# TETON DAM REAPPRAISAL

# WORKING DOCUMENT

Bureau of Reclamation
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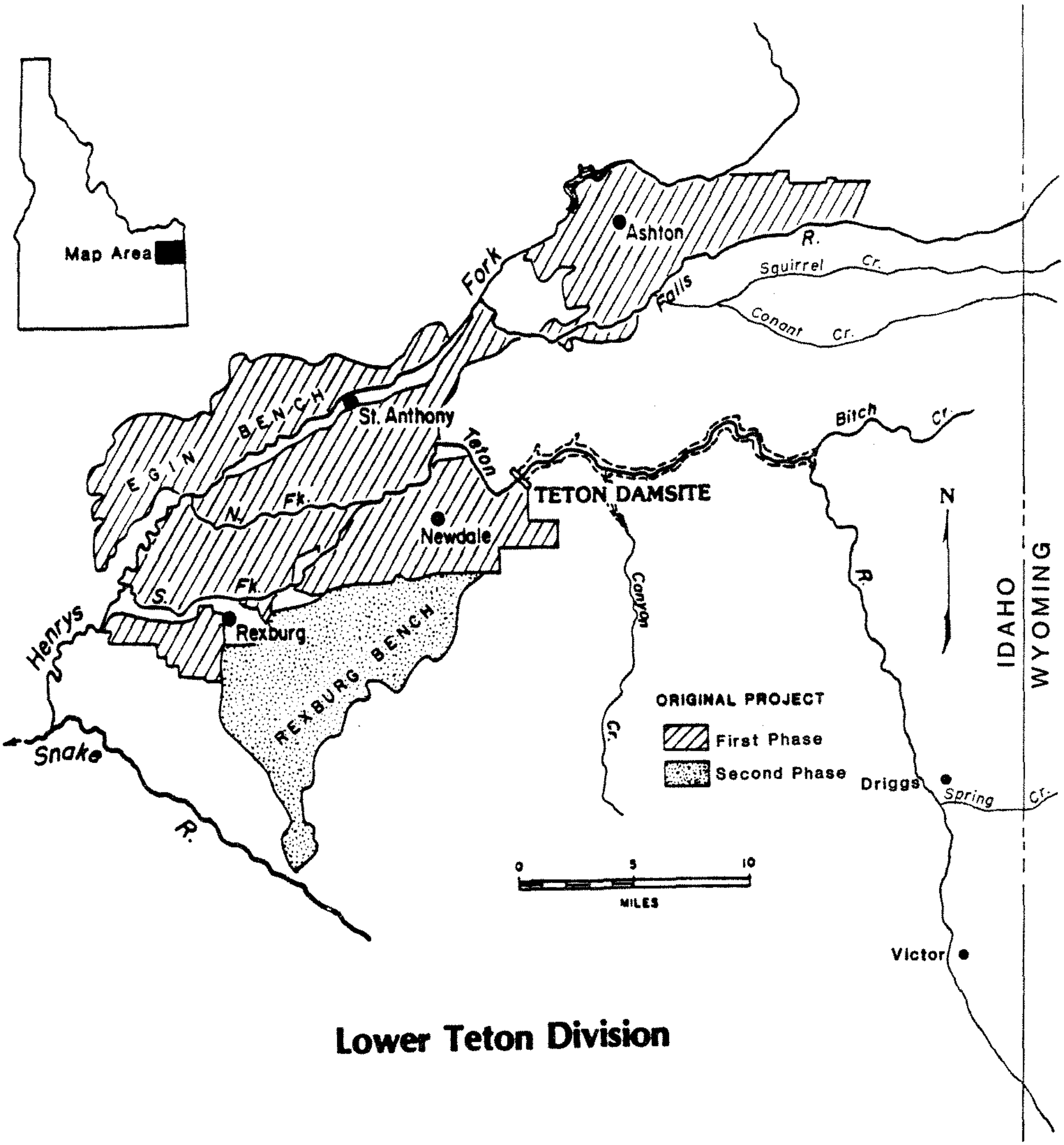
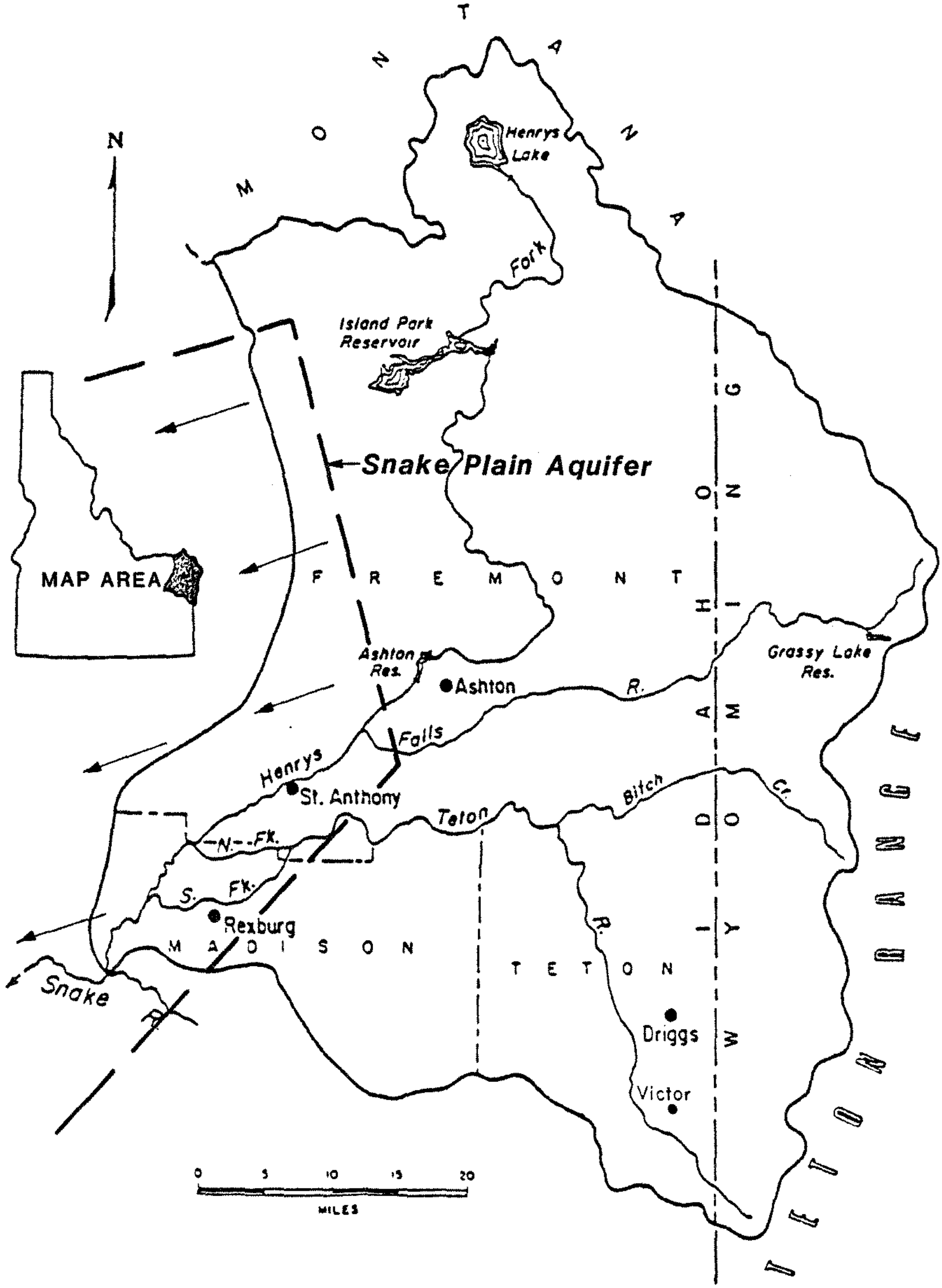



**Lower Teton Division**




Henrys Fork Basin

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# Acronyms and Abbreviations

| | |
|---|---|
| BLM | Bureau of Land Management |
| BPA | Bonneville Power Administration |
| cfs | cubic feet per second |
| FMID | Fremont-Madison Irrigation District |
| FWS | U.S. Fish and Wildlife Service |
| IDC | interest during construction |
| IDFG | Idaho Department of Fish and Game |
| kWh | kilowatt-hour |
| OM&R | Operation maintenance, and replacement |
| SCORP | Statewide Comprehensive Outdoor Recreation Plan |

## SUMMARY

This report presents the findings of an appraisal-level evaluation of reconstruction of Teton Dam. A reappraisal of Teton Dam reconstruction was requested by the State of Idaho Legislature, and Congress included the reappraisal study in the Bureau of Reclamation's program. The primary emphasis of this evaluation is to provide an indication of potential project accomplishment, development costs, and financial obligations for the Teton Project development as authorized.

Engineering, economic, and environmental information from prior project evaluations was updated as part of the reappraisal. Project purposes included in the original Teton Project authorization were all considered in the reappraisal. These purposes include irrigation, flood control, power, recreation, and fish and wildlife.

The reappraisal is preliminary in scope. If further consideration is given to Teton Dam reconstruction, detailed investigation in several categories would be required. The major issues and additional study needs for a detailed study have been identified as part of the reappraisal

### Development Considerations

#### Irrigation

Analysis of actual irrigation diversions for recent years indicates that the 135,000-acre Fremont-Madison Irrigation District (FMID) does not have a sufficient water supply during below normal water years. The extent of district shortages varies with individual canal companies that make up the FMID. A major factor is the seniority of natural flow rights held by each canal company. About half of the district lands experience shortages during drought periods; shortages vary from 20 to 80 percent for individual canal companies.

The average annual supplemental irrigation need for the FMID is estimated at 20,000 acre-feet, but the need in individual years when supplemental water is required varies from 3,000 acre-feet to about 122,000 acre-feet.[1] This level reflects the quantity of water needed to achieve the 1988 supply which was 87 percent of FMID diversions in years of excellent water supplies. At this level of water supply, some entities would receive less than an acceptable supply in short water years.

#### Fish and Wildlife

Before construction of Teton Dam, the full length of the Teton River provided an excellent and popular fishery and upland game habitat for various kinds of wildlife as well as a rather limited big game wintering area. Alternative habitat for big game was included in the original Teton Dam development plan and much of that work has been implemented.

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[1]This estimate is based on the amount of water purchased in 1988 by the FMID from District 01 waterbank and related resources as correlated to other water years of the historical period. This amount would be replaced by the Teton Project.

Most of the resident fishery mitigation measures were dependent on a water supply to be provided from storage in Teton reservoir. Other fishery mitigation measures included fish screening facilities on all new canals diversions and funding of hatchery facilities to rear trout and kokanee salmon for release into the reservoir and river below the dam. Measures dependent on completion of the dam and other facilities were not implemented.

The present recommendation for mitigation of resident fish with reconstruction of Teton Dam includes maintenance of a year-round streamflow below the dam at 450 cubic feet per second. This level of flow would require an average annual release from storage of 41,000 acre-feet each year.

There is now a need for additional winter flows in the Henrys Fork below Island Park Dam to maintain an open flowing river for trumpeter swans that winter in the area. A flow of 300 cubic feet per second from December through March has been suggested as adequate. The average annual release from storage needed for this purpose is estimated at 24,000 acre-feet.

### Recreation

High priority recreational needs identified for the Teton Dam project area are campgrounds, picnic areas, and boating opportunities. About 10 to 15 percent of the needs of the area could be served through development of recreation facilities with reconstruction of Teton Dam.

### Flood Control

Teton Dam would be designed to provide full control of floods up to the estimated 200-year frequency level. There would be no flood reduction benefits realized for larger flood occurrences.

### Power

Bonneville Power Administration is the marketing agency of Federally produced electrical energy in the Pacific Northwest. In southern Idaho, the energy demand for Federal power in fiscal year 1990 was about four times the amount produced by Federal plants in the area. Federal power needs in excess of available production must be imported from other Federal powerplants in the Pacific Northwest. Rehabilitation and replacement of some Federal plants in southern Idaho will partially alleviate this situation; the ratio of demand to marketable production will decline to about 3 to 1. Generation from a Teton powerplant would add about 80 million kilowatt-hours annually and decrease the ratio of demand to marketable production to about 2.7 to 1.

## Reconstruction

The analysis for reconstruction of Teton Dam focused on the functions that were included in the original authorization. These functions were aimed primarily at local needs and included irrigation water supply, hydropower, flood control, and recreation. In this analysis, instream flow improvement to enhance trumpeter swans (migratory wildfowl) was added.

Reclamation recognizes that there are regional water needs under discussion at present. Primary among these is additional flow release to the lower Snake River for downstream salmon migration (water budget flows for anadromous fish). Hydroelectric power generation is another regional concern. Operation studies focusing on these functions rather than local needs were not conducted, however some observations are possible.

Under a scenario emphasizing an anadromous fish flow function, the average annual amount of storage yield available could be about 44,000 acre-feet after meeting resident fish mitigation needs. This water would be used to supplement Snake River flows below Brownlee Reservoir during April, May, and June for fish migration purposes. During good water years it is unlikely that the entire volume of 44,000 acre-feet could be released within this timeframe without causing some flooding downstream to American Falls Reservoir.

A scenario with emphasis on hydroelectric power production is unlikely to produce significantly more power than the average annual generation of 80 million kilowatt-hours estimated for the supplemental irrigation scenario. This is due to the fact that the peak demand period for Federal generation in the southern Idaho area coincides with seasonal releases for irrigation purposes.

Project Features

It was assumed that with reconstruction project features would be similar to those included in phase 1 development proposed in the 1964 Congressional authorization of the Lower Teton Division (Public Law 88-583); Teton Dam and reservoir would be key features. The reservoir would have a total capacity of 288,000 acre-feet of which 200,000 acre-feet would be active capacity available for project functions. Facilities include (1) the dam, spillway, and reservoir, (2) irrigation pump and canal facilities, (3) power generation, switchyard, power substations, and transmission line facilities, (4) fish and wildlife mitigation facilities, lands, and improvements, and (5) recreation lands and facilities. The deep wells and pumping facilities in the original authorization were not included in this analysis.

Two construction options were evaluated: (1) a rockfill embankment dam, and (2) a roller compacted concrete dam. Both designs would accommodate the probable maximum flood and incorporate most of the remaining dam structure including the existing spillway; a new auxiliary spillway is also include in each option. For the embankment option, the auxiliary spillway would be located through a low area in the reservoir rim approximately 8,500 feet northeast of the existing spillway. Discharge would be into an existing stream tributary that enters the Teton River about 4 miles downstream of the damsite. The concrete dam option would contain an auxiliary spillway on the dam.

Irrigation features would include canal outlet works and feeder pipeline at the dam and a gravity and pump canal to convey a supplemental water supply to existing irrigated lands. Hydroelectric power facilities include a powerplant consisting of two 10,000 kilowatt generators (with space for a third 10,000 kilowatt unit) and a switchyard; These facilities would be reconstructed at the same locations and to the same criteria as the original structures.

Recreation features would include an optimum development of 200 picnic units, 400 camp sites, and 6 boat ramps. The recreational development would include landscaping and improvements on approximately 300 acres.

Accomplishment

An evaluation of potential accomplishments indicates that the needs for a supplemental irrigation water supply, trumpeter swan flows, and resident fish flows to satisfy project mitigation requirements could be met. However, there would be an insufficient water supply after meeting these needs for other uses such as new irrigation and flows to aid the outmigration of salmon and steelhead trout smolts in the Snake-Columbia River system.

Costs

Project investment would be $215.4 million for the rockfill embankment option and $339.8 million for the concrete dam option. Annual operation, maintenance and replacement is estimated at $464,000. Investment and annual operating costs are summarized in table A.

Table A.--Investment and Operating Costs

| Item | Rockfill Embankment Dam | Concrete Roller Compacted Dam |
|---|---|---|
| Construction cost | $167,900,000 | $264,900,000 |
| Interest during construction | $ 47,500,000 | $ 74,900,000 |
| Total investment | $215,400,000 | $339,800,000 |
| Annual operation, maintenance, replacement, and power | $464,000 | $464,000 |

Cost Effectiveness

A cost-benefit ratio was not estimated for this analysis. During the period since Teton Dam failed there have been significant changes in Reclamation's criteria for estimating irrigation benefits and significant changes in development of the flood plain below the dam that would have a large impact on flood control benefits. Detailed analysis would require a decision on irrigation benefit criteria and a detailed inventory of existing development in the flood plain. A reasonable indication of cost effectiveness is the cost per acre-foot of water.

Although the reservoir would have an active capacity of 200,000 acre-feet, the average annual water supplied by the project would be considerably less; 41,000 acre-feet to mitigate the resident fishery, 24,000 acre-feet to enhance trumpeter swans, and 20,000 acre-feet supplemental irrigation water supply. The investment cost per acre-foot of project water supply would be $2,500 with the embankment option and about $4,000 with the concrete dam option.

If the investment were amortized over a 50-year period at the current applicable interest rate of 8-7/8 percent, the annual cost per acre-foot of project water supply would be $230 for a rockfill embankment option and $360 for a concrete dam option. Annual operating costs would add about $5.50 per acre-foot of yield.

## Cost Allocation

An allocation of costs to project beneficiaries is a first step in estimating repayment obligation. Table B shows the costs allocated to: (1) irrigation, (2) power, (3) flood control, (4) trumpeter swan flows, and (5) recreation.

## Repayment

Some repayment requirements and cost-sharing policies have changed since Teton Dam was authorized. It is unclear at this time whether reconstruction would require reauthorization. The appropriate repayment criteria would have to be established through reauthorization or some other process. The discussion in this section uses current criteria; the major change from earlier criteria is that a portion of recreation costs are now reimbursable. Costs allocated to flood control and trumpeter swan (migratory water fowl) flows are considered non-reimbursable under current Reclamation regulations and policy.

Table B.--Cost Allocation

| Function | Embankment Dam | | Concrete Dam | |
|---|---|---|---|---|
| | Investment | Annual Costs | Investment | Annual Costs |
| | 1,000 dollars | | | |
| Irrigation | 66,700 | 53 | 95,000 | 53 |
| Power | 44,300 | 263 | 55,100 | 263 |
| Flood control | 62,600 | 74 | 114,100 | 74 |
| Swan flows | 35,500 | 34 | 64,800 | 34 |
| Recreation | 6,300 | 40 | 10,800 | 40 |
| Total | 215,400 | 464 | 339,800 | 464 |

Construction costs allocated to irrigation that is Federally funded are reimbursable without interest and the repayment period may be up to 50 years. Assuming a 50 year repayment period, the average annual supplemental water supply of 20,000 acre-feet would cost $52 per acre-foot with an embankment dam and $74 per acre-foot with a concrete dam. Annual operating costs would add about $3 per acre-foot. Repayment on irrigation is based on the user ability to repay with the remaining costs paid by non-Federal interests.

Costs allocated to power are repaid with interest over a 50-year period plus annual operating cost. Assuming the current applicable interest rate of 8 7/8 percent, the power rate necessary to recover the allocated investment cost and annual operating costs would be about 53 mills per kilowatt-hour with the embankment dam and about 65 mills per kilowatt-hour with the concrete dam.

A portion of the costs allocated to recreation are reimbursable and repayment must be assumed by a non-Federal entity. The annual repayment over a 50-year period plus the operating costs would total about $85,600.

## Further Investigation Requirements

Any future investigation must address several pertinent issues in detail. Some of these are:

- Additional hydrologic data are required to test the permeability of the reservoir area. The hydrologic study performed for the original dam should be updated to include all inflow-outflow records obtained during the filling of the reservoir.

- Records from the initial filling of the reservoir should be examined to determine if the original projections on water loss and bank storage can be supported.

- Further study is needed to adequately define the effects of fissures in the right abutment on anticipated seepage and bank storage. There is no question that these fissures increase the permeability of the abutments and serve as significant feeders to smaller joint conduits.

- Additional geologic investigation for the auxiliary spillway in the embankment dam option will be required to determine the extent of foundation grouting required to prevent seepage past the crest structure.

- A state-of-the-art seismotectonic study should be implemented for the final design data collection.

- New topographic maps will be needed to refine all excavation and dam quantities.

- Further onsite investigations will be necessary to confirm or correct the assumptions made in the appraisal studies concerning the present condition of all structures.

- The adequacy of the existing outlet works structures with respect to evacuation rates should be reevaluated using current criteria and guidelines.

- The inflow design flood approved for use in the original design of the Teton dam is not compatible with present design criteria. Prior to any final design work for a new Teton Dam a new probable maximum flood study should be done. The new study would include changes in meteorologic criteria, development of more detailed information on soils and loss rate, and development of a reservoir operation curve.

- An excavation contract should be considered as part of final design data collection.

- Prepare final design for the dam.

In addition, review and detailed analyses of the following would be needed:

- Water requirements for project functions.
- Water quality of donwstream releases.
- The relationship of the ground-water system to the Teton River.
- Environmental effects of construction and operation and the mitigation measures needed.
- Determination of the economic and financial criteria applicable to the project.
- Significance of cultural resources; conduct data recover excavations if required.

# INTRODUCTION

This report presents the findings of an appraisal-level evaluation of reconstructing Teton Dam on the Teton River in southeastern Idaho. The evaluation is based primarily on existing data; the collection of new data has been minimal. Information was available from project reviews conducted during the period 1981-1983. This information was updated where appropriate and construction and annual operating costs were indexed to January 1990 price levels. The Fremont-Madison Irrigation District, Idaho Water Resources Department, U.S. Fish and Wildlife Service, Corps of Engineers, and University of Idaho Extension Service provided information for use in the evaluation.

# BACKGROUND

## Initial Construction and Failure

In 1964, Congress authorized the construction of the Lower Teton Division of the Teton Basin Project, with Teton Dam and Reservoir as key features (Public Law 88-583). Project purposes included irrigation, power, recreation, fish and wildlife, and flood control.

Construction of the dam was nearly completed at a cost of more than $70 million and the reservoir had almost filled when Teton Dam failed on June 5, 1976. Subsequently, Congress provided more than $320 million to claimants for compensation of damages caused by the failure.

The project authorization was supported by House Document 208, 88th Congress, 2d Session, which includes the Bureau of Reclamation's Special Report of March 1962 and Reevaluation Statement of February 1963. The Lower Teton Division was to be developed in two phases. The first phase included Teton Dam, Reservoir, and Power and Pumping Plant; ground-water exchange wells; and other features. Ground-water wells were an essential part of the project to assure a firm water supply in dry years; ground-water pumping was estimated to be up to 400 cubic feet per second (cfs) in dry years and would take place in the project service area. The first phase would provide supplemental irrigation water supplies for about 110,000 acres in the Fremont-Madison Irrigation District (FMID), hydropower generation, flood control, measures for recreation, and fish and wildlife mitigation.

All of the studies on the first phase were brought to feasibility grade in the definite plan report of February 1969. The final environmental statement was filed in July 1971, and construction began in 1972.

Teton Dam impounded a reservoir with a total storage capacity of 288,250 acre-feet of which 200,000 acre-feet was active joint-use capacity for irrigation, flood control, recreation, and power. The 88,250 acre-feet of inactive storage was to allow service to Fremont Gravity Canal, reduce the lift for the Teton Pumping Plant, and maintain a minimum head for Teton Powerplant.

The second phase was defined as the irrigation of 37,000 acres of dryland on Rexburg Bench. The water supply was to be based on the use of about half of the active storage capacity of Teton Reservoir plus a number of wells to be developed for an exchange water supply in dry years. The authorizing legislation stipulated that construction of facilities solely to provide water to lands in the Rexburg Bench area was not to commence until a finding of feasibility on the second phase had been provided to Congress.

In the interim between project authorization and initiation of the first phase construction, much of the dryland of the Rexburg Bench was brought under irrigation through privately developed wells. Consequently, as a part of its Second Phase investigations, Reclamation studied the possibility of constructing Federal facilities to serve other lands in the Rexburg Bench vicinity, but an economically justified plan could not be developed. Private irrigators then proposed contracting for Teton Reservoir storage to irrigate some 40,000 acres of lands adjacent to and upstream from the reservoir. Analysis of those irrigation proposals was in progress when Teton Dam failed.

## State Legislative Memorial

The FMID and others have for several years expressed interest in reconstructing Teton Dam. It has been Reclamation's position that public sensitivities over the 1976 dam failure required that any consideration of reconstruction should be at the direction of Congress.

In March 1989, the Idaho State Legislature memorialized (HJM 7) the Congress asking for the authorization and appropriation of funds to the Bureau of Reclamation to evaluate the feasibility of reconstructing Teton Dam. Congress included funds in Reclamation's fiscal year 1990 program for an appraisal-level evaluation.

## Status of Reservoir Site Lands

About 6,090 acres of private lands were acquired in fee title and 78 acres in easements for the Teton Reservoir site. Since dam failure, some of these lands have been leased for agriculture and others are being managed for wildlife. Agriculture leases cover one calendar year and may be renewed for an additional 4 years. The leases can be terminated after one year by written notification.

In addition, 3,471 acres of State of Idaho owned lands within the reservoir site were exchanged for Federal lands through the Bureau of Land Management (BLM). Reclamation did not complete a withdrawal on the exchange lands and now administers the lands for wildlife purposes under an agreement with BLM.

For wildlife mitigation purposes, Reclamation acquired 9,113 acres of private lands for development of the Tex Creek Wildlife Mitigation Area and submitted a withdrawal application to the Bureau of Land Management in 1975 for an additional 9,606 acres of public lands. The withdrawal application was terminated and replaced by a 1981 cooperative agreement among BLM, State of Idaho, and Reclamation. All of these lands are now managed as the Tex Creek Wildlife Mitigation Area. Reclamation also acquired 468 acres of private lands in fee title at Cartier Slough. Both of these areas are being managed for wildlife purposes by the Idaho Department of Fish and Game.

## Status of Reservoir Water Permits

The United States, in 1960, filed for a water right for storage of 315,000 acre-feet at the Teton site for irrigation, flood control, and power (Permit R-1072/22-2290). In June 1986, the State extended the time period to July 1, 1991 for Reclamation to submit proof of beneficial use of the Teton water right.

## Status of Project Wells

In addition to reservoir water rights, Reclamation filed for ground-water rights for project purposes. License 22-7062 was issued in 1973 for a water right of 0.1 cfs for domestic use at one well. The major ground-water right (Permit 22-7022) is 670 cfs (45 wells total) for irrigation purposes. The time period for submitting proof of beneficial use for these rights has been extended to July 1, 1991.

Five project wells were drilled and developed by Reclamation. They have been leased by the FMID and used periodically since 1976.

# FUNCTIONAL CONSIDERATIONS

This section provides background information and reviews present issues related to the five authorized functions of the Lower Teton Division.

## Irrigation

### Early Irrigation Water Use

Irrigation was first developed in the Henrys Fork and Teton River areas in the late 1800's and was the first commercial diversion of the water resource. Irrigation continues to dominate water resource use.

The first water right recorded on the Teton River is dated June 1, 1879; there were 22 water rights on the Teton River prior to the first right on the Henrys Fork on April 25, 1885. Water rights obtained on the Teton River and Henrys Fork River through early 1888 were for small quantities of water on lands adjacent to the streams. The first large water right on the Henrys Fork was for 600 cfs by the St. Anthony Union Canal Company, on June 21, 1888.

By the early 1890's most of the water rights in the lower Teton basin that could be met in all years were established, and by 1900 the streams of the Snake River system were over-appropriated. An adjudication was made in 1910.

Over-appropriation of natural flows coupled with the existence of large but unusable spring flows led to the development of storage reservoirs. The Henrys Lake storage facility was privately constructed in 1922. The Federal Henrys Fork subbasin storage, which includes Island Park and Grassy Lake Dams, was authorized by a finding of feasibility by the Secretary of the Interior, and approved by the President on September 20, 1935. Reclamation completed construction of Island Park Dam in 1938 and Grassy Lake Dam in 1939.

Recently, an examination of the Snake River watermaster's regulation schedules for Water District 01 showed that in about 50 percent of the years only those natural flow rights dated 1896 or earlier were permitted to divert water in mid-July. By mid-August, 1896 water rights are permitted to divert in only 30 percent of the years. In years of below average runoff, rights dated several years earlier than 1896 are generally cutoff in July and August.

Fremont-Madison Irrigation District

The Fremont-Madison Irrigation District (FMID) was formed in 1936 for irrigation contracting and operating purposes. The 7 canal and ditch companies that own space in Henrys Lake were incorporated into the FMID. FMID contracts for all of the storage in Island Park Reservoir and in Grassy Lake.

The FMID provides administrative assistance to 40 independently organized canal and ditch companies. Operation and maintenance of facilities is accomplished by the individual entities. Operation and maintenance of jointly used conveyance facilities are done under contract administered by the district. Reclamation operates and maintains the Federally constructed reservoirs and bills FMID for the costs. The owners of the Henrys Lake storage operate and maintain the facility.

Pre-1970 Irrigation Development

After the turn of the century, irrigation in the Henrys Fork subbasin expanded rapidly for a period of time. In 1920, there were 185,000 acres irrigated in Fremont and Madison Counties, and the demand for irrigation water exceeded the supply. Fair and equitable distribution of available water became an explosive issue during times of heavy demand and limited supply. The solution to the difficulties was worked out by the Committee of Nine, a group formed in 1923 to represent the water users of Snake River system.

The majority of the storage and conveyance facilities in the subbasin were constructed in the late 1930's, but by then the irrigated acreage in the Fremont and Madison Counties had declined to about 146,000 acres due to drought and the national depression. About 120,000 acres were irrigated by diversions from Falls River, Henrys Fork, and the lower reach of the Teton River (generally within the FMID). (About 111,200 acres of this area were to be served a supplemental water supply from Teton reservoir.) Between 1940 and 1970 the irrigated acreage within the two counties increased to about 160,000 acres.

Post-1970 Irrigation Development

Irrigated acreage in the upper Snake River expanded in the 1970's and through the early 1980's as a result of ground-water development and direct pumping from the Teton River. At present, all of the Rexburg Bench area initially scheduled for second phase development of the Lower Teton Division is irrigated by wells. Significant portions of land along the Teton River that are suitable for irrigation have been developed by pumping directly from the Teton River or from wells. Junior water rights (dating after 1970) for diversions from the Teton River include a provision that allows continued diversion when there is an inadequate water supply to satisfy those rights if the diverter replaces the surface water supply through groundwater pumping directly to the river. Total irrigated acreage in the two counties in 1982 was 220,000 acres, an increase of 60,000 acres from 1970. About 135,000 acres are within the FMID.

There remains a significant acreage that appears to be suitable for irrigation development along the Teton River, Squirrel Creek, and Conant Creek.

Changing Irrigation Practices and Conditions

Irrigation practices in the FMID are changing. Many water users have switched from early gravity and subirrigation methods to sprinkler application. Center pivot sprinklers are being used more frequently on farms growing potatoes. Use of hand-move sprinkler lines and wheel-move systems has increased in areas where less intensive crops such as hay and grain predominate. This trend toward sprinkler application has accelerated in the last 5 years in some portions of the FMID.

Twenty-five years ago, nearly all of the of irrigated land on the Egin Bench (about 25,000 acres) were subirrigated. Soil in this area is relatively sandy with limited water holding capacity. Due to the ease of working the soil and its suitability for producing potatoes, a major shift has been made to sprinkler irrigation systems in this area. In 1990, only 7,000 acres or 28 percent of the irrigated area was continuing to be subirrigated. A major part of the shift to sprinkler irrigation has been within the past 3 to 5 years. The ground-water table, however, is generally being maintained to accommodate those who still subirrigate and to provide a buffer to avoid stress of all crops within the area during peak water demand periods.

Fremont-Madison Irrigation District Water Rights

The water rights held by FMID patrons consist of individual natural flow rights and storage rights. The first right on Teton River is dated June 1, 1879 and is for 1.7 cfs. This is the second right in Upper Snake River Water District 01, the first being on Moody Creek, March 15, 1879, a tributary to the South Fork of the Teton River.

The St. Anthony Union Canal Company right in 1888 marked the development of canals to serve large areas of lands that might be considerable distance from the river. Prior to this time, diversions were small and for lands adjacent to the streams.

The priority dates of natural flow rights on the Henrys Fork system range from 1879 to 1979 and constitute about 18 percent of total natural flow rights of the upper Snake River system. Of the 18 percent, almost 60 percent have a priority date of 1896 or earlier. The natural flow rights on the Henrys Fork and its tributaries, exclusive of the storage rights, total 7,031 cfs. Of this amount 2,210 cfs is on the Teton River.

Existing storage reservoirs in the upper Snake River system, including those in the Henrys Fork subbasin, and their respective storage rights and priority dates are shown in table 1.

Table 1.--Upper Snake River Storage Rights[1]

| Reservoir | Storage Right (acre-feet) | Date |
|---|---|---|
| Jackson Lake | 299,000 | Aug 23, 1906 |
| Jackson Lake | 138,800 | Aug 18, 1910 |
| Jackson Lake | 409,200 | May 24, 1913 |
| Total Jackson Lake | 847,000 | |
| Lake Walcott | 95,200 | Dec 14, 1909 |
| Henrys Lake | 79,350 | May 15, 1917 |
| Henrys Lake | 10,650 | Jul 29, 1965 |
| Total Henrys Lake | 90,000 | |
| American Falls | 159,400 | Mar 29, 1921 |
| American Falls | 1,700 | Mar 30, 1921 |
| American Falls | 1,538,900 | Mar 31, 1921 |
| Total American Falls | 1,700,000 | |
| Island Park | 45,000 | Mar 29, 1921 |
| Island Park | 90,000 | Mar 14, 1935 |
| Total Island Park | 135,000 | |
| Grassy Lake | 15,200 | Feb 13, 1936 |
| Palisades | 259,600 | Mar 29, 1921 |
| Palisades | 940,400 | Jul 28, 1939 |
| Total Palisades | 1,200,000 | |

[1]Claimed under present adjudication process

Figure 1 is a schematic used for water right accounting purposes in the upper Snake River system.

All of the storage in Island Park Reservoir and in Grassy Lake is owned by the FMID. Storage in Henrys Lake is owned exclusively by seven irrigation entities within the FMID. These three storage facilities hold about 6 percent of the upper Snake River storage right. Both Grassy Lake and Henrys Lake have difficulty filling because of their junior water right status and the relatively small drainages above these reservoirs.

Adequacy of Irrigation Water Supply

Reclamation investigations that were completed in the 1960's prior to construction and failure of Teton Dam and a 1981 review of resources and needs of the Teton Project area indicate a need for supplemental water for

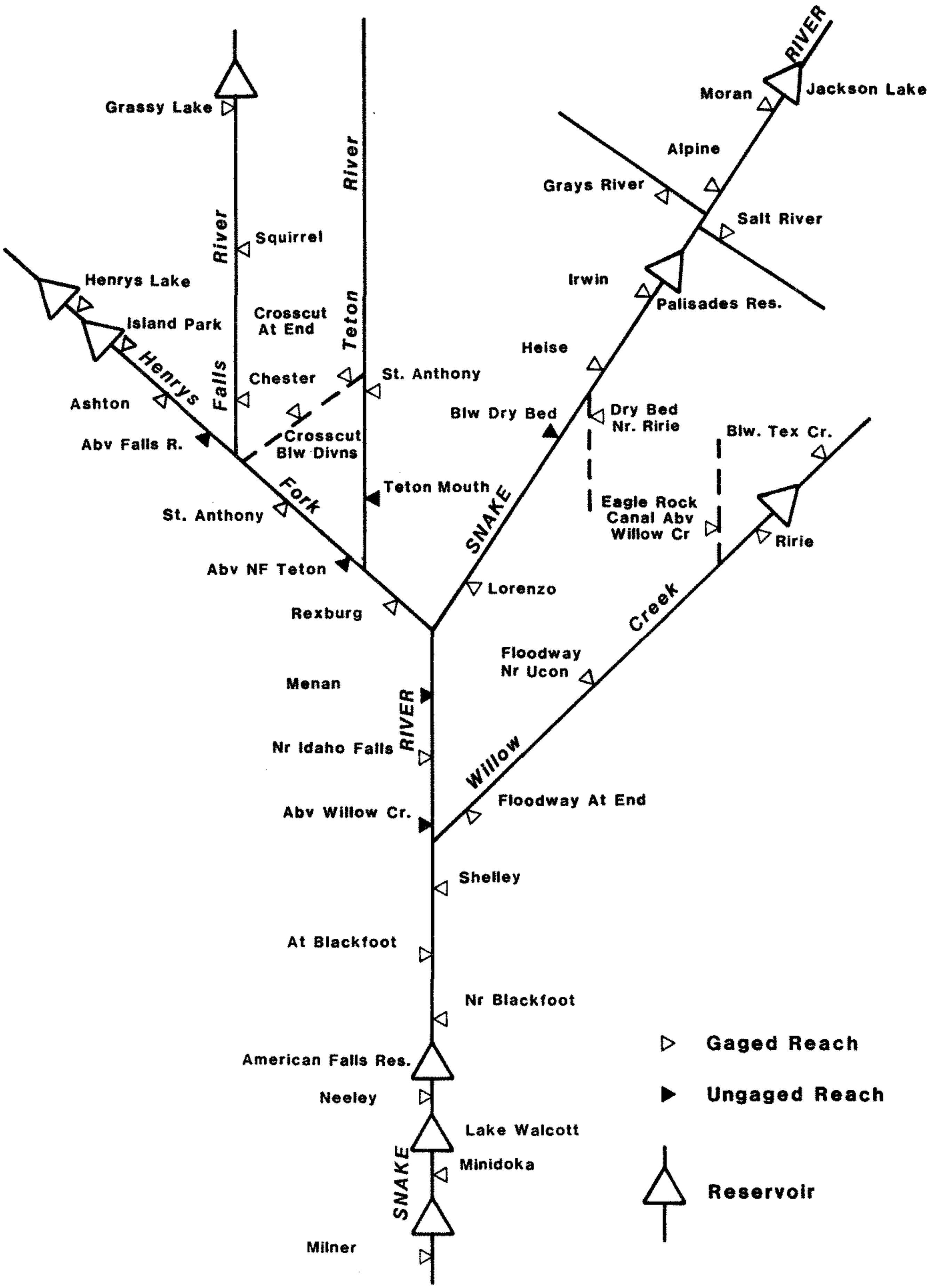


FIGURE 1. Upper Snake System for Water Right Accounting

irrigation during water-short years. More efficient application of irrigation water, additional ground-water development, and direct pumping from the Teton River appear to have decreased the need created by increased irrigated acreage within the FMID and part of the supplemental irrigation need that existed before Teton Dam was constructed. Discussions with the FMID staff, board of directors, and individual irrigators indicate that shortages still occur during years of low precipitation.

During years of low runoff, the natural flow and Henrys Fork storage rights held by FMID entities do not adequately supply the normal diversion needs of many of these entities. In these years, all or most of this deficiency could theoretically be supplied from ground-water pumping, District 01 waterbank rentals, and any water accumulated in unassigned storage space held by the FMID. The irrigators view irrigation water obtained from the waterbank and related sources during low runoff years as an unreliable supplemental water source and would prefer an assured water supply from Teton storage to which a water right would be ascribed.

Operation studies have been completed using a computer model of the upper Snake River System. The model simulates river flows which would occur during a recurrence of the historic water supply conditions for the period 1928-1983 with the present level of irrigation and storage development in place. These operation studies suggest that there is sufficient water within the upper Snake River system to meet water needs of the basin, including irrigation needs of the FMID in most years; minor shortages would occur during major droughts. The water supply identified in the operation studies includes natural flow rights, storage rights, and water from District 01 waterbank and related sources.

Reclamation traditionally plans water supply projects which limit irrigation shortages to a maximum of (1) 50 percent of a full water supply in a single year and (2) a 10 percent average shortage in any 10 consecutive years. This is considered an adequate irrigation water supply.

The operation studies assume that water exchanges could be made when and where needed to meet the demands. The studies indicates that FMID should be capable of obtaining an adequate water supply. The irrigation diversions of some FMID entities during drought years have been below the average diversions experienced during excellent water supply years. It appears that hydraulic constraints of irrigation conveyance and distribution facilities, location constraints of some district lands, and real or perceived institutional constraints have reduced the effectiveness of the waterbank and related resource options available to the FMID.

During low water supply years, diversion capability is physically limited. The canal systems are not capable of delivering water to some lands at low diversion rates. Low storage supplies make exchanges operationally difficult and environmentally undesirable. Institutionally there is a reluctance to bear the cost or to rely on the uncertain nature of a water supply from the waterbank.

These factors have apparently constrained the effectiveness of acquiring the supplemental water supply via the system exchange process of the waterbank. Some irrigation entities within FMID have voluntarily elected or been forced to reduce their diversions during years of low runoff. Diversion records from years of below normal runoff show that some canal companies within the FMID may experience shortages that exceed the criteria defined by Reclamation as acceptable for traditional planning studies.

A comparison of FMID diversions in years of excellent water supplies with diversions in years of below average runoff provides an indication of the portion of the supplemental need that is not physically being met by water from District 01 waterbank and related water sources. Table 2 shows the average diversions for 1983, 1984 and 1986 for those systems that experienced significant shortages in 1977 and 1988 and the proportionate amount of water diverted in the two drought years.

Table 2.--Selected FMID Diversions

| Diversion Entity | Diversions | | |
|---|---|---|---|
| | Full Supply[1] | 1977[2] | 1988 |
| | (acre-feet) | (percent of full supply) | |
| Chester | 22,100 | 22 | 38 |
| Curr | 15,700 | 63 | 77 |
| Marysville | 28,200 | 86 | 87 |
| Farmers Own | 17,100 | 68 | 88 |
| Squirrel Creek | 2,300 | 47 | 75 |
| Canyon Creek | 6,200 | 26 | 65 |
| City of Rexburg | 6,200 | 39 | 63 |
| Pencock-Byington | 3,800 | 30 | 48 |
| Stewart | 2,600 | 36 | 100 |
| Teton Island Feeder | 123,100 | 45 | 78 |
| Wilford | 54,300 | 28 | 62 |
| Woodmansee-Johnson | 2,800 | 57 | 61 |
| Consolidated | 89,000 | 53 | 79 |
| Dewey | 4,900 | 48 | 95 |
| Farmers Friend | 48,000 | 18 | 57 |
| Twin Groves | 48,600 | 37 | 50 |

[1]Represents an average of 1983, 1984, and 1986 diversions
[2]The percent values for 1977 should be viewed with caution because the irrigated acreage in the project area increased about 20 percent from 1970 to 1988. During the same period there was a significant shift from gravity and subirrigation to sprinkler application. It is uncertain how accurately the 1983, 1984, 1986 average represents a full water supply for 1977.

Annual precipitation in the project area in 1983, 1984, and 1986 was above average. The average district diversion of 1,220,000 acre-feet for the 1983, 1984 and 1986 seasons was selected for comparison with diversions during low runoff years (1977 and 1988). In contrast, precipitation in 1977 and 1988 was below normal, storage supplies were low, and irrigation diversions by some irrigation entities within FMID were below the 1983-1986 average. Irrigation diversions in 1977 were 56 percent and in 1988 were 87 percent of the "full water supply" diversion of 1,220,000 acre-feet.

A review of diversions by individual canal companies shows that some entities experienced much greater shortages than the average during these two drought periods. The irrigated acreage of the entities that experienced significant shortages in drought years constitutes about 45 percent (about 60,000 acres) of the FMID lands.

Supplemental Irrigation Water Supply Need

The FMID has historically obtained some water from the District 01 waterbank during below normal runoff years. Prior to 1977, accounting procedures for segregation of natural flow diversions were coarse. Lack of computational tools and water measurements resulted in a somewhat simplistic method of determining when diversions were allowed under the natural flow rights. Additional water measurements on streams and diversions, improved reporting techniques, and computer accounting procedures have made it possible to more accurately determine the amount of natural flow available to and diverted by an entity on a given day during the irrigation season. Any canal which diverts water in excess of the computed natural flow entitlement is charged for storage water. If the canal does not own or has exhausted its storage water allocation for the year, the canal is assumed to rent water from the waterbank.

During the 1988 irrigation season some entities within FMID exceeded their computed natural flow entitlements and storage water allocations. Records show that FMID entities acquired about 40,000 acre-feet of supplemental water from District 01 waterbank and related sources during that year. Based on this supplemental water purchase (40,000 acre-feet) for 1988 and the correlation of the 1988 water year unregulated flow with the unregulated flow for the Henrys Fork subbasin for the historical period of record (56 years), it is estimated that the annual supplemental irrigation water requirement for FMID would average about 20,000 acre-feet.

During years of low water supplies, the annual supplemental requirement over the 56-year period of record varies from 3,000 to 122,000 acre-feet. The greatest requirement exists during the critical water period of the study which is the recorded water supply for the early 1930's. It is emphasized that this amount of supplemental water would provide canal companies within the FMID with a water supply in low runoff years equivalent in shortages (same percentage) to that experienced in 1988. The shortage for some canal companies in 1988 is not considered acceptable under Reclamation criteria for irrigation. Although the diversions to FMID lands totaled 87 percent of average demand (about 150,000 acre-feet less than the average demand was diverted), some entities experienced shortages of more than 50 percent.

Present and Future Water Management Programs

The main conveyance facilities of the FMID are being reviewed and measures are being planned to further increase the efficiency of system operation. The district plans to evaluate irrigation demands, source and availability of water supply, impact of changing needs on return flows and other water uses, and potential system and operational improvements. That evaluation will provide valuable information to FMID managers as they plan water management operations.

## Fish and Wildlife

### Resource

The Teton River provides an excellent and popular fishery over its total length. Above the Teton reservoir site, extensive gravel areas are distributed throughout the river and its tributaries, and these areas are used by spawning fish in both spring and fall. Cutthroat, brook, and rainbow trout and mountain whitefish are abundant. Fishing in the 17 mile reach of the river inundated by Teton reservoir (Teton River Canyon) was once considered one of the finest in Idaho and contained a self-sustaining population of cutthroat trout. Excellent trout habitat composed of deep pools, riffles, and an abundance of gravel areas made it highly suitable for spawning and rearing. Construction of Teton Dam and subsequent failure had a significant impact on the habitat of the stream reach in the reservoir area but an even greater impact on the stream reach immediately downstream of Teton Dam. With time, even the stream reach immediately downstream of the dam could generally recover to its previous condition.

The upper Teton River (above the reservoir area) has excellent cover for wildlife which is present in the marshy bottom lands. Much of the bottomland consists of wet meadows covered with marsh grasses, sedges, and rushes. The abundant shrubby vegetation is composed largely of willows, bog birch, and shrubby cinquefoil. Numerous islands are present in the slow flowing, meandering stream. Its channels are lined with a dense growth of aquatic plants, and grain fields are present on adjacent bench lands.

Wildlife habitat in the Teton reservoir area has been substantially altered due to the construction and subsequent failure of Teton Dam. Mitigation requirements for reconstruction of the dam would be based on the habitat as it existed before the original construction.

Before construction, the wildlife habitat in the Teton reservoir area (Teton River Canyon) consisted of scattered stands of Douglas-fir and aspen with good bunchgrass cover and a few shrubs on the north slopes of the canyon. Juniper, sagebrush, rabbitbrush, bitterbrush, and cheatgrass existed on the exposed south canyon walls. However, cliffs constitute a large portion of the south-exposed face. Vegetation was dense along the river bottom where the predominant species were red-osier dogwood, water birch, chokecherry, serviceberry, willow, and currant. Farmland adjacent to the canyon was and continues to be cultivated to the canyon rim providing very little cover and only limited food for wildlife.

At present, both the rim area and the canyon area support upland game. Big game make only limited use of the rim area. Mule deer and elk inhabit the canyon lands and moose are seen occasionally. Small numbers of big game are resident in the canyon, and a significant deer herd currently winters there. Elk also use the area during winters but no estimate of the total wintering population has been made. Re-establishment of the wildlife habitat in the canyon area, both within and below the reservoir site, can occur given time.

## Mitigation

A major part of the original fish and wildlife mitigation plan for the construction of Teton Dam has been implemented. The U.S. Fish and Wildlife Service (FWS) has reviewed the original mitigation plan, identified the mitigation measures that have been implemented, and made some preliminary recommendations as to additional mitigating measures that might be needed using present criteria. Table 3 shows the measures of the original mitigation plan, the level of implementation, and FWS current recommendations for additional mitigating measures.

If the Lower Teton Division were to be investigated at the feasibility level, the FWS would need to prepare a Coordination Act Report. During the Coordination Act process, detailed instream flow, habitat, and other studies would be completed, and the preliminary recommendations presented here would be refined to develop a formal mitigation plan for the project.

Table 3.--Mitigation Measures

| Original Mitigation Plan | Implementation | Current FWS Recommendations |
|---|---|---|
| 300 cfs minimum instream flow maintained in most years, 150 cfs in dry years | None | 450 cfs minimum instream flow maintained in all years |
| Construct fish screens on all new canals, the existing Canyon Creek diversion, and 13 existing diversions on the Teton River below the dam | None | Construct fish screens on all new canals, the existing Canyon Creek diversion, and all existing diversions on the Teton River below the dam. Provide 15 cfs flow in Canyon Creek |
| Fund hatchery facilities to rear trout and kokanee for release into the reservoir and river below the dam | None | Fund hatchery facilities to rear trout and kokanee for release into the reservoir |
| Maintain minimum pool of 100,000 acre-feet | None | Maintain minimum pools of 30 percent of the total storage capacity (96,000 acre-feet) |
| Purchase, fence, and develop 960 acres of reservoir take line for big game range | Purchased 883 acres. Fencing and habitat development not complete | Complete fencing and habitat development of 883 acres. Fund IDFG to do OM&R |
| Acquire and develop 15,140 acres for big game range in Tex Creek area. Fund Idaho Department of Fish and Game to do operation, maintenance, and replacement | Acquired and developed 18,719 acres for big game range in Tex Creek area. Funding IDFG to do OM&R | Continue present development |
| Acquire 455 acre of wetlands in Cartier Slough area. Fund IDFG to do OM&R | Acquired 468 acres of wetland in Cartier Slough area. Funding IDFG to do OM&R | Acquire and enhance several thousands acres of river flood plain lands |
| Not included | None | Provide improved instream flows for fish habitat below existing Reclamation projects |
| Not included | None | Operate project so that salmon and steelhead smolt outmigration is not adversely impacted |

## Enhancement

Although the authorized Lower Teton Division did not include a fish and wildlife enhancement function (only mitigation), consideration could be given to using Teton storage water in conjunction with the operation of other upper Snake River storage facilities for fish and wildlife enhancement. Possible measures include: (1) improvement of winter flows in the Henrys Fork for maintenance of Trumpeter swans, (2) improvement of stream flows below Palisades, American Falls, and Island Park Dams, (3) provide water to increase and improve wetland areas, (4) improve the riparian habitat of tributaries and main-stem systems within the upper Snake, (5) aid in the outmigration of anadromous fish smolts to the ocean with improved spring flows in the lower Snake River, and (6) assist in providing winter range for big game populations in eastern Idaho. The ability to assist in these types of enhancement depends on many factors of which water is a major element.

## Recreation

Water-based recreation demand continues to expand. Current estimates of recreational needs for the Teton Project area were developed from information provided by the Idaho Statewide Comprehensive Outdoor Recreation Plan (SCORP). The Lower Teton Division is located in SCORP Region VI which encompasses 9 counties in southeastern Idaho: Lemhi, Custer, Butte, Clark, Jefferson, Fremont, Madison, Bonneville, and Teton Counties. High priority development needs were identified to be campgrounds, picnic areas, and swimming areas. Boating and waterskiing were next in importance. River running or floating by rafts, canoes, and kayaks has become a popular activity. The increased flows that would be provided downstream from the dam would enhance this activity.

Population growth during the last 20 years and projections to the year 2000 in SCORP Region VI indicate a general population increase in eight of the nine counties. The percent increase from 1980 to the year 2000 is estimated to ranged from 2 percent to 65 percent for a net increase in Region VI population of about 46,000 people. Most of this increase will occur in the Lower Teton Division market area which includes Bonneville, Fremont, Jefferson, Madison and Teton Counties. As the population increases the demand for recreation facilities and opportunities will also increase.

The projected demand for additional camping, picnicking and boating facilities by the year 2000 (taken from the 1983 SCORP) for Region VI are 5,600 campsites, 2,200 picnic sites, and 60 boat ramps. Of these projected needs, 2,700 campsites, 1,750 picnic sites, and almost all of the boat ramps will be needed in the Lower Teton Division recreation market area.

Recreational facilities recommended for development at Teton reservoir include 400 campsites, 200 picnic units, and 6 boat ramps. An analysis based on current recreation information should be included if detailed project investigation is initiated.

## Flood Control

Flooding along the Teton River continues to be a concern to residents of the area. A review of the flood characteristics and flood regulation potential for the area has been provided by the Corps of Engineers.

### Characteristics

The Teton River and its tributaries are fed largely by snowmelt and therefore have quite regular patterns of low flows during late summer, fall, winter, and early spring months and high flows during the late spring and early summer. Runoff volumes caused by snowmelt can be forecast with reasonable accuracy based on seasonal precipitation, water content of the snow on the ground, earlier runoff, and other factors that can be evaluated prior to the spring runoff.

Most flooding conditions in Teton River and tributaries result from snowmelt which produces a series of high flows for prolonged periods of several days to several weeks in the late spring and early summer. A combination of unusually high accumulation of water in snow and high snowmelt temperatures and/or rainfall augmenting snowmelt runoff has caused overbank flows to prevail for periods of several weeks.

Occasionally flooding results from a combination of early spring rainstorms and ice formation in the Teton River and its tributaries. In these instances, ice jams form after a prolonged period of subfreezing temperatures followed by a sudden moderation of temperatures and early spring rainstorms primarily in the lower areas. The ice accumulates at constrictions or obstructions and even with relatively low water discharges the surface elevation is raised to flood heights, often causing extensive local flooding.

Although not common, rainstorms alone during the spring months have caused out-of-bank flows in small drainage areas.

There have been about 20 large floods in the Teton River basin over the last 100 years. Peak discharges during these floods ranged from 4,000 cfs to more than 6,000 cfs; normal channel capacity is about 1,500 cfs. A large majority of these floods were due to snowmelt. The 1962 and 1963 floods were exceptions. These were winter floods that resulted from rapid temperature rises and moderate rains with ice clogging the channels. Extensive inundation of adjacent lands caused severe damage.

### Regulation

The entire active storage capacity of Teton reservoir (200,000 acre-feet) would be available on a joint use basis to store flows excess to the downstream channel capacities. The evacuation and use of space in the reservoir would be based on forecasts of seasonal flood runoff volumes and parameter curves that take into consideration: (1) date, (2) allowable downstream channel capacities, and (3) forecasted seasonal runoff volumes.

A part of the reservoir capacity would be reserved for flood control through the winter and for storage of rain floods during early spring months. For ultimate irrigation development, 30,000 acre-feet of flood control space would be retained until March 1. Between March 1 and May 10, the space reservation would be reduced gradually to zero in years in which runoff forecasts indicate no need for space for control of snowmelt floods.

Based on reservoir operation studies, Teton reservoir would afford full control of floods up to a 200-year frequency flood. No flood reduction benefits would be realized for floods that exceed the 200-year frequency.

## Power Generation

The Bonneville Power Administration (BPA) is the marketing agency for power produced at Federal dams in the Pacific Northwest. In southern Idaho, Federal power generation in excess of Federal project irrigation requirements is marketed within the southern Idaho Federal power area. Federal preference customers include cooperatives, municipalities, and private utilities in southern Idaho and adjacent parts of Wyoming, Montana, Utah, Nevada, and Oregon.

Until the early 1970's, enough power was generated at the Federal powerplants in southern Idaho to meet the demands of the Federal customers in that area. Throughout the 1970's, however, demand continued to grow rapidly, while generation at Federal powerplants remained constant. Demands exceeded generation by the mid-1970's and were about twice as large as the available Federal generation in southern Idaho by the end of the 1970's.

To meet the demand electric power must be imported into southern Idaho from other Federal powerplants in the Pacific Northwest and must be wheeled over private utility lines. Additional Federal generation in southern Idaho would help reduce wheeling charges.

Present demand for electrical energy in the southern Idaho area is slightly above 2 billion kilowatt-hours (kWh) per year. After a period of rapid growth in demand, BPA forecasts now indicate that the demands of southern Idaho preference customers have stabilized. In fact, demands during the 12 month periods ending June 30 of 1989 and 1990 decreased about 1.5 percent. Future demand will be linked closely with economic growth of the area but continued use of conservation measures is expected to preclude significant increases in the near future.

Generation from Federal powerplants in southern Idaho totaled 726 million kWh in fiscal year 1989. After adjustment for transmission losses and irrigation pump loads on Federal projects, 437 million kWh were available to meet demands of those customers in the southern Idaho area supplied by BPA. This amount supplies about 20 percent of BPA's existing demand. Marketable generation from Federal powerplants is expected to increase to about 710 million kWh by 1995 as a result of rehabilitation and replacement of the Minidoka Powerplant and uprate and rewind of Palisades Powerplant. Table 4 shows marketable average annual Federal generation and Federal demands now and in the future.

Table 4.--Federal Power Generation and Demand in Southern Idaho

| Fiscal Year | Marketable Average Annual Federal Generation | Federal Demand |
|---|---|---|
| | ------- (million kWh) ------- | |
| 1990 | 437 | 2,032 |
| 1995 | 710 | 2,073 |
| 2000 | 710 | 2,150 |

## Cultural Resources

Federal laws and regulations require that significant cultural resources in a project impact area be identified and either protected or mitigated commensurate with a plan approved by the State Historic Preservation Officer and the Advisory Council on Historic Preservation. Investigations to locate, evaluate, and mitigate impacts to cultural resource properties could be necessary if Teton Dam were replaced.

Archeological surveys were conducted of some or all of the Teton Reservoir pool area in 1958 and 1967. In 1967, several archeological sites were test excavated, apparently without yielding significant deposits as no data recovery excavations followed. In 1972, the area of the "second phase" distribution system was surveyed, and three archeological sites were recorded and later test excavated. One sites (10-MO-8) appears to be eligible for nomination to the National Register of Historic Places and contains deposits as much as 8,000 years old. The remnants of a ranch headquarters located in the pool area may also contain significant archeological deposits and be eligible for nomination to the National Register.

Reclamation would need to consult with the Idaho State Historic Preservation Officer to assess whether or not additional surveys and test excavations would be needed. If sites are found that are eligible for nomination to the National Register of Historic Places, data recovery excavations would be required. Site 10-MO-8 from previous survey efforts would probably have to be excavated if project development would affect the site.

# TETON WATER RESOURCE

## Existing Water Resource

### Natural Flow

The major streams in the Teton Basin Project area are the Henrys Fork (sometimes referred to as the North Fork of the Snake River) and its two main tributaries, Falls River and Teton River (See Henrys Fork Basin map). The Henrys Fork runoff averages about 2 million acre-feet annually. Of this, the Teton and Falls Rivers each contribute about a half million acre-feet.

## Storage

Storage facilities on the Henrys Fork and Falls River provide regulation for part of the natural flows. Henrys Lake is located at the headwaters of Henrys Fork and Island Park Reservoir is about 15 miles further south. Grassy Lake is located on Grassy Creek, a headwater tributary of Falls River in Wyoming. The total active storage capacity of these three reservoirs is about 240,000 acre-feet; about 127,300 acre-feet (plus 7,700 acre-feet after the threat of flooding is past) in Island Park Reservoir, about 15,000 acre-feet in Grassy Lake, and 90,000 acre-feet in Henrys Lake.

## Waterbank

A less direct water resource for the Teton Project area is the upper Snake River waterbank (District 01). Storage water owned by irrigation entities and municipalities and retained in Federal reservoirs can be made available through District 01 waterbank procedures. Water committed to the bank by July 1 is placed into a common pool and leased to districts or individual diverters. The present cost of leasing water from the waterbank is $2.75 per acre-foot.

If there is an adequate supply, waterbank users physically located downstream from the storage supply have direct access to the waterbank resource. Users physically located upstream from the waterbank supply can also use the resource through an exchange program. The exchange water supply is limited by the amount of streamflow physically available in the river in the upstream areas and the amount of that supply that belongs to water right holders located downstream of the waterbank. Users with a junior water right supply can access the waterbank resource providing there is sufficient natural flows or storage water high enough in the system to meet their needs. Needs of senior water right holders traditionally met by the upstream water supply can then be met from the waterbank storage available in the lower system, making it possible to effect an exchange.

At times natural flows are inadequate to meet the demands high in the systems and thus an exchange is not possible. This seriously constrains the amount of water exchange physically possible in the Ashton vicinity of the FMID and appears to be a severe limitation in dry years for irrigators who rely heavily on the waterbank exchange.

## Ground Water

The highly productive Snake Plain aquifer extends beneath the lower Henrys Fork and lower Teton River areas. Ground water has become an important resource in the area over the past 20 years. The Rexburg Bench is now irrigated by private wells. Other areas irrigated by ground water are; (1) lower bench lands north of the Teton River, (2) lands along the upper Teton River on the east side between Bitch Creek and Spring Creek and, (3) lands on the west side of the river where the rivers enter the Teton River canyon upstream to the entrance on Forest Service land near Victor.

An appreciable ground-water resource does not appear to be available in the area that is generally east of St. Anthony and north of the Teton River from Canyon Creek to Bitch Creek and north of Bitch Creek (see Lower Teton Division map).

Existing and past surface irrigation practices in the Teton Project area have contributed to the ground-water aquifer. Flood irrigation methods and subirrigation have resulted in a perched water table in parts of this area. The local perched ground-water body is located above the lower lying regional aquifer. The irrigators continue to manipulate the perched ground water for subirrigation in the St. Anthony-Rexburg area.

Percolation from the perched water table contributes an estimated 600,000 acre-feet of annual recharge to the Snake Plain aquifer. About one-half of this contribution occurs within the relatively small Egin Bench area and most of the remainder occurs in the lower Teton River area in the Rexburg vicinity. The recharge to the Snake Plan aquifer from irrigation activity in the area represents more than 10 percent of the regional aquifer's total recharge. Since the Henrys Fork recharge enters the upper end of the aquifer, upstream from nearly all points of use, it is beneficial to a large area. In addition to the 600,000 acre-feet of annual recharge from irrigation, the Henrys Fork basin contributes another 300,000 acre-feet of annual recharge to the regional aquifer from precipitation, percolation from streambeds, and ground-water underflow from neighboring highlands.

## Potential Water Resources

### Streamflows

Natural streamflows are unable to meet existing natural flow and storage rights when drought conditions exist. In years of below average runoff, the Teton River and the Falls River each average less than 350 cfs from early fall to late winter. Development and use of exchange wells in high yielding aquifers lower in the basin and implementing water conservation measures in the St. Anthony-Rexburg area offer opportunities for freeing up streamflows in the upper valleys for additional irrigation or other use. Use of exchange wells in conjunction with the waterbank supplies for exchange is a current practice that is helping to meet a portion of the irrigation needs in the area.

### Storage Water

The relatively high runoff of the Teton and Falls Rivers and their tributaries during good water years provides a potential for storage. Although the runoff of the Teton River averages more than 500,000 acre-feet annually, it varies greatly from year to year, ranging from a minimum of 300,000 acre-feet to a maximum of 900,000 acre-feet. Storage development on the Teton River (there are no storage facilities at present) would appear to be beneficial. Falls River with only 15,000-acre-feet of storage has an average annual runoff of 600,000 acre-feet and a minimum and maximum respectively of 300,000 acre-feet and 800,000 acre-feet.

The Teton site is considered the best alternative available on the Teton River. Storage sites previously identified on Falls River would encroach on Yellowstone National Park. Past efforts to develop storage on Falls River included considerable lobbying following investigations in the early 1900's but were unsuccessful.

Potential storage high in the Henrys Fork system exists on smaller tributaries that could function as off-site storage which would receive a water supply from the Teton or Falls Rivers. Seventeen sites with storage capacities that range from 10,000 acre-feet to 210,000 acre-feet have been identified. Major sources of water for the larger sites are the Henrys Fork and the Teton and Falls Rivers. Many of these sites include hydro-generation potential.

## Ground Water

Ground water is used at a number of locations throughout the study area. Ground-water levels appear to be stable in the Rexburg Bench even though practically the entire bench land is currently irrigated from wells. High yielding wells in this area are common. Further irrigation development would be on dry farmed lands above the bench. These lands are in steep, rolling topography that would be difficult to irrigate and would require high pump lifts.

Private development of ground water for irrigation has occurred in the middle Teton River area. The risk of developing a low yielding or non-producing well is quite high. A thorough study of the geology and ground-water potential of the middle Teton River area upstream from the Teton dam site would probably provide information for more favorable siting of wells. The influence of geological faulting on the aquifer and the possibility of a deeper, higher-yielding aquifer zone should be examined. The relationship of the ground-water system and the Teton River should also be studied. Preliminary information indicates that ground water is tributary to the river in this area; however, stream gauging has not shown any significant gain to the Teton River from Bitch Creek downstream to the Teton dam site.

Based on available data for Ashton vicinity south of Henrys Fork, the prospects for new well development appear limited. A few shallow wells yield moderate amounts of water from the perched aquifer. Previous studies have concluded that most of the perched water is tributary to the Henrys Fork. Deeper test wells have not been productive. As the Teton River area develops, geologic studies and deeper drilling might show greater promise for the development of new productive wells.

The current ground-water use in the project area greatly exceeds the levels identified in the original Lower Teton study and proposed for use in the authorized Lower Teton Division. It is important that the total ground-water pumpage be kept to a reasonable level because the Henrys Fork basin is an important contributor to recharge of the Snake Plain aquifer. Significant future ground-water withdrawals should be monitored to ascertain the impact of increased pumpage on ground-water levels in the Mud Lake area to the west and in other irrigated areas.

## Operational Organization

With the exception of storage facilities and the Cross Cut Canal, the main conveyance, lateral and diversion facilities within the FMID are owned and operated by 40 private irrigation entities. The FMID's primary function is to provide administrative support and billing for the canal companies. The FMID does not coordinate irrigation diversions, water deliveries or reuse of return flows. As a result, a significant quantity of water returns to the Henrys Fork and possibly to the Teton River. The benefits of these return flows to the lower system and whether these return flows could be more beneficially retained in the Henrys Fork storage for use further upstream in the system each season has not been evaluated.

## Conservation

Water conservation is generally viewed as beneficial. Although there appears to be potential for water conservation in the FMID, the net effect may not be favorable. Aquifer recharge due to the irrigation methods used in the area provides a natural storage reservoir for the Snake River system. The time lag associated with return flows is a major factor to be considered in determining beneficial effects. The larger the return flows that occur at the time when natural streamflows are low and diversions are being made from surface storage, the greater the benefit of the recharge activity. How beneficial this resource may be has not been fully quantified.

The St. Anthony, Rexburg, and Newdale areas (about 81,000 acres south of the Henrys Fork/Falls River confluence) have used subirrigation and flood irrigation methods. Subirrigation requires diversions in excess of 10 acre-feet per acre to build and maintain water table levels. Only a small portion of this water is consumptively used by the crops and most of the diversion serves to recharge the aquifer. In recent years many of the irrigators in this area have changed to sprinkler irrigation systems but diversions to canals and laterals have not decreased. Continued large diversions appear to be due to (1) large amounts of seepage from canals, (2) continued use of subirrigation methods on part of the land in the area, and (3) ponding measures to maintain the water table for the subirrigation sector.

Flood irrigation practices have included the diversion of high spring flows early in the irrigation season to raise the water table. The water table is then maintained as long as sufficient water is available. As water supplies become short, diversions are directed more toward meeting just the crop needs. There are indications that farm operations using flood irrigation are converting to more efficient methods of irrigation. The conversion is due in part to economic considerations.

Further evaluation of opportunities for water conservation opportunities should be explored.

## WATER USE SCENARIOS

### Authorized Operation

The functions of the authorized Lower Teton Division are irrigation, recreation, fish and wildlife mitigation, electrical power generation, and flood control. First phase development, which included construction of the dam and appurtenances, ground-water development, and limited canal facilities, focused on a supplemental water supply for existing irrigation. Other first phase development included recreational facilities, land acquisition and facilities for fish and wildlife mitigation, and power generating facilities. The primary objective of the second phase was to be new irrigation development with additional ground-water development.

In the first phase, an average annual supplemental irrigation water supply of 55,000 acre-feet was to be provided by the project to 111,210 acres. During the driest year on record (1934) there would be a supplemental need for 514,000 acre-feet of water. The supplemental supply would reduce the critical year shortages to an average of about 10 percent. In the second phase, new irrigation of 37,000 acres was to be developed on the Rexburg Bench area and would require about 140,000 acre-feet for a full supply.

Recreation facilities were to consist of camp sites, picnic units, and boat ramp lanes located at the reservoir. Storage space was not dedicated to the recreation function.

Fish and wildlife mitigation was to include establishment of browse plants in designated areas, land acquisition for exclusive wildlife habitat, spawning facilities, hatchery ponds, fish screens on major diversions, and a 300 cfs flow below the dam during average and above average water years. When reservoir carryover fell below normal, the minimum flow was to be reduced to 150 cfs.

Electrical generation would be incidental to the reservoir operation and would not specifically draw on the storage in the reservoir.

Flood control was to be accomplished by jointly using the 200,000 acre-feet of active storage space with irrigation. Of the active storage space, 30,000 acre-feet would be reserved for flood control during the winter and until March 1 of each year. Reservoir fill each year was to be in accordance with established flood control rule curves.

### Scenario Descriptions

Four scenarios were originally envisioned for this analysis. The first scenario generally corresponds to the first phase operation as originally envisioned but is modified to reflect current needs and considerations. The second scenario includes new irrigation in the FMID area. The third and fourth scenarios, which would add new irrigation and other water use modifications lower in the Snake River system, were not developed because water would not be available to go beyond scenarios 1 or 2.

Scenario 1

Scenario 1 includes supplemental irrigation for the FMID, enhanced winter streamflows below Island Park Dam for trumpeter swans, and mitigation streamflows below Teton Dam for resident fish. Flood control operation is included by use of rule curves. Power generation and recreation would be incidental functions. New irrigation development is not included.

The total irrigation requirements for the FMID area is based on an evaluation of the average irrigation diversions in recent years and represents requirements with the present level of development.

The estimated supplemental irrigation supply requirement (irrigation water obtained from District 01 waterbank and related sources) was developed using data on waterbank and related water source acquisitions during 1988 as applied to the 56-year period of record. The supplemental irrigation supply need averages 20,000 acre-feet per year and varies from none to 122,000 acre-feet in individual years. This approach provides a conservative estimate of irrigators' need for a supplemental water supply for two reasons. First, irrigators accept some level of shortage during dry years because of the added costs to acquire a supplemental supply. Second, it is physically impossible to deliver water from the supplemental water source to all district lands.

A supplemental irrigation water supply from storage would be made available to the FMID. In contrast to the original plan, no well development is included or would be needed. Storage water would also be available for streamflow maintenance in the Teton River and in the Henrys Fork for resident fishery below Teton Dam and for trumpeter swans below Island Park Dam on the Henrys Fork. No water or storage space is specifically identified for recreation or electrical generation. Flood control operation is essentially the same as that described in the documents leading to the authorizing legislation.

In their July 31, 1990 draft Planning Aid Memorandum, the FWS recommend an instream flow of 450 cfs at the confluence of Teton River and Henrys Fork. During water short years, when reservoir "carryover" is below normal, there would be insufficient water to meet all functional needs and instream flows would be reduced to 300 cfs.

There is also a need during winter months to maintain flows in the Henrys Fork below Island Park Dam to keep the river free of ice in order to insure an available food source for trumpeter swans. Flows of 300 cfs have been suggested from December through March for this purpose except during mild winters when ice build-up would not be a major problem. Water would be released from Island Park Reservoir in exchange for water stored in Teton Reservoir. In this scenario, no allowance was made for mild winters, and the need for a 300 cfs flows was assumed for all years.

Recreation and electrical generation are non-consumptive users of the water supply. Reservoir pool for recreational activity and electrical energy generation was not considered in this scenario, and generation is based on the water released for resident fish flows, irrigation, and flood control.

Scenario 2

Scenario 2 is the same as scenario 1 with a new irrigation increment in the Henrys Fork and Teton River area. For the analysis an additional irrigation diversion of 104,000 acre-feet annually was assumed but a specific acreage was not identified[1]. Ground-water wells for exchange pumping to the river would be used to meet the additional irrigation demand as needed.

Scenario 3 and 4

Scenarios 3 and 4 were not developed because analysis indicated that the water supply was inadequate. Both were envisioned to be the same as Scenario 1 with an increment. Scenario 3 would include a new irrigation increment below the Lower Teton Division in lieu of the new irrigation in the FMID area. The water supply would be provided from the Teton reservoir but would be diverted from the Snake River. In Scenario 4 the water supply not required for other functions would be released from Teton reservoir at appropriate times for water budget flows (flushing flows for anadromous fish) below Brownlee Dam on the lower Snake River.

## Scenario Analysis

Operation studies were completed using a computer model of the upper Snake River system. The model simulates physical operation but makes no assumptions based on water right allocations which in reality could constrain exchanges needed to meet water demands for various purposes. The model uses the water supply for the 56-year period of record, 1928-1983. In these analyses, irrigation was given the major priority followed by instream flows for trumpeter swans and then mitigation flows for resident fish. Allocation of reservoir space to specific functions would require more detailed information and study.

Scenario 1

An assumption is made that the supplemental irrigation need that may be provided by District 01 waterbank and related sources is replaced by the Teton Project. The supplemental supply has been estimated at an average of 20,000 acre-feet per year and 122,000 acre-feet in the critical year.

The upper Henrys Fork system could provide flows (released from Island Park Dam) to enhance trumpeter swans in every year; exchange water for irrigation would be supplied from the Teton reservoir to lands normally supplied from the Henrys Fork and the Falls River.

A resident fishery flow target of 450 cfs at the mouth of the Teton River could be fully met in only 14 years of the 56-year period of record. Reduced flows would generally occur during the fall and winter months. The resident fishery flows would drop below 300 cfs for brief periods in 2 years of the 56 year period.

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[1]Lands to be developed for irrigation must be classified for irrigation suitability and so certified to Congress by Reclamation.

Based on the 1962 Teton Project report and the 1969 preconstruction report, the average annual generation powerplant would be about 80,000,000 kWh. The dependable generating capacity would be about 11 megawatts.

Flood control measures would effectively control major flooding up to the estimated 200-year frequency level. Flood control measures are based on interagency guidelines and established reservoir operating rule curves for flood control purposes.

The maintenance of the resident fish and trumpeter swan flows would have minimal effect on the Snake River flow regime. Generation at existing powerplants downstream to Swan Falls would be increased by an annual average of 2,000,000 kWh. In addition, the irrigation supply available from the Snake River would be increased by about 20,000 acre-feet during the critical water year of the 56-year study period. Impacts below Swan Falls would be insignificant.

Other Scenarios

Scenario 1 appears to approach full development of the Teton River water resource (the recommended stream maintenance flows could not be met in all years). To further test this hypothesis, scenario 2 was analyzed.

In scenario 2, the additional demand of 104,000 acre-feet for new irrigation in the Henrys Fork and Teton River would be met primarily from ground water and not from Teton reservoir. Wells would be the sole water source for the additional irrigation demand about 60 percent of the time; storage water would be sufficient to meet the entire additional demand 25 percent or less of the time.

Although maintaining flows for trumpeter swans is a secondary priority, they were met in every year in this scenario because of the timing of releases, December through March.

The fishery flow of 450 cfs below Teton Dam could be met in only 4 years of the 56-year period of analysis. In most years, these flows would at times fall to or below 300 cfs and in individual years would be below the recommended flow for periods of 1 to 8 months.

The increased demand on the upper Henrys Fork and Teton River systems would result in increased irrigation shortage in the lower portion of the FMID. Irrigation shortages downstream on the Snake River, although minor, would approximately double in the 2 most critical water supply years of the historical period of analysis. Because of the heavy annual draft on the Teton reservoir, the amount of carryover storage during good water years would be limited. Teton reservoir would be drafted to minimum pool about 30 percent of the time.

Because the demands of Scenario 2 were greater than the resource capability, scenarios 3 and 4, which have even greater resource demands, were not analyzed.

The analysis for reconstruction of Teton Dam focused on the functions that were included in the original authorization. These functions were aimed primarily at local needs and included irrigation water supply, hydropower, flood control, and recreation. Because of the local trauma associated with the failure of Teton Dam and remaining local concerns about the safe operation of a second dam at the site, it is felt that any reconstruction plan must focus on functions that meet local needs. For that reason this reconstruction analysis focused on the authorized functions and added instream flows for trumpeter swan enhancement, an issue of recent local concern.

Reclamation recognizes that there are regional water needs under discussion at present. Primary among these is additional flow release to the lower Snake River for salmon migration (water budget flows). Hydroelectric power generation is another regional concern. Operation studies focusing on these functions rather than local needs were not conducted; however, some observations are possible.

First, any operation scenario for a new Teton Dam would require mitigation flows for resident fish and operation to control local flooding conditions. The average annual quantity of water required for mitigation is estimated to be about 41,000 acre-feet. Second, the total project water supply would not change significantly. Third, operation of the reservoir must be coordinated with existing storage projects and consistent with agreements with Idaho Power Company.

Under a scenario emphasizing an anadromous fish flow function, the average annual amount of project storage available could be about 44,000 acre-feet after meeting resident fish mitigation needs. In addition, there could be constraints to the release of the water which is needed in April, May, and June. It is unlikely that the entire 44,000 acre-feet could be released in these months without some flooding between the dam and American Falls Reservoir in good water years. Operating agreements would be needed with Idaho Power Company for release of the water from Teton reservoir for storage and later release from Brownlee Reservoir downstream on the Snake River.

A scenario with emphasis on hydroelectric power production is unlikely to produce significantly more power than the average annual generation of 80,000,000 kWh estimated for the supplemental irrigation scenario. This is due to the fact that the peak demand period for Federal generation in the southern Idaho area coincides with seasonal releases for irrigation purposes.

In summary, Scenario 1 water demands for supplemental irrigation needs and trumpeter swan and resident fishery flows would nearly fully utilize Teton reservoir. Any significant increase in demands above those levels would be difficult to meet and could probably be met from the reservoir only in years of above normal water supply.

## RECONSTRUCTION ANALYSIS

Two alternative construction concepts were analyzed: a rockfill embankment dam and a roller-compacted concrete dam. Both options would accommodate the probable maximum flood having a peak inflow of 79,000 cfs and a 15-day volume of 287,000 acre-feet, and both would incorporate the existing spillway into the design. In addition, the total reservoir capacity would be 288,000 acre-feet of which 200,000 acre-feet would be active capacity for both options.

The embankment dam would have a crest width of 35 feet, crest elevation of 5332.0 feet above sea level, and structural height of 302 feet. The concrete dam would have a crest width of 30 feet, crest elevation of 5326.4 feet, and structural height of 405 feet. The additional height of the concrete dam in relation to the embankment dam (405 feet compared to 302) is below surface level due to the necessity of excavation to place the concrete dam foundation on bedrock.

The crest length of both dams would be identical. A portion of the original embankment that remains undamaged on the right abutment would be incorporated into both alternatives. In addition, about 550 feet of the original embankment on the left abutment would be used with the embankment dam alternative. Crest length of new construction would be 1,700 feet for the embankment alternative and 2,250 feet for the concrete alternative.

The existing gated spillway with a crest length of 72 feet and a crest elevation of 5305.0 feet would be retained in both options, and both options would require an auxiliary spillway. For the embankment option the auxiliary spillway would be constructed in a low area in the reservoir rim approximately 8,500 feet northeast of the existing spillway. This would discharge into an existing stream that empties into the Teton River, approximately 4 miles downstream from the dam. The auxiliary spillway would be a 500-foot-wide excavated trapezoidal channel, containing a reinforced concrete crest structure. The spillway crest elevation would be at elevation 5321 feet, with the unlined excavated channel at elevation 5317.5 feet. The crest elevation was established at 1 foot above the normal reservoir surface elevation to reduce the potential of over-topping by wave action during normal reservoir releases.

The auxiliary spillway for the concrete option would be part of the dam structure and would have a crest elevation 5320.4 feet. The spillway could have a stepped chute which converges to 800 feet of width at the toe of the dam. A spillway crest length of 1,000 feet would establish a maximum reservoir water surface at elevation 5326.4 feet.

Features specific to irrigation include the canal outlet works and feeder pipeline at the dam and a gravity and pump canal to convey a supplemental water supply to existing irrigated lands. The existing outlet works, including all steel pipe and concrete, would be removed and replaced. The full costs of the conveyance facilities are included in the appraisal estimate.

The original power and pumping plant was a reinforced concrete structure with a steel-framed, precast concrete superstructure located at the base of the left abutment of the dam. The structure was completely buried by the Teton Dam failure but was partially uncovered under a later salvage contract. Mechanical and electrical equipment present at that time was destroyed or has since been removed. It is assumed that the plant and switchyard would be reconstructed at the same locations and to the same criteria as the original structures.

## Costs

Appraisal level designs and cost estimates for the reconstruction of Teton Dam and appurtenant structures (rockfill embankment and concrete roller compacted options) were done in September 1982 and modified and updated in March 1990 using January 1990 price levels. The previously designed structures were not significantly changed. New estimates were developed for a spillway and the auxiliary spillway to accommodate present design standards for a probable maximum flood.

The capital cost of the Lower Teton Division would include the cost of the dam, spillway, and reservoir and additional costs for (1) irrigation pump and canal facilities; (2) power generation, switchyards, power substations, and transmission line facilities; (3) fish and wildlife mitigation facilities, lands, and improvements; and (4) recreation lands and facilities. Deep wells and associated pumping facilities included in the original plan are excluded.

Total project construction cost with an embankment dam and appurtenances is estimated at $167,900,000. Construction of a concrete dam in lieu of the embankment structure would increase the cost almost $100 million for a total of $264,900,000. The construction costs by major feature are shown in Table 5.

Table 5.--Construction Costs, Teton Project Reappraisal (January 1990 price level)

| Item | Rockfill Embankment Dam | Concrete Roller Compacted Dam |
|---|---|---|
| Teton Dam and reservoir | | |
| Dam | $ 68,500,000 | $181,100,000 |
| Spillway facilities | 13,700,000 | 400,000 |
| Other dam & reservoir items | 30,800,000 | 28,500,000 |
| Subtotal dam and reservoir | $113,000,000 | $210,000,000 |
| Irrigation conveyance and pump items[1] | $ 25,100,000 | $ 25,100,000 |
| Powerplant, transmission lines,[1] switchyards, & substations | $ 24,300,000 | $ 24,300,000 |
| Recreational facilities | $ 700,000 | $ 700,000 |
| Fish and wildlife mitigation | $ 3,000,000 | $ 3,000,000 |
| General property-reserved works | $ 1,800,000 | $ 1,800,000 |
| Total | $167,900,000 | $264,900,000 |

[1]Does not include costs for replacement wells (and associated powerlines and equipment) included in the original plan

## Project Costs to be Allocated

An allocation of costs distributes project costs among the project beneficiaries (functions) and is a preliminary step to analysis of cost effectiveness and estimating repayment obligation.

Cost to be allocated includes construction costs plus the interest during construction. Interest during construction for this analysis is based on a construction schedule which includes a preconstruction activity period and a 6-year construction period. This construction schedule is consistent with the construction schedule presented in the 1969 project definite plan report.

The total project investment would be $215,400,000 for a rockfill embankment dam and $339,800,000 for a roller compacted concrete dam. Investments costs for the two options and the annual operation, maintenance, replacement, and power costs are shown in table 6.

Table 6.--Costs to be Allocated

| Item | Rockfill Embankment Dam | Concrete Roller Compacted Dam |
|---|---|---|
| Construction Cost | $167,900,000 | $264,900,000 |
| Interest during construction | $ 47,500,000 | $ 74,900,000 |
| Total investment | $215,400,000 | $339,800,000 |
| Annual operation, maintenance, replacement, and power | $464,000 | $464,000 |

## Allocation of Costs

Project investment that is specific to a given function is allocated to that function. For example the investment in a powerplant is allocated to the power function. Some project features or facilities are beneficial to more than one function, they have joint use, and the allocation of investment must be handled differently. Joint use facilities for the Lower Teton division include the dam and the reservoir. For this analysis, allocation of joint use facility costs considered: (1) "use of facility" and (2) prior allocation of joint use facilities (from documents used in authorization and subsequent supporting studies).

In this analysis, costs were allocated to irrigation, power, flood control, recreation, and trumpeter swan enhancement. The cost of facilities required to conserve or mitigate existing fish and wildlife values is considered a project cost to be allocated among all project beneficiaries. The allocated costs by function are shown in Table 7.

Table 7.--Cost Allocation, Lower Teton Division Reappraisal

| Function | Embankment Dam Construction | Embankment Dam IDC[1] | Embankment Dam Investment | Embankment Dam Annual OM&R[2] | Concrete Dam Construction | Concrete Dam IDC[1] | Concrete Dam Investment | Concrete Dam Annual OM&R[2] |
|---|---|---|---|---|---|---|---|---|
| | 1,000 dollars | | | | | | | |
| Irrigation | 52,000 | 14,700 | 66,700 | 53 | 74,100 | 20,900 | 95,000 | 53 |
| Power | 34,500 | 9,800 | 44,300 | 263 | 43,000 | 12,100 | 55,100 | 263 |
| Flood control | 48,800 | 13,800 | 62,600 | 74 | 88,900 | 25,200 | 114,100 | 74 |
| Swan flows | 27,700 | 7,800 | 35,500 | 34 | 50,500 | 14,300 | 64,800 | 34 |
| Recreation | 4,900 | 1,400 | 6,300 | 40 | 8,400 | 2,400 | 10,800 | 40 |
| Total | 167,900 | 47,500 | 215,400 | 464 | 264,900 | 74,900 | 339,800 | 464 |

[1]Interest during construction
[2]Operation, maintenance, and replacement

The simplified allocation procedure used in this analysis will provide a fair estimate of cost assigned to various project functions and an indication of the financial obligation to implement a project. A more complex procedure would be necessary in any detailed study intended to support project construction.

## Cost Effectiveness of Project

A cost-benefit analysis was not prepared for this study. If feasibility level studies are conducted in the future, development of benefits for each function to compare with costs would be required. Reclamation criteria for developing irrigation benefits have changed dramatically since authorization and a decision on the criteria to be used for calculating benefits would be needed. The flood plain below Teton Dam was significantly changed with failure of the dam. An estimate of potential flood control benefits would require a detailed inventory of existing development. The cost per acre-foot of water--by capacity, by yield, and by function--included in this section provides an indication of cost effectiveness of reconstructing Teton Dam.

The reservoir has 288,000 acre-feet of storage capacity. Of this capacity 200,000 acre-feet is active and can be diverted or released. Based on the active capacity of the reservoir, the project investment would be about $1,100 per acre-foot for an embankment dam and $1,700 per acre-foot for a concrete dam.

The active capacity volume is much larger than the yield; that is, on the average, much of the annual runoff that would enter the reservoir would be released to meet senior water rights and would not be available for storage or new uses. In Scenario 1 as discussed earlier and used in this analysis, the supplemental irrigation supply from the Teton Project replaces the FMID water supply obtained from District 01 waterbank and related sources. The flows for resident fishery and flows for trumpeter swans are increased flows from the Teton Project. Other project functions, including recreation and power generation, would be incidental to the storage and storage releases for other functions. Teton Dam and reservoir would provide an average annual volume of 41,000 acre-feet to increase flows for mitigation of the resident fishery, 24,000 acre-feet for enhancement of trumpeter swans, and 20,000 acre-feet for supplemental irrigation to replace the present supplemental irrigation supply.

The ratio of active storage capacity to project water supply is about 2.4 to 1. This ratio results because project accomplishment is constrained by existing water rights and the widely varying amount of annual precipitation and runoff.

The investment cost per acre-foot of project water supply would be about $2,500 for a rockfill embankment dam and would be about $4,000 for a concrete dam. If annualized over a 50-year period with an interest rate of 8-7/8 percent, the annual cost per acre-foot of water, would be $230 for an embankment dam and $360 for a concrete dam. In addition, there would be an annual cost of about $5.50 per acre-foot for operation, maintenance, and replacement.

The cost of water for specific functions--supplemental irrigation and trumpeter swan flows--was analyzed. It was assumed for this analysis that the benefits attributable to flood control, power, and recreation were equal to the costs allocated to those functions. Water supplied for supplemental irrigation would average about 20,000 acre-feet per year and for trumpeter swans about 24,000 acre-feet. On this basis, the investment cost for irrigation water would be almost $3,300 per acre-foot with an embankment dam and $4,800 per acre-foot for a concrete dam. The investment cost for trumpeter swans flows would be about $1,500 per acre-foot with an embankment dam and $2,700 per acre-foot for a concrete dam. Costs for irrigation water are much greater than for the swan flows because irrigation costs include pumps and canals for water distribution whereas the swan flow costs are limited to storage facility costs. Table 8 summarizes the costs per acre-foot of water.

Table 8.--Cost Effectiveness

| Criterion | Cost per Acre-Foot of Water: Embankment Dam | Cost per Acre-Foot of Water: Concrete Dam |
|---|---|---|
| Total investment cost compared to: | | |
| Reservoir active capacity | $1,100 | $1,700 |
| Reservoir average annual yield | $2,500 | $4,000 |
| Annualized total investment cost compared to average annual yield | $230 | $360 |
| Allocated investment cost by function compared to average annual use for: | | |
| Supplemental irrigation | $3,300 | $4,800 |
| Trumpeter swan flows | $1,000 | $2,700 |

## Repayment

Some repayment requirements and cost-sharing policies have changed since Teton Dam was authorized. It is unclear at this time whether reconstruction of Teton Dam will require reauthorization. The appropriate repayment criteria would have to be established through reauthorization or some other process. A change from the earlier repayment criteria is that 50 percent of the recreation costs are now reimbursable under the Federal Water Project Recreation Act of 1965; under the original authorization all of the recreations costs were non-reimbursable. Current repayment policy is discussed below.

Repayment requirements of Federally constructed water resource projects are established by several statutes including the Reclamation Project Act of 1939, the Federal Water Project Recreation Act of 1965 as amended by the Water Resources Development Act of 1974, and other amendments to these acts.

Project repayment obligations vary by functions some of which are nonreimbursable, i.e., the Federal Government absorbs the cost. Other project functions require partial or full repayment of allocated or assigned costs.

Current repayment policy is directed at recovery of development costs from project beneficiaries and repayment within the full ability to repay. In recent years greater emphasis has been placed on non-Federal entities to assume more responsibility for financing a part of the project costs. Current repayment policies for functions that are a part of the multipurpose Lower Teton Division are shown in Table 9.

Under those policies, irrigation, recreation, and power would have a repayment obligation. The annual irrigation repayment obligation attributable to investment would average about $52 per acre-foot of supplemental water with an embankment dam and $74 per acre-foot with a concrete dam. Irrigation would have an additional obligation of about $3 per acre-foot of supplemental water to cover the annual operation and maintenance costs.

Recreation would have an annual repayment obligation of $45,600 for the reimbursable portion of facilities unique to the recreation function plus $40,000 in annual operation and maintenance costs.

Power would have an annual repayment obligation of about $4 million for an embankment dam and $5 million for a concrete dam. The unit cost of electrical energy, including investment and annual operation and maintenance, would be about 53 mills per kWh for an embankment dam and 65 mills per kWh for a concrete dam. Table 10 summarizes repayment obligation for the three functions.

Table 9.-- Current Bureau of Reclamation Repayment and Cost Sharing Criteria

| Function | Related Project Features | Repayment and Cost Sharing |
|---|---|---|
| Irrigation | Storage, canals, lifts | Payment of allocated construction costs without interest and annual operation costs up to the user's ability to pay; contract may be for a period of 40 years unless a longer period is stipulated in the authorization. A 50-year repayment period, typical of many authorizations, is assumed in this analysis |
| Fish and wildlife | | |
| Resident fish | Storage | Mitigation - paid by project beneficiaries in accordance with allocation of costs |
| Trumpeter swans | Storage | Enhancement of migratory wildfowl, (species of special consideration) - Assumed to be non-reimbursable |
| Recreation | Land and facilities | Repayment of 50 percent of construction costs associated directly with recreation with interest over a 50-year period plus annual operating costs[1] |
| Power | Storage, powerplant, and associated facilities | Total repayment of construction costs with interest over the authorized repayment period plus annual operating costs |
| Flood control | Storage | Non-reimbursable under current Reclamation policy |

[1]Recreation was non-reimbursable (no repayment obligation) under the original authorization.

Table 10.--Repayment Obligation of
Irrigation, Recreation and Power Functions

| Item | Irrigation | | Recreation | | Power | |
|---|---|---|---|---|---|---|
| | Embankment Dam | Concrete Dam | Embankment Dam | Concrete Dam | Embankment Dam | Concrete Dam |
| Construction cost | $52,000,000 | $74,100,000 | $350,000 | $350,000 | $34,550,000 | $43,000,000 |
| IDC | 0 | 0 | $ 99,000 | $ 99,000 | $ 9,800,000 | $12,200,000 |
| Repayment obligation | $52,000,000 | $74,100,000 | $449,000 | $449,000 | $44,350,000 | $55,200,000 |
| Repayment provisions | 50-years without interest | | 50-years with interest | | 50-years with interest | |
| Current interest rate | Not applicable | | 10.075 percent | | 8.875 percent | |
| Annual payment | $1,040,000 | $1,482,000 | $45,600 | $45,600 | $ 3,992,800 | $ 4,969,700 |
| Payment/unit | $52/acre-foot | $74/acre-foot | -- | -- | 50 mills/kWh | 62 mills/kWh |
| Operation, maintenance, & replacement | ------ $2.70 acre-foot ------ | | ------ $40,000/Year ----- | | ----- 3.3 mills/kWh ---- | |

## Cost Sharing

Since the mid-1980's, it has been a goal of Federal water project programs to realize some upfront funding of construction costs from a non-Federal entity. The objective is for non-Federal entities to provide cash or in-kind services at the time of construction to reduce the demand on the Federal treasury.

If upfront construction financing is provided by the subscriber to a water service, then their repayment obligation is reduced by the amount paid upfront. If a state or local government entity provides the upfront financing other than as a grant, it could share in the revenues from project water sales over a period of time to recover its investment. The magnitude and type of cost sharing in the form of upfront funding is to be negotiated on a project-by-project basis unless otherwise provided by law.

# MAJOR INVESTIGATION REQUIREMENTS

The Teton damsite received intense investigation following failure of the dam in 1976. Reclamation designers and independent consultants have concluded that a safe dam can be constructed at the site.

## Failure Considerations and Appraisal Level Dam Designs

Foundation surface and subsurface investigations performed subsequent to the failure of Teton Dam raised some questions concerning the adequacy of the grout curtain along the reach where the embankment failed. Other concerns include the manner in which the abutments and abutment materials were treated and placed.

Failure of the Teton dam was determined by investigators to be attributable in part to internal erosion (piping) of the core of the dam deep in the right foundation key trench, with the eroded soil particles finding exits through channels in and along the interface of the dam with the highly pervious abutment rock and talus. Investigation of reservoir seepage loss was initiated subsequent to Teton dam failure. Objectives were to examine seepage loss data and determine if: (1) the magnitude of seepage loss, can be conclusively determined, (2) seepage loss is a serious consideration for a reservoir at the site, (3) there are reasonable measures which might be taken to reduce seepage loss, and (4) more data is needed and can be developed for reconstruction of Teton Dam.

A conceptual geologic model was developed in the re-interpretation of the local and regional geological setting with benefit of data from post-failure investigations of the dam. This model provides specific targets for exploration and evaluation if dam reconstruction is considered.

Appraisal level designs have been developed for a roller-compacted concrete dam and for a rockfill embankment dam. These designs address the geologic and other findings to the extent that available data allow.

## Final Dam Design

Detailed study will be necessary to build on the appraisal level design concepts and to provide information for final design. Major items are listed below:

- Additional hydrologic data are required to test the permeability of the reservoir. The hydrologic study performed for the original dam should be updated to include all inflow-outflow records obtained during the filling of the reservoir.

- Records from the initial filling of the reservoir should be examined to determine if the original projections on water loss and bank storage can be supported.

- Further study is needed to adequately define the effects of fissures in the right abutment on seepage and bank storage. There is no question that these fissures increase the permeability of the abutments and serve as significant feeders to smaller joint conduits.

- Additional geologic investigation for the auxiliary spillway in the embankment dam option will be required to determine the extent of foundation grouting required to prevent seepage past the crest structure.

- A state-of-the-art seismotectonic study should be implemented for the final design data collection.

- New topographic maps will be needed to refine all excavation and dam quantities

- Further onsite investigations will be necessary to confirm or correct the assumptions made in the appraisal studies concerning the present condition of all structures

- The adequacy of the existing outlet works structures with respect to evacuation rates should be reevaluated using current criteria, guidelines, and reservoir operation curves.

- The inflow design flood approved for use in the original design of the Teton dam is not compatible with present design criteria. Prior to any final design work for a new Teton Dam a new probable maximum flood study should be done. The new study would include changes in meteorologic criteria and development of more detailed information on soils and loss rate.

- An excavation contract should be considered as part of final design data collection.

- Final dam design

## Water Needs and Supply

The water requirements for project functions should be verified. The resident fishery need could best be verified by evaluating the instream habitat potential of the Teton River from the damsite to the mouth. The effects of the project on downstream water quality should be evaluated.

The need for flows in the Henrys Fork to maintain trumpeter swans should be based on an evaluation of historical temperatures correlated with ice formation problems, swan population, and swan habitat. Some of the trumpeter swans are being relocated because the overwintering population has grown to exceed the capacity of the available habitat.

Changes in irrigation technology and irrigated acreage within FMID have altered irrigation water needs. About 70,000 acres of land was annexed into the FMID during the Teton Dam construction period in the early 1970's in anticipation of receiving water from Teton storage. Some of these lands were previously irrigated but were in need of a supplemental water supply. The remaining acreage would have been new irrigation development and would have been dependent on Teton Dam and reservoir for their total water supply. Subsequent to the dam failure, some of the potential new irrigation development obtained a water supply by pumping from the Teton River and from wells. The level of supplemental water need for existing irrigated lands within the district needs to be more precisely identified.

FMID is cooperating with Reclamation to formulate a "System Management Program" to serve as the framework within which the district can evaluate water needs and can make decisions regarding water supply and current and future water demands. The second step would be implementation of specific measures of the program.

## Ground Water Resource

The western half to two-thirds of the presently irrigated land in the Lower Teton Division area is located in the Snake Plain aquifer. There exists a perched aquifer and a deep regional aquifer. The perched aquifer is separate from the lower lying regional aquifer. However, percolation of the perched water contributes a significant annual recharge to the regional aquifer. It is recognized that the amount of recharge is large but precise quantification has not been made because of limited available data, and the extent of private development of ground water for irrigation in some areas of the Lower Teton Division.

A better understanding of the geology, recharge occurrence and capability, and ground-water potential of the Teton Project area is necessary before major well development and pumping is incorporated into a project proposal that includes new irrigation development. In the eastern portion of the project area, where ground-water development has been risky, additional study of the aquifer would probably provide information for more favorable siting of wells. The influence of faulting on the aquifer and the possibility of a deeper, higher-yielding aquifer zone should be examined.

The relationship of the ground-water system to the Teton River should also be considered. Preliminary information indicates that ground water is tributary to the river, although stream gauging has not shown any significant gain to the Teton River from Bitch Creek downstream to Teton Dam.

## Teton Project and the Snake River Adjudication

Adjudication of the Snake River Basin will not be completed for a number of years. Quantification of Indian and Federal reserved water rights may create new interest in additional storage within the basin. However, at this time it does not appear that additional storage will be required to satisfy these claims.

There is no moratorium on ground-water development in the Teton area. However, the regional ground water in much of the Teton area has been determined to be trust water and new uses will have to meet certain tests established by the state. It is unclear whether the existing project ground-water permits would be subject to the current review requirements. It is felt that meeting the new criteria, if required, would not be an insurmountable problem. Clarification is required.

## Teton Storage Site

It is the policy of the State of Idaho that potential reservoir sites be protected from significant land use change while recognizing the rights of existing land owners. Improvements and new development within potential reservoir sites which could increase reservoir costs significantly are discouraged. The Idaho State Water Plan dated December 12, 1986 identifies the Teton Dam site as a location to be preserved for eventual dam and reservoir construction. The water plan is updated every 5 years.

## Environmental Consideration

Reconstruction of Teton Dam will require a review of environmental effects and mitigation measures. Studies, including habitat evaluation procedures, to identify streamflow requirements may be needed.

Reclamation would need to consult with the Idaho State Historic Preservation Officer to assess whether or not additional surveys and test excavations would be needed. If sites are found that are eligible for nomination to the National Register of Historic Places, data recovery excavations would be required. Site 10-MO-8 from previous survey efforts would probably have to be excavated if project development would affect the site.