PROJECT SUMMARY
SANDSTONE DAM

Wyoming Water Development Commission
January, 1993
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I. INTRODUCTION

The purpose of this document is to provide the reader with a brief overview of the proposed Sandstone Dam project and to provide a synopsis of key issues and concerns that have been raised during project planning. If more information is needed, please contact Mike Purcell, John Jackson or Mike Carnevale in the Wyoming Water Development Office. A tremendous volume of information has been developed over the past ten years and this brief report does not attempt to summarize all the information and reports that have been completed.

II. BACKGROUND

The Wyoming Water Development Commission (WWDC) proposes to construct a dam and reservoir on Savery Creek, a tributary of the Little Snake River. The proposed project is located in Carbon County in south-central Wyoming and would provide an agricultural water supply for irrigators in the Little Snake River Basin (Figure 1). The proposed project is intended to serve as mitigation to irrigators in the Little Snake River Valley who believe that the Cheyenne Stage I and Stage II diversion projects have reduced the amount of water available for diversion to croplands and future economic growth.

The proposed reservoir is being sponsored by the Wyoming Water Development Commission as a state project. The irrigators under the Little Snake River Conservancy District (District) would be the direct beneficiaries of the reservoir. There are 83 members in the District in Wyoming. Two of the members are municipalities. In a report completed in 1980, Banner Associates, Inc. identified 11,516.6 acres being irrigated in the Little Snake River Valley and 17,892.5 acres with water rights. Irrigated crops include alfalfa, native hay and small grains, most of which are used for local livestock production.

In 1979, the legislature enacted W.S. 41-2-204, which defined the Stage I, II, and III Projects, as well as "in-basin needs". In 1980, the legislature authorized the Stage II Project and, in the same legislation, instructed the Wyoming Water Development Commission to "study the feasibility of constructing in the Little Snake River drainage, above the confluence of the river and Savery Creek, a reservoir of at least three thousand (3,000) acre feet." The legislation noted that the "reservoir shall satisfy immediate in-basin agricultural, recreational, and municipal needs and shall promote in-basin water purity." In 1983, the legislature included a provision in the criteria for
Figure 1. Location of the proposed Sandstone Reservoir.
the water development program, which specified that a project involving a trans-basin diversions shall address the impact of the diversion and recommend measures to mitigate any impact identified in the basin of origin. Subsequent session laws identified the Sandstone Dam as the in-basin component of the Stage III project. The WWDC prepared preliminary designs and cost estimates for a 52,000 acre foot reservoir that would yield 32,000 acre feet per year on a firm annual basis. The reservoir operating plan proposed to use 12,000 acre feet per year for supplemental irrigation water and 20,000 acre feet per year for future industrial use. A Draft Environmental Impact Statement was completed and mitigation required by Section 7 of the federal Endangered Species Act was negotiated with the U.S. Fish and Wildlife Service. In 1987, the WWDC requested construction funding for the Sandstone Dam. The legislature denied the request. However, in 1988 and 1989, the Wyoming legislature appropriated $5,000,000 each year ($10,000,000 total) toward the construction of the Sandstone Dam. While it does not appear that any of the previous statutes obligate the state to construct the Sandstone Dam, there is certainly a question of legislative intent.

In 1992, the United States Army Corps of Engineers (Corps) denied the permit for the larger Sandstone Dam, which was to have a capacity of 52,000 acre feet and a yield of 32,000 acre feet/year. The permit was denied because there was not a defined need for 20,000 acre feet of the reservoir yield to be marketed to industry. In the Record of Decision denying the Dredge and Fill (404) Permit, Colonel Stewart Bornhoft (the reviewing officer) stated:

"Specifically the proponent was unable to identify how most of the reservoir yield would be used. Such information is needed so that secondary effects can be determined. The secondary effects depend to a considerable extent on how the water is used. We could not make a complete comparison between project alternatives, since much of the project's secondary effects are not known. Since the National Environmental Policy Act requires that all significant impacts be identified before resources are irretrievably committed to a project, the unknown impacts associated with the future water usage allowed no option but permit denial."

"... a thorough analysis of alternatives was not possible due to the lack of adequate information on how the project yield ultimately would be used. This problem is magnified by the requirements of the section 404(b)(1) guidelines, which state that no discharge of fill material shall be permitted if there is a practicable alternative to the proposed discharge
which would have less adverse impact on the aquatic ecosystem. The public interest review for the permit depends on a determination of which alternative can achieve the project goals with the least environmental damage."

However, the Corps denied the 404 Permit "without prejudice", and suggested downsizing and rescoping the project as an alternative.

The 1991 Legislature provided a $400,000 appropriation, from the $10,000,000, previously set aside in 1988 and 1989, to investigate water storage alternatives to the Sandstone Dam project to determine if a smaller reservoir(s) could be economically constructed in the Little Snake watershed to provide supplemental irrigation water to Little Snake Valley irrigators. The legislation also authorized the evaluation of irrigation canals and diversion structures in the valley. The consultant hired by the WWDC investigated more than 20 potential reservoir sites in the valley. The report concluded that a small roller compacted concrete (RCC) dam impounding 23,000 acre feet of water at the Sandstone site was probably a technologically feasible project. Further, although expensive, the small Sandstone Dam was also the most cost effective project for providing storage for late season irrigation water and would serve the greatest number of irrigators.

At the November meeting of the WWDC, the District requested a 100% grant for a downsized 23,000 acre-foot Sandstone Reservoir and expressed their intention to pursue funding from the Wyoming legislature. The project is being sought as mitigation for water depletions and impacts resulting from the Cheyenne Stage I and Stage II diversion projects. The least costly dam design for a 23,000 acre-foot reservoir at the Sandstone site is a roller compacted concrete structure. A dam impounding 23,000 acre-feet would yield 12,000 acre-feet of water per year for irrigation. The RCC design eliminates the need for excavating an emergency spillway and could provide a base for future expansion if the need for more storage developed. However, there is a question relative to the capability of the foundation to support a RCC dam. If the 1993 Legislature authorizes the construction of the Sandstone Dam, additional geotechnical work would have to be completed, prior to beginning final design, to determine the capability of the foundation to support the proposed dam as well as future enlargements. Table 1 compares the large Sandstone Project (52,000 AF) with the small project presently under consideration.

After considering the factors discussed above, and recognizing the irrigators' limited ability to repay even 25% of the project costs, the WWDC elected to recommend construction of a state sponsored project whereby storage water would be sold to the
irrigators at a price based on their ability to pay and the benefits that they would accrue from the additional water. In taking this action, the WWDC hoped to provide a forum for discussion, and resolution of the matter of legislative intent relative to mitigation in the Little Snake Valley for the Stage I and II trans-basin diversion projects.

Table 1. Comparison of Large and Small Sandstone Reservoirs

<table>
<thead>
<tr>
<th>Uses</th>
<th>Large Reservoir</th>
<th>Small Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industrial, Agricultural, Municipal, Recreation</td>
<td>Agricultural, Recreation, Municipal</td>
</tr>
<tr>
<td>Type</td>
<td>Zoned Earthfill</td>
<td>Roller Compacted Concrete</td>
</tr>
<tr>
<td>Height</td>
<td>200 feet</td>
<td>135 feet</td>
</tr>
<tr>
<td>Crest Length</td>
<td>3100 feet</td>
<td>1700 feet</td>
</tr>
<tr>
<td>Crest Elevation</td>
<td>6958 msl</td>
<td>6898 msl</td>
</tr>
<tr>
<td>Crest Width</td>
<td>30 feet</td>
<td>15 feet</td>
</tr>
<tr>
<td>Fill Volume</td>
<td>6,125,000 cu yd</td>
<td>325,000 cu yd</td>
</tr>
<tr>
<td>Reservoir Volume</td>
<td>52,000 AF</td>
<td>23,000 AF</td>
</tr>
<tr>
<td>Surface Acres</td>
<td>960 acres</td>
<td>463 acres</td>
</tr>
<tr>
<td>Firm Yield</td>
<td>32,000 AF</td>
<td>12,000 AF</td>
</tr>
<tr>
<td>Project Cost</td>
<td>$70,000,000</td>
<td>$30,000,000</td>
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</table>

III. PROPOSED PROJECT BUDGET

The proposed Level III budget for the downsized Sandstone Reservoir is $30,000,000. The budget would be provided by an appropriation of $20,400,000 from Water Development Account No. 1 (the New Development Account) and the uncommitted balanced of the appropriations for construction of Sandstone Reservoir provided in 1988 and 1989, which total $9,600,000. Table 2
summarizes the proposed budget for the small Sandstone Reservoir.

Table 2. Proposed Budget for the Proposed 23,000 AF Sandstone Reservoir

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization</td>
<td>L.S.</td>
<td>125,000</td>
<td>5.00</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Fdn. excavation</td>
<td>C.Y.</td>
<td>150,000</td>
<td>2.00</td>
<td>300,000</td>
</tr>
<tr>
<td>Abutment trench</td>
<td>C.Y.</td>
<td>325,000</td>
<td>30.00</td>
<td>9,750,000</td>
</tr>
<tr>
<td>RCC</td>
<td>C.Y.</td>
<td>20,000</td>
<td>150.00</td>
<td>3,000,000</td>
</tr>
<tr>
<td>Conv. concrete</td>
<td>L.F.</td>
<td>20,000</td>
<td>25.00</td>
<td>1,125,000</td>
</tr>
<tr>
<td>Pressure grout</td>
<td>L.F.</td>
<td>45,000</td>
<td>20.00</td>
<td>900,000</td>
</tr>
<tr>
<td>Blanket grout</td>
<td>L.F.</td>
<td>20,000</td>
<td>20.00</td>
<td>400,000</td>
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<tr>
<td>Drain holes</td>
<td>L.S.</td>
<td>3</td>
<td>25,000.00</td>
<td>75,000</td>
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<tr>
<td>Outlet works</td>
<td>L.S.</td>
<td>250</td>
<td>1,000.00</td>
<td>250,000</td>
</tr>
<tr>
<td>Spillway</td>
<td>L.S.</td>
<td>1,000.00</td>
<td>2,250,000</td>
<td></td>
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<tr>
<td>Clearing</td>
<td>Ac.</td>
<td>250</td>
<td>1,000.00</td>
<td>250,000</td>
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<tr>
<td>Road relocation</td>
<td>L.S.</td>
<td>250</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td>Stream diversion</td>
<td>L.S.</td>
<td>200</td>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td>Dewatering</td>
<td>L.S.</td>
<td>250</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td>Gages</td>
<td>Ea.</td>
<td>3</td>
<td>25,000.00</td>
<td>75,000</td>
</tr>
<tr>
<td>Keyway</td>
<td>C.Y.</td>
<td>2,500</td>
<td>100.00</td>
<td>250,000</td>
</tr>
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</table>

Estimated Construction Cost $21,875,000
Construction Engineering $2,187,500
Subtotal $24,062,500
Contingency $3,609,375
Total Construction Budget $27,671,875

Final Design 1,000,000
Permitting and Mitigation 500,000
Miscellaneous 1,100,000
Total Project Budget $30,271,875
Use $30,000,000

IV. ECONOMICS

The economics of the "Reduced Size" Sandstone Reservoir is based on benefits derived from irrigation, recreation, municipal and flood control purposes that can be expressed in dollar terms. Other benefits that are not as easily defined are those benefits associated with development of a portion of our compacted share of the Little Snake River, employment during construction and the preparation of a base for future industrial water development.

This analysis is based on the report, An Economic Analysis of Sandstone Dam and Reservoir, prepared by Western Research Corporation under contract to the WWDC. This analysis was performed on the "Large Size" Sandstone Reservoir with a storage
capacity of 52,000 acre-feet. The "Reduced Size" Sandstone Reservoir would store about 23,000 acre-feet.

The only benefits that will not be realized from a smaller reservoir are the benefits that could be attributed to industrial development utilizing Sandstone Reservoir. The agricultural benefits would remain the same, as would the municipal benefits. The recreation and flood control benefits would diminish due to the smaller reservoir size for recreation and the smaller reservoir capacity to retain floods.

Western Research Corporation (WRC) used a 100 year project life for its analysis of the economic benefits and costs. This is a standard used by the United States Bureau of Reclamation in analysis of similar projects. The discount rate calculated by WRC is a real rate adjusted for inflation. The rate is 3.7% after inflation.

The following sections will describe the benefits for each use category.

A. Benefits

1. Irrigation Benefits

The agricultural economy of the Little Snake Basin is based upon livestock production. Approximately 20,000 acres along Savery Creek and the Little Snake River downstream from its confluence with Savery Creek are irrigated or potentially irrigable. The majority of this land is devoted to the production of grass and alfalfa hay for winter livestock feed.

The Sandstone Project would provide two types of benefits to agricultural operators in the Little Snake Basin. First, it would provide irrigation water to mitigate, or make up for, any irrigation water depletions caused by Cheyenne's Stage I and II diversions. Second, the project would supply additional late season irrigation water to area ranchers who have inadequate irrigation water supplies during the months of August and September.

Assuming some irrigation water is lost due to the Stage I and II diversions, there will be negative impacts on hay yields and farm income in the Little Snake Basin. Analyses of crop budgets and historical data related to crop prices and farm productivity indicate that each acre-foot of supplemental irrigation water in the Little Snake drainage probably adds $15 to $25 to net farm income. Impacts to Little Snake River Basin irrigators resulting from the Stage
I and Stage II projects were estimated by Western Research Corporation (WRC). WRC, in consultation with hydrologists, estimated that the Stage I and Stage II projects reduced the water available to Little Snake Valley irrigators by 2,000 acre-feet annually. Assuming a $20 farm income loss for each acre-foot of irrigation water lost and that 2,000 acre-feet of irrigation water is lost annually, the Stage I and II diversions could potentially cost area ranchers $40,000 in direct farm net income annually. The secondary income losses associated with the direct farm income loss would be approximately $32,000, for a total annual economic loss of $72,000.

The Sandstone Project has the potential of mitigating these losses by supplying replacement water from reservoir storage. Thus, approximately $72,000 annually can be attributed to the project as a mitigation benefit. It should be emphasized that this analysis only addresses impacts to the existing irrigation operation and does not include impacts of the diversions to future economic growth in the basin.

In addition to mitigating the effects of Stage I and II diversions, the Sandstone Project would supply additional late-season irrigation water to area ranchers. Hydrological studies undertaken by Western Water Consultants, under contract to Stone and Webster Engineering Corporation in 1986, indicate that, taking into account return flows, reservoir releases of 12,000 acre-feet annually would result in about 13,000 acre-feet of water being available for diversion by irrigators.

If we assume that 2,000 acre-feet of this water would go to mitigate the effects of the Stage I and II diversions, approximately 11,000 acre-feet would be available for additional irrigation purposes. Assuming a $20 increase in farm income for each acre-foot of additional water, a direct irrigation benefit of $220,000 would accrue to area ranchers. The secondary benefits of this income to the local economy would approximate $176,000, for a total annual benefit of $396,000. Overall, the combined direct and indirect economic benefits attributable to both Stage I and II mitigation and supplemental late season irrigation water would approximate $468,000 annually.

2. Recreation Benefits

Sandstone Reservoir would be operated as a cold-water trout fishery by the WWDC. The reservoir would be
operated to provide a minimum fisheries pool of approximately 4,600 acre-feet, and a minimum stream flow of 24 cfs or inflow to Sandstone Reservoir, whichever is less, would be maintained on Savery Creek downstream from the reservoir. If possible, the WWDC would obtain public access to three miles of Savery Creek downstream from the reservoir and a public trout fishery would be maintained in that section of the creek.

Overall, WRC estimated the recreational benefits attributable to the "Large" Sandstone to be on the order of $131,700 annually. This annual benefit was reduced by the ratio of the surface area of the "Large" reservoir to the surface area of the "Reduced" reservoir at maximum pool or about 56%. The resultant benefit would be about $74,000 annually.

3. Municipal Water Supply Benefits

The towns of Baggs and Dixon are located along the Little Snake River downstream from the proposed reservoir site. Baggs currently obtains its municipal water from an infiltration gallery in the Little Snake River alluvial aquifer. Dixon's water supply is also supplied from an infiltration gallery under the river. Both communities have only junior water rights, and have experienced water shortages during extended periods of low flows in the river.

Previous studies completed by Stone and Webster (SWEC, 1986) have identified a long-term need for approximately 200 acre-feet of additional municipal water annually to meet the needs of the two communities. These municipal water needs could be met by the Sandstone Project.

WRC estimated the alternative cost of supplying the two communities with 200 additional acre-feet of municipal water to be approximately $3,300 annually.

4. Flood Control Benefits

The community of Baggs and agricultural lands along the Little Snake River are subject to flooding during periods of unusually high flows in the river. In 1984, flood damages due to extremely high run-off conditions were estimated to exceed $2,000,000 (SWEC, 1986). Although Sandstone Dam and Reservoir would not be operated specifically for flood control purposes, it would attenuate flood flows along Savery Creek.
somewhat, and have some minor attenuating effects downstream on the Little Snake River.

The Sandstone Dam and Reservoir Concept Design Report (SWEC, 1986) estimates the annual flood damage reduction benefits attributable to the "Large" reservoir would be approximately $6,100 annually. This annual benefit was reduced by the ratio of the capacity of the "Large" reservoir to the capacity of the "Reduced" reservoir or about 44%. The resulting benefit is about $2,700 annually.

The discounted benefits presented in Table 3 must be compared to the discounted costs of the Sandstone Project to get an idea of the relationship between the costs and benefits.

B. Costs

Table 2 presented on page 6 summarizes the costs that will be incurred with construction of a "Reduced" Size Sandstone reservoir.

C. Benefit:Cost Analysis

Table 3 summarizes the results of the benefit estimation. The total benefit discounted to a present value is estimated to be $14,419,000.

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Estimated Benefit</th>
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</thead>
<tbody>
<tr>
<td>Irrigation benefits</td>
<td>$12,314,000</td>
</tr>
<tr>
<td>Recreation benefits</td>
<td>1,947,000</td>
</tr>
<tr>
<td>Municipal benefits</td>
<td>87,000</td>
</tr>
<tr>
<td>Flood control benefits</td>
<td>71,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$14,419,000</strong></td>
</tr>
</tbody>
</table>

Historically, benefit:cost analyses have been used to estimate economic efficiency of public investments. The Benefit:Cost Ratio is used to compare one investment to another. In this case, the ratio has been calculated but this potential investment has not been compared to others. In the case of a downsized Sandstone Reservoir, built to supply irrigation water to Little Snake River Valley farms and ranches, the ratio would be 0.46 : 1.00, using the estimated benefits and costs listed above, discounted to a present value at a rate of 3.7 percent.
V. PROJECT FINANCING

The statutory criteria providing guidance to the commission relative to its funding recommendations states that any water development project may be financed by grants not to exceed 75% of the total cost of the project (unless it is a storage project). As demonstrated in the following discussion, the District could not afford the project even with a 75% grant.

In 1991, the WWDC conducted an economic evaluation and survey of the irrigators' willingness to pay and determined that 82% of the respondents were willing to pay $5.00/acre foot for supplemental water. Sixty-three percent were willing to purchase some water at $10.00/acre foot and 42% were willing to purchase supplemental water at $15.00/acre foot.

Assuming an ability and willingness to pay of $15/acre foot and a reservoir yield of 12,000 acre feet, the district could retire a loan of $3,900,000 (4%, 50 years). Further, assuming that the priority should be to rehabilitate the existing irrigation system and it would require a 25% loan of $675,000 to complete the improvements, the District would have the maximum additional debt capacity of $3,225,000. Assuming the WWDC would provide a 75% grant, the maximum affordable cost for the Sandstone Dam would be $12,900,000.

Assuming the WWDC recommended a grant of 75% ($22,500,000) and a loan of 25% ($7,500,000) with a term of 50 years at 4% interest, the annual repayment would be $349,127.00. If 15,000 acres would benefit from construction of the reservoir and were to be assessed, the annual cost for loan retirement would be $23.28 per acre. Additional assessments would have to be levied for diversion dam and canal improvements, establishment of a sinking fund and annual operating expenses.

Based on the above analyses, the WWDC concluded that the District could not afford the project even under the most favorable financing plan that could be provided by the Water Development Program.

VI. SELENIUM AND OTHER TRACE ELEMENTS

During the environmental assessment process for the large Sandstone Dam, several individuals questioned the impact of high selenium concentrations in Little Snake River valley soils on water quality in the proposed reservoir.

To resolve this issue, the WWDC entered into a contract with the U.S. Geological Survey (USGS) to study the range of selenium and associated trace-element concentrations in soil, rock, water and streambed sediments in the drainage area of the proposed Sandstone Reservoir. The report concluded that concentrations
of selenium and other trace metals including uranium, arsenic and molybdenum were low. The report concluded:

"On the basis of analyses of data collected during this study, construction of the proposed Sandstone Reservoir is not expected to increase the concentrations of selenium and associated trace elements in the reservoir water greater than the maximum contaminant levels for public drinking-water supplies and freshwater aquatic organisms established by the U.S. Environmental Protection Agency."

The most seleniferous soils in the basin are located several miles west of the proposed dam site and outside of the Savery Creek Drainage. Because selenium concentrations in the Savery Creek watershed are low and Sandstone Reservoir will have a relatively short flushing time, toxic concentrations of selenium and other trace metals would not be expected to occur.

VII. LANDSLIDES AND FAULTS

A. Landslides

The WWDC has recognized for a long time that there are many active landslides in the Savery Creek drainage in the vicinity of the proposed Sandstone Dam. In fact, one of the deciding factors in the selection of this dam site, as the preferred alternative, was the lack of slide activity along the axis of the dam. However, there are two slides located in the pool of the proposed large Sandstone Reservoir, the toes of which will be inundated by waters impounded by the 52,000 acre-foot dam. These slides were extensively studied by Stone and Webster Engineering Corporation during the concept design (Level II) phase of the large Sandstone Reservoir. In response to public concern over the possibility of a landslide causing catastrophic failure of the dam due to overtopping, the landslides were monitored for an additional two years in 1987 and 1988. In a letter report dated January 17, 1989, Stone and Webster concluded:

"The monitored slide movements, groundwater levels and spring flows are generally consistent with those measured previously and continue to confirm the technical feasibility of the project as described in our 1986 and 1987 reports. The reader is referred to these previous reports for a detailed evaluation of the impacts of the slide movements, groundwater levels and spring flows on the project."
The Concept Design report completed in 1986 stated:

"An effort was made to estimate the maximum possible influence of slope movements on the reservoir. The maximum volume of soil which might potentially move into the reservoir from the landslides and raveling of slopes during the life of the project was estimated. For purposes of this estimate, it was assumed that both the existing landslides would move 1/2 foot per year, that the upper 20 feet of the soils on each slide would move 4 feet per year, and that raveling of slopes would result in movement into the reservoir of a volume of soil 10 feet deep extending 100 feet from the high water line around the remainder of the reservoir rim. Even with these generous numbers, the total volume estimated is about 3400 acre feet over the life of the project. This is only slightly greater than the amount of borrow to be removed from the reservoir so the resulting storage lost will be insignificant compared to the reservoir volume.

In the very unlikely event that movement of the existing slides along Savery and Big Sandstone Creeks totally blocked the valley, it is estimated that reservoir storage losses could be on the order of 8,500 acre-feet or about 15 percent of proposed reservoir storage capacity."

The impact of landslides on the small Sandstone Reservoir was not determined in the recently completed Level I planning study. However, the smaller reservoir will saturate even less of the toes of the landslides. Therefore, the impact of the small reservoir on slope movement may be less than for the large reservoir. Prior to design of the small Sandstone Dam, the potential impact on reservoir operation due to slope movements will be assessed.

B. Faults

Four faults are known within the site boundaries. Three of these are minor features with offsets measured in tens of feet and lengths of a few miles. The fourth, an unnamed fault, has an offset of 500-900 feet and is located approximately 900 to 1200 feet downstream of the dam site. It has been mapped as about 14 miles long and extends
southeastward across the Savery Creek Valley. The probable last displacement along this fault occurred one million years ago and the recurrence probability is low. However, Stone and Webster Engineering Corporation considered it in their analyses "in the interests of conservatism." In fact, all the assumptions used by Stone and Webster in their earthquake analyses were extremely conservative.

Historic records indicate no earthquake exceeding a magnitude 4.4 have occurred within the region of the proposed dam. Stone and Webster estimated the maximum probable earthquake which could occur at or near the dam site to be in the Richter magnitude range of 5.5-6.5. Earthquakes located in western Wyoming or eastern Idaho would not generate acceleration forces at the dam site greater than those resulting from the local probable maximum earthquake. Any dam built at the Sandstone site will be designed to withstand acceleration forces resulting from an earthquake of Richter magnitude 5.5-6.5.

VIII. FOUNDATION STRENGTH

The strength of the foundation and abutments of the Sandstone Dam site was extensively studied as part of the conceptual design of the previously proposed 52,000 acre foot earth-fill dam. In 1985, the consultant determined that the foundation at the site was strong enough to bear the weight of a zoned earth-fill structure but may be inadequate to bear the load of a large roller compacted dam. The consultant concluded that for a dam designed to impound 52,000 acre feet of water, the zoned earthfill structure was best suited to the site.

During the recently completed Level I planning study of irrigation systems and potential irrigation reservoir sites, additional field work was not undertaken at the proposed Sandstone Dam site. The Level I consultant used geotechnical information collected during previous investigations. Using the existing information for the Sandstone site, the Level I consultant concluded:

"...an upstream membrane type roller compacted concrete (RCC) dam will be most suitable for a smaller (23,000 acre-foot) reservoir at the Sandstone dam site. This conclusion is based on the following factors:

- An RCC dam can be constructed to allow large flood-flows to pass over a section of the dam. This alleviates the need for a large, costly side-channel spillway which would be necessary at this site for an earth or rockfill dam.
• A smaller quantity of fill is required than for a conventional earthfill dam. Typically, the required volume for a RCC dam is one-half to one-third that required for a comparable earthfill dam.

• Aggregate for the dam can be generated from processing material on site (especially the stream channel deposits within the valley bottom), and/or imported from the Little Snake River Valley.

• An RCC dam can be raised to accommodate future expansion requirements for the reservoir, providing foundation conditions are adequate.

• The foundation conditions may be conducive to an RCC dam of the size being considered, if the foundation is prepared adequately. Further field and laboratory investigations will be necessary to verify this condition. Current data are not adequate to determine strength characteristics of the foundation...

In conclusion, further geotechnical work will be needed prior to construction of an RCC dam at the Sandstone dam site to determine the amount of work needed to prepare the foundation for construction. If a RCC dam cannot be constructed at the Sandstone site or if more foundation preparation than anticipated by the Level I study is needed to support the RCC dam, the project cost may be higher than the $30,000,000 estimated in the recently completed Level I study. If this proves to be the case, the WWDC will minimize work on the project until additional legislative input is received.

IX. PERMITTING AND MITIGATION

A plan to mitigate the on-site impacts of the large Sandstone Dam was completed prior to initiation of the permitting process and approved by the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service (FWS). This plan will serve as the framework for the revised mitigation plan that will be developed should the small Sandstone Project receive approval from the Wyoming legislature.

The recently completed Level I report proposed the following mitigation measures as part of the overall package:

• A minimum pool of 4,600 acre-feet would be reserved for recreation and maintenance of the reservoir fishery.
An instream flow of 24 cfs or the natural flow of Savery Creek into Sandstone Reservoir, whichever is less, has been proposed as mitigation for inundation of the existing stream fishery. Storage of flows would be prohibited whenever the natural flow in the river is less than 24 cfs.

A plan for mitigation of wetland, terrestrial and aquatic resources impacted by the proposed project will be developed in cooperation with the Wyoming Game and Fish Department.

There are several important permitting issues that will have to be resolved prior to the construction of the proposed 23,000 acre-foot reservoir. The Corps' denial of a 404 Permit for the large Sandstone Reservoir has been discussed earlier in the background section of this document. Clearly, unless there is a demonstrated need for nearly the entire yield of the reservoir, the Corps feels that they have sufficient authority under the National Environmental Policy Act (NEPA) and the federal Clean Water Act (CWA) to deny a 404 Permit.

In the letter of denial and Record of Decision, the Corps left the door open to re-scope the Sandstone Project. In his letter to Michael Purcell, Administrator of the WWDC, Colonel Stewart Bornhoft stated:

"Please note that this denial is based on procedural deficiencies rather than unacceptable environmental impacts. Consequently, the Corps is prepared to reopen consideration of your application in the event that the ultimate use of the reservoir yield can be clearly defined."

Further, in the Record of Decision, Colonel Bornhoft stated:

"The National Environmental Policy Act requires that all significant environmental impacts of a project be identified before and irretrievable commitment of resources is made on the project. The nature if this proposal prohibits the discovery of all significant impacts. Therefore, a permit for the 52,000 acre-foot reservoir on Savery Creek for the Sandstone Project is hereby denied. Should the proponent supply us with clear documentation of demonstrated need for essentially the entire reservoir yield, the Sandstone project could be reconsidered for authorization under the Clean Water Act. This denial will not prejudice any future evaluation of the Sandstone Project."

Because the entire yield of the small Sandstone Dam will be used for irrigation of croplands, the major stumbling block in the path of permitting the project will be eliminated. However,
there are other permitting issues that will have to be resolved prior to project construction.

A. Environmental Protection Agency Involvement

The United States Environmental Protection Agency (EPA) has oversight responsibilities for ensuring that the provisions of NEPA are followed by other federal agencies. The Corps administers the 404 Permit program but the EPA has ultimate veto authority. EPA oversight had much to do with the Corps veto of the large Sandstone Dam project. The EPA will be heavily involved in the review of the smaller Sandstone Project.

B. Analysis of Alternatives Related to Avoidance of Wetland Impacts

The Corps and the EPA will be involved with the selection and analysis of alternatives to the small Sandstone Dam. In the past, these agencies requested that a wide array of alternatives be examined. The issue that provides the trigger for most federal involvement is potential impact to wetlands. Because wetlands and free flowing streams will be impacted by the proposed project, the Corps and EPA will evaluate the project and alternatives using the following criteria:

1. Avoidance. Are there other alternatives that meet project purposes that will avoid impacts to the streams and wetlands?

2. Minimization. Are there other alternatives that meet project purposes that will minimize impacts to the streams and wetlands?

3. Mitigation. If stream and wetland impacts are an unavoidable aspect of the project, how will they be mitigated?

C. Project Scope

The purpose of the proposed project will change from primarily an industrial water supply with additional agricultural, municipal, and recreation benefits to primarily an agricultural water supply with secondary recreation and possibly municipal benefits. This is a significant change in project scope and may affect the alternatives that will have to be evaluated.
D.  Endangered Species (Section 7) Consultation

The U.S. Fish and Wildlife Service (FWS) is the federal agency responsible for enforcing the provisions of the federal Endangered Species Act. The act requires the FWS to determine if a project requiring a federal permit or action will adversely impact the habitat of endangered species. If the FWS determines that a project may adversely impact an endangered species, the FWS, in consultation with the project proponent must develop mitigation measures that will offset the proposed impacts to the endangered species. This consultation is required by Section 7 of the Endangered Species Act and is commonly referred to as Section 7 Consultation.

There are four species of endangered fishes endemic to the Yampa River watershed downstream from the proposed Sandstone Dam project. The species are the Colorado River squawfish, humpback chub, bonytail chub and razorback sucker. The razorback sucker is the most recent addition to the list and was added in November 1992.

Prior to rejection of the 404 Permit by the Corps for a 52,000 acre-foot Sandstone Dam, the WWDC and the FWS had reached agreement in principle relative to the measures that would have to be implemented should a 52,000 acre-foot Sandstone Dam be constructed. This agreement will provide the basis for negotiations between the WWDC and the FWS if the Wyoming legislature authorizes Level III funding for a smaller reservoir. However, the addition of the razorback sucker to the endangered species list may change the terms of the previously reached agreement. The razorback sucker has different habitat requirements than the other three species and spawns earlier than the squawfish or the chubs.

The impact of reservoir operations on downstream endangered species will be minimal. A one time depletion charge of approximately $12.00 per acre foot of depletion (about $144,000.00) will have to be paid to the Colorado River Endangered Fish Recovery Program. Additional mitigation may be required by the FWS.

E.  Archeological Clearance

In 1985, the Wyoming State Archeologist conducted a Class III cultural resource survey of the proposed Sandstone Reservoir project area. Twelve archeological sites have been recorded on the project. Six are historic, five are prehistoric and one has historic and prehistoric components.
In 1988, the WWDC, under the direction of the State Archeologist, contracted with Mariah Associates, Inc. to complete test excavations at seven of these sites to determine if they were eligible for inclusion in the National Register of Historic Places (NRHP) and to obtain information for the development of a data recovery plan for the eligible sites. Only one site was determined to be eligible for the NRHP. Impacts to this site will be mitigated.

F. Water Resources Modeling

Extensive investigations and modeling of water usage and demands in the Little Snake Valley has been completed by Western Water Consultants, Inc. Using the Wyoming Integrated River System Operation Study Model (WIRSOS), Western Water Consultants also has completed numerous operation studies of the proposed Sandstone Dam (both the large and small reservoir configurations) to determine the firm reservoir yield and impacts to stream flows in Savery Creek and the Little Snake River. The operation of the proposed reservoir has fully considered senior water rights. Senior water appropriators are protected by Wyoming state law and will not be damaged by reservoir operations.