 | 14,201 | 13,039 | 7,807 | 5,659 |
| Oct-76 | 394 | 1,040 | 394 | - | - | 360 | 1,486 | 360 | - | - |
| Nov-76 | - | - | - | - | - | - | - | - | - | - |
| Dec-76 | - | - | - | - | - | - | - | - | - | - |
| Jan-77 | - | - | - | - | - | - | - | - | - | - |
| Feb-77 | - | - | - | - | - | - | - | - | - | - |
| Mar-77 | - | - | - | - | - | - | - | - | - | - |
| Apr-77 | 770 | 644 | 644 | 126 | 74 | 534 | 356 | 356 | 178 | 129 |
| May-77 | 3,036 | 1,699 | 1,699 | 1,337 | 780 | 2,309 | 709 | 709 | 1,600 | 1,160 |
| Jun-77 | 6,402 | 2,215 | 2,215 | 4,187 | 2,443 | 5,061 | 2,141 | 2,141 | 2,920 | 2,116 |
| Jul-77 | 7,216 | 893 | 893 | 6,323 | 3,689 | 5,601 | 1,289 | 1,289 | 4,312 | 3,125 |
| Aug-77 | 5,168 | 572 | 572 | 4,596 | 2,682 | 3,839 | 817 | 817 | 3,022 | 2,190 |
| Sep-77 | 1,205 | 632 | 632 | 573 | 334 | 1,044 | 952 | 952 | 92 | 67 |
| Total | 24,191 | 7,695 | 7,049 | 17,142 | 10,002 | 18,748 | 7,750 | 6,624 | 12,124 | 8,787 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-77 | 162 | 569 | 162 | - | - | 173 | 813 | 173 | - | - |
| Nov-77 | - | - | - | - | - | - | - | - | - | - |
| Dec-77 | - | - | - | - | - | - | - | - | - | - |
| Jan-78 | - | - | - | - | - | - | - | - | - | - |
| Feb-78 | - | - | - | - | - | - | - | - | - | - |
| Mar-78 | - | - | - | - | - | - | - | - | - | - |
| Apr-78 | 279 | 1,637 | 279 | - | - | 141 | 904 | 141 | - | - |
| May-78 | 3,600 | 20,371 | 3,600 | - | - | 2,759 | 4,088 | 2,759 | - | - |
| Jun-78 | 6,402 | 21,672 | 6,402 | - | - | 5,061 | 19,394 | 5,061 | - | - |
| Jul-78 | 8,341 | 4,247 | 4,247 | 4,094 | 2,389 | 6,496 | 4,937 | 4,937 | 1,559 | 1,130 |
| Aug-78 | 5,749 | 2,237 | 2,237 | 3,512 | 2,049 | 4,298 | 1,975 | 1,975 | 2,323 | 1,684 |
| Sep-78 | 511 | 1,702 | 511 | - | - | 484 | 2,032 | 484 | - | - |
| Total | 25,044 | 52,435 | 17,438 | 7,606 | 4,438 | 19,412 | 34,143 | 15,530 | 3,882 | 2,814 |
| Oct-78 | 611 | 424 | 424 | 187 | 109 | 534 | 606 | 534 | - | - |
| Nov-78 | - | - | - | - | - | - | - | - | - | - |
| Dec-78 | - | - | - | - | - | - | - | - | - | - |
| Jan-79 | - | - | - | - | - | - | - | - | - | - |
| Feb-79 | - | - | - | - | - | - | - | - | - | - |
| Mar-79 | - | - | - | - | - | - | - | - | - | - |
| Apr-79 | 770 | 1,008 | 770 | - | - | 534 | 557 | 534 | - | - |
| May-79 | 3,343 | 17,570 | 3,343 | - | - | 2,554 | 5,018 | 2,554 | - | - |
| Jun-79 | 6,402 | 8,107 | 6,402 | - | - | 5,061 | 7,911 | 5,061 | - | - |
| Jul-79 | 7,852 | 3,618 | 3,618 | 4,234 | 2,471 | 6,106 | 3,874 | 3,874 | 2,232 | 1,618 |
| Aug-79 | 5,492 | 2,011 | 2,011 | 3,481 | 2,031 | 4,095 | 1,625 | 1,625 | 2,470 | 1,790 |
| Sep-79 | 1,607 | 1,078 | 1,078 | 529 | 309 | 1,368 | 1,293 | 1,293 | 75 | 54 |
| Total | 26,077 | 33,816 | 17,646 | 8,431 | 4,919 | 20,252 | 20,884 | 15,475 | 4,777 | 3,462 |
| Oct-79 | 320 | 839 | 320 | - | - | 300 | 1,199 | 300 | - | - |
| Nov-79 | - | - | - | - | - | - | - | - | - | - |
| Dec-79 | - | - | - | - | - | - | - | - | - | - |
| Jan-80 | - | - | - | - | - | - | - | - | - | - |
| Feb-80 | - | - | - | - | - | - | - | - | - | - |
| Mar-80 | - | - | - | - | - | - | - | - | - | - |
| Apr-80 | 577 | 1,146 | 577 | - | - | 379 | 633 | 379 | - | - |
| May-80 | 2,708 | 18,132 | 2,708 | - | - | 2,048 | 4,421 | 2,048 | - | - |
| Jun-80 | 6,402 | 24,436 | 6,402 | - | - | 5,061 | 20,326 | 5,061 | - | - |
| Jul-80 | 7,454 | 7,177 | 7,177 | 277 | 162 | 5,790 | 9,347 | 5,790 | - | - |
| Aug-80 | 5,058 | 3,361 | 3,361 | 1,697 | 990 | 3,752 | 3,343 | 3,343 | 409 | 296 |
| Sep-80 | 219 | 2,623 | 219 | - | - | 248 | 3,942 | 248 | - | - |
| Total | 22,738 | 57,714 | 20,764 | 1,974 | 1,152 | 17,578 | 43,211 | 17,169 | 409 | 296 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-80 | 46 | 588 | 46 | - | - | 80 | 840 | 80 | - | - |
| Nov-80 | - | - | - | - | - | - | - | - | - | - |
| Dec-80 | - | - | - | - | - | - | - | - | - | - |
| Jan-81 | - | - | - | - | - | - | - | - | - | - |
| Feb-81 | - | - | - | - | - | - | - | - | - | - |
| Mar-81 | - | - | - | - | - | - | - | - | - | - |
| Apr-81 | 731 | 1,935 | 731 | - | - | 503 | 1,069 | 503 | - | - |
| May-81 | 2,752 | 10,186 | 2,752 | - | - | 2,082 | 2,482 | 2,082 | - | - |
| Jun-81 | 6,402 | 5,631 | 5,631 | 771 | 450 | 5,061 | 5,891 | 5,061 | - | - |
| Jul-81 | 7,194 | 2,849 | 2,849 | 4,345 | 2,535 | 5,584 | 2,930 | 2,930 | 2,654 | 1,924 |
| Aug-81 | 4,586 | 1,479 | 1,479 | 3,107 | 1,813 | 3,379 | 1,240 | 1,240 | 2,139 | 1,550 |
| Sep-81 | 486 | 1,159 | 486 | - | - | 464 | 1,260 | 464 | - | - |
| Total | 22,197 | 23,827 | 13,974 | 8,223 | 4,798 | 17,153 | 15,712 | 12,360 | 4,793 | 3,474 |
| Oct-81 | - | 1,212 | - | - | - | - | 1,733 | - | - | - |
| Nov-81 | - | - | - | - | - | - | - | - | - | - |
| Dec-81 | - | - | - | - | - | - | - | - | - | - |
| Jan-82 | - | - | - | - | - | - | - | - | - | - |
| Feb-82 | - | - | - | - | - | - | - | - | - | - |
| Mar-82 | - | - | - | - | - | - | - | - | - | - |
| Apr-82 | 770 | 2,078 | 770 | - | - | 534 | 1,148 | 534 | - | - |
| May-82 | 3,018 | 28,775 | 3,018 | - | - | 2,294 | 6,927 | 2,294 | - | - |
| Jun-82 | 6,261 | 17,271 | 6,261 | - | - | 4,948 | 15,333 | 4,948 | - | - |
| Jul-82 | 7,582 | 4,988 | 4,988 | 2,594 | 1,514 | 5,892 | 6,235 | 5,892 | - | - |
| Aug-82 | 5,492 | 2,490 | 2,490 | 3,002 | 1,752 | 4,095 | 2,280 | 2,280 | 1,815 | 1,316 |
| Sep-82 | - | 1,582 | - | - | - | - | 2,412 | - | - | - |
| Total | 23,123 | 58,396 | 17,527 | 5,596 | 3,265 | 17,763 | 36,068 | 15,948 | 1,815 | 1,316 |
| Oct-82 | - | 858 | - | - | - | 4 | 1,226 | 4 | - | - |
| Nov-82 | - | - | - | - | - | - | - | - | - | - |
| Dec-82 | - | - | - | - | - | - | - | - | - | - |
| Jan-83 | - | - | - | - | - | - | - | - | - | - |
| Feb-83 | - | - | - | - | - | - | - | - | - | - |
| Mar-83 | - | - | - | - | - | - | - | - | - | - |
| Apr-83 | 260 | 1,706 | 260 | - | - | 126 | 942 | 126 | - | - |
| May-83 | 3,391 | 24,117 | 3,391 | - | - | 2,593 | 4,839 | 2,593 | - | - |
| Jun-83 | 6,388 | 44,459 | 6,388 | - | - | 5,050 | 34,448 | 5,050 | - | - |
| Jul-83 | 7,727 | 12,196 | 7,727 | - | - | 6,007 | 16,006 | 6,007 | - | - |
| Aug-83 | 4,247 | 4,994 | 4,247 | - | - | 3,111 | 5,917 | 3,111 | - | - |
| Sep-83 | - | 2,850 | - | - | - | 58 | 4,302 | 58 | - | - |
| Total | 22,013 | 91,180 | 22,013 | - | - | 16,949 | 67,680 | 16,949 | - | - |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-83 | 240 | 1,529 | 240 | - | - | 236 | 2,186 | 236 | - | - |
| Nov-83 | - | - | - | - | - | - | - | - | - | - |
| Dec-83 | - | - | - | - | - | - | - | - | - | - |
| Jan-84 | - | - | - | - | - | - | - | - | - | - |
| Feb-84 | - | - | - | - | - | - | - | - | - | - |
| Mar-84 | - | - | - | - | - | - | - | - | - | - |
| Apr-84 | 289 | 1,620 | 289 | - | - | 149 | 894 | 149 | - | - |
| May-84 | 3,757 | 39,353 | 3,757 | - | - | 2,884 | 7,893 | 2,884 | - | - |
| Jun-84 | 3,916 | 22,126 | 3,916 | - | - | 3,072 | 17,422 | 3,072 | - | - |
| Jul-84 | 6,449 | 6,328 | 6,328 | 121 | 71 | 4,991 | 8,010 | 4,991 | - | - |
| Aug-84 | 5,438 | 3,402 | 3,402 | 2,036 | 1,188 | 4,053 | 3,510 | 3,510 | 543 | 394 |
| Sep-84 | 733 | 2,636 | 733 | - | - | 663 | 3,066 | 663 | - | - |
| Total | 20,822 | 76,994 | 18,665 | 2,157 | 1,259 | 16,048 | 42,981 | 15,505 | 543 | 394 |
| Oct-84 | - | 1,651 | - | - | - | - | 2,359 | - | - | - |
| Nov-84 | - | - | - | - | - | - | - | - | - | - |
| Dec-84 | - | - | - | - | - | - | - | - | - | - |
| Jan-85 | - | - | - | - | - | - | - | - | - | - |
| Feb-85 | - | - | - | - | - | - | - | - | - | - |
| Mar-85 | - | - | - | - | - | - | - | - | - | - |
| Apr-85 | 237 | 5,271 | 237 | - | - | 107 | 2,911 | 107 | - | - |
| May-85 | 3,239 | 26,315 | 3,239 | - | - | 2,471 | 6,680 | 2,471 | - | - |
| Jun-85 | 5,678 | 6,345 | 5,678 | - | - | 4,482 | 6,036 | 4,482 | - | - |
| Jul-85 | 6,142 | 4,284 | 4,284 | 1,858 | 1,084 | 4,747 | 4,850 | 4,747 | - | - |
| Aug-85 | 6,221 | 2,570 | 2,570 | 3,651 | 2,130 | 4,672 | 2,261 | 2,261 | 2,411 | 1,747 |
| Sep-85 | 1 | 1,802 | 1 | - | - | 953 | 2,269 | 953 | - | - |
| Total | 21,518 | 48,238 | 16,009 | 5,509 | 3,215 | 17,432 | 27,366 | 15,021 | 2,411 | 1,747 |
| Oct-85 | - | 1,320 | - | - | - | - | 1,886 | - | - | - |
| Nov-85 | - | - | - | - | - | - | - | - | - | - |
| Dec-85 | - | - | - | - | - | - | - | - | - | - |
| Jan-86 | - | - | - | - | - | - | - | - | - | - |
| Feb-86 | - | - | - | - | - | - | - | - | - | - |
| Mar-86 | - | - | - | - | - | - | - | - | - | - |
| Apr-86 | - | 4,355 | - | - | - | - | 2,405 | - | - | - |
| May-86 | 3,683 | 33,418 | 3,683 | - | - | 2,825 | 6,703 | 2,825 | - | - |
| Jun-86 | 5,856 | 20,232 | 5,856 | - | - | 4,625 | 14,704 | 4,625 | - | - |
| Jul-86 | 7,929 | 4,058 | 4,058 | 3,871 | 2,259 | 6,168 | 4,041 | 4,041 | 2,127 | 1,542 |
| Aug-86 | 5,819 | 2,666 | 2,666 | 3,153 | 1,840 | 4,353 | 2,367 | 2,367 | 1,986 | 1,439 |
| Sep-86 | 438 | 1,874 | 438 | - | - | 425 | 2,422 | 425 | - | - |
| Total | 23,725 | 67,923 | 16,701 | 7,024 | 4,099 | 18,396 | 34,528 | 14,283 | 4,113 | 2,981 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Oct-86 | - | 1,054 | - | - | - | 31 | 1,506 | 31 | - | - |
| Nov-86 | - | - | - | - | - | - | - | - | - | - |
| Dec-86 | - | - | - | - | - | - | - | - | - | - |
| Jan-87 | - | - | - | - | - | - | - | - | - | - |
| Feb-87 | - | - | - | - | - | - | - | - | - | - |
| Mar-87 | - | - | - | - | - | - | - | - | - | - |
| Apr-87 | 770 | 2,526 | 770 | - | - | 534 | 1,395 | 534 | - | - |
| May-87 | 3,027 | 10,907 | 3,027 | - | - | 2,302 | 3,115 | 2,302 | - | - |
| Jun-87 | 6,195 | 4,907 | 4,907 | 1,288 | 752 | 4,895 | 4,647 | 4,647 | 248 | 180 |
| Jul-87 | 7,317 | 3,061 | 3,061 | 4,256 | 2,483 | 5,681 | 2,912 | 2,912 | 2,769 | 2,007 |
| Aug-87 | 5,438 | 2,101 | 2,101 | 3,337 | 1,947 | 4,053 | 1,945 | 1,945 | 2,108 | 1,528 |
| Sep-87 | 1,363 | 1,358 | 1,358 | 5 | 3 | 1,171 | 1,870 | 1,171 | - | - |
| Total | 24,110 | 25,914 | 15,224 | 8,886 | 5,185 | 18,667 | 17,390 | 13,542 | 5,125 | 3,715 |
| Oct-87 | 80 | 1,189 | 80 | - | - | 107 | 1,699 | 107 | - | - |
| Nov-87 | - | - | - | - | - | - | - | - | - | - |
| Dec-87 | - | - | - | - | - | - | - | - | - | - |
| Jan-88 | - | - | - | - | - | - | - | - | - | - |
| Feb-88 | - | - | - | - | - | - | - | - | - | - |
| Mar-88 | - | - | - | - | - | - | - | - | - | - |
| Apr-88 | 482 | 1,253 | 482 | - | - | 303 | 692 | 303 | - | - |
| May-88 | 2,874 | 11,574 | 2,874 | - | - | 2,180 | 2,325 | 2,180 | - | - |
| Jun-88 | 6,056 | 4,014 | 4,014 | 2,043 | 1,192 | 4,785 | 4,317 | 4,317 | 467 | 339 |
| Jul-88 | 7,727 | 2,987 | 2,987 | 4,740 | 2,766 | 6,007 | 2,940 | 2,940 | 3,067 | 2,223 |
| Aug-88 | 5,669 | 1,677 | 1,677 | 3,992 | 2,329 | 4,235 | 1,678 | 1,678 | 2,557 | 1,853 |
| Sep-88 | 784 | 1,296 | 784 | - | - | 704 | 1,721 | 704 | - | - |
| Total | 23,672 | 23,990 | 12,898 | 10,775 | 6,287 | 18,321 | 15,372 | 12,229 | 6,091 | 4,415 |
| Oct-88 | 240 | 662 | 240 | - | - | 236 | 946 | 236 | - | - |
| Nov-88 | - | - | - | - | - | - | - | - | - | - |
| Dec-88 | - | - | - | - | - | - | - | - | - | - |
| Jan-89 | - | - | - | - | - | - | - | - | - | - |
| Feb-89 | - | - | - | - | - | - | - | - | - | - |
| Mar-89 | - | - | - | - | - | - | - | - | - | - |
| Apr-89 | 555 | 1,306 | 555 | - | - | 362 | 721 | 362 | - | - |
| May-89 | 3,757 | 2,559 | 2,559 | 1,198 | 699 | 2,884 | 518 | 518 | 2,366 | 1,715 |
| Jun-89 | 5,645 | 432 | 432 | 5,213 | 3,042 | 4,456 | 1,223 | 1,223 | 3,233 | 2,343 |
| Jul-89 | 7,942 | 1,185 | 1,185 | 6,757 | 3,942 | 6,178 | 406 | 406 | 5,772 | 4,183 |
| Aug-89 | 5,078 | 572 | 572 | 4,506 | 2,629 | 3,768 | 128 | 128 | 3,640 | 2,638 |
| Sep-89 | 716 | 98 | 98 | 618 | 360 | 649 | 88 | 88 | 562 | 407 |
| Total | 23,933 | 6,814 | 5,641 | 18,292 | 10,672 | 18,533 | 4,030 | 2,961 | 15,573 | 11,286 |

Table C-37
Remaining Demands and Project Water Deliveries

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 Lands | | | | | Group 2 Lands | | | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) |
| Average | | | | | | | | | | |
| Oct | 281 | 852 | 261 | 21 | 12 | 256 | 1,233 | 256 | - | - |
| Nov | - | - | - | - | - | - | - | - | - | - |
| Dec | - | - | - | - | - | - | - | - | - | - |
| Jan | - | - | - | - | - | - | - | - | - | - |
| Feb | - | - | - | - | - | - | - | - | - | - |
| Mar | - | - | - | - | - | - | - | - | - | - |
| Apr | 485 | 1,475 | 465 | 20 | 12 | 310 | 818 | 283 | 27 | 20 |
| May | 3,403 | 14,830 | 3,153 | 250 | 146 | 2,602 | 3,756 | 2,270 | 332 | 240 |
| Jun | 5,906 | 11,042 | 4,872 | 1,034 | 604 | 4,664 | 9,684 | 4,224 | 440 | 319 |
| Jul | 7,641 | 3,707 | 3,558 | 4,082 | 2,382 | 5,938 | 4,355 | 3,767 | 2,172 | 1,574 |
| Aug | 5,465 | 1,953 | 1,928 | 3,537 | 2,064 | 4,074 | 1,911 | 1,818 | 2,256 | 1,635 |
| Sep | 814 | 1,350 | 665 | 149 | 87 | 753 | 1,845 | 718 | 35 | 25 |
| Total | 23,994 | 35,209 | 14,902 | 9,093 | 5,306 | 18,597 | 23,603 | 13,335 | 5,262 | 3,814 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-59 | 393 | 1,659 | 393 | - | - | - | - | - |
| Nov-59 | - | - | - | - | - | - | - | - |
| Dec-59 | - | - | - | - | - | - | - | - |
| Jan-60 | - | - | - | - | - | - | - | - |
| Feb-60 | - | - | - | - | - | - | - | - |
| Mar-60 | - | - | - | - | - | - | - | - |
| Apr-60 | 438 | 1,612 | 438 | - | - | 28 | 6 | 21 |
| May-60 | 2,986 | 3,957 | 2,986 | - | - | 952 | 215 | 737 |
| Jun-60 | 5,488 | 3,156 | 3,156 | 2,332 | 1,690 | 3,052 | 689 | 2,363 |
| Jul-60 | 6,827 | 2,043 | 2,043 | 4,784 | 3,467 | 10,183 | 2,300 | 7,883 |
| Aug-60 | 4,826 | 1,614 | 1,614 | 3,212 | 2,328 | 7,478 | 1,689 | 5,789 |
| Sep-60 | 564 | 1,630 | 564 | - | - | - | - | - |
| Total | 21,522 | 15,671 | 11,194 | 10,328 | 7,486 | 21,692 | 4,900 | 16,792 |
| Oct-60 | - | 1,029 | - | - | - | - | - | - |
| Nov-60 | - | - | - | - | - | - | - | - |
| Dec-60 | - | - | - | - | - | - | - | - |
| Jan-61 | - | - | - | - | - | - | - | - |
| Feb-61 | - | - | - | - | - | - | - | - |
| Mar-61 | - | - | - | - | - | - | - | - |
| Apr-61 | 252 | 1,114 | 252 | - | - | 6 | 1 | 4 |
| May-61 | 3,356 | 1,927 | 1,927 | 1,429 | 1,036 | 3,322 | 656 | 2,666 |
| Jun-61 | 5,526 | 1,681 | 1,681 | 3,845 | 2,787 | 6,298 | 1,244 | 5,054 |
| Jul-61 | 6,507 | 1,587 | 1,587 | 4,920 | 3,566 | 10,582 | 2,091 | 8,491 |
| Aug-61 | 3,420 | 1,495 | 1,495 | 1,925 | 1,395 | 4,594 | 908 | 3,686 |
| Sep-61 | - | 1,877 | - | - | - | - | - | - |
| Total | 19,061 | 10,710 | 6,942 | 12,119 | 8,784 | 24,802 | 4,900 | 19,902 |
| Oct-61 | 63 | 711 | 63 | - | - | - | - | - |
| Nov-61 | - | - | - | - | - | - | - | - |
| Dec-61 | - | - | - | - | - | - | - | - |
| Jan-62 | - | - | - | - | - | - | - | - |
| Feb-62 | - | - | - | - | - | - | - | - |
| Mar-62 | - | - | - | - | - | - | - | - |
| Apr-62 | 354 | 3,022 | 354 | - | - | - | - | - |
| May-62 | 2,831 | 6,226 | 2,831 | - | - | 394 | 196 | 198 |
| Jun-62 | 5,290 | 5,397 | 5,290 | - | - | - | - | - |
| Jul-62 | 6,712 | 4,487 | 4,487 | 2,225 | 1,613 | 4,272 | 2,128 | 2,144 |
| Aug-62 | 5,028 | 3,890 | 3,890 | 1,138 | 825 | 5,170 | 2,576 | 2,595 |
| Sep-62 | 776 | 3,248 | 776 | - | - | - | - | - |
| Total | 21,054 | 26,981 | 17,691 | 3,363 | 2,438 | 9,836 | 4,900 | 4,936 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-62 | 482 | 1,930 | 482 | - | - | - | - | - |
| Nov-62 | - | - | - | - | - | - | - | - |
| Dec-62 | - | - | - | - | - | - | - | - |
| Jan-63 | - | - | - | - | - | - | - | - |
| Feb-63 | - | - | - | - | - | - | - | - |
| Mar-63 | - | - | - | - | - | - | - | - |
| Apr-63 | 36 | 2,170 | 36 | - | - | - | - | - |
| May-63 | 3,304 | 4,427 | 3,304 | - | - | 2,291 | 624 | 1,666 |
| Jun-63 | 4,828 | 4,660 | 4,660 | 168 | 122 | 1,541 | 420 | 1,121 |
| Jul-63 | 6,758 | 3,069 | 3,069 | 3,689 | 2,674 | 8,795 | 2,397 | 6,398 |
| Aug-63 | 4,519 | 2,362 | 2,362 | 2,157 | 1,563 | 5,353 | 1,459 | 3,894 |
| Sep-63 | 607 | 2,172 | 607 | - | - | - | - | - |
| Total | 20,534 | 20,790 | 14,520 | 6,014 | 4,359 | 17,980 | 4,900 | 13,080 |
| Oct-63 | 630 | 1,385 | 630 | - | - | - | - | - |
| Nov-63 | - | - | - | - | - | - | - | - |
| Dec-63 | - | - | - | - | - | - | - | - |
| Jan-64 | - | - | - | - | - | - | - | - |
| Feb-64 | - | - | - | - | - | - | - | - |
| Mar-64 | - | - | - | - | - | - | - | - |
| Apr-64 | 72 | 2,591 | 72 | - | - | - | - | - |
| May-64 | 2,490 | 4,948 | 2,490 | - | - | 1,237 | 468 | 770 |
| Jun-64 | 4,923 | 5,004 | 4,923 | - | - | - | - | - |
| Jul-64 | 7,052 | 4,288 | 4,288 | 2,764 | 2,003 | 7,285 | 2,754 | 4,531 |
| Aug-64 | 4,184 | 3,185 | 3,185 | 999 | 724 | 4,440 | 1,678 | 2,762 |
| Sep-64 | 992 | 2,506 | 992 | - | - | - | - | - |
| Total | 20,343 | 23,907 | 16,580 | 3,763 | 2,727 | 12,963 | 4,900 | 8,063 |
| Oct-64 | 680 | 1,654 | 680 | - | - | 18 | 14 | 3 |
| Nov-64 | - | - | - | - | - | - | - | - |
| Dec-64 | - | - | - | - | - | - | - | - |
| Jan-65 | - | - | - | - | - | - | - | - |
| Feb-65 | - | - | - | - | - | - | - | - |
| Mar-65 | - | - | - | - | - | - | - | - |
| Apr-65 | 583 | 3,107 | 583 | - | - | 60 | 50 | 10 |
| May-65 | 2,690 | 4,500 | 2,690 | - | - | - | - | - |
| Jun-65 | 5,070 | 5,469 | 5,070 | - | - | - | - | - |
| Jul-65 | 6,486 | 5,075 | 5,075 | 1,411 | 1,023 | 3,204 | 2,646 | 558 |
| Aug-65 | 3,978 | 4,421 | 3,978 | - | - | 2,651 | 2,190 | 462 |
| Sep-65 | 237 | 4,433 | 237 | - | - | - | - | - |
| Total | 19,724 | 28,659 | 18,313 | 1,411 | 1,023 | 5,933 | 4,900 | 1,033 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-65 | 680 | 1,984 | 680 | - | - | 61 | 13 | 48 |
| Nov-65 | - | - | - | - | - | - | - | - |
| Dec-65 | - | - | - | - | - | - | - | - |
| Jan-66 | - | - | - | - | - | - | - | - |
| Feb-66 | - | - | - | - | - | - | - | - |
| Mar-66 | - | - | - | - | - | - | - | - |
| Apr-66 | 583 | 2,146 | 583 | - | - | - | - | - |
| May-66 | 2,977 | 4,570 | 2,977 | - | - | - | - | - |
| Jun-66 | 5,427 | 3,942 | 3,942 | 1,485 | 1,076 | 4,912 | 1,043 | 3,869 |
| Jul-66 | 6,769 | 2,964 | 2,964 | 3,805 | 2,758 | 9,930 | 2,109 | 7,821 |
| Aug-66 | 4,837 | 2,685 | 2,685 | 2,152 | 1,560 | 7,805 | 1,658 | 6,148 |
| Sep-66 | 1,297 | 2,345 | 1,297 | - | - | 365 | 77 | 287 |
| Total | 22,570 | 20,636 | 15,128 | 7,442 | 5,394 | 23,073 | 4,900 | 18,173 |
| Oct-66 | 0 | 1,370 | - | - | - | - | - | - |
| Nov-66 | 0 | 0 | - | - | - | - | - | - |
| Dec-66 | 0 | 0 | - | - | - | - | - | - |
| Jan-67 | 0 | 0 | - | - | - | - | - | - |
| Feb-67 | 0 | 0 | - | - | - | - | - | - |
| Mar-67 | 0 | 0 | - | - | - | - | - | - |
| Apr-67 | 487 | 2,817 | 487 | - | - | 14 | 7 | 6 |
| May-67 | 2,281 | 4,005 | 2,281 | - | - | - | - | - |
| Jun-67 | 4,220 | 5,511 | 4,220 | - | - | - | - | - |
| Jul-67 | 6,517 | 4,676 | 4,676 | 1,841 | 1,334 | 4,190 | 2,242 | 1,948 |
| Aug-67 | 4,946 | 3,999 | 3,999 | 947 | 686 | 4,955 | 2,651 | 2,304 |
| Sep-67 | 650 | 3,478 | 650 | - | - | - | - | - |
| Total | 19,101 | 25,856 | 16,313 | 2,788 | 2,021 | 9,159 | 4,900 | 4,259 |
| Oct-67 | 622 | 1,798 | 622 | - | - | - | - | - |
| Nov-67 | 0 | 0 | - | - | - | - | - | - |
| Dec-67 | 0 | 0 | - | - | - | - | - | - |
| Jan-68 | 0 | 0 | - | - | - | - | - | - |
| Feb-68 | 0 | 0 | - | - | - | - | - | - |
| Mar-68 | 0 | 0 | - | - | - | - | - | - |
| Apr-68 | 0 | 3,026 | - | - | - | - | - | - |
| May-68 | 3,058 | 4,507 | 3,058 | - | - | - | - | - |
| Jun-68 | 4,828 | 4,900 | 4,828 | - | - | - | - | - |
| Jul-68 | 6,383 | 4,844 | 4,844 | 1,539 | 1,115 | 4,818 | 3,828 | 990 |
| Aug-68 | 2,971 | 4,570 | 2,971 | - | - | 1,203 | 956 | 247 |
| Sep-68 | 1,411 | 4,456 | 1,411 | - | - | 146 | 116 | 30 |
| Total | 19,273 | 28,101 | 17,734 | 1,539 | 1,115 | 6,167 | 4,900 | 1,267 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-68 | 347 | 1,932 | 347 | - | - | - | - | - |
| Nov-68 | - | - | - | - | - | - | - | - |
| Dec-68 | - | - | - | - | - | - | - | - |
| Jan-69 | - | - | - | - | - | - | - | - |
| Feb-69 | - | - | - | - | - | - | - | - |
| Mar-69 | - | - | - | - | - | - | - | - |
| Apr-69 | 528 | 3,113 | 528 | - | - | - | - | - |
| May-69 | 3,510 | 4,712 | 3,510 | - | - | - | - | - |
| Jun-69 | 4,520 | 4,673 | 4,520 | - | - | - | - | - |
| Jul-69 | 6,465 | 5,036 | 5,036 | 1,429 | 1,036 | 4,307 | 2,552 | 1,756 |
| Aug-69 | 4,902 | 4,886 | 4,886 | 16 | 12 | 3,964 | 2,348 | 1,616 |
| Sep-69 | 961 | 4,642 | 961 | - | - | - | - | - |
| Total | 21,233 | 28,994 | 19,788 | 1,445 | 1,047 | 8,272 | 4,900 | 3,372 |
| Oct-69 | - | 1,988 | - | - | - | - | - | - |
| Nov-69 | - | - | - | - | - | - | - | - |
| Dec-69 | - | - | - | - | - | - | - | - |
| Jan-70 | - | - | - | - | - | - | - | - |
| Feb-70 | - | - | - | - | - | - | - | - |
| Mar-70 | - | - | - | - | - | - | - | - |
| Apr-70 | 512 | 2,921 | 512 | - | - | 178 | 91 | 86 |
| May-70 | 3,510 | 4,638 | 3,510 | - | - | 78 | 40 | 38 |
| Jun-70 | 4,013 | 4,518 | 4,013 | - | - | - | - | - |
| Jul-70 | 7,093 | 4,576 | 4,576 | 2,517 | 1,824 | 5,121 | 2,631 | 2,490 |
| Aug-70 | 4,453 | 4,465 | 4,453 | - | - | 3,813 | 1,959 | 1,854 |
| Sep-70 | 1,494 | 4,273 | 1,494 | - | - | 348 | 179 | 169 |
| Total | 21,075 | 27,379 | 18,558 | 2,517 | 1,824 | 9,537 | 4,900 | 4,637 |
| Oct-70 | 622 | 1,865 | 622 | - | - | - | - | - |
| Nov-70 | - | - | - | - | - | - | - | - |
| Dec-70 | - | - | - | - | - | - | - | - |
| Jan-71 | - | - | - | - | - | - | - | - |
| Feb-71 | - | - | - | - | - | - | - | - |
| Mar-71 | - | - | - | - | - | - | - | - |
| Apr-71 | 217 | 2,302 | 217 | - | - | - | - | - |
| May-71 | 2,882 | 4,628 | 2,882 | - | - | - | - | - |
| Jun-71 | 5,120 | 4,539 | 4,539 | 581 | 421 | 421 | 200 | 221 |
| Jul-71 | 7,039 | 4,752 | 4,752 | 2,287 | 1,658 | 6,645 | 3,152 | 3,493 |
| Aug-71 | 4,054 | 4,084 | 4,054 | - | - | 3,263 | 1,548 | 1,715 |
| Sep-71 | 1,157 | 3,713 | 1,157 | - | - | - | - | - |
| Total | 21,091 | 25,883 | 18,223 | 2,868 | 2,079 | 10,329 | 4,900 | 5,429 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-71 | - | 1,534 | - | - | - | - | - | - |
| Nov-71 | - | - | - | - | - | - | - | - |
| Dec-71 | - | - | - | - | - | - | - | - |
| Jan-72 | - | - | - | - | - | - | - | - |
| Feb-72 | - | - | - | - | - | - | - | - |
| Mar-72 | - | - | - | - | - | - | - | - |
| Apr-72 | 335 | 1,921 | 335 | - | - | - | - | - |
| May-72 | 3,206 | 3,276 | 3,206 | - | - | - | - | - |
| Jun-72 | 5,279 | 3,336 | 3,336 | 1,943 | 1,408 | 3,685 | 850 | 2,835 |
| Jul-72 | 6,851 | 2,284 | 2,284 | 4,567 | 3,310 | 10,129 | 2,336 | 7,793 |
| Aug-72 | 4,826 | 2,056 | 2,056 | 2,770 | 2,008 | 7,385 | 1,703 | 5,681 |
| Sep-72 | 844 | 1,949 | 844 | - | - | 46 | 11 | 35 |
| Total | 21,341 | 16,356 | 12,061 | 9,280 | 6,726 | 21,244 | 4,900 | 16,344 |
| Oct-72 | - | 993 | - | - | - | - | - | - |
| Nov-72 | - | - | - | - | - | - | - | - |
| Dec-72 | - | - | - | - | - | - | - | - |
| Jan-73 | - | - | - | - | - | - | - | - |
| Feb-73 | - | - | - | - | - | - | - | - |
| Mar-73 | - | - | - | - | - | - | - | - |
| Apr-73 | 12 | 2,421 | 12 | - | - | - | - | - |
| May-73 | 2,365 | 5,003 | 2,365 | - | - | - | - | - |
| Jun-73 | 5,050 | 4,842 | 4,842 | 208 | 151 | 151 | 90 | 61 |
| Jul-73 | 5,890 | 4,671 | 4,671 | 1,219 | 884 | 3,075 | 1,830 | 1,246 |
| Aug-73 | 5,101 | 4,320 | 4,320 | 781 | 566 | 4,962 | 2,952 | 2,010 |
| Sep-73 | 1,140 | 3,724 | 1,140 | - | - | 48 | 28 | 19 |
| Total | 19,558 | 25,974 | 17,350 | 2,208 | 1,600 | 8,236 | 4,900 | 3,336 |
| Oct-73 | 680 | 1,861 | 680 | - | - | 59 | 21 | 38 |
| Nov-73 | - | - | - | - | - | - | - | - |
| Dec-73 | - | - | - | - | - | - | - | - |
| Jan-74 | - | - | - | - | - | - | - | - |
| Feb-74 | - | - | - | - | - | - | - | - |
| Mar-74 | - | - | - | - | - | - | - | - |
| Apr-74 | 80 | 2,331 | 80 | - | - | - | - | - |
| May-74 | 3,420 | 4,710 | 3,420 | - | - | - | - | - |
| Jun-74 | 5,526 | 4,500 | 4,500 | 1,026 | 744 | 1,376 | 496 | 880 |
| Jul-74 | 5,511 | 4,039 | 4,039 | 1,472 | 1,067 | 5,142 | 1,854 | 3,288 |
| Aug-74 | 5,101 | 3,723 | 3,723 | 1,378 | 999 | 6,288 | 2,267 | 4,021 |
| Sep-74 | 1,494 | 3,077 | 1,494 | - | - | 724 | 261 | 463 |
| Total | 21,812 | 24,241 | 17,936 | 3,876 | 2,809 | 13,590 | 4,900 | 8,690 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-74 | 258 | 1,801 | 258 | - | - | - | - | - |
| Nov-74 | - | - | - | - | - | - | - | - |
| Dec-74 | - | - | - | - | - | - | - | - |
| Jan-75 | - | - | - | - | - | - | - | - |
| Feb-75 | - | - | - | - | - | - | - | - |
| Mar-75 | - | - | - | - | - | - | - | - |
| Apr-75 | 583 | 2,141 | 583 | - | - | 425 | 284 | 141 |
| May-75 | 1,955 | 4,767 | 1,955 | - | - | - | - | - |
| Jun-75 | 4,971 | 4,467 | 4,467 | 504 | 365 | 365 | 244 | 121 |
| Jul-75 | 6,560 | 4,399 | 4,399 | 2,161 | 1,566 | 2,739 | 1,829 | 910 |
| Aug-75 | 4,924 | 4,251 | 4,251 | 673 | 488 | 3,807 | 2,543 | 1,264 |
| Sep-75 | 1,041 | 3,764 | 1,041 | - | - | - | - | - |
| Total | 20,292 | 25,590 | 16,954 | 3,338 | 2,419 | 7,337 | 4,900 | 2,437 |
| Oct-75 | 680 | 1,883 | 680 | - | - | 113 | 30 | 84 |
| Nov-75 | - | - | - | - | - | - | - | - |
| Dec-75 | - | - | - | - | - | - | - | - |
| Jan-76 | - | - | - | - | - | - | - | - |
| Feb-76 | - | - | - | - | - | - | - | - |
| Mar-76 | - | - | - | - | - | - | - | - |
| Apr-76 | 507 | 1,971 | 507 | - | - | 30 | 8 | 22 |
| May-76 | 3,265 | 4,429 | 3,265 | - | - | - | - | - |
| Jun-76 | 5,439 | 4,085 | 4,085 | 1,354 | 981 | 2,765 | 724 | 2,040 |
| Jul-76 | 6,948 | 2,976 | 2,976 | 3,972 | 2,879 | 8,929 | 2,339 | 6,590 |
| Aug-76 | 4,924 | 2,817 | 2,817 | 2,107 | 1,527 | 6,709 | 1,758 | 4,951 |
| Sep-76 | 1,000 | 2,370 | 1,000 | - | - | 157 | 41 | 116 |
| Total | 22,763 | 20,531 | 15,330 | 7,433 | 5,387 | 18,703 | 4,900 | 13,803 |
| Oct-76 | 393 | 1,235 | 393 | - | - | - | - | - |
| Nov-76 | - | - | - | - | - | - | - | - |
| Dec-76 | - | - | - | - | - | - | - | - |
| Jan-77 | - | - | - | - | - | - | - | - |
| Feb-77 | - | - | - | - | - | - | - | - |
| Mar-77 | - | - | - | - | - | - | - | - |
| Apr-77 | 583 | 3,562 | 583 | - | - | 203 | 37 | 165 |
| May-77 | 2,521 | 3,131 | 2,521 | - | - | 1,940 | 356 | 1,583 |
| Jun-77 | 5,526 | 1,967 | 1,967 | 3,559 | 2,580 | 7,139 | 1,312 | 5,827 |
| Jul-77 | 6,116 | 1,521 | 1,521 | 4,595 | 3,330 | 10,145 | 1,864 | 8,281 |
| Aug-77 | 4,192 | 1,473 | 1,473 | 2,719 | 1,971 | 6,843 | 1,257 | 5,586 |
| Sep-77 | 1,140 | 1,435 | 1,140 | - | - | 401 | 74 | 327 |
| Total | 20,471 | 14,324 | 9,598 | 10,873 | 7,881 | 26,671 | 4,900 | 21,771 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-77 | 189 | 772 | 189 | - | - | - | - | - |
| Nov-77 | - | - | - | - | - | - | - | - |
| Dec-77 | - | - | - | - | - | - | - | - |
| Jan-78 | - | - | - | - | - | - | - | - |
| Feb-78 | - | - | - | - | - | - | - | - |
| Mar-78 | - | - | - | - | - | - | - | - |
| Apr-78 | 154 | 2,433 | 154 | - | - | - | - | - |
| May-78 | 3,013 | 4,731 | 3,013 | - | - | - | - | - |
| Jun-78 | 5,526 | 4,619 | 4,619 | 907 | 657 | 657 | 316 | 342 |
| Jul-78 | 7,093 | 4,407 | 4,407 | 2,686 | 1,947 | 5,466 | 2,624 | 2,841 |
| Aug-78 | 4,693 | 4,212 | 4,212 | 481 | 349 | 4,082 | 1,960 | 2,122 |
| Sep-78 | 528 | 3,569 | 528 | - | - | - | - | - |
| Total | 21,196 | 24,743 | 17,122 | 4,074 | 2,953 | 10,205 | 4,900 | 5,305 |
| Oct-78 | 584 | 1,838 | 584 | - | - | 109 | 49 | 60 |
| Nov-78 | - | - | - | - | - | - | - | - |
| Dec-78 | - | - | - | - | - | - | - | - |
| Jan-79 | - | - | - | - | - | - | - | - |
| Feb-79 | - | - | - | - | - | - | - | - |
| Mar-79 | - | - | - | - | - | - | - | - |
| Apr-79 | 583 | 2,420 | 583 | - | - | - | - | - |
| May-79 | 2,789 | 5,083 | 2,789 | - | - | - | - | - |
| Jun-79 | 5,526 | 4,643 | 4,643 | 883 | 640 | 640 | 287 | 353 |
| Jul-79 | 6,668 | 4,398 | 4,398 | 2,270 | 1,645 | 5,734 | 2,569 | 3,165 |
| Aug-79 | 4,472 | 4,099 | 4,099 | 373 | 270 | 4,092 | 1,833 | 2,259 |
| Sep-79 | 1,494 | 3,678 | 1,494 | - | - | 363 | 163 | 200 |
| Total | 22,116 | 26,159 | 18,590 | 3,526 | 2,556 | 10,938 | 4,900 | 6,038 |
| Oct-79 | 328 | 1,839 | 328 | - | - | - | - | - |
| Nov-79 | - | - | - | - | - | - | - | - |
| Dec-79 | - | - | - | - | - | - | - | - |
| Jan-80 | - | - | - | - | - | - | - | - |
| Feb-80 | - | - | - | - | - | - | - | - |
| Mar-80 | - | - | - | - | - | - | - | - |
| Apr-80 | 414 | 2,460 | 414 | - | - | - | - | - |
| May-80 | 2,236 | 5,083 | 2,236 | - | - | - | - | - |
| Jun-80 | 5,526 | 4,919 | 4,919 | 607 | 440 | 440 | 737 | - |
| Jul-80 | 6,322 | 4,891 | 4,891 | 1,431 | 1,037 | 1,199 | 2,008 | - |
| Aug-80 | 4,097 | 4,495 | 4,097 | - | - | 1,287 | 2,155 | - |
| Sep-80 | 271 | 4,181 | 271 | - | - | - | - | - |
| Total | 19,194 | 27,868 | 17,156 | 2,038 | 1,477 | 2,925 | 4,900 | - |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-80 | 87 | 2,091 | 87 | - | - | - | - | - |
| Nov-80 | - | - | - | - | - | - | - | - |
| Dec-80 | - | - | - | - | - | - | - | - |
| Jan-81 | - | - | - | - | - | - | - | - |
| Feb-81 | - | - | - | - | - | - | - | - |
| Mar-81 | - | - | - | - | - | - | - | - |
| Apr-81 | 549 | 2,348 | 549 | - | - | - | - | - |
| May-81 | 2,274 | 4,185 | 2,274 | - | - | - | - | - |
| Jun-81 | 5,526 | 4,035 | 4,035 | 1,491 | 1,081 | 1,531 | 654 | 876 |
| Jul-81 | 6,097 | 3,622 | 3,622 | 2,475 | 1,794 | 6,253 | 2,673 | 3,580 |
| Aug-81 | 3,690 | 3,252 | 3,252 | 438 | 317 | 3,681 | 1,573 | 2,108 |
| Sep-81 | 507 | 2,979 | 507 | - | - | - | - | - |
| Total | 18,730 | 22,512 | 14,326 | 4,404 | 3,192 | 11,464 | 4,900 | 6,564 |
| Oct-81 | - | 1,503 | - | - | - | - | - | - |
| Nov-81 | - | - | - | - | - | - | - | - |
| Dec-81 | - | - | - | - | - | - | - | - |
| Jan-82 | - | - | - | - | - | - | - | - |
| Feb-82 | - | - | - | - | - | - | - | - |
| Mar-82 | - | - | - | - | - | - | - | - |
| Apr-82 | 583 | 2,460 | 583 | - | - | - | - | - |
| May-82 | 2,505 | 4,771 | 2,505 | - | - | - | - | - |
| Jun-82 | 5,403 | 4,379 | 4,379 | 1,024 | 742 | 742 | 540 | 202 |
| Jul-82 | 6,434 | 4,711 | 4,711 | 1,723 | 1,249 | 2,762 | 2,010 | 752 |
| Aug-82 | 4,472 | 4,250 | 4,250 | 222 | 161 | 3,228 | 2,349 | 879 |
| Sep-82 | - | 4,199 | - | - | - | - | - | - |
| Total | 19,397 | 26,273 | 16,428 | 2,969 | 2,152 | 6,733 | 4,900 | 1,833 |
| Oct-82 | 5 | 2,065 | 5 | - | - | - | - | - |
| Nov-82 | - | - | - | - | - | - | - | - |
| Dec-82 | - | - | - | - | - | - | - | - |
| Jan-83 | - | - | - | - | - | - | - | - |
| Feb-83 | - | - | - | - | - | - | - | - |
| Mar-83 | - | - | - | - | - | - | - | - |
| Apr-83 | 137 | 1,900 | 137 | - | - | - | - | - |
| May-83 | 2,831 | 3,967 | 2,831 | - | - | - | - | - |
| Jun-83 | 5,514 | 3,839 | 3,839 | 1,675 | 1,214 | 1,214 | 1,923 | - |
| Jul-83 | 6,560 | 3,967 | 3,967 | 2,593 | 1,879 | 1,879 | 2,977 | - |
| Aug-83 | 3,397 | 3,967 | 3,397 | - | - | - | - | - |
| Sep-83 | 63 | 3,839 | 63 | - | - | - | - | - |
| Total | 18,507 | 23,544 | 14,239 | 4,268 | 3,093 | 3,093 | 4,900 | - |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-83 | 258 | 1,899 | 258 | - | - | - | - | - |
| Nov-83 | 0 | 0 | - | - | - | - | - | - |
| Dec-83 | 0 | 0 | - | - | - | - | - | - |
| Jan-84 | 0 | 0 | - | - | - | - | - | - |
| Feb-84 | 0 | 0 | - | - | - | - | - | - |
| Mar-84 | 0 | 0 | - | - | - | - | - | - |
| Apr-84 | 162 | 3,892 | 162 | - | - | - | - | - |
| May-84 | 3,149 | 6,937 | 3,149 | - | - | - | - | - |
| Jun-84 | 3,354 | 6,690 | 3,354 | - | - | - | - | - |
| Jul-84 | 5,450 | 6,004 | 5,450 | - | - | 71 | 209 | - |
| Aug-84 | 4,425 | 5,391 | 4,425 | - | - | 1,582 | 4,691 | - |
| Sep-84 | 724 | 4,939 | 724 | - | - | - | - | - |
| Total | 17,522 | 35,752 | 17,522 | - | - | 1,652 | 4,900 | - |
| Oct-84 | 0 | 2,492 | - | - | - | - | - | - |
| Nov-84 | 0 | 0 | - | - | - | - | - | - |
| Dec-84 | 0 | 0 | - | - | - | - | - | - |
| Jan-85 | 0 | 0 | - | - | - | - | - | - |
| Feb-85 | 0 | 0 | - | - | - | - | - | - |
| Mar-85 | 0 | 0 | - | - | - | - | - | - |
| Apr-85 | 117 | 3,153 | 117 | - | - | - | - | - |
| May-85 | 2,698 | 5,621 | 2,698 | - | - | - | - | - |
| Jun-85 | 4,894 | 5,420 | 4,894 | - | - | - | - | - |
| Jul-85 | 5,183 | 4,865 | 4,865 | 318 | 230 | 1,315 | 1,125 | 189 |
| Aug-85 | 5,101 | 4,368 | 4,368 | 733 | 531 | 4,409 | 3,775 | 635 |
| Sep-85 | 1,041 | 4,002 | 1,041 | - | - | - | - | - |
| Total | 19,034 | 29,921 | 17,983 | 1,051 | 762 | 5,724 | 4,900 | 824 |
| Oct-85 | 0 | 2,019 | - | - | - | - | - | - |
| Nov-85 | 0 | 0 | - | - | - | - | - | - |
| Dec-85 | 0 | 0 | - | - | - | - | - | - |
| Jan-86 | 0 | 0 | - | - | - | - | - | - |
| Feb-86 | 0 | 0 | - | - | - | - | - | - |
| Mar-86 | 0 | 0 | - | - | - | - | - | - |
| Apr-86 | 0 | 3,718 | - | - | - | - | - | - |
| May-86 | 3,085 | 6,626 | 3,085 | - | - | - | - | - |
| Jun-86 | 5,050 | 6,390 | 5,050 | - | - | - | - | - |
| Jul-86 | 6,735 | 5,735 | 5,735 | 1,000 | 725 | 4,525 | 2,841 | 1,684 |
| Aug-86 | 4,754 | 5,150 | 4,754 | - | - | 3,279 | 2,059 | 1,220 |
| Sep-86 | 465 | 4,718 | 465 | - | - | - | - | - |
| Total | 20,089 | 34,356 | 19,089 | 1,000 | 725 | 7,804 | 4,900 | 2,904 |

Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Oct-86 | 34 | 2,380 | 34 | - | - | - | - | - |
| Nov-86 | - | - | - | - | - | - | - | - |
| Dec-86 | - | - | - | - | - | - | - | - |
| Jan-87 | - | - | - | - | - | - | - | - |
| Feb-87 | - | - | - | - | - | - | - | - |
| Mar-87 | - | - | - | - | - | - | - | - |
| Apr-87 | 583 | 2,470 | 583 | - | - | - | - | - |
| May-87 | 2,513 | 4,402 | 2,513 | - | - | - | - | - |
| Jun-87 | 5,345 | 4,245 | 4,245 | 1,100 | 797 | 1,729 | 697 | 1,032 |
| Jul-87 | 6,203 | 3,810 | 3,810 | 2,393 | 1,734 | 6,224 | 2,508 | 3,716 |
| Aug-87 | 4,425 | 3,421 | 3,421 | 1,004 | 728 | 4,203 | 1,694 | 2,509 |
| Sep-87 | 1,279 | 3,134 | 1,279 | - | - | 3 | 1 | 2 |
| Total | 20,382 | 23,862 | 15,885 | 4,497 | 3,259 | 12,159 | 4,900 | 7,259 |
| Oct-87 | 117 | 1,581 | 117 | - | - | - | - | - |
| Nov-87 | - | - | - | - | - | - | - | - |
| Dec-87 | - | - | - | - | - | - | - | - |
| Jan-88 | - | - | - | - | - | - | - | - |
| Feb-88 | - | - | - | - | - | - | - | - |
| Mar-88 | - | - | - | - | - | - | - | - |
| Apr-88 | 331 | 4,386 | 331 | - | - | - | - | - |
| May-88 | 2,381 | 4,625 | 2,381 | - | - | - | - | - |
| Jun-88 | 5,225 | 4,587 | 4,587 | 638 | 462 | 1,993 | 655 | 1,338 |
| Jul-88 | 6,560 | 3,399 | 3,399 | 3,161 | 2,291 | 7,280 | 2,394 | 4,886 |
| Aug-88 | 4,624 | 2,627 | 2,627 | 1,997 | 1,447 | 5,629 | 1,851 | 3,779 |
| Sep-88 | 769 | 2,542 | 769 | - | - | - | - | - |
| Total | 20,007 | 23,747 | 14,211 | 5,796 | 4,201 | 14,903 | 4,900 | 10,003 |
| Oct-88 | 258 | 1,321 | 258 | - | - | - | - | - |
| Nov-88 | - | - | - | - | - | - | - | - |
| Dec-88 | - | - | - | - | - | - | - | - |
| Jan-89 | - | - | - | - | - | - | - | - |
| Feb-89 | - | - | - | - | - | - | - | - |
| Mar-89 | - | - | - | - | - | - | - | - |
| Apr-89 | 395 | 1,831 | 395 | - | - | - | - | - |
| May-89 | 3,149 | 4,201 | 3,149 | - | - | 2,414 | 432 | 1,982 |
| Jun-89 | 4,865 | 3,243 | 3,243 | 1,622 | 1,176 | 6,561 | 1,175 | 5,385 |
| Jul-89 | 6,746 | 2,860 | 2,860 | 3,886 | 2,817 | 10,942 | 1,960 | 8,981 |
| Aug-89 | 4,114 | 2,182 | 2,182 | 1,932 | 1,400 | 6,667 | 1,194 | 5,473 |
| Sep-89 | 709 | 1,811 | 709 | - | - | 767 | 137 | 630 |
| Total | 20,236 | 17,449 | 12,796 | 7,440 | 5,393 | 27,351 | 4,900 | 22,451 |

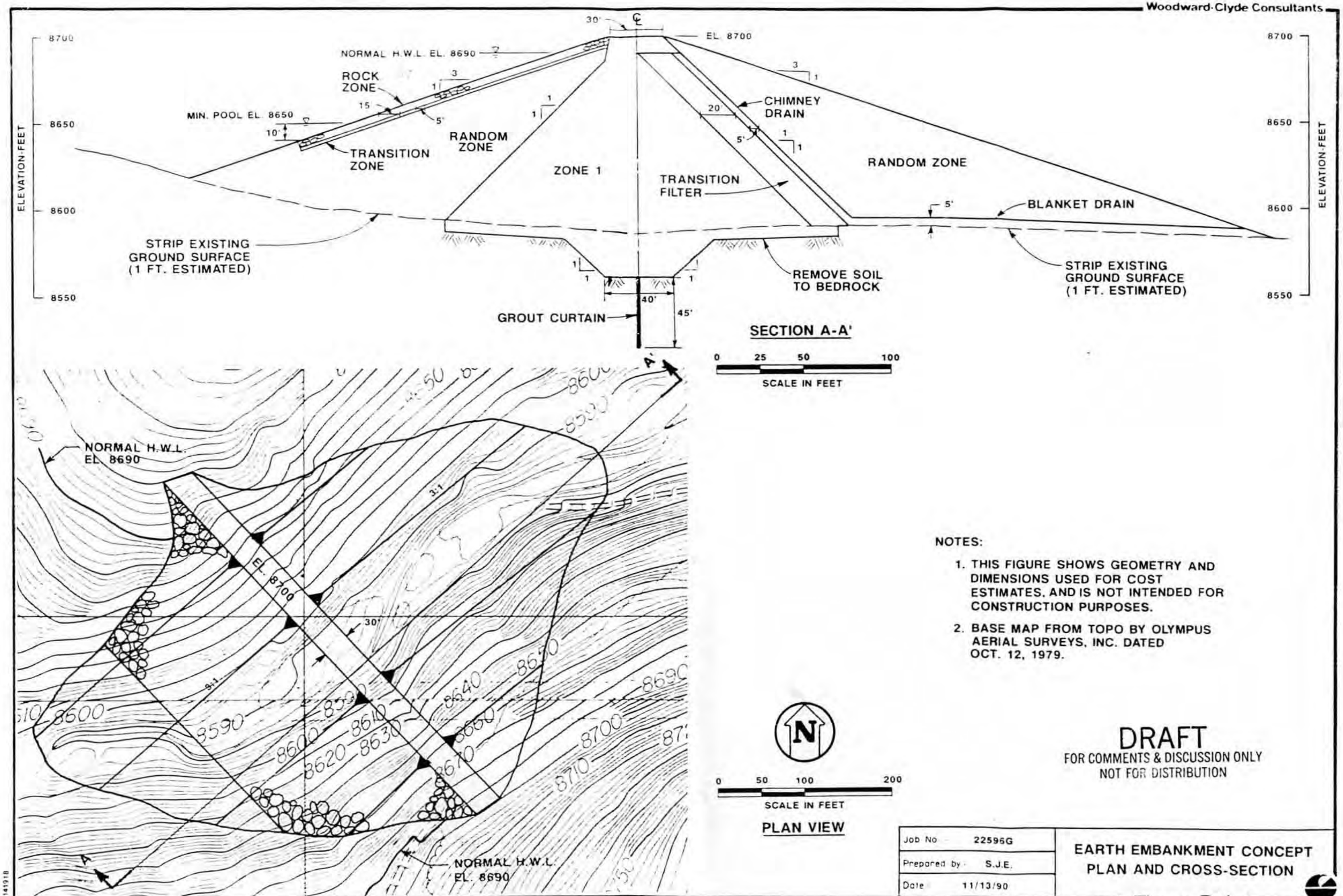
Table C-37
Remaining Demands and Project Waer Deliveries

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|
| | Group 3 Lands | | | | | Total Irrigable Area | | |
| | Head of Canal Diversion Requirement (ac-ft) | Local Supplies (ac-ft) | Beneficial Local Supplies (ac-ft) | Remaining Demand Total Area (ac-ft) | Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Total Remaining Demand on Land Eligible to Receive Project Water (ac-ft) | Project Irrigation Release (ac-ft) | Irrigation Shortage (ac-ft) |
| Average | | | | | | | | |
| Oct | 280 | 1,680 | 280 | - | - | 12 | 4 | 8 |
| Nov | - | - | - | - | - | - | - | - |
| Dec | - | - | - | - | - | - | - | - |
| Jan | - | - | - | - | - | - | - | - |
| Feb | - | - | - | - | - | - | - | - |
| Mar | - | - | - | - | - | - | - | - |
| Apr | 339 | 2,592 | 339 | - | - | 31 | 16 | 15 |
| May | 2,841 | 4,620 | 2,793 | 48 | 35 | 421 | 100 | 321 |
| Jun | 5,093 | 4,455 | 4,195 | 898 | 651 | 1,574 | 477 | 1,131 |
| Jul | 6,485 | 3,999 | 3,980 | 2,504 | 1,815 | 5,771 | 2,293 | 3,547 |
| Aug | 4,448 | 3,590 | 3,443 | 1,005 | 729 | 4,427 | 1,974 | 2,586 |
| Sep | 822 | 3,289 | 822 | - | - | 112 | 36 | 76 |
| Total | 20,308 | 24,226 | 15,852 | 4,456 | 3,229 | 12,349 | 4,900 | 7,683 |

# ATTACHMENT D

PRELIMINARY DESIGN
DRAWINGS

Sanpete Water
Conservancy District



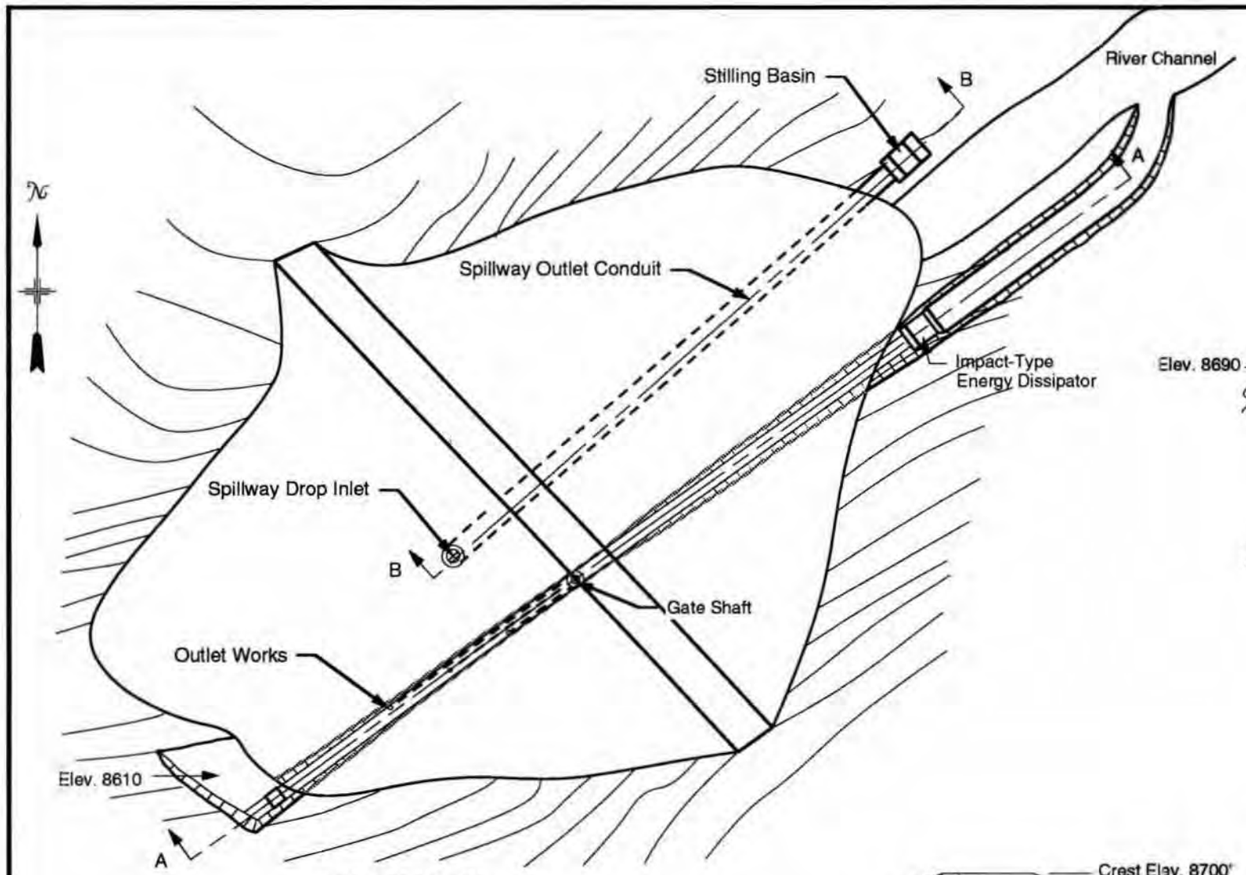

NOTES:

1. THIS FIGURE SHOWS GEOMETRY AND DIMENSIONS USED FOR COST ESTIMATES, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
2. BASE MAP FROM TOPO BY OLYMPUS AERIAL SURVEYS, INC. DATED OCT. 12, 1979.

DRAFT
FOR COMMENTS & DISCUSSION ONLY
NOT FOR DISTRIBUTION

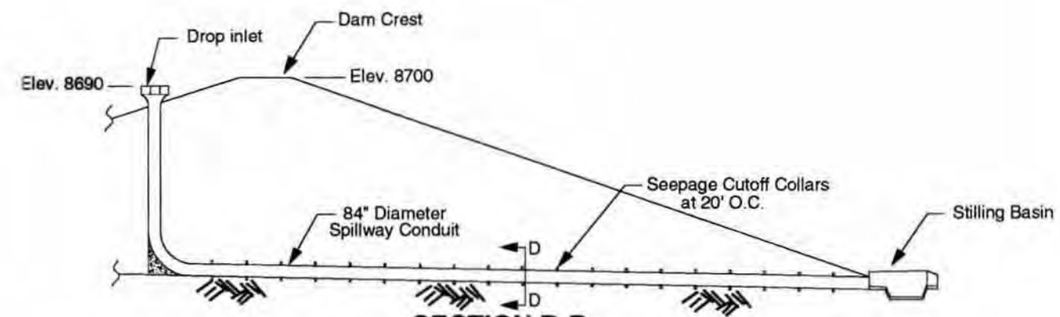
| | |
|---|---|
| Job No. 22596G | EARTH EMBANKMENT CONCEPT PLAN AND CROSS-SECTION |
| Prepared by S.J.E. | |
| Date 11/13/90 | |

Figure D-1




**PLAN VIEW**

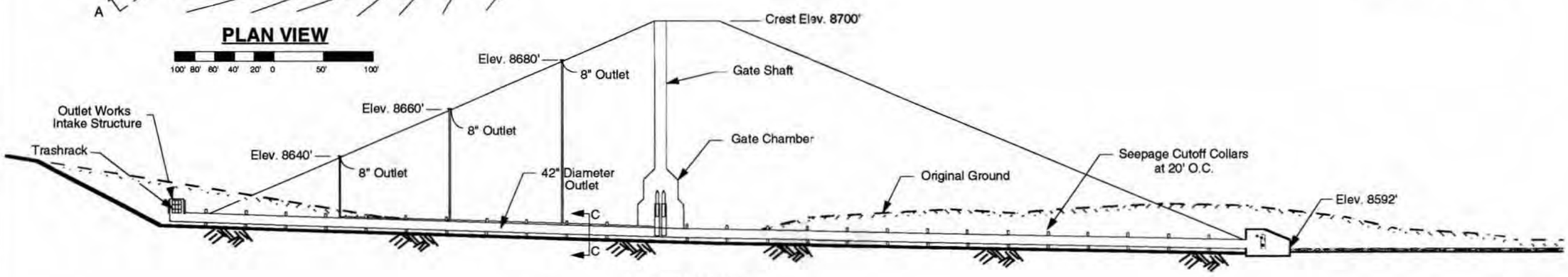
100' 80' 60' 40' 20' 0 50' 100'




**SECTION B-B**
**THROUGH DROP INLET SPILLWAY**

50' 40' 30' 20' 10' 0 25' 50'

PRELIMINARY
NOT FOR CONSTRUCTION




**SECTION A-A**
**SECTION THROUGH OUTLET WORKS**

50' 40' 30' 20' 10' 0 25' 50'

**NARROWS DAM**
RECONNAISSANCE LEVEL
**NARROWS SITE - EMBANKMENT ALTERNATIVE**
**OUTLET WORKS AND SPILLWAY**

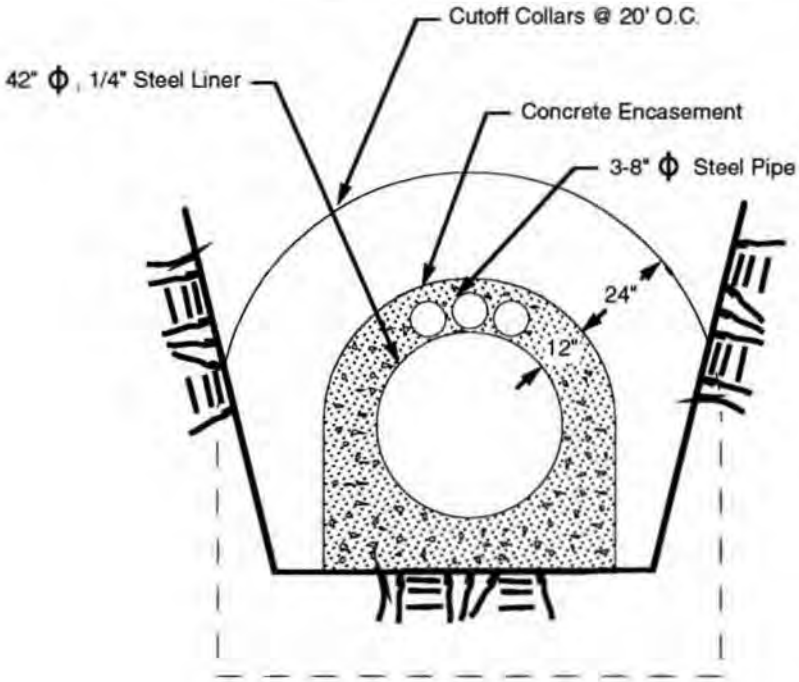
PREPARED FOR
**SANPETE WATER CONSERVANCY DISTRICT**

| | |
|---|---|
| DRAWING NO: 90-200-007 | DECEMBER 19, 1990 |
| DESIGNED BY: R. NOBLE | DRAWN BY: P. WRIGHT |

Figure D-2

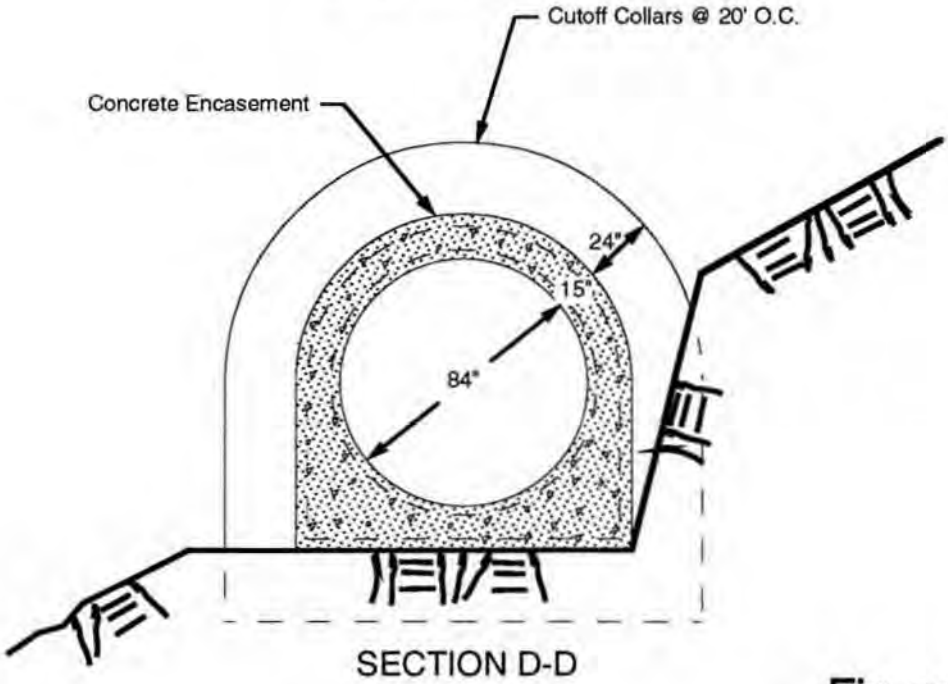
# TYPICAL SECTIONS

## Outlet Works



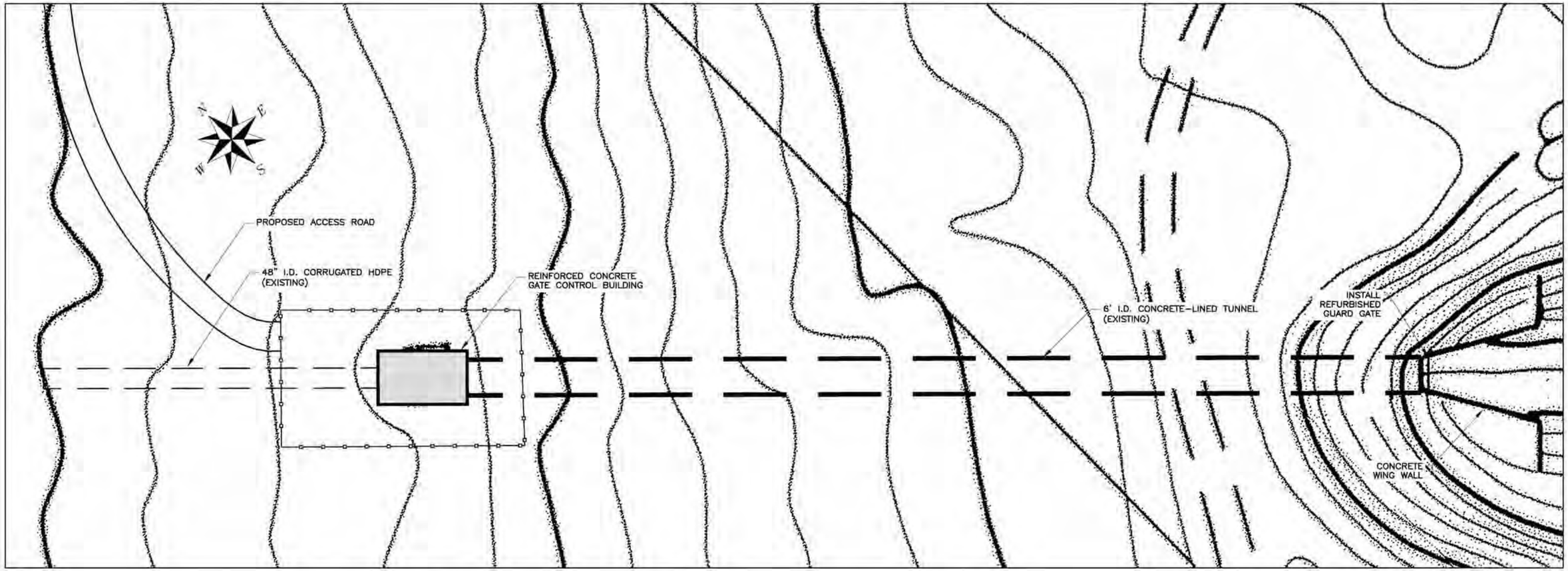

SECTION C-C

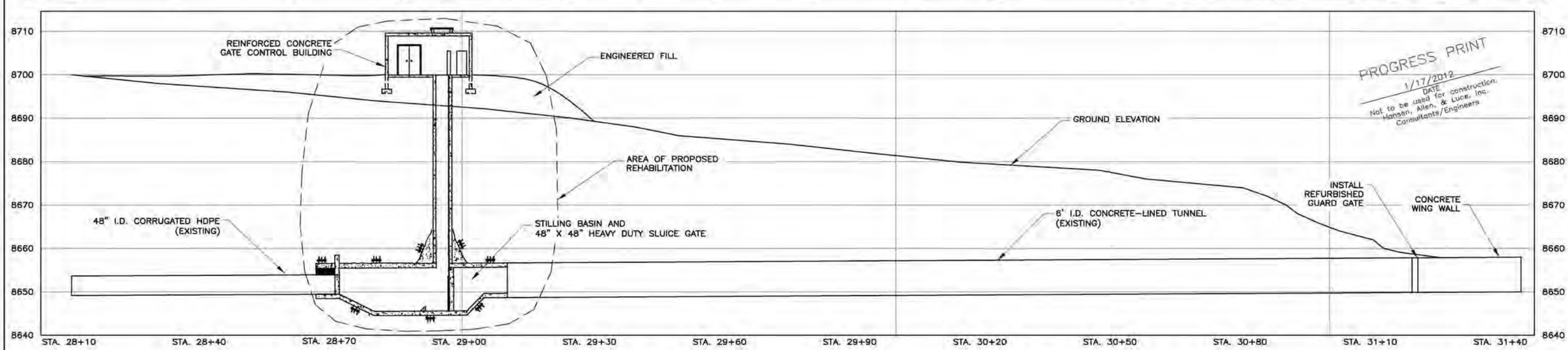
## Drop Inlet Spillway




SECTION D-D

Figure D-3

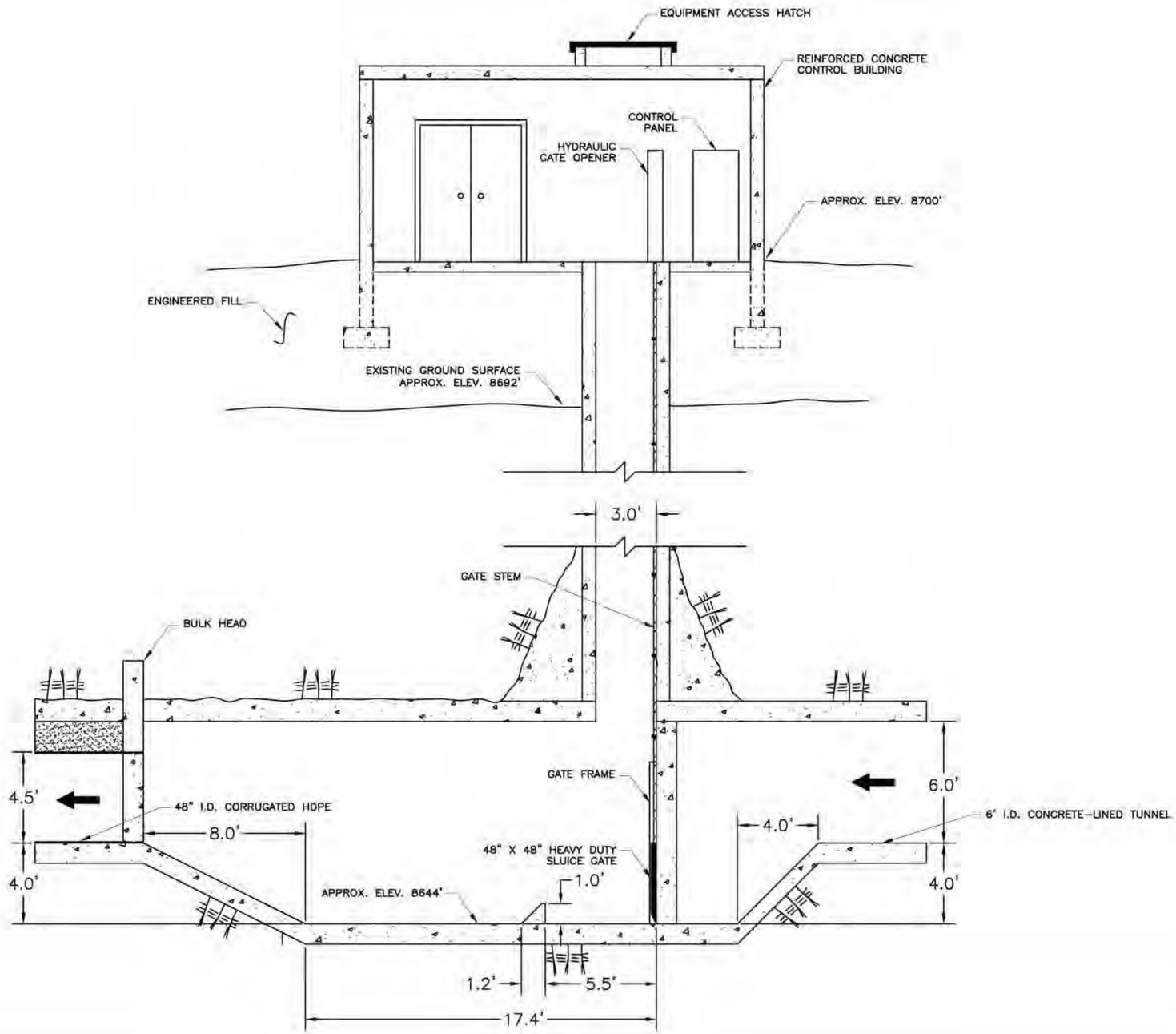



PROGRESS PRINT
1/17/2012
DATE
Not to be used for construction.
Hansen, Allen, & Luce, Inc.
Consultants/Engineers

FILE NAME:
FILE DATE:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HANSEN ALLEN & LUCE ENGINEERS | PROJECT ENGINEER | DESIGNED RMN | 3 | | | | | SCALE: NTS | SANPETE WATER CONSERVANCY DISTRICT NARROWS PROJECT | NARROWS TUNNEL INLET REHABILITATION CONCEPTUAL DESIGN PLAN AND PROFILE | SHEET D-4 |
| | | DRAFTED TBB | 2 | | | | | | | | |
| | | CHECKED | 1 | | | | | | | | |
| | | DATE | NO. | DATE | REVISIONS | BY | APVD. | | | | |



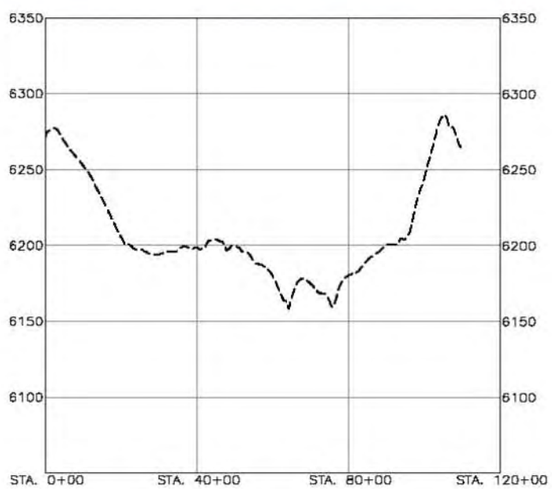

PROGRESS PRINT
1/17/2012
DATE
Not to be used for construction.
Hansen, Allen, & Luce, Inc.
Consultants/Engineers

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HANSEN ALLEN & LUCE ENGINEERS | PROJECT ENGINEER | DESIGNED RMN | 3 | | | | | SCALE NTS | SANPETE WATER CONSERVANCY DISTRICT NARROWS PROJECT | NARROWS TUNNEL INLET REHABILITATION CONCEPTUAL DESIGN ELEVATION VIEW | SHEET D-5 |
| | | DRAFTED TBB | 2 | | | | | | | | |
| | | CHECKED | 1 | | | | | | | | |
| | | DATE | NO. | DATE | REVISIONS | BY | APVD. | | | | |

HANSEN ALLEN & LUCE INC ENGINEERS

# EAST BENCH PIPELINE HEADWORKS

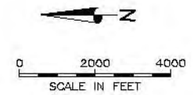
FIGURE D-6

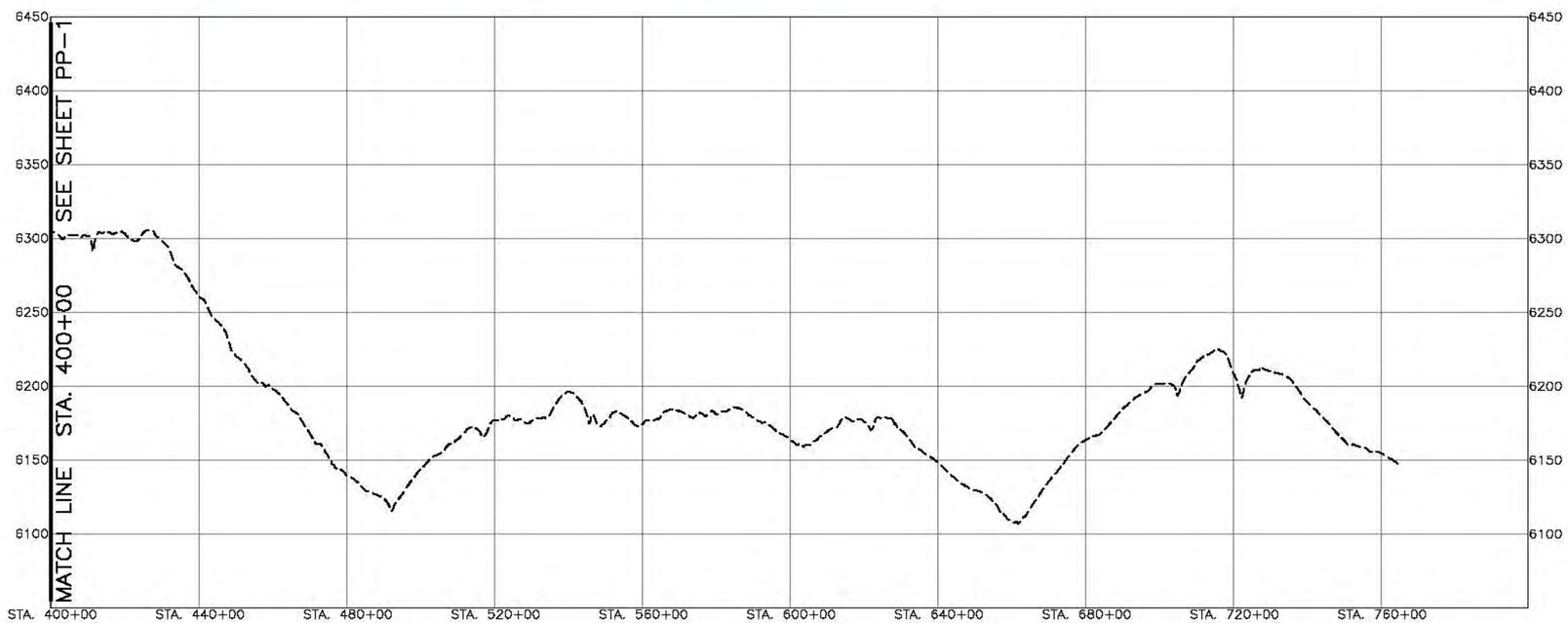


FILE NAME:
FILE DATE:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HANSEN ALLEN & LUCE ENGINEERS | PROJECT ENGINEER | DESIGNED RMN | 3 | | | | | SCALE NTS | SANPETE WATER CONSERVANCY DISTRICT NARROWS PROJECT | EAST BENCH & OAK CREEK PIPELINES | SHEET D-7 |
| | | DRAFTED TBB | 2 | | | | | | | | |
| | | CHECKED | 1 | | | | | | | | |
| | | DATE | NO. | DATE | REVISIONS | BY | APV'D. | | | | 321.10.100 |

7/04




FILE NAME:
FILE DATE:

HANSEN ALLEN & LUCE inc ENGINEERS

PROJECT ENGINEER

| DESIGNED | RMN | 3 | | | | |
|---|---|---|---|---|---|---|
| DRAFTED | TBB | 2 | | | | |
| CHECKED | | 1 | | | | |
| DATE | | NO. | DATE | REVISIONS | BY | APVD. |

SCALE: NTS

SANPETE WATER CONSERVANCY DISTRICT
NARROWS PROJECT

EAST BENCH & OAK CREEK PIPELINES

SHEET D-8

321.10.100

7/04

# ATTACHMENT E

PRELIMINARY COST ESTIMATES

Sanpete Water Conservancy District

**Table E-1**
Narrows Dam and Reservoir
Estimate of Direct Construction Costs
(based on 2006 unit prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Dam Structure** | | | | |
| Mobilization | 1 | LS | 165,600 | 165,600 |
| Diversion | 1 | LS | 90,000 | 90,000 |
| Clearing | 1 | LS | 50,000 | 50,000 |
| Foundation stripping | 7,800 | CY | 3.00 | 23,400 |
| Unclassified excavation/bedrock | 12,250 | CY | 20.00 | 245,000 |
| Dewatering | 1 | LS | 25,000 | 25,000 |
| Foundation preparation | 5,000 | SY | 45.00 | 225,000 |
| Foundation grouting | 2,500 | LF | 75.00 | 187,500 |
| Zone I | 125,000 | CY | 8.00 | 1,000,000 |
| Random zone | 184,000 | CY | 4.00 | 736,000 |
| Drain | 16,800 | CY | 60.00 | 1,008,000 |
| Filter | 19,700 | CY | 40.00 | 788,000 |
| Upstream rock zone | 13,100 | CY | 35.00 | 458,500 |
| Upstream transition | 4,200 | CY | 15.00 | 63,000 |
| Crest surfacing | 300 | CY | 25.00 | 7,500 |
| Instrumentation | 1 | LS | 50,000 | 15,000 |
| Reclamation | 5 | AC | 4,000.00 | 20,000 |
| Unlisted items (10%) | 1 | LS | 510,750 | 510,750 |
| **Subtotal - Dam Structure** | | | | **5,618,250** |
| | | | | |
| **Outlet Works** | | | | |
| Mobilization | 1 | LS | 31,000 | 31,000 |
| Excavation, rock | 10,900 | CY | 35.00 | 381,500 |
| Steel Liner 38"Ø x 1/4" | 550 | ft | 186.41 | 102,526 |
| Concrete, casing | 312 | CY | 350.00 | 109,200 |
| Reinforcement, casing | 8,100 | lb. | 0.81 | 6,561 |
| Concrete, cutoff collar | 50 | CY | 450.00 | 22,500 |
| Reinforcement, cutoff collar | 4,900 | CY | 0.81 | 3,969 |
| 8" Steel Pipe for multiple-level outlet | 600 | ft | 50.00 | 30,000 |
| Concrete Casing (Pipe and racks) | 6 | CY | 350.00 | 2,100 |
| Reinforcement, casing | 600 | lb. | 0.81 | 486 |
| 8" Line Gate | 3 | ea. | 750.00 | 2,250 |
| Concrete, gate shaft | 108 | CY | 550.00 | 59,400 |
| Reinforcement, gate shaft | 13,685 | lb. | 0.81 | 11,085 |
| Miscellanneous metalwork, gate shaft | 6,050 | lb. | 3.40 | 20,570 |

**Table E-1 (continued)**
Narrows Dam and Reservoir
Estimate of Direct Construction Costs
(based on 2006 prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Outlet Works (continued)** | | | | |
| Slide gates, 38" high pressure (2) | 28,000 | lb. | 2.72 | 76,160 |
| Concrete, intake structure | 16 | CY | 450.00 | 7,200 |
| Reinforcement, intake tower | 2,325 | lb. | 0.81 | 1,883 |
| Concrete, stilling basin | 88 | CY | 450.00 | 39,375 |
| Reinforcement, stilling basin | 8,750 | lb. | 0.81 | 7,088 |
| Trash racks | 600 | lb. | 6.28 | 3,768 |
| Controls | 1 | LS | 10,000 | 10,000 |
| Unlisted items (10%) | 1 | LS | 92,862 | 92,862 |
| **Subtotal - Outlet Works** | | | | **1,021,482** |
| **Spillway** | | | | |
| Mobilization (5%) | 1 | LS | 43,600 | 43,600 |
| Excavation, rock | 560 | CY | 20.00 | 11,200 |
| Concrete, backfill | 104 | CY | 250.00 | 26,000 |
| Concrete | 1,200 | CY | 550.00 | 660,000 |
| Reinforcement | 162,224 | lb. | 0.81 | 131,401 |
| Unlisted items (10%) | 1 | LS | 87,220 | 87,220 |
| **Subtotal - Spillway** | | | | **959,422** |
| **Total Direct Costs - Narrows Dam and Reservoir** | | | | **7,599,154** |

**Table E-2**
Narrows Tunnel Inlet Rehabilitation
Estimate of Direct Construction Costs
(based on 2011 unit prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| Gate shaft concrete demolition | 20 | C.Y. | $700.00 | $14,311 |
| Stilling Basin Rock Excavation | 43 | C.Y. | $690.00 | $29,644 |
| Control House Structural Fill | 365 | C.Y. | $18.05 | $6,589 |
| Fill Hauling | 365 | C.Y. | $4.78 | $1,745 |
| Concrete in Control House | 36 | C.Y. | $400.00 | $14,237 |
| Concrete in Stilling Basin and Gate Shaft | 75 | C.Y. | $600.00 | $44,956 |
| Reinforcing Steel | 10,125 | LB | $0.89 | $9,011 |
| 48" Sluice Gate with Controls | 1 | L.S. | $35,000 | $35,000 |
| Gate controls | 1 | L.S. | $25,000 | $25,000 |
| Refurbish and Install Guard Gate | 1 | L.S. | $20,000 | $20,000 |
| Power and SCADA System | 1 | L.S. | $11,000 | $11,000 |
| **Total Direct Costs - Narrows Tunnel Rehabilitation** | | | | **$211,493** |

**Table E-3**
Upper Cottonwood Creek, East Bench, and Oak Creek Pipelines
Estimate of Direct Construction Costs
(based on 2011 unit prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Upper Cottonwood Creek Pipeline** | | | | |
| Material | | | | |
| 30" HDPE, PE4710 | 4,400 | LF | 71 | 312,400 |
| Installation | | | | |
| 30" HDPE, PE4710 | 4,400 | LF | 30 | 132,000 |
| Manholes, 6-foot deep | 7 | ea. | 2,975.00 | 20,825 |
| Stilling basin | 1 | LS | 20,000 | 20,000 |
| Unlisted Items (10%) | 1 | LS | | 49,000 |
| **Total Direct Costs - Upper Cottonwood Creek Pipeline** | | | | **534,225** |
| **East Bench Pipeline** | | | | |
| Right-of-way, perpetual easement | 51 | AC | 500 | 25,500 |
| Material | | | | |
| 30" HDPE, PE4710 | 9,650 | LF | 71 | 685,150 |
| 28" HDPE, PE4711 | 29,850 | LF | 56 | 1,671,600 |
| 26" HDPE, PE4712 | 8,800 | LF | 48 | 422,400 |
| 24" HDPE, PE4713 | 10,600 | LF | 47 | 498,200 |
| 22" HDPE, PE4714 | 12,900 | LF | 42 | 541,800 |
| 20" HDPE, PE4715 | 4,931 | LF | 32 | 157,792 |
| Installation | | | | |
| 30" HDPE, PE4710 | 9,650 | LF | 30 | 289,500 |
| 28" HDPE, PE4711 | 29,850 | LF | 30 | 895,500 |
| 26" HDPE, PE4712 | 8,800 | LF | 24 | 211,200 |
| 24" HDPE, PE4713 | 10,600 | LF | 24 | 254,400 |
| 22" HDPE, PE4714 | 12,900 | LF | 22 | 283,800 |
| 20" HDPE, PE4715 | 4,931 | LF | 20 | 98,620 |
| Appurtenant valves and gates | 1 | LS | 400,000 | 400,000 |
| Unlisted Items (10%) | 1 | LS | | 644,000 |
| **Total Direct Costs - East Bench Pipeline** | | | | **7,079,462** |
| **Oak Creek Pipeline** | | | | |
| Right-of-way, perpetual easement | 9 | AC | 100 | 900 |
| Material | | | | |
| 12" HDPE, DR 21, PR 101, PE4710 | 3,800 | LF | 12 | 45,705 |
| 12" HDPE, DR 19, PR 112, PE4710 | 5,900.0 | LF | 13 | 78,029 |
| 10" HDPE, DR 32.5, PR 64, PE4710 | 400.0 | LF | 6 | 2,251 |
| 10" HDPE, DR 26, PR 81, PE4710 | 1,900 | LF | 7 | 13,235 |
| Installation | | | | |
| 12" HDPE, DR 21, PR 101, PE4710 | 3,800 | LF | 14 | 53,200 |
| 12" HDPE, DR 19, PR 112, PE4710 | 5,900.0 | LF | 14 | 82,600 |
| 10" HDPE, DR 32.5, PR 64, PE4710 | 400.0 | LF | 14 | 5,600 |
| 10" HDPE, DR 26, PR 81, PE4710 | 1,900 | LF | 14 | 26,600 |
| Appurtenant valves and gates | 1 | LS | 14,000 | 14,000 |
| Unlisted Items (10%) | 1 | LS | | 32,000 |
| **Total Direct Costs - Oak Creek Pipeline** | | | | **354,120** |

**Table E-4**

Highway SR-264 Relocation

Estimate of Direct Construction Costs

(based on 2008 unit prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| Mobilization | 1 | LS | $210,000.00 | $210,000 |
| Traffic Control | 1 | LS | $10,000.00 | $10,000 |
| Dust Control & Watering | 500 | 1000 gal | $20.00 | $10,000 |
| Survey | 1 | LS | $21,000.00 | $21,000 |
| Roadway Excavation | 23,251 | CY | $8.00 | $186,008 |
| Clearing and Grubbing | 18 | ac. | $2,400.00 | $43,200 |
| Untreated Base Course 3/4 inch or 1 inch Max | 36,175 | ton | $11.00 | $397,925 |
| Hot-Mix Asphalt - 3/4 Inch | 14,642 | ton | $85.00 | $1,244,570 |
| Strip, Stockpile, and Spread Topsoil | 30,624 | SY | $0.77 | $23,580 |
| Broadcast Seed | 6 | ac. | $442.00 | $2,652 |
| 24 Inch Pipe Culvert, Class C | 600 | LF | $24.79 | $14,874 |
| **Total Direct Costs - Highway Relocation** | | | | **$2,163,809** |

**Table E-5**
Narrows Reservoir Recreation Area
Estimate of Direct Construction Costs
(based on 2006 unit prices)

| Item | Quantity | Unit | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Day Use Area** | | | | |
| Parking | 2,600 | SF | 1.86 | 4,836 |
| 10 Tables w/ shelter | 10 | ea. | 5,600.00 | 56,000 |
| 6 concrete pads | 1,458 | SF | 3.18 | 4,636 |
| 6 upright grills | 6 | ea. | 210.00 | 1,260 |
| 6 unit posts | 6 | ea. | 65.00 | 390 |
| 1-Inch water line (furnished and installed | 600 | LF | 14.97 | 8,982 |
| 2 Frostproof hydrants | 2 | ea. | 785.00 | 1,570 |
| Restroom (double vault unit) | 2 | ea. | 29,000.00 | 58,000 |
| 60 Tables 8 ft. | 60 | ea. | 1,015.00 | 60,900 |
| 60 Concrete pads | 21,780 | SF | 3.18 | 69,260 |
| 60 Fire circles | 60 | ea. | 214.00 | 12,840 |
| 60 Asphalt spurs | 34,223 | SF | 1.86 | 63,655 |
| 60 Unit posts | 60 | ea. | 65.00 | 3,900 |
| Restroom (double vault unit) | 4 | ea. | 29,000.00 | 116,000 |
| 1-Inch water line (furnished and installed | 6,000 | LF | 14.97 | 89,820 |
| 10 Frostproof hydrants | 10 | ea. | 785.00 | 7,850 |
| Developed spring | 1 | LS | 25,000.00 | 25,000 |
| Storage tank (10,000 gal.) | 1.0 | LS | 20,000.00 | 20,000 |
| **Boat Ramp** | 10,000 | SF | 3.37 | 33,700 |
| Unlisted Items (10%) | 1 | LS | | 63,860 |
| **Total Direct Costs - Recreation Area** | | | | **702,460** |

**Table E-6**
Wetlands, Wildlife, and Fishery Mitigation
Estimate of Direct Construction Costs
(based on 2006 unit prices)

| Item | Quantity | Unit | Unit Price | Cost |
|---|---|---|---|---|
| Wetland Mitigation Area | 220 | AC | 5,822.00 | 1,280,840 |
| Plantings and improvements on wetland mitigation areas | 1 | LS | 500,000.00 | 500,000 |
| Wildlife conservation easement adjacent to Reservoir | 150 | AC | 500.00 | 75,000 |
| Acquire section of land on Price River below Scofield Reservoir | 640 | AC | 500.00 | 320,000 |
| Fencing for section of land on Price River below Scofield Reservoir | 4 | mile | 10,455.00 | 41,820 |
| Acquire land on middle Gooseberry Creek | 6 | AC | 2,000.00 | 12,000 |
| Fencing on middle Gooseberry Creek | 0.25 | mile | 10,455.00 | 2,614 |
| Middle Gooseberry Creek channel rehabilitation | 3 | mile | 9,886.00 | 29,658 |
| Monitoring mitigation | 1 | LS | 40,353.00 | 40,353 |
| Depletion charge for F&WLS endangered fishes recovery implementation program | 5,717 | AC-FT | 15.25 | 87,184 |
| Acquire stream segments (Mud Creek 4 mi., Lower Fish Creek 2 mi., Upper Fish Creek 1 mi., Winterquarters Creek 2.5 mi., Pondtown Creek 2 mi.) | 206 | AC | 1,000.00 | 206,000 |
| Fence stream segments | 25.00 | mile | 10,455.00 | 261,375 |
| Enhance stream segments | 13.50 | mile | 12,106.00 | 163,431 |
| Upper Gooseberry Creek Tributaries planting & channel improvements | 1 | LS | 9,886.00 | 9,886 |
| **Total Direct Costs - Wetlands, Wildlife, and Fishery Mitigation** | | | | **3,030,161** |

**Table E-7**
Summary of Direct Costs
Narrows Project
(Unit -- $)

| Facility | Direct Cost | Oct 2011 Index | Index 2[1] | Indexed Oct 2011 Direct Cost |
|---|---|---|---|---|
| Narrows Dam and Reservoir | 7,599,154 | 324 | 269 | 9,152,884 |
| Narrows Tunnel Inlet Rehabilitation | 211,493 | 365 | 365 | 211,493 |
| Upper Cottonwood Creek Pipeline | 534,225 | 369 | 369 | 534,225 |
| East Bench Pipeline | 7,079,462 | 369 | 369 | 7,079,462 |
| Oak Creek Pipeline | 354,120 | 369 | 369 | 354,120 |
| Highway SR-264 Relocation | 2,163,809 | 336 | 340 | 2,138,352 |
| Recreation Area | 702,460 | 360 | 303 | 834,605 |
| Wetlands, Wildlife, and Fishery Mitigation | 3,030,161 | 360 | 303 | 3,600,191 |
| **Total Direct Cost** | **21,674,883** | | | **23,905,333** |

[1] Index varies by item. Oct 2006 index used for dam, recreation area and mitigation, Oct 2008 used for highway. Oct 2011 used for tunel inlet and pipelines.

**Table E-8**
Estimated Construction Funding Schedule
Narrows Project
(Unit -- $)

| Facility | 2011 Direct Cost | Contingencies | Engineering & Administration | Estimated Cost Increase to Contract Award | Total w/ Cost Increase | Estimated Funding Requirements FY 2013 | FY 2014 | FY 2015 |
|---|---|---|---|---|---|---|---|---|
| Narrows Dam and Reservoir | 9,152,884 | 915,288 | 1,510,226 | 1,186,786 | 12,765,000 | 755,113 | 8,046,624 | 3,963,263 |
| Narrows Tunnel Inlet Rehabilitation | 211,493 | 21,149 | 34,896 | 27,423 | 295,000 | 17,448 | 277,552 | |
| Upper Cottonwood Creek Pipeline | 534,225 | 53,423 | 88,147 | 69,269 | 745,000 | 44,074 | 700,926 | |
| East Bench Pipeline | 7,079,462 | 707,946 | 1,168,111 | 917,941 | 9,873,000 | 584,056 | 9,288,944 | |
| Oak Creek Pipeline | 354,120 | 35,412 | 58,430 | 45,916 | 494,000 | 29,215 | 464,785 | |
| Highway SR-264 Relocation | 2,138,352 | 213,835 | 352,828 | 277,264 | 2,982,000 | | 176,414 | 2,805,586 |
| Recreation Area | 834,605 | 41,730 | 131,450 | 103,298 | 1,111,000 | 65,725 | 1,045,275 | |
| Wetlands, Wildlife, and Fishery Mitigation | 3,600,191 | 360,019 | 594,032 | 466,810 | 5,021,000 | | 3,364,070 | 1,656,930 |
| **Total Direct Cost** | **23,905,332** | **2,348,803** | **3,938,120** | **3,094,706** | **33,286,000** | **1,495,630** | **23,364,591** | **8,425,779** |
| | | | | | | | **GRAND TOTAL =** | **$33,286,000** |

# ATTACHMENT F

## UTAH DIVISION OF WATER RESOURCES HYCON COMPUTER MODEL

1. PROGRAM DOCUMENTATION
2. MODEL OUTPUT

Sanpete Water Conservancy District

# A COMPUTER PROGRAM FOR HYDROLOGIC AND ECONOMIC ANALYSES OF WATER RESOURCE PROJECTS (HYCON)

David B. Cole
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Utah Division of Water Resources
February, 1982

1567 B

# A COMPUTER PROGRAM FOR HYDROLOGIC AND ECONOMIC ANALYSES OF WATER RESOURCE PROJECTS

The HYCON program was developed and modified for use on the WANG VS-100 Computer System. This program has the capability of analyzing the hydrologic and economic effects of changing irrigation systems, efficiencies, timing, and/or water supplies. The effect of constructing a reservoir and/or well may also be evaluated.

The program will ~~evaluate~~ do the evaluation using mean annual values or may analyze the hydrology and economics over a number of years. If a multi-year evaluation is to be performed, the monthly streamflow data must be stored in a data file using the standard format. The precipitation data may also be varied each year and must be stored in a data file if mean annual precipitation is not used. The consumptive use may be read in for each crop instead of computed. If this option is used the values must be stored in a data file before the HYCON program is executed.

The HYCON program is accessed by running a procedure called HYCON in Library PROGRAMS on Volume VOL666. A screen will appear describing the program and allowing previously saved data to be read from a file. When the data preparation portion of the program is complete, the data may be saved in a file. If previously saved data is to be retrieved, the next screen will allow the file, Library, and Volume Names of the data file to be entered. The next screen allows the program options to be set. If the number of years is less than 2, a mean monthly analysis will be performed. The following screen allows the project name, per cent daylight hours, mean monthly temperatures and precipitation, and various other options and data to be entered.

If a mean monthly analysis is to be performed, the next screen allows the input of the mean monthly water supplies in acre-feet for the pre-project and project conditions. The primary water supplies may be routed through a reservoir, the secondary supplies are not.

The following screens allow the crop data to be entered. The crop data has been regionalized by dividing it into areas with different growing seasons. If use of crops other than those shown is desired, additional data must be added to the basic data file describing the crops.

If the operation of a reservoir is to be simulated with HYCON, a screen will appear allowing the reservoir parameters to be input. The area-capacity relationship is in the form of two power curve equations as follows:

$$\text{Area} = \begin{cases} C1 * VOL^{C2} & \text{for } VOL \leq C5 \\ C3 * VOL^{C3} & \text{for } VOL > C5 \end{cases}$$

The reservoir capacities, mean monthly temperatures and precipitation, and minimum outflow are also entered on this screen. The net evaporation for the reservoir is computed from the temperatures and precipitation.

After the data has been entered a final screen will appear allowing the data to be stored in a data file and/or the HYCON program analysis computed. The only other screen that will appear for a mean monthly analysis is a screen allowing the print file to be named. If a multi-year analysis is being performed, other screens will appear requesting the names of the files containing the water supply and precipitation data, depending on the options being used.

## PROGRAM DESCRIPTION

HYCON is a Fortran IV computer program linked to a BASIC program which accepts, formats, and stores the data. The programs were developed for use on the WANG VS-100 Computer System.

The HYCON program was developed to aid in analyzing the hydrologic and economic effects of changing an irrigation water supply, timing of the supply, reservoir storage, well development, and/or changing the irrigation efficiencies. An earlier version of this program (developed in 1974 and described in 'A Fortran IV Computer Program for Hydrologic and Economic Analyses for Project Feasibility Reports') did the analysis computations using mean monthly water supplies and yields. The newer version of the program described in this report has the capability of analyzing and summarizing the data on a monthly basis over a series of years.

The program first performs a hydrologic analysis comparing the water supply to the computed irrigation requirements to determine crop yields with and without the project. The two different yield levels are used as input to an economic crop budget which computes the economic returns. The economic returns are used as a measure of the direct benefits of constructing a project.

## HYDROLOGIC ANALYSIS

The hydrologic analysis section of the program operates on a monthly basis. Mean monthly values for temperature, precipitation, and streamflow may be used on a calendar year basis or the hydrologic analyses may be performed on changing streamflow and/or precipitation data over a series of years. The program will compute consumptive used based on the Modified Blaney-Criddle equation described in the Soil Conservation Service Technical Release 21 or the consumptive use in feet may be read in for each crop.

When operating on a mean monthly basis the water supply may be included from two sources, primary and secondary. The primary source may be routed through a reservoir. The secondary source may be a separate surface supply or an underground source produced by wells.

When simulating a series of years the water supply is read from a data file with a value in acre-feet for each month of the analysis. The data file must be set up using the Division of Water Resources standard format (8X,I4,I2,12F5.0,F6.0) on a water year basis. The program will

convert water years to calendar years. An option has been provided which allows the same water supply data to be used with and without the project when only the efficiencies are different. Otherwise, the data is read from two separate files. The precipitation may be included on a mean monthly basis or may be read from a data file with different values each year. The precipitation must be stored in the data file in the same format as the streamflow with the exception that it is on a calendar year basis.

The program operates on a crop priority concept. A different analysis is performed each year for the without and with project conditions. The net irrigation requirement is computed for each crop for each month based on the temperature and precipitation. ~~Divisions~~ Diversions are made to the crops in the order they are included in the data; the last crops getting water only after the requirements of the first crops are satisfied. A monthly accounting of soil moisture storage is made for each crop. If a crop runs out of water during the growing season, the program reduces the acreage of that crop by matching the available moisture to the crop's consumptive use. Once a crop's acreage has been reduced during a given month, it remains at that reduced level for the rest of the growing season.

The average yield for each crop is computed for each year by applying the yield curves in the basic data file to the reduced crop acreage for each month. These yields are used in the economic analysis section of the program.

## ECONOMIC ANALYSIS

The economic analysis is performed for each year using without and with project yields. The gross income for each crop is computed by multiplying the crop production by the unit price. The base cash costs and payments to labor are interpolated from the data in the basic data file based on the yield computed for that crop. The ~~specified~~ interest rate is applied to the total of the base cash cost and payment to labor to compute the interest on the operating capital.

The fixed equipment is computed from an equation based on the typical farm size. The net returns are computed by subtracting property taxes, existing water costs, base cash costs, payment to labor, interest on operating capital and the fixed equipment cost ~~for~~ from the gross income for each crop. The net returns are weighted by acreage to obtain a weighted net return without and with the project. These weighted net returns are multiplied by the acreage and the without project return subtracted from the with project return to compute the return to water which is a measure of the economic benefits of constructing a project.

If a number of years are being analyzed the economic analysis is performed each year and summarized in a table. The yields are averaged for the period of record and an additional analysis is performed using the average yields.

## PROGRAMMERS NOTES

The source code for the program is stored in Library HYCONXXX on Volume VOL666. The object code is stored in Library HYCONOBJ. The program consists of a Fortran subroutine called HYCON linked to a basic program called HYCONEDT. The HYCONEDT program accepts, formats and stores the data in a data file. It will also store the data in a scratch file and call the HYCON program which reads the scratch file and performs the computations. The HYCON program may also be run independent of HYCONEDT. The format and notation for the input data is the same as described in 'A Fortran IV Computer Program for Hydrologic and Economic Analyses for Project Feasibility Reports' with the exception that an additional record (card) must be provided as the first record in the data. Notation and formatting for this record are in Table 1. The notation and format for the rest of the data is attached.

Table 1 Notation and Format for Additional Record

| Variable | Format | Description |
|---|---|---|
| NYYRS | I5 | Number of years to be analyzed-if less than 2 a mean monthly analysis will be performed. |
| INYEAR | I5 | Initial year for multi-year analysis |
| IREDCU | ~~F5.0~~ I5 | Logic variable: if set equal to 1 consumptive use values will be read in for each crop; if not equal to 1 consumptive use will be computed. |
| ISAMEQ | I5 | Logic variable: If set equal to 1 the without and with project water supplies will be the same for a multi-year analysis. |
| NPRINT | I5 | Logic variable: Sets amount of print to be generated by the program as follows: |

| | | |
|---|---|---|
| | | 10 or more: A hydrologic and economic report will be printed for each year along with the summary tables and input data.<br><br>5 - 9: An economic report will be printed for each year along with the summary tables and input data.<br><br>2 - 4: Summary tables and input data will be printed.<br><br>1 or less: Only summary table will be printed. |
| IPREC | I5 | Logic variable: If set equal to 1 precipitation will be read each year. |
| PRECF | F5.0 | Precipitation factor used to compute effective precipitation. |

The HYCON program will use up to 8 different data files depending on the program options. If a multi-year analysis is to be performed a number of times, it is convenient to assign the files in a procedure. The files are described in Table 2.

Table 2 File Descriptions

| Unit No. | Description |
|---|---|
| 1 | Basic data file contains KC value, yield curve, and yield-labor-base cash cost curves for each crop. |
| 5 | General data file containing with and without project information. May be created by HYCONEDT. |
| 3 | Without project water supply in acre-feet |
| 4 | With project water supply in acre-feet |
| 6 | Print file |
| 8 | Precipitation data file |

| | |
|---|---|
| 9 | Consumptive use data file (Format is 16F5.0 one ~~and~~ card for each crop without and with project). |
| 16 | Scratch file; saves summary table for multi-year simulation. |

The procedure which executes the program is stored in a file named HYCON in Library PROGRAMS on Volume VOL666. This file may be copied and the file assignments changed to fit a specific problem.

An example printout, the HYCON procedure, and a complete listing of the computer programs follow.

# NOTATION

## Basic Data Input

| | |
|---|---|
| NCROPS | Number of crops in the basic data portion of the program. |
| VAR(N) | Abbreviated monthly names based on a calendar year. |
| CKCJ(I,K) | Monthly consumptive use coefficients reflecting the growth stage of the crop. |
| YCURJ(I,K) | Monthly crop yield values assuming moisture is available to the crop. |
| XI(I,M) | Crop yield values for base cash cost and labor and management cost curves. |
| YI(I,M) | Base cash cost curve values based on crop yield. |
| ZI(I,M) | Labor and management cost curve values based on crop yield. |

## General Input Data

| | |
|---|---|
| PNAME(N) | Project name. |
| PLD(K) | Monthly percentage of daylight hours in the year. |
| TFS | Typical farm size in acres. |
| OCI | Interest on operating capital. |
| WCOST | Local water cost per acre. |
| VCLND | Crop land value per acre. |
| VPAST | Pasture value per acre. |
| TAXC | Local taxes on crop land per acre. |

| | |
|---|---|
| TAXP | Local taxes on pasture per acre. |
| CIX | Production cost index(CIX=1.0 for 19~~XX~~81) |
| TEMP(K) | Project area mean monthly temperature in degrees Fahrenheit. |
| PREC(K) | Project area mean monthly precipitation in inches. |

Non-Project and Project Data

| | |
|---|---|
| IRES(J) | Reservoir logic (IRES=1 for reservoir; IRES=0 if no reservoir. |
| ISMS(J) | Soil moisture logic (ISMS=1 to divert water for soil moisture storage; ISMS=0 no diversions for soil moisture storage). |
| NC(J) | Number of crops. |
| EFOF(J) | On farm irrigation efficiency. |
| EFCV(J) | Canal conveyance efficiency. |
| IP(I,J) | Crop logic (IP=1 for pasture; IP=0 for other crops). |
| IDCP(I,J) | Crop identification logic (See Table 1 and Table 2 for crop identification numbers). |
| CNAME(I,J,N) | Crop name. |
| UT(I,J) | Crop production units (i.e. TON, BU, AUM, etc.). |
| YIELDI(I,J) | Crop production potential yield per acre. |
| UP(I,J) | Unit price value of crops. |
| ACRES(I,J) | Crop acres. |
| SMC(I,J) | Crop soil moisture capacity in inches. |
| SMICI(I,J) | Crop initial soil moisture in inches. |
| KS(I,J) | Diversion logic (KS=month in which diversions are to begin). |

| | |
|---|---|
| KE(I,J) | Diversion logic (KE=month in which diversions are to end). |
| QX(1,J,K) | Mean monthly values of primary water supply in acre-feet. |
| QX(2,J,K) | Mean monthly values of secondary water supply in acre-feet. |
| C1,C2,C3,C4,C5 | Reservoir surface area - capacity coefficients (for ~~S=C5A=C1S^C2~~; for S>C5 A=C3S^C4). $S \leq C5$ $A = C1 \times S^{C2}$ |
| SMX(J) | Reservoir maximum storage capacity in acre-feet. |
| SMN(J) | Reservoir minimum storage in acre-feet. |
| STOIC(J) | Reservoir initial storage in acre-feet. |
| TEMPR(J,K) | Reservoir mean monthly temperature in degrees Fahrenheit. |
| PRECR(J,K) | Reservoir mean monthly precipitation in inches. |
| QRMN(J,K) | Reservoir monthly minimum releases in acre-feet. |

## BASIC DATA INPUT AND FORMAT

Card #1

| Column | Variable | Format |
|---|---|---|
| 1-10 | NCROPS | I10 |

Card #2

| Column | Variable | Format |
|---|---|---|
| 1-52 | VAR(N) | 13A4 |

Card #3

| Column | Variable | Format |
|---|---|---|
| 1-60 | CKCJ(I,K) | 12F5.0 |

Card #4

| Column | Variable | Format |
|---|---|---|
| 1-60 | YCURJ(I,K) | 12F5.0 |

Card #5

| Column | Variable | Format |
|---|---|---|
| 1-80 | XI(I,M) | 8F10.0 |

Card #6

| Column | Variable | Format |
|---|---|---|
| 1-80 | YI(I,M) | 8F10.0 |

Card #7

| Column | Variable | Format |
|---|---|---|
| 1-80 | ZI(I,M) | 8F10.0 |

Note: Cards #3 through #7 are repeated for each crop and each area.

# INPUT DATA AND FORMAT

## General Input Data:

### Card #1

| Column | Variable | Format |
|---|---|---|
| 1-80 | PNAME(N) | 20A4 |

### Card #2

| Column | Variable | Format |
|---|---|---|
| 1-70 | PDL(K) | 12F5.0, F10.0 |

### Card #3

| Column | Variable | Format |
|---|---|---|
| 1-10 | TFS | F10.0 |
| 11-20 | OCI | F10.0 |
| 21-30 | WCOST | F10.0 |
| 31-40 | VCLND | F10.0 |
| 41-50 | VPAST | F10.0 |
| 51-60 | TAXC | F10.0 |
| 61-70 | TAXP | F10.0 |
| 71-80 | CIX | F10.0 |

### Card #4

| Column | Variable | Format |
|---|---|---|
| 1-70 | TEMP(K) | 12F5.0, F10.0 |

### Card #5

| Column | Variable | Format |
|---|---|---|
| 1-70 | PREC(K) | 12F5.0, F10.0 |

## Non-Project and Project Data:

### Card #6

| Column | Variable | Format |
|---|---|---|
| 1-10 | IRES(J) | I10 |
| 11-20 | ISMS(J) | I10 |
| 21-30 | NC(J) | I10 |

Card #7

| Column | Variable | Format |
|---|---|---|
| 1-10 | EFOF(J) | F10.0 |
| 11-20 | EFCV(J) | F10.0 |

Card #8

| Column | Variable | Format |
|---|---|---|
| 1- 2 | IP(I,J) | I2 |
| 3- 4 | IDCP(I,J) | I2 |
| 5-16 | CNAME(I,J,N) | 3A4 |
| 17-20 | UT(I,J) | A4 |
| 21-30 | YIELD(I,J) | F10.0 |
| 31-40 | UP(I,J) | F10.0 |
| 41-50 | ACRES(I,J) | F10.0 |
| 51-60 | SMC(I,J) | F10.0 |
| 61-70 | SMICI(I,J) | F10.0 |
| 71-75 | KS(I,J) | 15 |
| 76-80 | KE(I,J) | 15 |

Card #9

| Column | Variable | Format |
|---|---|---|
| 1-80 | QX(I,J,K) | 12F6.0, F8.0 |

Card #10

| Column | Variable | Format |
|---|---|---|
| 1-80 | QX(2,J,K) | 12F6.0, F8.0 |

Card #11

| Column | Variable | Format |
|---|---|---|
| 1-50 | C1,C2,C3,C4,&C5 | 5F10.0 |
| 51-60 | SMX(J) | F10.0 |
| 61-70 | SMN(J) | F10.0 |
| 71-80 | STOIC(J) | F10.0 |

Card #12

| Column | Variable | Format |
|---|---|---|
| 1-70 | TEMPR(J,K) | 12F5.0, F10.0 |

Card #13

| Column | Variable | Format |
|---|---|---|
| 1-70 | PRECP(J,K) | 12F5.0, F10.0 |

Card #14

| Column | Variable | Format |
|---|---|---|
| 1-80 | QRMN(J,K) | 12F6.0, F8.0 |

Notes:

(1) Card #8 is repeated for each crop.

(2) Cards #11, 12, 13 & 14 are required only if the project (or non-project) has a reservoir (IRES(J)=1).

(3) Cards #6 through #14 are for non-project conditions. Repeat cards #6 through #14 for project conditions; i.e., cards #15 through #23 are for project conditions.

Economic Analysis Worksheet

Project: Narrows Project

Crop Production Costs and Benefits

| Crop | Acres | Per-cent | Yield per Acre | | Unit Price | Return per Acre | Prop. Taxes | Water Cost | Fixed & Varib. Costs | Int. Oper. Cap. | Total Cash Cost | Net Return Water | Wt Net Return Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pre-Project** | | | | | | | | | | | | | |
| Barley | 469. | 9. | 100.0 | Bu | 4.86 | 486.00 | 10.00 | 10.00 | 270.14 | 10.81 | 300.95 | 185.05 | 15.75 |
| Alfalfa 1 Cutting | 469. | 9. | 2.5 | Ton | 82.00 | 205.00 | 10.00 | 10.00 | 242.15 | 9.69 | 271.84 | -66.84 | -5.69 |
| Alfalfa 3 Cutting | 2052. | 37. | 4.4 | Ton | 163.90 | 727.32 | 10.00 | 10.00 | 211.80 | 8.47 | 240.27 | 487.05 | 181.32 |
| Pasture | 2522. | 46. | 1.6 | AUM | 54.63 | 90.10 | 10.00 | 10.00 | 24.95 | 1.00 | 45.95 | 44.15 | 20.20 |
| Total = | 5512. | | | | | | | | | | | Total = | 211.58 |
| **Project** | | | | | | | | | | | | | |
| Barley | 469. | 9. | 100.0 | Bu | 4.86 | 486.00 | 10.00 | 10.00 | 270.14 | 10.81 | 300.95 | 185.05 | 15.75 |
| Alfalfa 3 Cutting | 2052. | 37. | 6.0 | Ton | 163.90 | 983.40 | 10.00 | 10.00 | 232.89 | 9.32 | 262.21 | 721.19 | 268.48 |
| Alfalfa 1 Cutting | 469. | 9. | 2.5 | Ton | 82.00 | 205.00 | 10.00 | 10.00 | 242.15 | 9.69 | 271.84 | -66.84 | -5.69 |
| Pasture | 2522. | 46. | 3.0 | AUM | 54.60 | 163.79 | 10.00 | 10.00 | 28.17 | 1.13 | 49.29 | 114.50 | 52.39 |
| Total = | 5512. | | | | | | | | | | | Total = | 330.93 |

Cropland Consumptive use from Diversions

| | |
|---|---|
| Project | 9116. |
| Pre-Project | 6190. |
| Increase | 2926. ac-ft |

Total Return to Water ($)

| | |
|---|---|
| Project | 1824085.62 |
| Pre-Project | 1166212.00 |
| Return to Water $ | 657873.63 |

Return to Water per ac-ft Increased CU =$224.85

Return to Water per Project Acre =$119.35

Hydrologic Data and Analysis

Pre-Project Conditions: Narrows Project

Irrigation Efficiencies Conveyance =1.00 On Farm =0.60 Combined =0.60

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cropland Climatic Data | | | | | | | | | | | | | |
| KT Coefficient | 0.30 | 0.30 | 0.32 | 0.46 | 0.61 | 0.78 | 0.92 | 0.88 | 0.71 | 0.53 | 0.31 | 0.30 | |
| Daylight Hours | 6.74 | 6.92 | 8.28 | 8.92 | 10.00 | 10.06 | 10.21 | 9.54 | 8.36 | 7.71 | 6.71 | 6.55 | |
| Temperature | 22.77 | 28.20 | 36.68 | 44.71 | 53.42 | 63.41 | 71.50 | 68.78 | 59.45 | 48.94 | 36.23 | 25.18 | 46.61 |
| Precipitation | 0.87 | 0.94 | 1.32 | 1.13 | 1.05 | 0.73 | 0.72 | 0.77 | 1.20 | 1.18 | 0.98 | 0.96 | 11.83 |
| Water Supply | | | | | | | | | | | | | |
| Primary | 0. | 0. | 0. | 275. | 2079. | 3362. | 2860. | 1827. | 567. | 202. | 0. | 0. | 11172. |
| Secondary | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Total | 0. | 0. | 0. | 275. | 2079. | 3362. | 2860. | 1827. | 567. | 202. | 0. | 0. | 11172. |
| Diversion Requirement | 0. | 0. | 0. | 30. | 1671. | 3473. | 4847. | 3532. | 1641. | 0. | 0. | 0. | 15194. |
| Water Shortage | | | | | | | | | | | | | |
| Root Zone | 0. | 0. | 0. | 0. | 0. | 66. | 1192. | 1023. | 644. | 0. | 0. | 0. | 2926. |
| Point of Diversion | 0. | 0. | 0. | 0. | 0. | 111. | 1987. | 1705. | 1074. | 0. | 0. | 0. | 4877. |
| Crop Soil Moisture | | | | | | | | | | | | | |
| Barley | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Alfalfa 1 Cutting | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Alfalfa 3 Cutting | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Pasture | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Crop Acreage | | | | | | | | | | | | | |
| Barley | 0. | 0. | 0. | 0. | 469. | 469. | 469. | 469. | 0. | 0. | 0. | 0. | |
| Alfalfa 1 Cutting | 0. | 0. | 0. | 469. | 469. | 469. | 469. | 469. | 469. | 469. | 0. | 0. | |
| Alfalfa 3 Cutting | 0. | 0. | 0. | 2052. | 2052. | 2052. | 2034. | 1934. | 1128. | 1128. | 0. | 0. | |
| Pasture | 0. | 0. | 0. | 2522. | 2522. | 2323. | 0. | 0. | 0. | 0. | 0. | 0. | |
| KC Coefficient | | | | | | | | | | | | | |
| Barley | 0.49 | 0.57 | 0.73 | 0.85 | 0.46 | 1.03 | 1.13 | 0.22 | 0.87 | 0.79 | 0.67 | 0.55 | |
| Alfalfa 1 Cutting | 0.63 | 0.73 | 0.86 | 0.99 | 1.08 | 1.13 | 1.11 | 1.06 | 0.99 | 0.91 | 0.78 | 0.64 | |
| Alfalfa 3 Cutting | 0.63 | 0.73 | 0.86 | 0.99 | 1.08 | 1.13 | 1.11 | 1.06 | 0.99 | 0.91 | 0.78 | 0.64 | |
| Pasture | 0.49 | 0.57 | 0.73 | 0.85 | 0.90 | 0.92 | 0.92 | 0.91 | 0.87 | 0.79 | 0.67 | 0.55 | |
| Consumptive Use | | | | | | | | | | | | | |
| Barley | 0.000 | 0.000 | 0.000 | 0.000 | 0.069 | 0.428 | 0.636 | 0.051 | 0.000 | 0.000 | 0.000 | 0.000 | |
| Alfalfa 1 Cutting | 0.000 | 0.000 | 0.000 | 0.082 | 0.293 | 0.470 | 0.623 | 0.507 | 0.293 | 0.000 | 0.000 | 0.000 | |
| Alfalfa 3 Cutting | 0.000 | 0.000 | 0.000 | 0.082 | 0.293 | 0.470 | 0.623 | 0.507 | 0.293 | 0.000 | 0.000 | 0.000 | |
| Pasture | 0.000 | 0.000 | 0.000 | 0.071 | 0.244 | 0.383 | 0.517 | 0.436 | 0.257 | 0.000 | 0.000 | 0.000 | |

Hydrologic Data and Analysis

Project Conditions: Narrows Project

Irrigation Efficiencies Conveyance =1.00 On Farm =0.60 Combined =0.60

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cropland Climatic Data | | | | | | | | | | | | | |
| KT Coefficient | 0.30 | 0.30 | 0.32 | 0.46 | 0.61 | 0.78 | 0.92 | 0.88 | 0.71 | 0.53 | 0.31 | 0.30 | |
| Daylight Hours | 6.74 | 6.92 | 8.28 | 8.92 | 10.00 | 10.06 | 10.21 | 9.54 | 8.36 | 7.71 | 6.71 | 6.55 | |
| Temperature | 22.77 | 28.20 | 36.68 | 44.71 | 53.42 | 63.41 | 71.50 | 68.78 | 59.45 | 48.94 | 36.23 | 25.18 | 46.61 |
| Precipitation | 0.87 | 0.94 | 1.32 | 1.13 | 1.05 | 0.73 | 0.72 | 0.77 | 1.20 | 1.18 | 0.98 | 0.96 | 11.83 |
| Water Supply | | | | | | | | | | | | | |
| Primary | 0. | 0. | 0. | 30. | 1671. | 3473. | 4847. | 3532. | 1641. | 207. | 0. | 0. | 15401. |
| Secondary | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Total | 0. | 0. | 0. | 30. | 1671. | 3473. | 4847. | 3532. | 1641. | 207. | 0. | 0. | 15401. |
| Diversion Requirement | 0. | 0. | 0. | 30. | 1671. | 3473. | 4847. | 3532. | 1641. | 0. | 0. | 0. | 15194. |
| Water Shortage | | | | | | | | | | | | | |
| Root Zone | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| Point of Diversion | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1. |
| Crop Soil Moisture | | | | | | | | | | | | | |
| Barley | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Alfalfa 3 Cutting | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Alfalfa 1 Cutting | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Pasture | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Crop Acreage | | | | | | | | | | | | | |
| Barley | 0. | 0. | 0. | 0. | 469. | 469. | 469. | 469. | 0. | 0. | 0. | 0. | |
| Alfalfa 3 Cutting | 0. | 0. | 0. | 2052. | 2052. | 2052. | 2052. | 2052. | 2052. | 2052. | 0. | 0. | |
| Alfalfa 1 Cutting | 0. | 0. | 0. | 469. | 469. | 469. | 469. | 469. | 469. | 469. | 0. | 0. | |
| Pasture | 0. | 0. | 0. | 2522. | 2522. | 2522. | 2522. | 2522. | 2522. | 2522. | 0. | 0. | |
| KC Coefficient | | | | | | | | | | | | | |
| Barley | 0.49 | 0.57 | 0.73 | 0.85 | 0.46 | 1.03 | 1.13 | 0.22 | 0.87 | 0.79 | 0.67 | 0.55 | |
| Alfalfa 3 Cutting | 0.63 | 0.73 | 0.86 | 0.99 | 1.08 | 1.13 | 1.11 | 1.06 | 0.99 | 0.91 | 0.78 | 0.64 | |
| Alfalfa 1 Cutting | 0.63 | 0.73 | 0.86 | 0.99 | 1.08 | 1.13 | 1.11 | 1.06 | 0.99 | 0.91 | 0.78 | 0.64 | |
| Pasture | 0.49 | 0.57 | 0.73 | 0.85 | 0.90 | 0.92 | 0.92 | 0.91 | 0.87 | 0.79 | 0.67 | 0.55 | |
| Consumptive Use | | | | | | | | | | | | | |
| Barley | 0.000 | 0.000 | 0.000 | 0.000 | 0.069 | 0.428 | 0.636 | 0.051 | 0.000 | 0.000 | 0.000 | 0.000 | |
| Alfalfa 3 Cutting | 0.000 | 0.000 | 0.000 | 0.082 | 0.293 | 0.470 | 0.623 | 0.507 | 0.293 | 0.000 | 0.000 | 0.000 | |
| Alfalfa 1 Cutting | 0.000 | 0.000 | 0.000 | 0.082 | 0.293 | 0.470 | 0.623 | 0.507 | 0.293 | 0.000 | 0.000 | 0.000 | |
| Pasture | 0.000 | 0.000 | 0.000 | 0.071 | 0.244 | 0.383 | 0.517 | 0.436 | 0.257 | 0.000 | 0.000 | 0.000 | |

# NARROWS PROJECT
# FINAL ENVIRONMENTAL IMPACT STATEMENT

## APPENDIX K

# SECTION 404(B)(1) ANALYSIS
# NARROWS PROJECT,
# SANPETE WATER CONSERVANCY DISTRICT

**Section 404(b)(1) Analysis**
Narrows Project
Sanpete Water Conservancy District
March 2012

# 1.0 PROJECT DESCRIPTION

## 1.1 PROPOSED ACTION ALTERNATIVE

The Sanpete Water Conservancy District (SWCD) has applied to the Bureau of Reclamation (Reclamation) for a Small Reclamation Projects Act (SRPA) loan to help finance construction of a reservoir and related facilities (Proposed Action). SWCD also has requested authorization to use federally administered withdrawn lands as the site for dam construction. Most of the reservoir basin would be located on adjacent, privately owned land. If Reclamation approves the SRPA loan and land use and Congress appropriates the necessary funds, a supplemental water supply would be developed for presently irrigated lands and municipal and industrial (M&I) water users in northern Sanpete County. A dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel and a proposed pipeline to Cottonwood Creek; the existing tunnel would be rehabilitated. Pipelines would be constructed to deliver the water to existing water distribution systems. Recreation facilities would be developed, and a 2,500-acre-foot minimum pool for fish habitat would be provided. The resulting water storage and delivery system would be a non-Federal project owned and operated by SWCD.

Mitigation measures would be implemented to offset adverse impacts. Additional water conservation measures would be required independent of the Proposed Action. To be eligible to receive water from the Narrows Project, water users would be required to use, or agree to implement, conservation measures.

## 1.2 PURPOSE AND NEED

The primary purpose of the Narrows Project is to enable SWCD to develop an irrigation and M&I supply source for users in north Sanpete County, Utah, whereby the average annual shortages to irrigators in the project area might be reduced as nearly as possible to 5 percent (%), which is considered full irrigation supply for Reclamation projects. Specifically, the following are water-related needs addressed by the proposed project:

- Demand for municipal water for present and future use exceeds the currently available supply. The proposed Narrows Project would develop, through exchange, an additional supply of municipal water to offset current shortages and accommodate anticipated population growth in the project area.
- The current water supply for agricultural irrigation does not provide adequate supply and storage at the times when it is needed—typically in July, August, and September of each year. The proposed Narrows Project would provide late season irrigation water to offset at least some of the current shortages.

In addition to the primary purpose of supplying water to Sanpete County, the project would have the additional benefit of providing improved and additional recreation and fishery opportunities in Sanpete County.

For purposes of complete analysis and potential impacts of this project, a broad range of alternatives have been evaluated thoroughly to fully comply with NEPA requirements and CFR 40 Part 230 Section 404(b)(1) Guidelines. The complete alternatives analysis is included in Chapter 2 of the Final Environmental Impact Statement (FEIS). A summary of the alternatives is included below. Potential impacts for the Proposed Action Alternative are addressed in Chapter 3 of the FEIS.

## 1.3 ALTERNATIVES CONSIDERED

### 1.3.1 Process Used to Develop Alternatives

The National Environmental Policy Act requires all agencies to write a detailed statement for major Federal actions having a significant effect on the environment, which must include a discussion of alternatives to the proposed action (see section 102(2)(c) of the Act). In addition, all Federal agencies must study, develop, and describe appropriate alternatives to recommended courses of action in any proposal that involves unresolved conflicts concerning alternative uses of available resources. To be considered reasonable, each alternative in the array (except "no action") must meet the proposal objectives (purpose & need) and the environmental standards (selection criteria).

Reclamation, as the lead agency, formed an interdisciplinary team that consisted of various Federal and State agencies and the SWCD. This team was formed to develop a set of selection criteria that could be used to formulate alternatives to the Narrows Project that would meet the purpose of and need for the proposed project. The selection criteria are:

1. The project must include an agricultural and municipal irrigation water supply as a project purpose and provide expected project benefits for at least the duration of the loan repayment period.
2. The project must provide an additional water supply to north Sanpete County during the season when it is needed.
3. The project must comply with all statutory and regulatory requirements and guidelines including Section 404 of the Clean Water Act, the National Historic Preservation Act (NHPA), and the Endangered Species Act.
4. The project must satisfy Small Reclamation Project Act requirements. The SRPA requires that a project be technically and financially feasible and in compliance with environmental requirements. To be considered financially feasible, the following would apply:
    a. The project sponsor should pay a minimum of 25% of the project costs at the time of construction.
    b. Loan repayment must use 100% of the project's irrigation amortization capacity (with certain exceptions), and repayment must be completed in 40 years or less. The amortization capacity is a measure of farmers' and ranchers' ability to repay.
    c. The loan factor (a measure of Federal interest subsidy) for the project must be 0.5 or less.
5. The project must divert and store water under legal claim of right and priority in full compliance with State law.

To fully explore the effects of the proposed action and possible alternate courses of action SWCD, working with Reclamation and the other cooperating agencies, developed an array of alternatives to answer the issues raised in chapter 1 of the FEIS.

### 1.3.2 Description of Alternatives

#### 1.3.2.1 No Action Alternative

The No Action Alternative represents the conditions of the affected area if Reclamation does not approve the SRPA loan and use of withdrawn lands by SWCD for the Narrows Project (figure 2-1). It establishes the baseline for evaluating the environmental impacts of providing a supplemental water supply to north Sanpete County. It also establishes anticipated conditions in the affected areas without further development and assumes that irrigation operations would continue according to historic use.

Under this alternative, the Narrows Dam and Reservoir would not be constructed. Without the dam construction, there would be no need to relocate SR-264; and there would be no recreational facilities constructed at the reservoir site. The East Bench, Oak Creek, and Upper Cottonwood Creek Pipelines would not be built. The existing Narrows Tunnel would be rehabilitated at some future date with other funding. The Cottonwood Creek Irrigation Company could not risk complete collapse and failure of the tunnel. If the tunnel were to collapse, the Cottonwood Creek Irrigation Company would have to acquire some type of emergency funding and would be required to repair it. The demand on municipal water supplies in Fairview, Mount Pleasant, Spring City, and Moroni would continue to increase as supplies for outdoor municipal uses run short and as the population increased. Most likely, there would be a conversion of agricultural water to municipal use as the demand for municipal water increased with a growing population.

Water conservation measures would continue to be implemented. These conservation measures would reduce average shortages on irrigated farmland to about 29.5% or about 15,250 acre-feet per year. Implementing new conservation measures most likely would reduce irrigation return flows now supplying wetlands, aquatic habitat, and downstream users by an estimated 3,500 acre-feet per year.

There would be no wetlands, wildlife, or fisheries mitigation measures implemented under the No Action Alternative because there would be no impact to existing wetlands and wildlife habitat. Streamflows in Gooseberry and Fish Creeks would remain unaltered from their present state. Under this alternative, no flatwater fishery would be developed in the proposed reservoir basin.

#### 1.3.2.2 Proposed Action Alternative

If Reclamation approves the SRPA loan and Congress appropriates the necessary funds and lands, a supplemental water supply would be developed for municipal water users and agricultural use in north Sanpete County under the Proposed Action. This additional water supply would satisfy the 1984 Compromise Agreement.

The Proposed Action would provide north Sanpete County an average annual supply of 4,281 acre-feet of supplemental irrigation water for 15,420 acres of presently irrigated farmland and 855 acre-feet of water for municipal use. The project would include construction of the 17,000 acre-foot Narrows Dam and Reservoir on Gooseberry Creek, pipelines to deliver the water to existing water distribution systems, rehabilitation of the existing 3,100 foot Narrows Tunnel, and relocation of 2.9 miles of State Road (SR) 264. The dam would be 120 feet high with a crest length of 550 feet and crest width of 30 feet.

The Narrows portion of the Gooseberry Project Plan would include a transmountain diversion of water from the Gooseberry Creek drainage of the Price-Green-Colorado River Basins to the San Pitch-Sevier River of the Great Basin. Geographically, the project facilities are located in close proximity to the drainage divide between the Price River system and the San Pitch River system. The general location is shown on the location map in the front of this document.

The Price River flows southeast to the Green River, a tributary of the Colorado River. The San Pitch River flows southwest to the Sevier River, which is completely consumed in the Bonneville Basin, a part of the arid Great Basin. The county line dividing Sanpete County and Carbon County is located more than 6 miles downstream from and about 3 miles east of the proposed Narrows damsite on Gooseberry Creek.

The proposed damsite, the transmountain Narrows Tunnel, and the project water distribution facilities are all located in Sanpete County. The source of the project water supply generally arises in Sanpete County and naturally flows into Carbon County and the Price River system, unless the flows are captured and diverted transmountain to Sanpete County. The service area of the Narrows Project would be situated in the San Pitch River drainage.

A dam and reservoir would be constructed on Gooseberry Creek, and water would be diverted through an existing tunnel to Cottonwood Creek. Pipelines would be constructed to deliver the water to existing water distribution systems located near Fairview, Utah. Recreation facilities would be developed at the reservoir, and a 2,500-acre-foot minimum pool for fish habitat would be maintained.

Mitigation measures would be implemented to offset adverse impacts to wetlands, terrestrial wildlife, and stream fisheries. In addition to mitigation measures to offset project impacts, other measures would be included to enhance or improve fish and wildlife habitat. Additional water conservation measures would be required independent of the Proposed Action. However, only those water users who have implemented or would agree to implement water conservation measures would be eligible to receive project water. These practices would include improved water conveyances such as lined canals, pipelines, or improved irrigation practices such as sprinklers or gated pipe.

#### 1.3.2.3 Mid-Sized Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 12,450 acre-feet. Of that amount, 9,950 acre-feet would be active capacity, and 2,500 acre-feet would be inactive storage. The 110 feet high dam, with a crest length of 475 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-11). Other features of the project would be the same as those for the Proposed Action and would include the construction of pipelines, rehabilitation of the existing Narrows Tunnel, relocation of SR-264, and provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are described in the SDEIS.

#### 1.3.2.4 Small Reservoir Alternative

This alternative would be similar to the Proposed Action except that the reservoir capacity would be limited to 7,900 acre-feet. Of that amount, 5,400 acre-feet would be active capacity, and 2,500 acre-feet would be inactive storage. The 100-feet-high dam, with a crest length of 425 feet and crest width of 30 feet, would be in the same location as that for the Proposed Action (figure 2-12). Other features of the project would be the same as those for the Proposed Action

and would include the construction of pipelines, rehabilitation of the existing Narrows Tunnel, relocation of SR-264, and provide recreation opportunities. Exceptions and differences between this alternative and the Proposed Action are described in the SDEIS.

### 1.3.3 Alternatives Considered and Eliminated from the Study

Several alternatives considered were determined to be nonviable because they did not meet the project's purpose and need. Specifically, they failed to meet one or more of the identified selection criteria listed above. The eliminated alternatives are listed below and described in detail in Chapter 2 of the FEIS.

- Direct Diversion Without Reservoir
- Direct Diversion with Reservoir in Sanpete Valley
- Conservation Without Development of Other Water Supplies
- Mammoth Damsite Alternative
- Valley Damsite Alternative
- Skyline Mine Alternative
- Year-round Release with Ground Water Exchange and Pumping Alternative
- New Ground Water Development
- New Surface Water Development in Sanpete County Alternative
- Central Utah Project Water Alternative
- Conservation Through Retirement of Irrigation
- Purchase of Sanpete County's Water Rights by Carbon County Water Interests
- Carbon County Proposed Recharge Alternative

### 1.3.4 Comparison of Alternatives

Table 2-8 in the FEIS compares the closely examined alternatives against the issues associated with the Proposed Action that are outlined in chapter 1. The scientific and analytical basis for these comparisons can be found in chapter 3.

## 1.4 GENERAL DESCRIPTION OF FILL MATERIAL

The project area includes Gooseberry Creek and its tributaries for construction of the Narrows Reservoir and also includes Cottonwood Creek and the area along the Oak Creek and the East Bench pipeline alignments.

### 1.4.1 Fill Material Characteristics

All fill materials used for construction of Narrows Dam would consist on naturally-occurring soils in the vicinity of the project area. Borrow materials for an earthfill embankment, available in the reservoir area, consist of clayey silts. Sand and gravel materials would be used in filter, drain and transition zones. Quarried rock would be used as riprap to protect the upstream face of the dam from wave action.

### 1.4.2 Source of Fill Material

Earthfill material for the Narrows Dam will be developed from a borrow area within the reservoir basin. Development of this area will affect wetlands and Gooseberry Creek. However, the impacts will occur with development of the reservoir regardless of whether the borrow area is used. It is estimated that 6.5 acres of stream and wetland areas will be impacted by excavation

of borrow material. During excavation of the borrow area, portions of Gooseberry Creek within the borrow area will be moved to the east using a membrane-lined channel. Following completion of the dam, Gooseberry Creek will be used to fill the reservoir basin and the membrane liner will be removed.

Sand and gravel materials to be used in filter, drain, and transition zones would be imported from commercial pits located in Sanpete Valley.

Rockfill material for the dam will be developed from a source area outside of the reservoir basin. Development of rockfill material would disturb approximately 2.0 acres. Following construction, the rockfill material source area will be recontoured, topsoil will be replaced, and the area will be revegetated. Virtually all runoff from disturbed areas will flow into Narrows Reservoir that will act as a trap for all upstream sediment. The current sediment load in Gooseberry Creek downstream from the proposed Narrows Reservoir will be reduced by about 400 tons per year with construction of the Proposed Action. This sediment would accumulate in the reservoir.

### 1.4.3 Construction Activities and Fill Quantities

Dam foundation excavation will be the first work associated with construction of the Narrows Reservoir. Gooseberry Creek will be left undisturbed during excavation and construction of the right side (facing downstream) of the dam foundation. Abutment excavation will proceed concurrently with the foundation excavation. The outlet works will be constructed in the right abutment. Following completion of the outlet works, Gooseberry Creek will be diverted through it, bypassing the dam foundation. With Gooseberry Creek diverted through the outlet works, the left side of the dam foundation will be excavated.

A small (less than 3-foot-high) temporary coffer dam may be constructed to train Gooseberry Creek into the temporary channel connecting to the outlet works. This could affect as much as 3,000-square-feet of stream and wetlands. The estimated volume of coffer dam embankment to be placed in Gooseberry Creek and adjacent wetlands within the reservoir basin is 200 cubic yards.

The footprint of the dam within wetland and stream areas is estimated to be 39,000 square-feet. The total estimated volume of embankment material to be placed above the existing wetlands and Gooseberry Creek, and within the footprint of the Narrows Dam, is 83,400 cubic yards. The total dam volume is estimated at 363,000 cubic yards.

## 1.5 DISCHARGE METHOD

The fill material would discharged primarily by cut and fill operations using bulk scrapers. Fill materials would be transported as necessary by haul truck from the point of excavation to the discharge site. Excavated material would be sorted and handled on site prior to placement in the discharge area. Placement of fill material would be accomplished in suitable lifts and would be compacted as required for structural and soil stability design criteria.

# 2.0 FACTUAL DETERMINATIONS

Other than the No Action alternative, the only practicable alternatives are the Proposed Action, Mid-sized Reservoir, and Small Reservoir alternatives. The Mid-sized and Small Reservoir alternatives are essentially the same as the Proposed Action Alternative except the size of the reservoir is progressively smaller. Environmental impacts from these three alternatives are very

similar with just slightly smaller affected areas for the Mid-sized and Small Reservoir alternatives. Mitigation measures for the alternatives are proportional to the affected areas for each. The Proposed Action more fully meets the stated purpose and need at a lower cost per acre-foot of water supplied as compared to the other two alternatives. Factual determinations are applicable to the Proposed Action Alternative.

## 2.1 PHYSICAL SUBSTRATE DETERMINATIONS

### 2.1.1 Substrate Elevation and Slope

The outlet from the Narrows Reservoir will tie into Gooseberry Creek at the same elevation as the existing channel. There are no expected changes in substrate elevation and slope upstream from the high water level of the proposed reservoir or downstream from the outlet of the reservoir.

### 2.1.2 Sediment Type

The origin of the fill to be discharged is primarily within the reservoir basin and does not represent a change from the historic sediment type within Gooseberry Creek. The exception to this is a relatively minor amount (less than 9 percent of the total embankment volume) of sand and gravel that would be imported from Sanpete Valley.

### 2.1.3 Fill Material Movement

The Narrows Reservoir is expected to act as a trap for sediments upstream from the dam effectively reducing sediment loads by 400 tons per year from the existing condition. Fill material discharged into the stream channel for construction of the dam will be permanently stabilized to prevent movement of the fill downstream.

### 2.1.4 Physical Effects on Benthos

There would be temporary effects on benthos as Gooseberry Creek is modified during construction of the dam. Since fill materials are of the same type as historic materials, and because benthic organisms tend to rapidly recolonize disturbed areas, it is expected that the lost benthic habitat of the stream channel that is inundated by the proposed reservoir will be replaced with new benthic habitat that will be developed within the reservoir. There will essentially be a shift from benthic organisms associated with flowing water habitat to those more adapted to lake conditions with the reservoir. It is anticipated that there will essentially be no change in benthic habitat upstream or downstream from the proposed reservoir.

### 2.1.5 Actions Taken to Minimize Impacts

Efforts were made to preserve the aquatic and terrestrial habitat while still accomplishing the goals of the project. Construction impacts would be minimized through implementation of erosion control measures and storm water pollution prevention. Measures include silt fences, soil stabilization practices, and turbidity barriers. Unavoidable adverse impacts will be compensated for through the construction of wetlands mitigation sites and through stream channel restoration and enhancement along Gooseberry Creek below the proposed dam.

## 2.2 WATER CIRCULATION, FLUCTUATIONS, AND SALINITY DETERMINATIONS

### 2.2.1 Predicted Water Quality Effects

Under the Proposed Action, there could be some water quality impacts during construction; however, measures would be implemented to minimize those impacts. The contractor would be required to comply with applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution. The contractor's construction activities would be performed by methods that would prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into streams, lakes, and underground water sources. Sanitary wastes would be disposed of by approved methods.

The construction contract would require the contractor to develop and implement a Water Quality Management Plan (Erosion Control Plan) and a Storm Water Pollution Prevention Plan. The contractor also would be required to implement the best management practices (BMPs) specified in the *Nonpoint Source Water Pollution Control Plan for Hydrologic Modifications in Utah*, which is an addendum to the *Utah Nonpoint Source Management Plan*. Specifically, applicable sections, such as Hydromod Planning Process, Measures to Control Construction Activities, and Impoundments, would be followed and implemented. Under a worst case scenario, if sediment control facilities temporarily failed and any stream sections were significantly impaired, remediation/restoration work would be implemented to the satisfaction of the appropriate government agencies.

Any construction work occurring in streams or associated wetlands would be conducted in compliance with USACE's 404 Permit and/or Utah State Engineer's stream alteration permit, which would include the State 401 certification process.

#### 2.2.1.1 Lower Gooseberry Reservoir

The average annual inflow (based on 1978– 2005 data) to Lower Gooseberry Reservoir would be reduced by 40%. The average annual phosphorus load levels below the proposed Narrows Reservoir would be reduced by about 113 kg/yr, resulting from phosphorus export and uptake in the Narrows Reservoir. This would result in a 45% reduction in the average nutrient load in the total inflowing water. The average in-lake phosphorus concentration would be reduced from 0.0131 to 0.0119 mg/L, and the probability of eutrophication would be reduced from 24.3 to 19.7%. Because the DO levels are greatest near the stream inlet, a decrease in inflow is expected to decrease the overall DO level of the reservoir in winter during iced-over conditions, thus increasing the potential for fish kills, unless mitigation were implemented. Mitigation is planned for this, which would include additional storage in the Narrows Reservoir and minimum streamflow releases as discussed in section 3.4 of the FEIS, "Fisheries."

#### 2.2.1.2 Scofield Reservoir

The results of the eutrophication study (Franson-Noble Engineering) with the Narrows Dam and Reservoir show that, under the Proposed Action, there would be a reduction of average annual phosphorus mass loading into Scofield Reservoir (105 kg/yr) and a slight increase of 10.8% in phosphorus in-lake concentration from 0.0279 to 0.0309 mg/L. The reduction in phosphorus loading results from basin export and uptake in Narrows and Lower Gooseberry Reservoirs. The overall probability of eutrophication for the period studied shows an increase from 68.3 to 73.5% (about a 5.2% increase). The probability of eutrophication was increased slightly every year

except 1984. Figure 3-6 of the FEIS shows a comparison of the future without project and project phosphorus level in Scofield Reservoir based on external loading.

As a result of the Proposed Action, the inflow to Scofield Reservoir would be reduced by an annual average of 5,726 acre-feet (about 9.2%). This means that Scofield Reservoir generally would operate at a lower elevation and smaller surface area. Its average flushing rate would decrease slightly, from 1.15 to 1.14. However, the flushing rate would drop below 0.85 in 10 of the 46 years studied, instead of 8 of 46 years as would occur in the future without the project (see Figure 3-7 of the FEIS). The critical low flushing rate would occur 22% of the time with the project as compared to 17% of the time without the project. During these periods of critical flushing rate, the probability of fish kills could be somewhat higher.

Taking into account the slight increase in in-lake phosphorus concentration and essentially no change in flushing rate, professional judgment would indicate that the overall water quality in Scofield Reservoir would be degraded only slightly by the Proposed Action without mitigation. Mitigation measures to offset this potential impact are described in section 3.5.3.2.6 of the FEIS.

2.2.1.3 Proposed Narrows Reservoir

The overall water quality in the proposed Narrows Reservoir is projected to be good. The probability of eutrophication would be about 12% (compared to 73.5% for Scofield Reservoir and 19.7% for Lower Gooseberry Reservoir). The proposed Narrows Reservoir is not expected to strongly stratify due to its shape, water budget, and location. The active pool (the storage above the inactive pool) would only be 45 feet in depth, with an average drawdown of 9 feet during the recreation season and 12 feet annually. The proposed plan is to have three outlets spaced 20 feet apart, at elevations 8,640; 8,660; and 8,680 feet, respectively. The normal water surface elevation is 8,690 feet. If a mild thermocline develops, it normally would start at about 16 to 20 feet and, over the summer season, migrate down to a depth of 32 to 45 feet depending upon the release pattern, level of water withdrawn, and type of year. Once the reservoir was constructed, filled, and operated for several years, an operating plan would be developed jointly with the State and Federal agencies to enhance habitat for fish and wildlife downstream. As a result of the small releases and stream channel conditions downstream, the water would reach ambient conditions within the first one-fourth to onehalf mile downstream, relative to temperature and dissolved oxygen, even if conditions were less than optimum in waters released.

Water quality at the proposed Narrows Reservoir would be protected by establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.

2.2.1.4 Price and Colorado Rivers

The Narrows Project would have virtually no effect on the lower Price River water quality during the November–April high TDS period, Narrows Project because the effects of depletions caused by the proposed Narrows Project would consist primarily of reduced spills from Scofield Reservoir during the snowmelt runoff period.

Implementing the Proposed Action would have a slight detrimental impact on Colorado River salinity. Construction and operation of the proposed Narrows Dam and Reservoir would remove about 1,520 tons of salt per year from the Colorado River system.

However, the project also would cause a depletion of about 5,597 acre-feet of water to the Colorado River system. An increased salinity concentration of about 0.54 mg/L would occur at Imperial Dam.

2.2.1.5 Cottonwood Creek and San Pitch River

The overall water quality of Upper Gooseberry Creek is better than that of Cottonwood Creek (see table 3-14 of the FEIS), so the additional water imported to Cottonwood Creek would improve slightly its quality. The exception may include temporary periods of slightly higher turbidity from the increased summer flows. Flows in Cottonwood Creek (below Left Hand Fork) would increase in July and August due to the increased irrigation releases, but these flows would be significantly less than peak flows that naturally occur during the spring snowmelt period. As discussed in the DEIS and the FEIS in section 3.14, “Slope and Channel Stability,” the Narrows Tunnel operating gate would be automated to regulate releases through the tunnel so that even during thunderstorms, the channel forming discharge would not increase above historical conditions. Consequently, even though the Proposed Action would increase the summer base flow, it would have no effect on Cottonwood Creek channel stability because the increase would be well below the 50-year channel forming discharge. Except during spring runoff and winter conditions, flows in the San Pitch River below the project area consist mostly of return flows from irrigation and municipal waste water. The project would increase the volume of return flows from both of these sources; but since no new lands receive project water, the quality of return flows would be similar to existing flows or possibly be of slightly better quality because lands would receive a more complete water supply. Consequently, the concentration of dissolved salts should be more diluted in the increased volume of return flows. The potential decrease in irrigation return flows resulting from increasing agricultural efficiencies would be offset by the increase of return flow from the additional project irrigation water. Even if the overall volume of return flow were reduced significantly due to increased efficiencies, the quality of the return flows likely would not change significantly, nor would the existing quality of the San Pitch River change significantly since it is already composed mostly of return flows.

As shown in table 3-17 of the FEIS, the salinity of lower San Pitch River is about 1,150 to 1,635 mg/L TDS compared to about 350 mg/L in Sixmile Creek. If the Manti Meadows Alternative wetland mitigation area is selected, and water is delivered from Sixmile Creek and replaced with project return flows delivered to Gunnison Reservoir in exchange, there could be some impact to effected irrigated lands.

Diversions to the wetland area would have to be timed to not significantly affect the exchanged irrigation water supply, or replacement waters would need to be blended with higher quality Sixmile water to avoid impact to crops using the water. Under worst case conditions, an agreement with the Manti Irrigation Company might be needed, and minimal compensation might be required.

2.2.2 Current Patterns, Circulation, and Water Level Fluctuations

Gooseberry Creek and its three unnamed tributaries are located high in the Price River drainage. This tributary of Fish Creek flows directly into Scofield Reservoir (see the location map at the front of this document). Other tributaries to Scofield Reservoir include Mud Creek and Pondtown Creek. The Price River, which flows out of Scofield Reservoir, is a tributary of the Green River— a tributary of the Colorado River. These three rivers are all located in the Colorado River Basin.

Cottonwood Creek, located in the San Pitch River Basin, is located on the opposite side of the divide from Gooseberry Creek.

Cottonwood Creek and the San Pitch River are located in the Sevier River subbasin of the Great Basin.

Typical of Wasatch Mountain streams, flows in these creeks are greatest in the spring, when snowmelt runoff is peaking. Peak flows during May and June are estimated to range from 15 to over 100 cubic feet per second (cfs) in Upper Gooseberry Creek near the proposed damsite. The flow declines considerably in late summer and reaches a minimum in late fall or winter. Late-season flows are estimated to be 1.5 to 5 cfs in Upper Gooseberry Creek.

The average annual natural runoff volume of Upper Gooseberry Creek, near the proposed damsite, is 9,032 acre-feet. Of this amount, an average of 1,815 acre-feet presently is stored in Fairview Lakes and diverted transmountain to Cottonwood Creek through the Narrows Tunnel. The remaining water continues down Gooseberry Creek to Fish Creek. An average of 35,800 acre-feet per year enters Scofield Reservoir from Fish Creek. The total annual inflow to Scofield Reservoir from all tributaries averages 57,500 acre-feet. The average total contents of Scofield Reservoir are about 42,360 acre-feet. All of these values are for the 1960–2002 hydrologic period.

The Price River below Scofield Reservoir, referred to as lower Fish Creek, has a wide range of flows that vary according to downstream water demands and hydrologic conditions. Releases consist of direct flow right bypasses and Scofield Reservoir storage deliveries for Scofield Project users. Spills occur when the reservoir is full and water flows over the spillway or when releases are made in excess of downstream demands. These total releases and spills have averaged 51,815 acre-feet for 1960–2002 but historically have varied from 13,762 to 154,475 acre-feet. Low flow conditions generally occur from November through March. There are no minimum flow requirements in the Price River, and it is not unusual for the flow below the dam to be completely shut off during winter months. Peak flows below the dam occur in wet years when the reservoir spills. While normal dam releases in June are about 150 cfs, the total releases with these spills have ranged up to more than 1,100 cfs. Since spills are in excess of downstream consumptive use requirements, they usually increase river flows throughout the lower Price River to the confluence with the Green River. From 1960 to 2002, the reservoir filled and spilled 17 times. This indicates that, on the average, the reservoir historically has spilled about every 2 to 3 years.

About 25 miles downstream from Scofield Reservoir near the small community of Heiner, the average annual flow of the Price River is about 81,000 acre-feet based on 1935–81 data. Within 5 miles of Heiner, numerous diversions from the river occur. The largest diversion is the head of the Carbon and Price Wellington Canals, located about 1.5 miles south of Spring Glen. Except during high water conditions when the flow of the river exceeds the capacity of the canals, the river essentially is dry below this diversion. In addition to irrigation water, winter flows also are diverted for stockwatering.

Irrigation return flows in this area discharge back to the river, and the flow of the river increases after passing through the Price-Wellington area. Near its confluence with the Green River, the average annual flow of the river is 94,929 acre-feet, based on 1960–92 records. The stream gauging station on the Price River at Woodside was discontinued in September 1992 and renewed in July 2000.

As mentioned previously, Cottonwood Creek, located in the San Pitch River Basin, has typical flow conditions as compared with other streams in the area with one noted exception. After spring runoff flows subside in late May or early June, natural flows are supplemented with releases from Fairview Lakes. These releases are made through an existing transmountain tunnel. Flows from Fairview Lakes are used by the Cottonwood-Gooseberry Irrigation Company as a source of supplemental irrigation water in the Fairview area. These supplemental releases generally occur in July and August. The historic average annual flow volumes at the tunnel outlet and the mouth of Cottonwood Creek have been 2,055 and 8,600 acre-feet, respectively.

Operation of the Narrows Project would affect streamflows in Gooseberry Creek, Fish Creek, Price River, Green River, Colorado River, Cottonwood Creek, and about 3 miles of the San Pitch River. Table 3-2 of the FEIS provides a comparison of average monthly streamflows under the four project alternatives evaluated. Monthly streamflow data were used to develop this table because reliable daily streamflow data were not available.

Impacts to Lower Gooseberry Creek and Fish Creek would occur primarily during the spring snowmelt period as water is stored in Narrows Reservoir for release later in the summer. Impacts to Lower Gooseberry Reservoir would consist of reduced inflow. However, the effect would be negligible because the reservoir is not operated as a storage reservoir. As a result, the outflow would be reduced in the same proportion as the inflow would be reduced. Impacts to Scofield Reservoir would be in the form of reduced inflows, resulting in a lowering of average reservoir storage. Impacts to regulated releases from Scofield Reservoir for Scofield Project use would occur only during multiple successive drought years, such as occurred in the early 1960s, early 1990s, and the early 2000s. Impacts to the Price, Green, and Colorado Rivers would result primarily in reduced spills from Scofield Reservoir.

The impacts of the Narrows Project on water resources are most pronounced near the reservoir. About 1 mile of Upper Gooseberry Creek and 4.3 miles of small streams in the proposed reservoir basin would be inundated by the reservoir. In addition, annual flows in the middle 3 miles of Gooseberry Creek between Narrows Reservoir and inflow into Lower Gooseberry Reservoir would be reduced by about 74%. Under the Proposed Action, a 1.0-cfs minimum flow would be made from Narrows Reservoir to Gooseberry Creek to provide a 1.5-cfs minimum flow at the USDA Forest Service campground ⅛ mile downstream from the proposed damsite. If the 1.5-cfs flow at the campground is not met, up to an additional 0.25 cfs would be released from the reservoir to meet the required flow. Minimum streamflow releases from Narrows Reservoir would eliminate periodic dry stream channels in the Middle Gooseberry Creek segment. An average of 300 acre-feet per year also would be released for channel maintenance or other instream flow purposes. Flows in Cottonwood Creek would increase during the irrigation season, with the import of project water through Narrows Tunnel. However, during the irrigation season, these flows would be less than peak flows that occur naturally during the spring snowmelt period. The Upper Cottonwood Creek Pipeline would convey these increased flows outside the stream channel between the tunnel outlet and the confluence with Left Hand Fork. About 300 feet below the Left Hand Fork confluence, the project flows would be discharged to the stream. At this point, the increase in average July and August flows from current conditions would be about 200%.

Depletions to the Price River drainage would average 5,597 acre-feet per year. This amount would consist of 5,227 acre-feet of transbasin diversions and 370 acre-feet of increased evaporation in the Price River Basin. When measured in Gooseberry Creek below Narrows Reservoir, the reduction in annual streamflow varies between 1,760 and 10,200 acre-feet, depending on the storage level of Narrows Reservoir and the magnitude of the streamflow into

the reservoir. As shown in table 3-2 of the FEIS, the greatest impact would occur during the spring snowmelt runoff period. Releases from Narrows Reservoir to Gooseberry Creek would remain at a minimum of 1.0 cfs; and when the reservoir is spilling or when flushing releases are made, the flow would be greater.

As a result of constructing Narrows Reservoir, the operation of Scofield Reservoir would be altered within the normal historic range. Scofield Reservoir would operate at a lower level with implementing the Proposed Action, as shown in Figure 3-1 of the FEIS. Under project conditions, the average total contents of Scofield Reservoir would be reduced from about 42,360 acre-feet to about 31,500 acre-feet. Average reduction in storage releases to irrigators in the Price area would be about 753 acre-feet per year. Total depletions to the Price River drainage would average 5,597 acre-feet per year. Both the volume and frequency of spills from the reservoir would be reduced. The average reservoir surface area would be reduced from 2,370 acres in the No Action Alternative to about 2,125 acres. This is about a 10% reduction or about 245 acres of the surface area of the No Action Alternative.

Since Scofield Reservoir would operate at a lower level, there is an increased potential for the reservoir to be drained to the bottom of its active storage. The frequency of this occurrence increases from 3 times in 43 years for the No Action Alternative to 12 times in 43 years with the Proposed Action.

During most years, controlled releases from Scofield Reservoir to meet Scofield Project demands would remain unaltered.

In summary, the residual impacts (after mitigation) of the Proposed Action include the inundation of 1.0 mile of Gooseberry Creek and 4.3 miles of unnamed tributaries. Flows in Gooseberry Creek below Narrows Reservoir, Fish Creek, and the Price River would be reduced as shown in table 3-2 of the FEIS. The flow in Cottonwood Creek below the confluence with Left Hand Fork would be increased during the nonrunoff portions of the irrigation season. Scofield Reservoir would operate at a lower level in most years; and reductions in storage releases to irrigators in the Price area would occur only after several successive years of drought but would average about 753 acre-feet per year. However, on the average, these reductions would be about 1,500 acre-feet less than those that would have occurred if Scofield Reservoir had not been enlarged to accommodate the Gooseberry Project (Narrows Project).

### 2.2.3 Salinity Gradients

Not applicable.

### 2.2.4 Actions to be Taken to Minimize the Impacts

A summary of the actions that will be taken to minimize impacts of the proposed project are listed below:

1. Contractor required to comply with applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution including development and implementation of
    a. A Water Quality Management Plan (Erosion Control Plan),
    b. A Storm Water Pollution Prevention Plan, and
    c. Best Management Practices (BMPs) for nonpoint source water pollution control.

2. Mitigation for potential decrease in overall DO level in Lower Gooseberry Reservoir by including additional storage in the Narrows Reservoir and requiring minimum streamflow releases as discussed in section 3.4 of the FEIS, “Fisheries.”
3. Mitigation for slight increase in in-lake phosphorus concentration in Scofield Reservoir by:
    a. stabilizing the Gooseberry Creek channel,
    b. Providing 300 acre-feet of water from Narrows Reservoir to augment winter flows into Lower Gooseberry Reservoir, and
    c. Making improvements for 9.5 miles of stream segments tributary to Scofield Reservoir to reduce external phosphorus loading.
4. Protection of water quality in the proposed Narrows Reservoir by establishing protection zones adjacent to the reservoir. Within these protection zones, land use practices would be restricted to eliminate activities that would impact reservoir water quality.
5. The Narrows Tunnel operating gate would be automated to regulate releases through the tunnel so that even during thunderstorms, the channel forming discharge would not increase above historical conditions.

## 2.3 SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

### 2.3.1 Expected Changes at Discharge Sites

Any potential temporary increases in suspended particulate and turbidity levels during construction and prior to permanent stabilization would be minimized through implementation of the Water Quality Management Plan, Storm Water Pollution Prevention Plan, and BMPs. After permanent stabilization measures are implemented, the Narrows reservoir is expected to act as a trap for sediments, having a beneficial effect upon downstream suspended particulates and turbidity.

### 2.3.2 Effects on Chemical and Physical Properties of the Water Column

The proposed project, along with the proposed mitigation measures, is not expected to significantly alter the chemical or physical properties of the water column. The project would not introduce new sources of toxic metals and organics, pathogens, or other parameters that would affect light penetration, dissolved oxygen levels, or aesthetics.

### 2.3.3 Effects on Biota

There are no anticipated measurable effects to important biota related to water quality changes attributable to the project.

### 2.3.4 Actions Taken to Minimize Impacts

The actions proposed to minimize impacts related to suspended particulates and turbidity are discussed above in section 2.2.4.

## 2.4 CONTAMINATION DETERMINATIONS

As discussed above, naturally-occurring fill materials proposed for this project will originate primarily within the Narrows Reservoir basin. These materials are located in an area that has not been affected by human activities that would result in contaminated soils. Discharge of the fill materials is proposed using BMPs to prevent the movement of fill materials from the

discharge site. Additionally, permanent stabilization of disturbed areas will prevent long term movement of discharged materials.

## 2.5 AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

### 2.5.1 Threatened and Endagered Species

No plant species currently receiving protection under the Endangered Species Act are known to exist in the project area.

A biological assessment of potential effects on endangered, threatened, and candidate wildlife and fish species was conducted for the Narrows Project. Federally listed or otherwise protected species addressed in the assessment included: bald eagle (*Haliaeetus luecocephalus*); Colorado pikeminnow, (*Ptychocheilus lucius*); bonytail chub (*Gila elegans*); humpback chub (*Gila cypha*); and razorback sucker (*Xyrauchen texanus*).

The U.S. Fish and Wildlife Service (Service) issued a final biological opinion on August 24, 2000, (Appendix C) that found that the proposed project would have no effect upon the bald eagle, which was subsequently delisted in 2007. The Service believes that the southwestern willow flycatcher (SWWF) found at the Fish Creek site is not the endangered subspecies; therefore, no discussion was offered specifically in reference to the SWWF. The Service concluded, however, that the project and associated depletion of water from the Colorado River system may affect the four endangered Colorado River fishes. While the opinion concluded that the proposed project may affect the four endangered fishes, it also stated that the project is not likely to jeopardize their continued existence, provided measures are implemented to offset project impacts (i.e., payment of a one-time financial contribution by SWCD).

### 2.5.2 Wildlife

The wildlife species found in the general project area are common in the Great Basin Desert valleys and Rocky Mountain Range. There are about 364 species of terrestrial vertebrates that may inhabit the project area. Approximately 88 bird species and 33 mammal species use the habitats that would be disturbed by the proposed project.

Table 3-1 of the FEIS summarizes the impacts to wildlife habitat that would result from construction of the Proposed Action. In an assumed worst-case situation where the most habitat would be lost at one time, it would take the reservoir 2 years to fill to capacity. The 1994 Fish and Wildlife Coordination Act Report evaluates the impacts of the proposed Narrows Project on fish and wildlife resources and recommends appropriate mitigation (see Appendix D).

A wildlife mitigation program has been designed to provide at least full mitigation for each impacted species. Because the wetland and upland wildlife mitigation measures are intended to provide full mitigation for project impacts, there would be no residual impacts.

### 2.5.3 Fisheries

Most of the Narrows Project alternatives have the potential to affect aquatic resources in Gooseberry Creek, Fish Creek, three unnamed headwater tributaries to Gooseberry Creek, Cottonwood Creek, Lower Gooseberry Reservoir, Fairview Lakes, and Scofield Reservoir (see the location map in the FEIS). Cottonwood Creek is in the San Pitch River Basin, whereas all of the others are in the Price River drainage. Cottonwood Creek flows into the San Pitch River

downstream from Fairview, Utah; but the San Pitch River, within the project area, does not support a sport fishery because of low summer flows.

Flows in Gooseberry Creek, its unnamed tributaries, and Cottonwood Creek presently are affected by the operation of Fairview Lakes, which store water during spring runoff. Water from the lakes is delivered during the irrigation season via one of the unnamed tributary streams and a canal to the Narrows Tunnel that discharges into Cottonwood Creek. The released water then is diverted for irrigation in Sanpete County.

Lower Gooseberry Creek and Fish Creek downstream from the confluence with Gooseberry Creek also are affected by the operation and limited regulation offered by Fairview Lakes. If the project is approved, an operating agreement would have to be negotiated between SWCD and Cottonwood-Gooseberry Irrigation Company (CGIC) to regulate seasonal releases from Fairview Lakes in connection with downstream discharges from the Narrows Reservoir.

Aquatic resources vary considerably between the different reservoirs and stream segments that could be affected by the Narrows Project. Fish habitat study reaches are shown in Figure 3-4 of the FEIS.

The State Engineer stipulates that a minimum of 1.0 cfs is to be released downstream from the proposed Narrows Dam; and, if the flow is not 1.5 cfs at the Gooseberry campground, SWCD is required to release 1.25 cfs from the dam. It also is stipulated that the dam be constructed with a multiple-level outlet to regulate water temperature for the trout located downstream from the dam.

The proposed project would cause flow reductions in Gooseberry and Fish Creeks as shown in Table 3-2 of the FEIS. Flows in Middle Gooseberry Creek immediately downstream from the proposed dam would be expected to be reduced on average by 74%, whereas flows downstream from Lower Gooseberry Reservoir would be expected to be reduced by 43%. In Fish Creek, flows would be expected to be reduced approximately 15%.

The 5,400-acre-feet diversion of project water into Cottonwood Creek would cause about a 200% increase in the base summer flow in Upper Cottonwood Creek (Table 3-2 of the FEIS). As shown, the base summer flows in Lower Cottonwood Creek would be increased by about 160%. However, the increased flows would occur only during the July-to-October period and not during the peak runoff or the low flow months (November–April). Additionally, these base summer flows would be less than the peak flows that currently shape the stream channel. Therefore, the stream channel itself would remain stable.

Providing a 2.0-cfs winter release through the Narrows Tunnel is expected to greatly increase the weighted usable area (WUA) for all fish species in Cottonwood Creek. This increased flow particularly would benefit the upper reaches of the creek and would be expected to facilitate the overwintering of fish.

The length of time required initially to fill Narrows Reservoir would, of course, depend on hydrologic conditions in the basin. During wet years, the reservoir could fill during a single spring runoff. For more normal conditions, if no diversions were made to Cottonwood Creek until the reservoir filled, it likely would fill in 2 years—almost certainly within 3 years. Under dry conditions, if diversions to Cottonwood Creek did occur during the filling period, it could take 5 to 15 years to fill Narrows Reservoir. Due to these hydrologic uncertainties, there is no firm filling schedule for the reservoir.

At maximum storage, the proposed Narrows Reservoir would inundate about 1 mile of Upper Gooseberry Creek and approximately 4.3 miles of the three headwater tributaries with permanent flows that join to form Gooseberry Creek.

Based on the stream habitat that would be inundated by the proposed reservoir, it is expected that 1.3 and 2.1 acres of streambased aquatic habitat would be lost in Gooseberry Creek and the tributaries, respectively. Using the standing crop estimates, approximately 230 pounds of stream-based cutthroat trout would be lost, of which 22% would occur in Gooseberry Creek and 78% would occur in the tributary streams, although the trout biomass likely would be converted into a flat-water equivalent.

The Utah Division of Wildlife Resources (UDWR) does not recognize the creation of a reservoir fishery as adequate compensation for the loss of stream aquatic resources. Creating an additional reservoir fishery would compensate for adverse effects that may occur on Lower Gooseberry Reservoir and Scofield Reservoir. This would represent a cumulative beneficial project impact to reservoir fishery.

In summary, the Proposed Action would result in loss of cutthroat trout stream habitat attributable to reservoir inundation and flow alteration. The project also would result in more reservoir habitat for cutthroat trout. The reservoir cutthroat trout habitat that would be created by the project would compensate for any adverse impacts that may occur on Gooseberry or Scofield Reservoirs. Therefore, mitigation for reservoir habitat has not been proposed.

A total of 11 fishery improvement and mitigation measures have been proposed by SWCD to compensate for the adverse aquatic impacts that have been identified with the proposed project. To the extent possible, an attempt was made to mitigate “in place” and “in kind.” These measures have been developed in coordination with various Federal and State agencies and were described in detail in chapter 2, section 2.2.2.2.1 of the FEIS. Table 3-11 of the FEIS is a summary of the aquatic impacts and proposed improvement and mitigation commitments for the Proposed Action.

The intent of the aquatic mitigation measures is to provide full mitigation for all adverse impacts resulting in no residual cumulative or overall impacts.

### 2.5.4 Wetland Resources

The wetlands affected by the project are not unique to the area. They consist of wetland plant communities common to high elevation mountain areas. Much of the area has been used for livestock grazing to the extent that rangeland restoration was necessary. In 1908, the USDA Forest Service established a controlled grazing plan for rangelands on the Manti-La Sal National Forest. Cattle and sheep grazing are still allowed in this area.

Major plant community types occurring in the reservoir basin have been mapped (see figure 3-8). The three major plant communities that would be affected most by reservoir inundation are:

1. Vasey sagebrush
2. Silver sagebrush
3. Riparian areas including wetlands

Within the proposed reservoir basin, water collects and forms wet meadows, riparian wetlands, and willow thickets. The wet meadows are located adjacent to streamside vegetation and on higher ridges where spring seeps occur. Vegetation consists of rushes (Juncus spp.), sedges (Carex spp.), and various hydric grasses, such as tufted hairgrass (Deschampsia casepitosa). Riparian wetlands occur in a dendritic pattern along small drainages within the basin. They consist of similar rush, sedge, and grass species and form narrow bands (usually 3–6 feet wide) of streamside vegetation. Less common in the reservoir basin are willow thickets. They occur primarily in the upper reaches of the proposed inundation area, usually along stream channels within the basin, and along Gooseberry and Cottonwood Creeks. Willow species include Drummond's willow (Salix drummondaiana), Booth willow (S. boothii), and Wolf willow (S. wolfii).

The proposed Narrows Reservoir would inundate 89 acres of wetlands.

Hydrologic and hydraulic studies were conducted to determine the potential impacts to the riparian and wetlands vegetation of Gooseberry Creek resulting from decreased flows. Flow measurements conducted by the Utah Division of Water Rights indicate that the stream is a "gaining stream." This means that the stream flow increases as it moves downstream because the stream is being fed by the adjacent ground water aquifer. Because the stream is serving as a drain for the ground water system, an increase or decrease in stream water level would result in a corresponding increase or decrease in the elevation of the ground water table adjacent to the stream.

Water surface profile studies were conducted to determine the depth of flow in Gooseberry Creek between the Narrows damsite and Lower Gooseberry Reservoir. The studies indicated that, with the reduced flows proposed by the Proposed Action and with the existing stream cross section, the depth of flow would decrease by 6 to 11 inches under worst case conditions. However, the project plan includes proposed modifications to this portion of the Gooseberry Creek channel. These modifications include narrowing the channel to maintain the depth of flow. In designing the stream channel modifications, the intent would be to create a stream channel that is more naturally suited to the new flow regime and that will have the same depth of flow as under baseline conditions. Therefore, the depth of ground water adjacent to the stream would not decrease, nor would there be any adverse effects on riparian and wetland vegetation adjacent to the stream. If anything, it is entirely possible that the wetland communities would be enlarged as a result of the project impacts; the current outer bounds of those communities likely would be unchanged as a result of the shallow ground water flowing toward the stream, but the wetlands likely would be increased precisely to the degree that the stream channel itself (or at least, the open water surface of the stream) narrows.

The process of narrowing the stream, as described in the FEIS, is planned so that the configuration of the narrowed streambanks would conform to that of the original streambank with respect to slope, materials, material size, and frequency as well as the water depth. The only change would be in the width of the channel and available open water surface. The result is that the same opportunity for overbank flows and wetted perimeter would exist as in the natural configuration. The gaining nature of the stream in this reach means that ground water is flowing toward and into the stream channel and that the stream does not provide the primary supply for the riparian community. The "wetted perimeter," therefore, should continue to be supplied from this source; and the stream will continue to gain as it flows. Bank saturation will not be affected here, as it would on many streams, because the direction of the ground water flows into the stream rather than away from it. While overbank flows may be reduced in frequency, such flows,

for this same reason, also are not critical to the bank saturation that supports the riparian community.

About 160 square feet (0.004 acre) of wetlands adjacent to Cottonwood Creek would be impacted by constructing the discharge structure at the end of the Upper Cottonwood Creek Pipeline. The remainder of the stream channel would not be affected. The channel presently is stable and adequately protected by natural cobble armoring.

Wetland mitigation measures are included in the project alternatives to mitigate for impacts to wetlands. The wetland mitigation measures would provide similar wildlife habitat values lost due to the inundation of the reservoir.

## 2.6 PROPOSED DISCHARGE SITE DETERMINATIONS

Placement of fill materials into waters of the United States would occur during construction of the Narrows damsite on Gooseberry Creek, during construction of the outlet structure from the pipeline on Cottonwood Creek, and during construction of the stream crossings for the East Bench Pipeline as described in Chapter 2 of the FEIS. Several alternatives were evaluated to determine whether they would meet the purpose and need of the project. The only practicable alternatives required discharge at each of the indicated sites. None of the other alternatives could meet the purpose and need of the project.

## 2.7 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

The following discussion addresses the cumulative impacts to area resources in the Upper Colorado River Basin. Any analysis of cumulative impacts must deal with the issue of scope, both in terms of spatial and temporal scales. In the following discussions, these scales will vary depending upon the resource under evaluation.

Since 1960, some 30 water resources projects have been built or are under construction by Reclamation in the Upper Colorado River Basin (Table 3-38 of the FEIS). Reclamation estimates that those projects have provided full irrigation service to 158,460 acres with supplemental service to another 204,870 acres. These developments account for an estimated 62,776,000 megawatt hours of generated power and some 431,100 acre-feet of M&I water supplied annually. Recreational use associated with these projects, including sightseeing, picnicking, camping, boating, fishing, hunting, and other activities, is estimated at 45,068,970 annual recreation days. In terms of average annual permanent employment opportunities, these projects are responsible for some 18,716 jobs.

Aside from providing a net increase of 41,900 annual recreation days, and providing 855 acre-feet of M&I water annually, the Narrows Project would not affect the above resources. No new acres of cropland would be irrigated; no new power would be generated; and no new permanent jobs would be created. Because there would be no net change in existing levels of these resources in the Upper Colorado River Basin, it is assumed that there would be no cumulative impact from the proposed project; and it has been determined that further analysis of cumulative impacts of the above described resources is not necessary.

Several resource issues have been affected by past Reclamation developments and would be affected by the proposed project; thus, they have the potential to contribute to cumulative (additive) impacts within the region and beyond. These issues involve stream depletions that can impact fisheries and endangered native fishes and changes in salt loading within the

Colorado River. These issues are treated in the FEIS under the headings of fisheries, threatened and endangered species, and water resources, use, and quality.

### 2.8 DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

Secondary impacts include reasonably foreseeable impacts that are caused by an action but do not occur until a later time or at a further distance. The FEIS considered secondary effects such as changes in land use, economic vitality, traffic, air quality and noise, water quality, public safety, and other resources. Secondary impacts were identified and evaluated as part of the EIS and mitigation measures were planned as necessary to result in no significant overall adverse effects on the aquatic ecosystem.

## 3.0 FINDINGS OF COMPLIANCE FOR THE NARROWS PROJECT

No significant adaptations of the guidelines were made relative to this evaluation.

Including the No Action Alternative, there were 17 alternatives evaluated in the EIS. It was determined that the No Action Alternative along with 13 of the other alternatives were not practicable because they do not meet the purpose and need for the project. The evaluation took into account cost, existing technology, and logistics in light of the overall project purposes. The only practicable alternatives included the Proposed Action, the Mid-Sized Reservoir, and the Small Reservoir alternatives. The only significant difference between these three alternatives was the size of the Narrows Reservoir and, consequently, the volume of water supplied for the purpose and need. The Proposed Action Alternative specified the largest reservoir. Because of this, the impacts of this alternative were slightly greater than the Mid-sized and Small reservoir alternatives. However, mitigation measures for the Proposed Action Alternative were increased to compensate for all impacts, effectively reducing the overall impact to zero. Also, with the Mid-sized and Small reservoir alternatives, the cost per acre-foot of water supplied was much greater than for the Proposed Action Alternative making them less practicable from a financial perspective.

Based on the project's compliance with the USACE 404 Permit and the State of Utah Stream Alteration Permit requirements, the proposed disposal of materials at the locations identified in the EIS would not violate any applicable State water quality standards.

Use of the selected disposal sites will not affect any federally listed threatened or endangered species or their critical habitat.

The proposed disposal will not result in significant adverse effects on human health and welfare, recreational fishing, plankton, fish, shellfish, wildlife or special aquatic sites provided the proposed mitigation measures and environmental improvements are incorporated into the project.

Appropriate steps were taken to minimize adverse effects during construction including development and implementation of a Water Quality Management Plan, Storm Water Pollution Prevention Plan, and Best Management Practices for minimization of suspended particulates and turbidity.

On the basis of the guidelines, the proposed disposal sites for the discharge of dredged or fill material is specified as complying with the requirements of CFR 40 Part 230 Section 404(b)(1)

with the inclusion of appropriate and practicable discharge conditions to minimize pollution or adverse effects to the affected aquatic ecosystems.