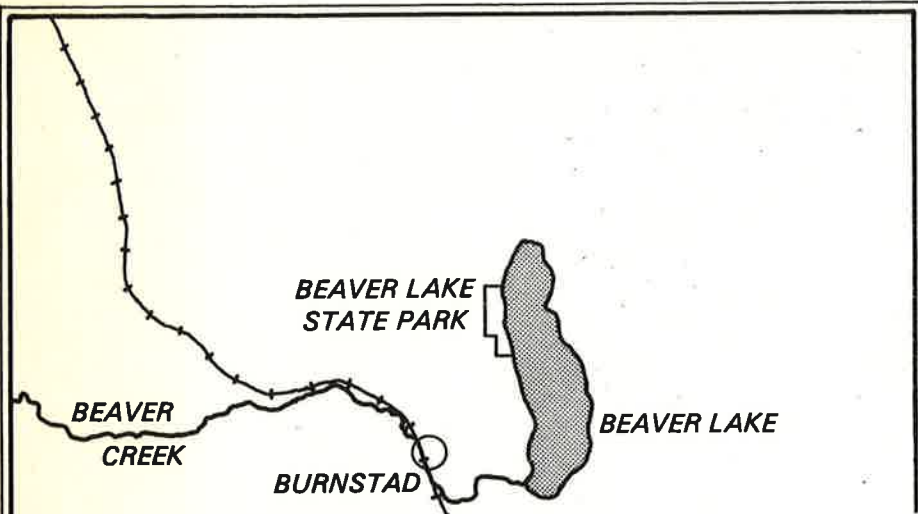
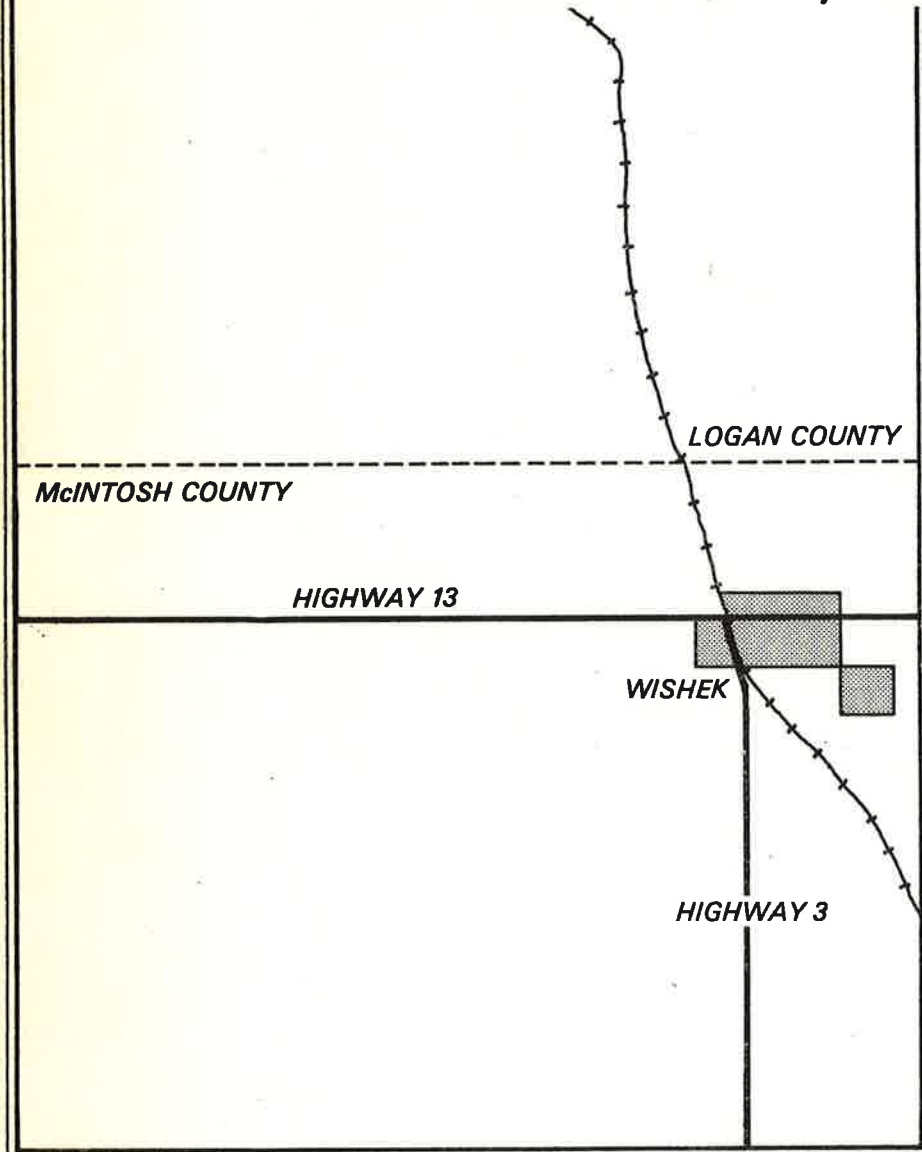


PRELIMINARY
ENGINEERING
REPORT



BEAVER LAKE DAM STUDY

LOGAN COUNTY, NORTH DAKOTA



SWC PROJECT NO. 390

NORTH DAKOTA
STATE WATER COMMISSION
MAY, 1983


PRELIMINARY ENGINEERING REPORT

Beaver Lake Dam Study
SWC Project #390

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North Dakota State Water Commission
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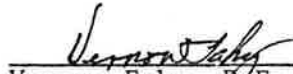
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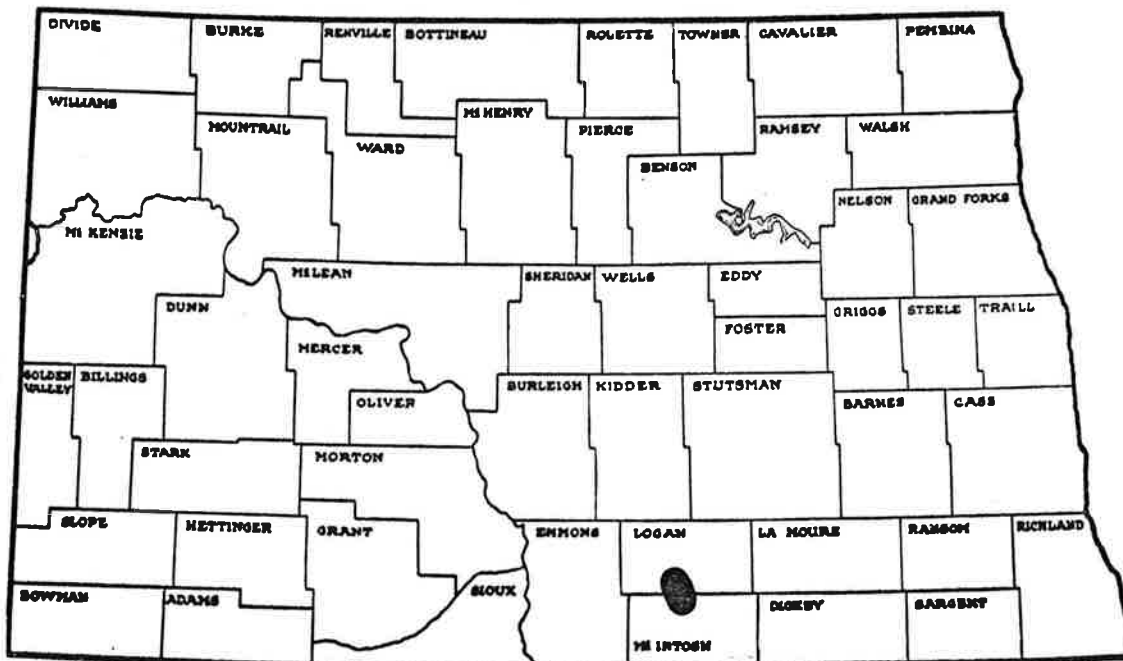
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I. INTRODUCTION

The Logan County Water Resource Board asked the State Water Commission to study the feasibility of reconstructing the outlet of Beaver Lake. (The study area is shown in Figure 1.) Appendix A contains a copy of the agreement. This preliminary engineering report contains the study results of the engineering analysis using a hydrologic study to evaluate the watershed. Evaluation of the watershed and existing outlet provided information for preliminary design and cost estimates for reconstruction. Flood frequency events of 10, 25, 50, and 100-year also were determined. Reconstructing the lake's outlet involves field surveys, hydrologic analysis, evaluating existing conditions, preliminary reconstruction design and cost estimate.

FIGURE 1 - Study Area Location



II. STUDY AREA DESCRIPTION

Beaver Lake Watershed is in Logan County with a southern portion in McIntosh County (Figure 2). The main inlet for Beaver Lake is in the NW $\frac{1}{4}$ of Section 34, Township 134 North, Range 71 West. The outlet is in

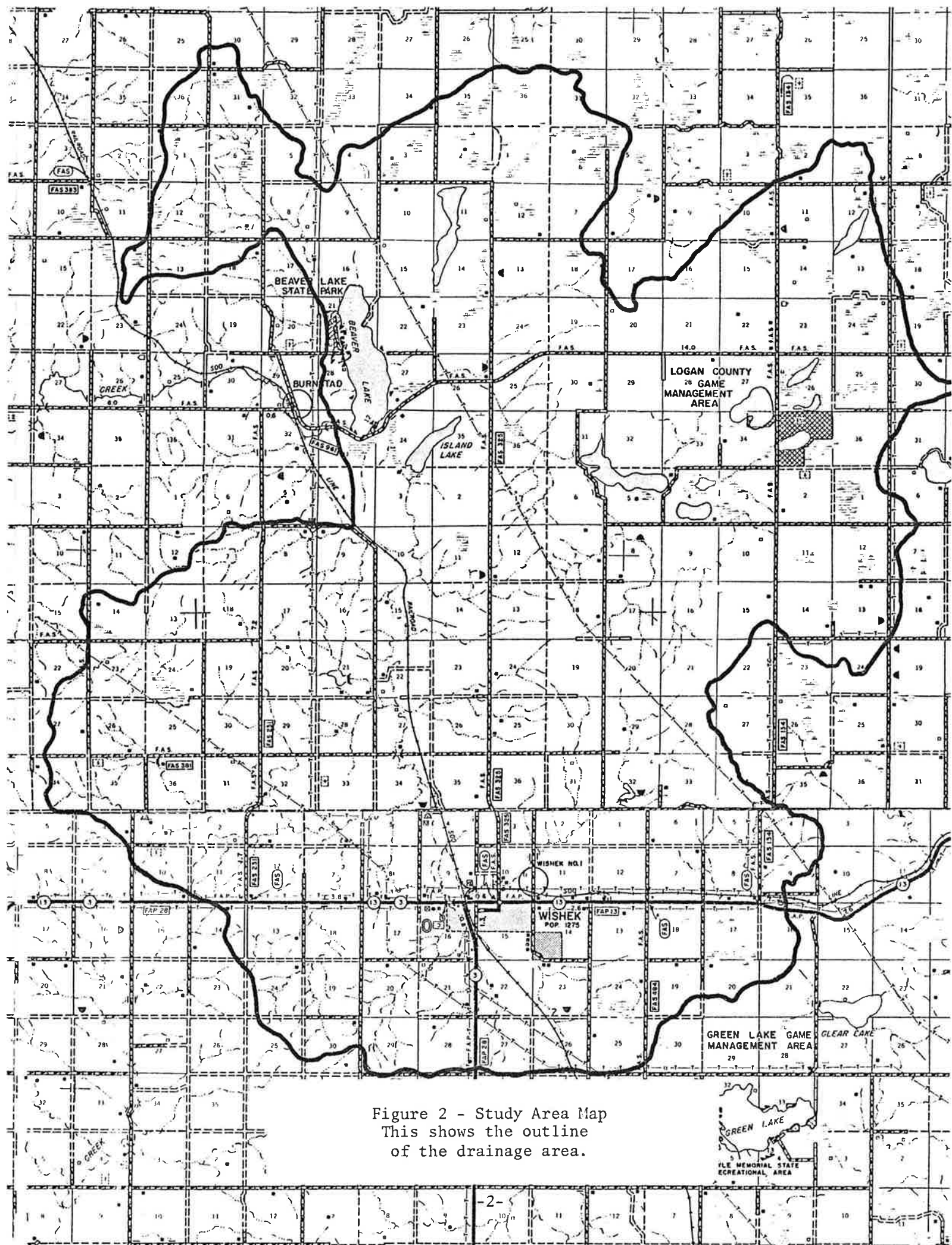


Figure 2 - Study Area Map
 This shows the outline
 of the drainage area.

the NE¼ of Section 33, Township 134 North, Range 71 West. The drainage area is 179 square miles, with approximately 75 square miles being noncontributing. Three slough areas in the watershed act like reservoirs, which accounts for the majority of noncontributing drainage area. Their capacity and outlet elevations prevents them from discharging. A fourth area is on the upstream side of the inlet to Beaver Lake. The inlet acts as a reservoir with the inlet structure being the control for discharges. The major land use is pasture.

Beaver Lake Dam

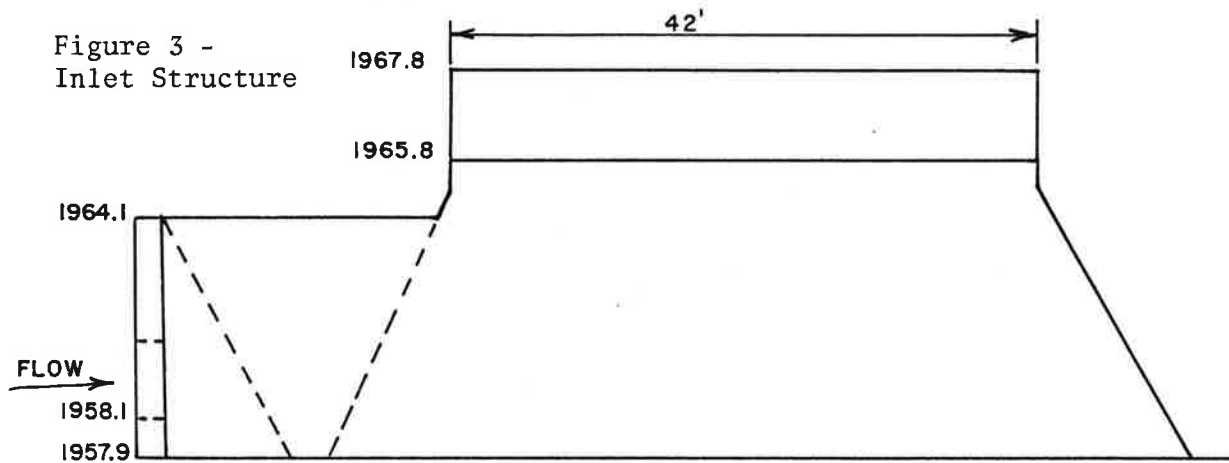
Beaver Lake Dam was constructed in 1934 by the Civilian Conservation Corporation (CCC). Originally the spillway structure was a rock and mortar, ogee, low overflow type weir. Crest length is 148 feet, with a width of 2.5 feet and freeboard of 4 feet.

Several repairs have been made to the weir including adding a sheet piling cutoff wall, a layer of mortar, and rock riprap on the downstream side of the weir. Even with the repairs, the weir no longer performs in an acceptable manner. Approximately one-half of the sheet piling is two feet higher than the weir. Local residents have also noticed leaks along the weir. The end abutments for the weir are in satisfactory condition, with the northwest side having a portion broken off.

The original design elevation of the weir was not tied to any established reference point. In November, 1962, the weir was surveyed at an elevation of 1961.5 msl, being referenced to State Engineer's bench mark, Number 118. The elevation of the weir has not been changed from its original design. An elevation of 1961.5 should be used in any reconstruction of the weir and would have no adverse effect on the original conditions surrounding the lake.

Beaver Lake Inlet Structure

There is a control on the main inlet of Beaver Lake in the NW $\frac{1}{4}$ Section 34, Township 134 North, Range 71 West (Figure 3). The bridge structure is a quad 8 by 11 by 42-foot, reinforced concrete, box culvert. A 6 foot high weir has been placed on the southeast end and is intended to control wind tides coming from the lake. The weir has two 24-inch openings with flapgates to allow low flows into the lake. Improvements to the outlet structure should not have significant impacts on water levels upstream of Beaver Lake.



Existing Flooding

Flooding is a concern in two areas around Beaver Lake. The first area of flooding involves erosion along the east shoreline that results from changing water levels. The second area of flooding is upstream of the inlet structure in Section 34. Land upstream is being flooded by backwater occurring from the weir located on the southeast end of the inlet. The structure does not provide relief from backwater flooding since it cannot pass a significant flow during times of high water. Reconstruction on the outlet will not change the flooding surrounding the inlet.

III. ENGINEERING ANALYSIS

Study Procedures

The procedure consisted of (1) determining the flows in Beaver Creek and the lake levels in Beaver Lake for the 10, 25, 50, and 100-year floods, (2) preparing a preliminary design of a new outlet structure for Beaver Lake, and (3) preparing a cost estimate for the new structure.

Basin Hydrology and Hydraulics

There is a limited amount of data for the Beaver Lake Watershed, with some general information provided by local residents. Included were past water elevations, water retention in certain areas, crop usage in the area, flooding history, and events involving the lake's inlet and outlet.

A Logan County Water Resource Board member estimated the outlet water elevation in 1979 was between 1964.0 and 1964.5. It was estimated that the 1979 discharge from Beaver Lake was approximately 1000 cfs.

The hydrology was completed by using the Corps of Engineers HEC-1 Model, 1981 revision. Input data for the model includes precipitation values, soil types, land use, and stream-bed cross-sections and slopes. Model results included inflows and outflows and lake levels for Beaver Lake for the 10, 25, 50, and 100-year frequency (Table 1).

Table 1 - Existing Flows and Elevations for
Beaver Lake

Flood Frequencies (year)	Inflows (cfs)	Weir Outflows (cfs)	Lake Elevations (feet)
10	895	560	1963.4
25	1400	985	1964.0
50	2260	1435	1964.5
100	3555	2245	1965.4

IV. OUTLET RECONSTRUCTION

The modification of the weir in Beaver Lake Dam would consist of installing a new sheet piling cutoff wall on the upstream side of the existing weir and placing a concrete apron over the sheet piling at elevation 1961.5 (Figure 4). The existing end abutments will be

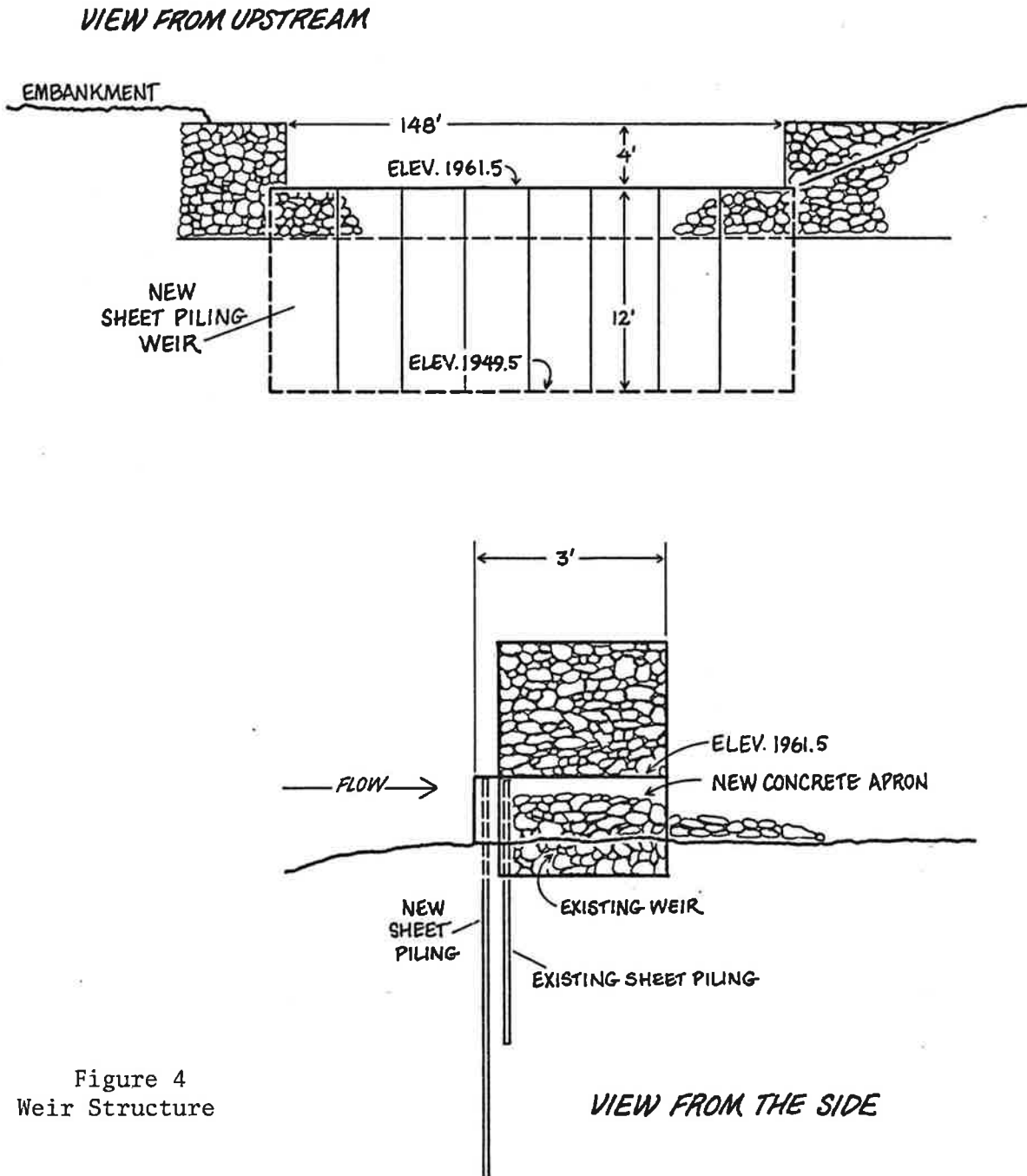


Figure 4
Weir Structure

used and the existing 148 foot width will not be changed.

A coffer dam will be constructed to prevent flows through the dam during the repair period. It is proposed to bury the existing structure in its present location as the existing piling is not reuseable. If problems develop, the existing structure may have to be removed.

Cost estimates for the changes are shown in Table 2. The cost estimate of \$40,000, is based on the construction being completed by State Water Commission personnel. New structure discharges and lake levels for selected frequency floods are in Table 3. Water elevations for the reconstructed outlet would be approximately 0.6 to 0.8 foot lower than for existing conditions.

Table 2 - Estimated Reconstruction Costs
(Force Account)

<u>Materials</u>	
PSA 23 - 112 pcs @ 12' = 41,260.80 #	\$15,000.00
Concrete - 20 cu. yds @ \$75	1,500.00
Rebar - 2,000 lbs @ .35	700.00
Gunite - 15 yds @ \$75	1,125.00
Mesh (2x2) - 750 square feet @ \$.30	<u>225.00</u>
Materials Total	\$18,550.00
<u>Labor</u>	
Four men - 15 days @ \$554	\$ 8,310.00
<u>Equipment</u>	
	\$ 3,500.00
<u>Contract Administration, Contingencies, & Engineering</u>	
	\$ 9,640.00
Total Estimated Cost	<u><u>\$40,000.00</u></u>

Table 3 - Discharge Flow and Elevations for Reconstructed Weir

Flood Frequencies (Year)	Outflow (cfs)	Elevation (feet)
10	680	1962.8
25	1130	1963.4
50	1580	1963.8
100	2450	1964.6

V. SUMMARY AND RECOMMENDATIONS

The preliminary engineering report contains the results of a feasibility study for reconstructing Beaver Lake outlet. A new concrete apron would be constructed along with a sheet piling cutoff wall. The weir would be set at the current outlet elevation of 1961.5 msl and current weir length of 148 feet. The Logan County Water Management Board members recommended that the existing outlet elevation not be changed.

The estimated cost of these improvements was estimated at \$40,000. These costs assume that the construction would be by State Water Commission field personnel and that the construction could be completed in 15 work days. We recommend the Beaver Lake Outlet be reconstructed as described in the report.

APPENDIX A

A G R E E M E N T

SWC Project #390

Investigation of the Reconstruction of the Outlet to Beaver Lake

I. PARTIES

THIS AGREEMENT is between the North Dakota State Water Commission, hereinafter referred to as the Commission, acting through the State Engineer, Vernon Fahy; and the Logan County Water Resource Board, hereinafter referred to as the Board, acting through its chairman, Ben Burlack.

II. PROJECT, LOCATION, AND PURPOSE

The Board wishes to investigate and determine the feasibility of reconstructing the outlet to Beaver Lake. The existing structure has been modified and repaired a number of times and no longer operates in an acceptable manner. This proposed structure is located in the NE 1/4 of Section 33, Township 134 North, Range 71 West in Logan County near the City of Burnstad.

III. PRELIMINARY INVESTIGATION

The parties agree that further information is necessary concerning the proposed project. Therefore, the Commission shall conduct an investigation consisting of the following:

1. Hydrologic investigation of the watershed to determine 10, 25, 50, and 100 year frequency flows into the lake.
2. Field surveys necessary for the hydrologic investigation, preliminary design, and the evaluation of potential flooding problems.
3. Preliminary design of the outlet structure.

4. Preliminary foundation and materials investigation at the site of the control structure.
5. A detailed cost estimate of the project.
6. A preliminary engineering report.

IV. DEPOSIT-REFUND

The Board shall deposit a total of \$4,000 with the Commission to pay for half the costs of the investigation. Upon receipt of a request from the Board to terminate proceeding further with the preliminary investigation or upon a breach of this agreement by any of the parties, the Commission shall provide the Board with a statement of all expenses incurred in the investigation and shall refund to the Board any unexpended deposit funds.

V. RIGHTS OF ENTRY

The Board agrees to obtain written permission from any affected landowners for field investigations by the Commission which are required for the preliminary investigation.

VI. INDEMNIFICATION

The Board hereby accepts responsibility for and holds the Commission harmless from all claims for damages to public or private property, rights or persons arising out of the project and the travel to and from the project site by the Board or any of its subcontractors, agents or employees. In the event such a suit is initiated or judgment entered against the Commission, the Board will indemnify the Commission for any settlement arrived at or judgment satisfied. No indemnification will be required of the Board for claims resulting from negligent acts of the Commission.

VII. CHANGES TO THE AGREEMENT

Changes to any contractual provisions herein will not be effective or binding unless such changes are made in writing, signed by both parties and attached hereto.

Ben Burlack
BEN BURLACK
Chairman

DATE:
Apr 9 - 1982

WITNESS:
James Schneider

Vernon Fahy
VERNON FAHY
State Engineer

DATE:
July 28, 1982

WITNESS:
D. J. [unclear]

