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# WHEATLAND RESERVOIR NO. 2 REHABILITATION PROJECT

LEVEL II FEASIBILITY STUDY

## **EXECUTIVE SUMMARY**

AUGUST, 1990

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WHEATLAND RESERVOIR NO. 2  
REHABILITATION PROJECT  
LEVEL II FEASIBILITY STUDY

EXECUTIVE SUMMARY

AUGUST 1990

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**LEVEL II - EXECUTIVE SUMMARY  
WHEATLAND RESERVOIR NO. 2 REHABILITATION PROJECT**

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## 1.0 INTRODUCTION

### 1.1 PROJECT AUTHORIZATION

The Wyoming Legislature authorized the Water Development Commission to conduct a Level II Feasibility Study of the rehabilitation of the Wheatland Reservoir No. 2 Dam. Level II activities included both a Phase I preliminary analysis and report, and a Phase II conceptual analysis and report. On July 1, 1989, the Wyoming Water Development Commission entered into a contract with Banner Associates, Inc. to provide the Level II services. This report is an executive summary of the Level II Feasibility Study, Final Phase I Report (Banner, February 1990) and the Level II Feasibility Study, Final Phase II Report (Banner, August 1990).

### 1.2 PROJECT DESCRIPTION AND PURPOSE

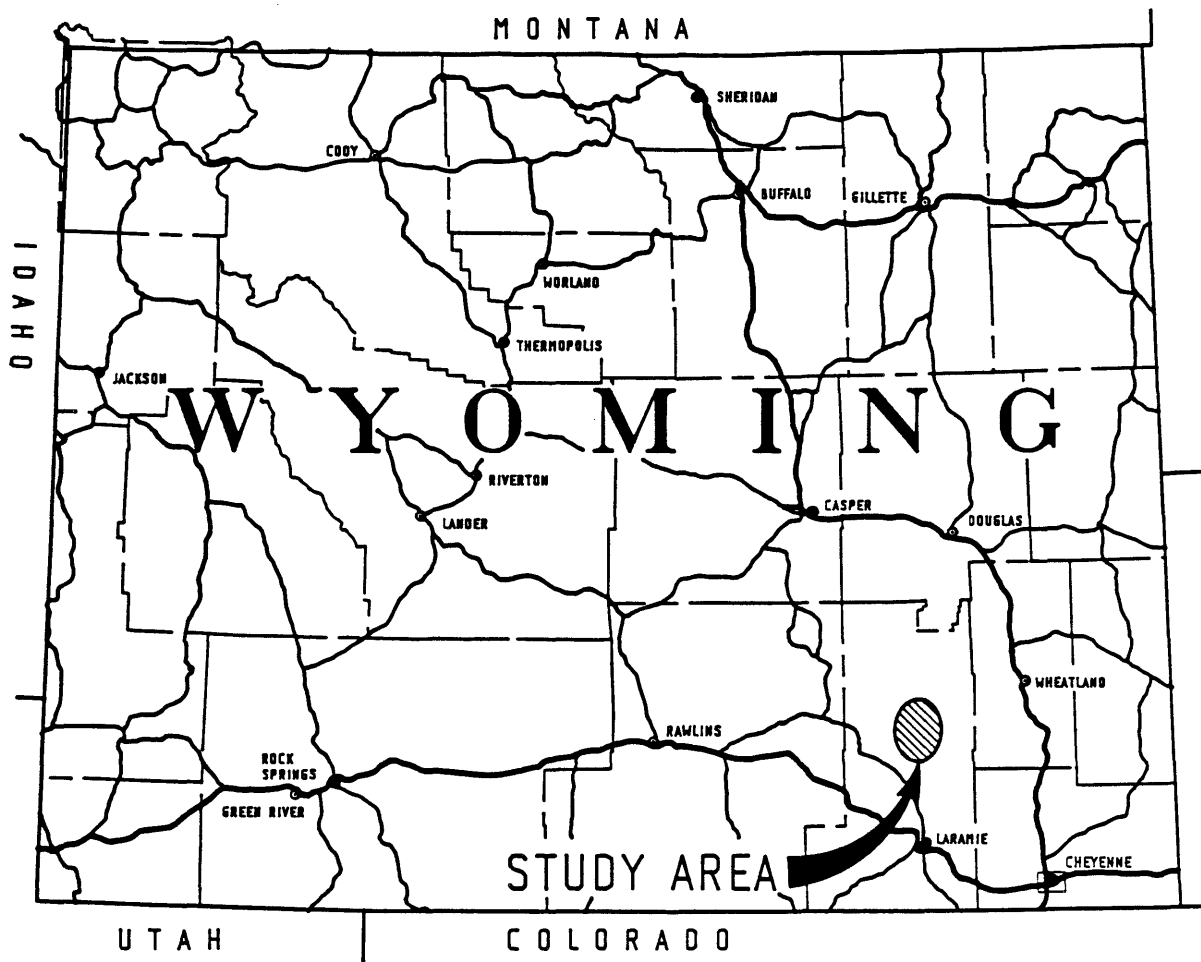
Wheatland Reservoir No. 2 is located on the Laramie River in Albany County, T21N and T22N, R73W and R74W, approximately 40 miles north of Laramie, Wyoming and 35 miles west southwest of Wheatland, Wyoming. The Wheatland Reservoir No. 2 Location Map and Vicinity Map are shown on Figures 1-1 and 1-2, respectively.

Wheatland Reservoir No. 2 Dam was constructed between 1880 and 1890 and was raised to its present elevation of approximately 6972 in the 1930's. The outlet works were modified to the present configuration in 1973. The dam is an earthfill structure approximately 8,280 feet long and is 36.6 feet high at the maximum section, impounding an active capacity of 98,934 acre-feet. The crest elevation varies along its length from a minimum of 6970.6 to a maximum of 6972.5 feet.

Discharge structures for Wheatland Reservoir No. 2 include a main spillway, an auxiliary spillway, a main outlet works, and three small irrigation gated outlet structures. The main spillway and its associated embankment is located approximately 5.8 miles northeast of the outlet works facilities (located near the center of the dam). The main spillway embankment is approximately 800 feet long and has a crest elevation is approximately 6967 feet, which is 4.5 feet below the top of the Wheatland Reservoir No.2 Dam. The auxiliary spillway is located near the left abutment of the dam and discharges into the Supply Canal to Wheatland Reservoir No. 3.

Wheatland Reservoir No. 2 is classified by the U.S. Army Corps of Engineers and the Wyoming State Engineer as a large size dam with a significant hazard potential. Typically, a dam with this classification is required to safely pass the Probable Maximum Flood (PMF) without failure of the dam.

This Level II Feasibility Study was initiated as a result of the Wyoming State Engineer's Office inspection report that expressed specific concerns about long-term safety of the dam and hydraulic adequacy of the spillways. The purpose of this study was to evaluate the condition of Wheatland Reservoir No. 2 facilities and to identify and describe those rehabilitation measures which may be necessary for continued safe and efficient operation of the facility. Wheatland Reservoir No. 2 is owned and operated by the Wheatland Irrigation District (WID), which is the sponsor of this project.



N



NO SCALE

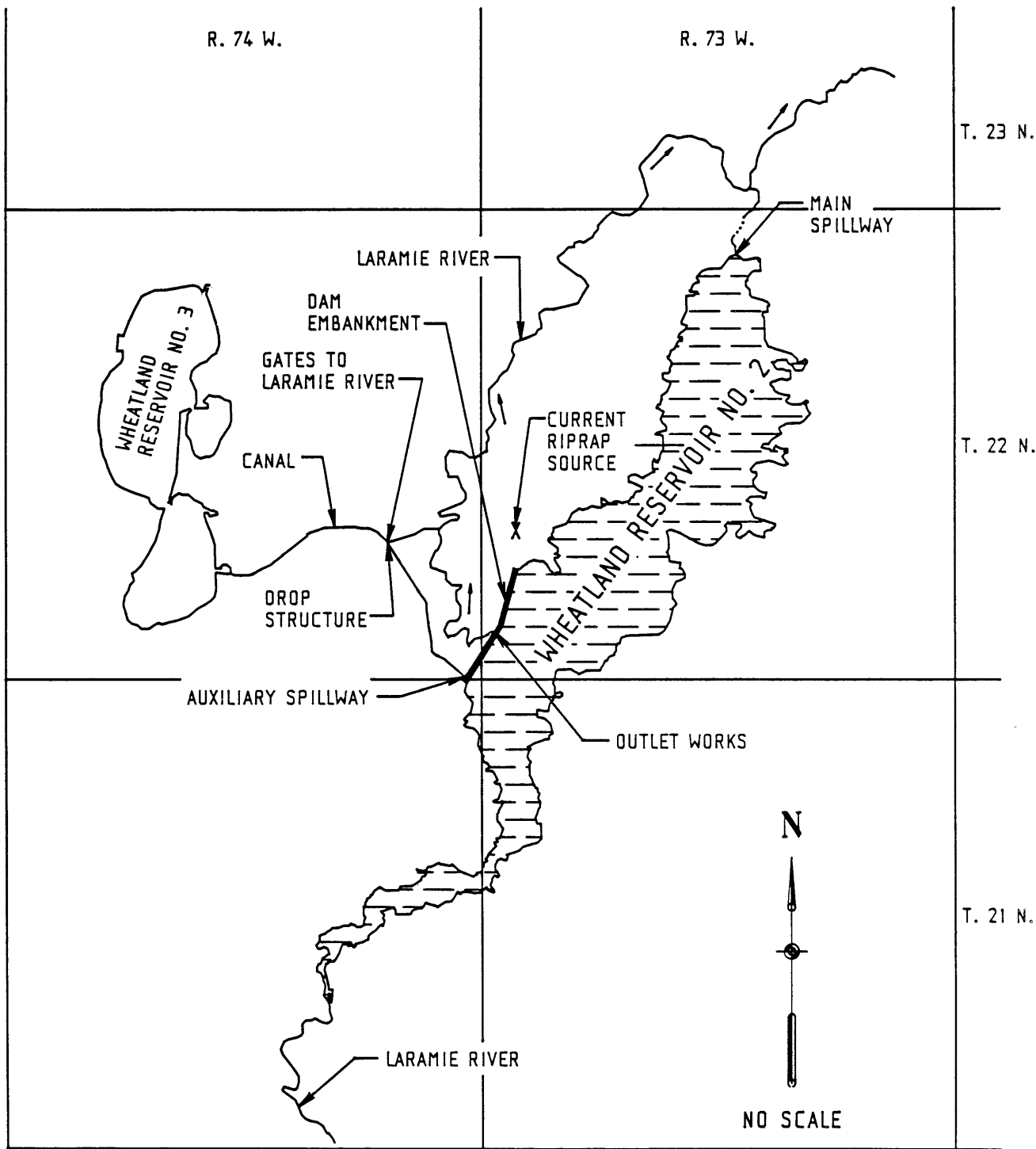
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WHEATLAND RESERVOIR NO. 2 REHABILITATION - EXECUTIVE SUMMARY

LOCATION MAP

FIGURE  
 1-1



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WHEATLAND RESERVOIR NO. 2 REHABILITATION -  
 EXECUTIVE SUMMARY

VICINITY MAP

FIGURE

1-2

## 2.0 SUMMARY OF LEVEL II , PHASE I FINDINGS

### 2.1 SCOPE

The Wheatland Reservoir No. 2 Project Level II, Phase I scope consisted of:

- A review of previous studies and reports.
- A flood analysis, including a PMF determination, a duration analysis, a hydraulic analysis, and several flood routing scenarios.
- An economic analysis including damage costs.
- A conservation pool analysis.
- A geotechnical evaluation including a stability analysis and test pits to evaluate existing conditions and determine potential borrow material sources.
- A safety inspection and operational analysis of existing outlet works, spillways, and canals.
- Development of rehabilitation alternatives and an opinion of probable cost for these alternatives.
- Survey of existing dam and facilities.
- Identification of permits and environmental studies required for construction of the various rehabilitation alternatives.

### 2.2 FLOOD ANALYSIS AND INCREMENTAL DAMAGES

Wheatland Reservoir No.2 is located on the Laramie River and has a contributing drainage area of approximately 1,607 square miles. It was determined that the Probable Maximum Flood (PMF) for the reservoir results in a peak inflow of approximately 124,200 cfs with a storm runoff volume of 656,500 acre-feet. The reservoir is capable of passing an event of somewhat less than the 50% PMF without the Wheatland Reservoir No. 2 Dam overtopping. The main spillway embankment (located at the north end of the reservoir) would overtop at a storm less than the 25% PMF. However, it is believed that overtopping of the main spillway embankment and its subsequent failure would not result in a catastrophic loss of storage of Wheatland Reservoir No. 2. The main spillway embankment for the most part is no more than three feet high with the natural ground level approximately at the normal high water line (elevation 6964). The ground slope from the main spillway area towards the reservoir is very shallow, and an extremely large volume of material would have to be eroded away before any significant depth of cutting would occur.

The hydrologic analyses showed that for all levels of a probable maximum flood (25%, 50%, and full PMF) performed with and without a dam failure, there would be no appreciable difference in flood levels - that is, no flood benefit is gained by increasing the spillway capacities to pass a PMF when compared against the existing configuration where Wheatland Reservoir No. 2 Dam would overtop and potentially fail during this extreme flood event.



### 2.3 ECONOMIC ANALYSIS

The result of the incremental damage assessment indicated property losses resulting from a flood of a magnitude in the range of the 25% PMF to the full PMF would be approximately \$12 million. The lives of 30 to 40 residents of the floodplain also would be at risk. This conclusion applies regardless of whether Wheatland Reservoir No. 2 is capable of passing the full PMF. There appears to be no significant difference in damages or risk to human life regardless of whether improvements are made to the Wheatland Reservoir No. 2 facilities. The simple fact that Wheatland Reservoir No. 2 exists has the effect of attenuation of the flood peak compared to the "without reservoir" scenario. In effect, the reservoir serves as a large detention pond to attenuate peak flow.

### 2.4 CONSERVATION POOL ANALYSIS

An analysis of the historic reservoir storage records was performed to determine the feasibility of maintaining a minimum pool of 15% to 20% of the total reservoir capacity. Based on filing maps and early contour maps of the reservoir site, a total capacity (dead pool plus active storage) of approximately 102,320 acre-feet is indicated. The results indicated that neither a 15% or 20% conservation pool could be maintained for 8 out of 10 years (based on entire period of record) unless past operating procedures would be modified. It was noted that the 15% level would have been encroached upon in only three years between 1968 and 1989. If a goal of maintaining a conservation pool is desired, it was recommended that a detailed operation study should be undertaken to determine what operational changes and constraints would be necessary. As noted above, generally higher storage levels have been observed over the past 20 years. An operation study could help explain if that has occurred from higher inflows, operational changes, and/or more efficient use of Wheatland Reservoir No. 3.

### 2.5 GEOTECHNICAL AND INSPECTION ANALYSIS

The Geotechnical Analysis and the Safety Inspection and Operational Analysis revealed no "fatal flaws"; that is, no deficiencies of a major nature with a high probability of a catastrophic failure in the immediate or near future. Previously published stability analysis reports were reviewed, and an additional stability analysis was performed. The factor of safety determined in this study was similar to those previously published, however the soil strength parameters could not be confirmed. Soil sampling, lab testing, and an evaluation of the stability using measured water levels should be performed. Field investigations were performed at eight test pit sites, and material tests were performed to determine suitability for proposed rehabilitation alternatives. Generally, the materials were suitable for the options considered, although not ideal. It was determined that the riprap and filter material could be obtained by processing - (screening and/or washing) the material from the current borrow source on the knob approximately 1/2-mile north of the right dam abutment (see Figure 1-2). However, the locally available material is of low quality, and a thicker design section and higher maintenance effort will be required.

In addition, the inspection analyses did reveal several deficiencies and potential problems which can be classed as "deferred maintenance" items; that is, items that have been neglected and should be included with an ongoing operation and maintenance program. In addition, there were several areas that were defined in both the Geotechnical Analysis and the Safety Inspection and Operational Analysis that may require further investigations to better define the rehabilitation efforts required.

## 2.6 REHABILITATION ALTERNATIVES

The rehabilitation alternatives and their associated opinion of probable costs developed in the Phase I Report included:

- Abandonment of the dam.
- Do nothing.
- Perform additional investigations.
- Upgrade existing facilities.
- "Armoring" of the main spillway embankment (concrete cap).
- Replace main spillway and main spillway embankment with a Roller Compacted Concrete (RCC) section.
- Upgrade the discharge channel downstream of the main spillway.
- Improve main spillway access.
- Motorize the auxiliary spillway gate operation.

## 2.7 PHASE I RECOMMENDATIONS

Based upon the Phase I investigations and input from the WWDC and the WID, the following rehabilitation alternatives (generally termed "Upgrade Existing Facilities") were recommended for inclusion in the Phase II Conceptual Design and Opinion of Probable Cost portion of the study:

- Fill in the low area of the dam crest.
- Riprap the upstream dam face.
- Establish a rodent control program.
- Evaluate the cause and repair the "sinkhole".
- Repair the two sloughed areas.
- Re-establish, or install new piezometers, seepage measurement weirs and embankment movement monuments.
- Repair existing irrigation outlets.
- Repairs to the outlet works and control building.
- Repairs to the main spillway.
- Repairs to the auxiliary spillway.

The Phase I Report further recommended the following be performed:

- Development of an operation, maintenance and inspection manual.
- Inspection and operation of the outlet works, main spillway, auxiliary spillway as well as the irrigation facilities at reservoir levels up to at least the NHWL at elevation 6964.
- Completion of additional strength testing and stability analyses as

well as observation and analysis with the reservoir at higher water levels.

- Development and implementation of an Emergency Action Plan as requested by the State Engineer's Office.

Additionally, following completion of the Phase I Report, meetings with the WWDC and WID resulted in the inclusion of the following activities into the Phase II Scope of Services: 1) preliminary-level evaluation of the canals, 2) preliminary snow control investigation, and 3) evaluation of a less costly method of stabilizing the main spillway embankment.

### 3.0 SUMMARY OF LEVEL II, PHASE II FINDINGS

#### 3.1 SCOPE

The Wheatland Reservoir No. 2 Project Level II, Phase II scope consisted of:

- Evaluating the condition and determining the hydraulic capacities of the existing canal system, and evaluating alternatives to improve the operating characteristics of the canal system.
- Snow control evaluations.
- Preparing a prioritized plan for the rehabilitation of the dam.
- Investigating protection of the main spillway embankment against lower frequency storms (up to 25% PMF).
- Preparing conceptual design documents for the rehabilitation measures identified for further evaluation in the Phase I report (this does not include canals).
- Developing a detailed opinion of probable cost for each conceptual design project component.
- Preparing an economic analysis to determine sponsor's ability to pay for the conceptual design rehabilitation alternatives.

#### 3.2 SUPPLY CANAL PRELIMINARY EVALUATION

The Supply Canal extends approximately 22,800 feet from Wheatland Reservoir No. 2's auxiliary spillway to Wheatland Reservoir No. 3. Approximately midway, a large drop structure and headgate system exists that allows water to be transported to the Laramie River via a 3,500-foot canal, or serve as an inlet/outlet for Wheatland Reservoir No. 3 (see Figure 1-2). The canal system was surveyed and inspected to determine deficiencies and to evaluate the hydraulic capacity. It was determined that the current canal configuration is capable of conveying 2,000 cfs, although the WID has typically limited releases to 750 cfs to avoid erosion problems. An evaluation was then performed to determine if rehabilitating the canal through lining or other improvements is warranted so that the full carrying capacity of the canal could be utilized.

The evaluation of the Supply Canal investigation resulted in the following recommendations based on a preliminary level of study:

1. No rehabilitation measures on the canal be performed at this time. Examination of flow records indicated that increasing the carrying capacity of the canals would not result in a significant number of years when available excess water could be delivered to Wheatland Reservoir No. 3 above the WID self-imposed constraint of 750 cfs. Also, further study would be necessary to establish that any gains achieved by increasing the canal carrying capacity would not be offset by increased evaporation and seepage losses in Reservoir No. 3.
2. Drop Structure - repair spalled concrete and replace the gate that has been removed.
3. The WID indicated that erosion problems have occurred within a short distance downstream of the auxiliary spillway. A hydraulic analysis of this reach of the canal does not indicate a need to extend the downstream apron to contain a hydraulic jump under normal operating conditions. Erosion in this reach of the canal can be handled through a regular maintenance program.

### 3.3 SNOW CONTROL PRELIMINARY INVESTIGATION

An investigation of the spillways and Supply Canal was performed to determine the operational and maintenance problems that exist as a result of snow accumulation, and to determine if those problems could be minimized with snow control measures. It was generally determined that in most years drifted snow in the spillways and canals is sufficiently melted by the time the spillways and Supply Canal are utilized. Snow accumulation caused by spoil piles along the top of the Supply Canal between the drop structure and Wheatland Reservoir No.3 is causing localized bank sloughing. Recommended snow control in this area consists of reshaping the spoil piles, and regrading so that snowmelt drains away from the canal. If reservoir levels permit, drifting below the auxiliary spillway could be minimized by keeping the gates open allowing the area to blow clear. Snow accumulation at the main spillway could also be minimized by the utilization of snow fence.

### 3.4 RECOMMENDATIONS FOR REHABILITATION MEASURES

Based upon an evaluation of the rehabilitation measures considered for further investigation, the following priority and summarized conceptual designs are recommended:

1. Riprap the upstream face of the dam crest - place 4' of riprap on 1' of bedding at a 3:1 slope (Riprap Option 1).
2. Develop rodent control program - excavation, replace, and compact rodent holes followed by poisoning program to prevent return.
3. Uncover the existing irrigation outlets and plug as appropriate.
4. Install piezometers, seepage measurement weirs, movement monuments.
5. Repair two sloughed areas.
6. Evaluate sinkhole.
7. Fill in low areas of dam crest.

8. Repair outlet works and control building - install anti-vortex device and trashracks.
9. Repair the auxiliary spillway - repair concrete, rollers, rails, and cables.
10. Repair the main spillway - construct additional downstream apron, repair concrete, rollers, rails, and cables.

Alternative measures to protect the main spillway embankment are not specifically recommended. Currently, the main spillway embankment will not be overtopped by a 19% PMF. Because of the low head between the NHWL and the top of the embankment, a secondary spillway would be inefficient. A spillway the width of the entire embankment (875') would be required to pass a 25% PMF. Measures less than those proposed in Phase I (RCC or concrete capping) would most likely still result in some degree of erosion when overtopped.

#### 4.0 COST SUMMARY AND ECONOMIC ANALYSIS

The opinion of probable cost to accomplish the above conceptual design rehabilitation measures is \$1,431,900. An itemized Cost Summary Table is presented on the following page. The costs are based on all dam rehabilitation measures being contracted for the necessary work. Many of the items could be performed by the WID's work force; however, that would not preclude the need for a qualified engineer to observe many of those procedures so that the desired end result is met.

Under current WWDC funding guidelines, the rehabilitation measures could be financed with a 50 percent grant and 50 percent loan mix, with the loan financed over a maximum of 50 years at 4 percent interest. With this financing scenario, the WID's annual debt retirement obligation would be approximately \$33,100. If improvements were financed solely through assessments, an increase of 60 cents per acre would be required. This corresponds to an increase of 8 percent, from \$8.50 to \$9.10 per acre. This increase would not significantly change the WID's assessments relative to other districts in the state.

The preliminary opinion of probable cost for the drop structure repair is \$38,000. The preliminary opinion of probable cost for both snow control measures would be \$113,000. The costs associated with the Supply Canal drop structure repair and snow control are not incorporated in the opinion of probable costs and economic analysis presented above. Since the Supply Canal and snow control portions of the study were of a preliminary nature, it is not known if they will be pursued further. If all the conceptual design recommendations AND the preliminary recommendations for the Supply Canal and snow control were pursued, the total opinion of probable cost would be the conceptual recommendations of \$1,431,900 plus the preliminary recommendations of \$151,000 for a sum of \$1,582,900.

**COST SUMMARY TABLE**  
**(with RIPRAP OPTION 1)**

WHEATLAND RESERVOIR NO. 2 - LEVEL II FEASIBILITY STUDY  
 CONCEPTUAL DESIGN RECOMMENDATIONS  
 OPINION OF PROBABLE COST

ITEM DESCRIPTION	AMOUNT
1) RIPRAP THE UPSTREAM DAM FACE - Option 1	\$ 581,325.00
2) DEVELOP RODENT CONTROL PROGRAM	\$ 78,200.00
3) UNCOVER IRRIGATION OUTLETS	\$ 8,050.00
4) DAM INSTRUMENTATION	\$ 23,000.00
5) REPAIR TWO SLOUGHED AREAS	\$ 5,520.00
6) EVALUATE AND REPAIR SINKHOLE	\$ 5,520.00
7) FILL IN DAM CREST LOW AREA	\$ 10,310.00
8) REPAIR OUTLET WORKS & BUILDING	\$ 36,820.00
9) REPAIR THE AUXILIARY SPILLWAY	\$ 61,080.00
10) REPAIR THE MAIN SPILLWAY	\$ 82,520.00
11) MAIN SPILLWAY EMBANKMENT	\$ 92,000.00
	SUBTOTAL \$ 984,300.00
15% Contingencies	\$ 147,600.00
	SUBTOTAL \$1,131,900.00
15% Design Engineering	\$ 169,800.00
	SUBTOTAL \$1,301,700.00
10% Construction Administration	\$ 130,200.00
	TOTAL \$1,431,900.00