State of Oklahoma
OWRB
WATER RESOURCES BOARD
the water agency

Oklahoma Comprehensive Water Plan
Supplemental Report

Water Conveyance
Issues & Recommendations

This study was funded through an agreement with the Oklahoma Water Resources Board under its authority to update the Oklahoma Comprehensive Water Plan, the state's long-range water planning strategy. Results from this and other studies have been incorporated where appropriate in the OCWP's technical and policy considerations. The general goal of the 2012 OCWP Update is to ensure reliable water supplies for all Oklahomans through integrated and coordinated water resources planning and to provide information so that water providers, policy-makers, and water users can make informed decisions concerning the use and management of Oklahoma's water resources.

Oklahoma Comprehensive Water Plan
OCWP

Water Conveyance Issues and Recommendations

This study was commissioned by the Oklahoma Water Resources Board (OWRB) as a part of the Oklahoma Comprehensive Water Plan (OCWP) to reexamine and update the existing infrastructure plan for the transference of water from approximately the eastern portion of the state to the west. This plan was originally detailed in the 1980 Water Plan and contemplated source waters primarily from eastern and southeastern Oklahoma. This particular study updated costs and examined alternative realignments and source water supplies, including Lake Texoma, Lake Eufaula and the Arkansas River system, and Kaw Lake and developed potential alignments, cost estimates, infrastructure needs and feasibility of each alternative. The OWRB does not formally propose the construction of these projects, but rather presents the results of this study to update the 1980 cross-state conveyance plan and provide an evaluation of potential alternatives to the public, policy makers and water users in Oklahoma.

The Oklahoma Water Resources Board respectfully requests public review of this document. Comments should be provided at any of the thirteen OCWP Feedback and Implementation meetings or in writing to the OWRB by May 31, 2011. An executive summary of this report and its recommendations will be published in the Executive Report of the 2012 Update of the Oklahoma Comprehensive Water Plan.

EXECUTIVE SUMMARY

The 1980 Oklahoma Comprehensive Water Plan (1980 Plan), published by the Oklahoma Water Resources Board (OWRB), presented a proposed Statewide Water Conveyance System as a means of assuring the entire state of adequate amounts of water through the year 2040. In general, this system conveyed water from 'water rich' eastern Oklahoma to 'water poor' western Oklahoma.

The 1980 Plan proposed two water conveyance systems to convey water to terminal storage reservoirs. The Northern Water Conveyance System involved conveying surplus flows from Robert S. Kerr Lake and Lake Eufaula through north central and northwestern Oklahoma. The Southern Water Conveyance System involved conveying surplus flows from the Kiamichi River, Hugo Lake, and the authorized Boswell Lake, to central and southwestern Oklahoma.

Since publication of the 1980 Plan, Oklahoma City, and other communities in central Oklahoma, have made efforts to obtain additional water resources from southeastern Oklahoma. Due to the above-mentioned effort, the OWRB decided that as part of the 2010 Plan update, the proposed water conveyance systems no longer have the requirement to convey water to central Oklahoma. Therefore, the systems proposed in the 1980 Plan require re-evaluation.

The starting point for the re-evaluation in this study was to identify the engineering and cost parameters used to derive the conveyance systems detailed in the 1980 Plan. The United States Army Corps of Engineers (USACE) and Bureau of Reclamation (BOR) provided support documents to the 1980 Plan; however, some of the original documents are missing. Despite this, the study is able to identify virtually all of the original design parameters.

Using these design parameters, derivation of current costs for individual elements that consist of a conveyance system (pumping stations, canals, siphons, pipelines, diversion dams and reservoirs) employed two methods. The first method used the USACE Civil Works Construction Cost Index System (CWCCIS) to escalate the 1980 Plan costs to current costs using historical cost indexes for different categories of civil engineering work. This involved applying an appropriate cost index to the cost for individual system elements. The second method used a current cost-estimating manual to derive costs from limited information, using unit costs for individual work tasks associated with each individual system element.

Using the projected 2040 conveyance water demands stated in the 1980 Plan, alternative conveyance routes that could meet these demands and were considered included:

- Convey water to southwestern Oklahoma using Lake Texoma as a water source, with no conveyance to central Oklahoma, as an alternative to the Southern Water Conveyance System given in the 1980 Plan
- Extend the Lake Texoma conveyance system north as an alternative to the Northern Water Conveyance System given in the 1980 Plan
- Extend the Northern Water Conveyance System south as an alternative to the Southern Water Conveyance System given in the 1980 Plan
- Convey water to north central and northwestern Oklahoma from Kaw Lake as an alternative to the Northern Water Conveyance System given in the 1980 Plan

Of the four alternatives considered, the study concluded that only one of them, supplying southwestern Oklahoma from Lake Texoma, is practicable to meet the 2040 water demands. Further, the practicality of this alternative is dependent upon several factors:

- Construction of the proposed Gainesville Lake on the Red River is required, as Lake Texoma alone cannot meet the water demand. Further study is required to assess its feasibility
- The water quality is such that chloride control is required to be in place
- Congressional approval is required for the reallocation of hydropower and inactive storage at Lake Texoma to water supply storage
- Reallocation of storage shall meet the storage allocation provisions of the Red River Compact

Using the current costs derived for individual conveyance system elements, overall construction and operational and maintenance costs were derived for the 1980 Plan conveyance systems plus the Lake Texoma alternate conveyance system. Table ES-1 and Table ES-2 provide the construction cost estimates for the two different estimation methods, and Table ES-3 provides the operational, maintenance and replacement (OM&R) cost estimates.

TABLE ES-1 - CONSTRUCTION COSTS, USING USACE CWCCIS

RESERVOIR SCENARIO	NORTHERN SYSTEM (1980 PLAN)	SOUTHERN SYSTEM (1980 PLAN)	LAKE TEXOMA SYSTEM
With Flood & Chloride Control	$13.4 billion	N/A	N/A
Without Flood & With Chloride Control	$13.1 billion	N/A	N/A
With Flood & Without Chloride Control	$14.2 billion	N/A	N/A
Without Flood & Chloride Control	$13.9 billion	$5.2 billion	$3.8 billion

TABLE ES-2 - CONSTRUCTION COSTS, USING RS MEANS COST ESTIMATING MANUAL

RESERVOIR SCENARIO	NORTHERN SYSTEM (1980 PLAN)	SOUTHERN SYSTEM (1980 PLAN)	LAKE TEXOMA SYSTEM
With Flood & Chloride Control	$19.0 billion	N/A	N/A
Without Flood & With Chloride Control	$18.6 billion	N/A	N/A
With Flood & Without Chloride Control	$20.2 billion	N/A	N/A
Without Flood & Chloride Control	$19.7 billion	$6.9 billion	$5.9 billion

TABLE ES-3 - ANNUAL OPERATIONAL, MAINTENANCE & REPLACEMENT (OM&R) COSTS, USING USACE CWCCIS

RESERVOIR SCENARIO	NORTHERN SYSTEM (1980 PLAN)	SOUTHERN SYSTEM (1980 PLAN)	LAKE TEXOMA SYSTEM
With Flood & Chloride Control	$548,400	N/A	N/A
Without Flood & With Chloride Control	$548,400	N/A	N/A
With Flood & Without Chloride Control	$549,400	N/A	N/A
Without Flood & Chloride Control	$549,300	$159,600	$177,400

For each conveyance system, two costs per acre-foot of water supplied were developed; one based on the higher estimated construction costs spread over a 100-year period, and one based on the estimated annual OM&R costs. The purpose for developing two values is that funding for construction and OM&R activities most likely will be by different methods. Table ES-4 and Table ES-5 provide the two types of costs per acre-foot of water supplied for each conveyance system.

TABLE ES-4 - COST OF WATER PER ACRE-FOOT SUPPLIED, BASED ON CONSTRUCTION COSTS

RESERVOIR SCENARIO	NORTHERN SYSTEM (1980 PLAN)	SOUTHERN SYSTEM (1980 PLAN)	LAKE TEXOMA SYSTEM
With Flood & Chloride Control	$157	N/A	N/A
Without Flood & With Chloride Control	$153	N/A	N/A
With Flood & Without Chloride Control	$167	N/A	N/A
Without Flood & Chloride Control	$163	$51	$69

TABLE ES-5 - COST OF WATER PER ACRE-FOOT SUPPLIED, BASED ON OM&R COSTS

RESERVOIR SCENARIO	NORTHERN SYSTEM (1980 PLAN)	SOUTHERN SYSTEM (1980 PLAN)	LAKE TEXOMA SYSTEM
With Flood & Chloride Control	$453	N/A	N/A
Without Flood & With Chloride Control	$453	N/A	N/A
With Flood & Without Chloride Control	$454	N/A	N/A
Without Flood & Chloride Control	$454	$116	$207

A cost-to-supply comparison of the three-conveyance systems studied against the cost of water supplied by the Lugert-Altus Irrigation District concluded that the conveyance systems are economically unfeasible to warrant the funding of construction. During the course of the study, new water deficit data (gap analysis) became available from CDM, the lead engineering firm in the development of the 2011 update to the Oklahoma Comprehensive Water Plan (OCWP). This shows that the projected 2060 water deficit is only 11% of the 2040 water deficit assumed in the 1980 Plan; therefore the conveyance systems evaluated in this study are over sized for the updated water deficit projection.

A recommendation of this study is therefore to undertake a further study to evaluate both statewide and regional conveyance systems based upon the new water deficit data. The study will require a review of the results from the water deficit analysis and the concurrent reservoir viability study. The study should focus on not just identifying potential statewide conveyance systems using Lake Eufaula, Lake Texoma, and Kaw Lake as water sources, but also using these and other reservoirs as water sources for regional conveyance systems. The study should focus on an analysis of the various alternatives to supply water to different regions of the state, leading to the ranking of viable concepts based on a cost/benefit measure. This will lead to a preferred conveyance concept (either regionally or statewide) for meeting the water deficit in each region.

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1.0 PURPOSE, GOALS, AND OBJECTIVES

1.1 INTRODUCTION

The 1980 Oklahoma Comprehensive Water Plan (1980 Plan), published by the Oklahoma Water Resources Board (OWRB), presented a proposed Statewide Water Conveyance System as a means of assuring the entire state of adequate amounts of water through the year 2040. In general, this system conveyed water from eastern Oklahoma to western Oklahoma. Most of the state's water resources are located in eastern Oklahoma, where water resources exceed any potential demands. In contrast, the situation is reverse in western Oklahoma, which is lacking in water resources and where potential demands exceed local water resources.

The 1980 Plan proposed two water conveyance systems to convey water to terminal storage reservoirs via a series of pumping plants, pipes, canals, and siphons. The Northern Water Conveyance System involved conveying surplus flows from Robert S. Kerr Lake and Lake Eufaula through north central and northwestern Oklahoma to nine terminal storage reservoirs. The Southern Water Conveyance System involved conveying surplus flows from the Kiamichi River, Hugo Lake, and the authorized Boswell Lake, all located in southeastern Oklahoma, to Lake Stanley Draper in central Oklahoma, and to seven terminal storage reservoirs in southwestern Oklahoma.

OWRB updated the 1980 Plan in 1995, and is currently going through the process of producing the 2011 Update to the Oklahoma Comprehensive Water Plan (2011 Plan). Since publication of the 1980 Plan, Oklahoma City, and other communities in central Oklahoma, have made efforts to obtain additional water resources from southeastern Oklahoma. This effort was recently realized when OWRB approved the transfer of water storage rights from Sardis Lake to Oklahoma City to help satisfy the long-term water supply needs of central Oklahoma.

Due to the above-mentioned effort, OWRB decided that as part of the 2011 Plan, the proposed water conveyance systems no longer have the requirement to convey water to central Oklahoma, and the systems proposed in the 1980 Plan require re-evaluation. OWRB selected C.

C. H. Guernsey & Company (GUERNSEY) to re-evaluate and revise the statewide water transfer system for the 2011 Plan.

1.2 GOALS AND OBJECTIVES

The following are the goals and objectives of the study to determine viable alternatives for a water transfer system:

- Identify the potential end-users of this study and format the deliverables to be responsive to their needs
- Review the 1980 Plan, other pertinent reports, and any available back-up information relating to water transfer
- Identify viable water shortage quantities, beginning with the amounts used in the 1980 Plan and modifying as necessary

- Prepare conceptual, high level layouts of alternative interconnected system routes for the western part of the state based upon the revised water usage quantities. These layouts will not include conveyance to Central Oklahoma:
    - Alternative Western Conveyance System using water supplied from Lake Texoma
    - Alternative Western Conveyance System using water supplied from Lake Eufaula and the Arkansas River
    - Alternative Northern Conveyance System using water supplied from Kaw Lake
- Prepare conceptual cost estimates for the 1980 Plan Conveyance System and feasible alternatives
- Coordinate with OWRB and CDM to gain synergy and collaboration while concurrently avoiding duplication of efforts
- Produce the report in a graphic style that is consistent with recent OWRB work products
- Optimize communication between stakeholders to keep OWRB staff informed, but with a minimum of inefficiency/disruption

1.3 DETAILED SCOPE OF SERVICES

The scope of services for this study, developed from the goals and objectives in coordination with OWRB personnel, involved six distinct tasks. The following sections provide detailed descriptions of the requirements involved in each task.

Task 1: Address Project Pre-planning Activities

GUERNSEY professionals reviewed and gathered preliminary project information prior to participating in the kick-off meeting. Additionally, key team members met to discuss project strategy prior to the kick-off meeting.

Task 2: Participate in Kick-off Meeting

GUERNSEY professionals participated in a kick-off meeting with OWRB that formulated the direction of the project, addressed scope activities, identified budget, and determined the schedule. GUERNSEY prepared minutes of meetings.

Task 3: Review the 1980 Plan and Other Relevant OWRB Documents/Consult with OWRB Personnel

GUERNSEY reviewed key sections of the 1980 Plan and other pertinent reports that provided information on the previous conveyance scenarios. GUERNSEY gathered institutional knowledge by consulting with identified OWRB personnel.

Task 4: Identify and Select Alternative Interconnected System Routes

Based on the information collected/discussed in Task 3, GUERNSEY prepared ***conceptual, high level*** layouts of alternative interconnected system routes. These concepts included the following sub-tasks:

A. Updated the 1980 Plan cost for the Northern Water Conveyance System and the Southern Water Conveyance System; costs updated using the same routes and assumptions shown in Figure 97 of the 1980 Plan

B. Prepared conceptual design and cost estimate for an alternative Southern Conveyance System, using ***Lake Texoma*** as a raw water source; determined the feasible routing and capacity required to supply water to southwestern Oklahoma using Lake Texoma as a source. Conveyance to central Oklahoma was not included because of the raw water study and other efforts addressed by Oklahoma City and others.

C. Prepared conceptual design for an alternative Western Conveyance System using ***Lake Texoma*** as a raw water source. Conveyance to central Oklahoma was not included, as described above; determined the feasible routing and capacity required to supply water to western Oklahoma using Lake Texoma as a source.

D. Prepared conceptual design for an alternative Western Conveyance System using ***Lake Eufaula and the Arkansas River system*** as a raw water source. Conveyance to central Oklahoma was not included, as described above; determined the feasible routing and capacity required to enable the Northern Water Conveyance System to serve southwestern Oklahoma.

E. Prepared conceptual design for an alternative Northern Conveyance System using ***Kaw Lake*** as a raw water source. Additionally, in the meeting of June 16, 2009, OWRB personnel indicated that evaluating opportunities to northeastern Oklahoma should also be included; determined the feasible routing and capacity required to supply water to western and northeastern Oklahoma using Kaw Lake as a source.

F. Tabulated conceptual cost estimates for each feasible alternative

G. Analyzed the feasibility of each identified alternative

Task 5: Prepare Water Conveyance Report

GUERNSEY prepared this draft report for review by the OWRB. Organization of draft is as follows:

- Executive Summary
- Table of Contents
- Purpose, Goals, and Objectives
- Methodology
- Alternative Water Conveyance System Alignments
- Cost Estimates
- Feasibility Analysis
- Conclusions and Recommendations
- Appendix A – Kick-Off Meeting Agenda and Notes
- Appendix B – Bibliography
- Appendix C – Energy Cost Estimations
- Appendix D – Cost Estimate Details

Task 6: Address OWRB Comments and Prepare Final Water Conveyance Report

GUERNSEY will address consolidated comments from OWRB on the draft report and prepare a final report.

2.0 METHODOLOGY

This study consisted of numerous activities designed to efficiently and effectively collect and analyze data. The following section provides details of the implemented activities.

2.1 KICK-OFF MEETING

A kick-off meeting, held on September 28, 2009, focused on gathering input and informing all parties of the overall project requirements. The meeting also discussed the goals and objectives of the study and the content of the completed report to the study.

Appendix A presents the agenda and meeting notes for the kick-off meeting. The appendix also contains a list of the goals and objectives and the proposed Table of Contents discussed at the meeting.

2.2 DATA COLLECTION

Chapter VI *Statewide Water Conveyance System* of the 1980 Plan contains information on the two proposed water conveyance systems. For each system, the information provided includes:

- A general description of the system
- A plan of the conveyance route and location of pumping plants and reservoirs
- The volume of conveyed water and allocation to the terminal reservoirs
- Pertinent data on the conveyance system (design capacity, pipe lengths, siphon lengths, canal lengths, pumping plant size)
- Alternative water conveyance systems considered
- Cost estimates for the system
- An overview of how the cost estimates were prepared

The 1980 Plan is therefore the starting point for updating the cost associated with the original proposed water conveyance systems and for estimating costs of the identified feasible alternative conveyance systems (Section 1.2). However, the 1980 Plan does not go into detail as to the derivation of the capacity and cost for each component within the systems.

The US Army Corps of Engineers (USACE) and the Bureau of Reclamation (BOR) jointly derived the components, routes, capacities, and costs associated with each conveyance system in the 1980 Plan. For both the Northern and Southern Water Conveyance Systems, USACE addressed the eastern half of the system and BOR focused on the western half of the system; therefore, these two organizations or OWRB should have copies of the data used to size and cost the systems.

Data collection involved making direct contact with each organization to request any data pertaining to the water conveyance systems. BOR and OWRB provided information through simple data requests and interaction. USACE provided information via a formal request made through the Freedom of Information Act (FOIA).

Appendix B provides a list of the obtained documents, and Table 1 lists the documents obtained by organization and conveyance system that support the 1980 Plan.

TABLE 1 - SUPPORT DOCUMENTS TO 1980 PLAN OBTAINED

CONVEYANCE SYSTEM	BOR		USACE
	SUPPORTING DATA	ENGINEERING APPENDIX	WATER TRANSFER SYSTEM
Northern	Yes	Yes	Yes
Southern	Yes	Not Available	Not Available

There are three support documents related to the Northern Water Conveyance System, but only one document related to the Southern Water Conveyance System. It is reasonable to assume that both BOR and USACE produced the same documentation for each water conveyance system, and so two documents relating to the Southern Water Conveyance System are missing. However, it is clear from a review of these documents that there was a consistent approach on the sizing and costing of the two systems, therefore design parameters that are available in the documents relating to the Northern Water Conveyance System are applicable to the design of the Southern Water Conveyance System.

The document review also indicated that the conveyance system routes had been prepared on US Geological Survey (USGS) topographical sheets with scales of 1:24,000 and 1:62,500. As no organization provided any sheets, it is reasonable to assume that they are missing.

In addition to the documentation identified in Table 1, one BOR document[1] from 1974 contained design and cost data for three alternative conveyance systems to serve southwestern Oklahoma. The document review shows that the basis for part of the Southern Water Conveyance System in the 1980 Plan is an updated version of one of these alternatives.

2.3 STANDARDIZED DESIGN ELEMENTS

As discussed in Section 2.2, the design of the individual elements that constitute the conveyance systems in the 1980 Plan are consistent in the parameters used to size the elements. This section describes the design parameters used to size each element in the 1980 Plan, and changes to those design parameters used in deriving element sizes for the alternative conveyance system alignments.

The individual elements that constitute the conveyance systems are:

- Water sources
- Pumping Plants
- Pressure Pipes
- Canals
- Siphons
- Terminal storage reservoirs

In the 1980 Plan, water sources consist of both existing and authorized reservoirs, and diversion dams on rivers. The topography of Oklahoma is such that the land slopes from western

[1] *Oklahoma State Water Plan Southwest 20 Counties*

Oklahoma to eastern Oklahoma, and as water conveyance is in the opposite direction, pumping plants are required to convey the water uphill through pressurized pipes. Where topography allows, the pipes discharge into canals and water flows under gravity to reduce pumping costs. Where a canal must cross an obstruction such as a highway, railroad, or river, inverted siphons convey the water under the obstruction from the end of one canal section to the start of the next, again to minimize pumping. Eventually topography dictates that a canal is no longer feasible and that pumps are required to convey it over higher ground. The conveyance system therefore consists of a series of pumping plants, pressure pipes, canals, and siphons to transport the water to the terminal reservoirs. In some instances, one terminal reservoir acts as a water source to feed another terminal reservoir.

The following sections provide the design parameters used to size each element.

2.3.1 PUMPING PLANT

The assumptions used in sizing the pumping plants in the 1980 Plan are as follows:

- Each pumping plant consists of nine vertical pumps, with an efficiency of 72%
- Plant capacity is the total required capacity plus 10% to account for loss of capacity due to sediment wear on the pumps
- Plant total dynamic head (TDH) consists of static head, discharge pipeline losses based on 0.00095 ft head per ft of pipe length, and 15 feet of losses through the plant

2.3.2 PRESSURE PIPES

The equation used to calculate pressure pipe diameters in the 1980 Plan was Manning's open channel flow equation, but rearranged to take into account a circular conduit flowing full and to express the result in terms of pipe diameter:

$$D^{2.67} = Q\,n/0.463\,S^{0.5}$$

where:

D = Pipe diameter (ft)
Q = Capacity (ft^3/s)
n = Manning roughness coefficient, taken as 0.014
S = Slope of energy line (ft/ft), taken as 0.00095

The 1980 Plan and supporting documents do not state the pipe diameters for each section of pressure pipe, but since it does state the capacity for each section, it was possible to calculate the required pipe diameter for each section. Some of the pipe diameters are in excess of 15 ft; however, standard pipe diameters for various pipe materials do not exceed either 12 ft (concrete and steel) or 13 ft (fiber-reinforced plastic). While manufacture of larger pipe diameters in these materials has been undertaken, this is uncommon and finding a manufacturer with the appropriate facilities may be problematic, making the pipe relatively expensive.

The alternative to these non-standard pipes is to install more than one standard diameter pipe such that the combined capacity of these pipes is equivalent to the required capacity. Adoption of this alternative also made the estimation of pipe costs easier, since unit costs are readily available for standard diameter pipe. Table 2 provides the capacities of standard diameter pipes with 12 ft selected as the largest standard diameter pipe, and using the Manning Equation with the stated values for n and S.

TABLE 2 - CAPACITY OF STANDARD DIAMETER PIPES

DIAMETER D (ft)	CAPACITY Q (ft^3/s)
4	41
5	75
6	122
7	183
8	262
9	358
10	475
11.5	689
12	772

2.3.3 SIPHONS

In the 1980 Plan, the design criterion for siphons is to achieve a velocity within the range of 5 to 10 ft/s. As with the pressure pipes, the 1980 Plan and supporting documents do not state the diameter of each section of siphon. However, it does state the capacity for each section, and so it was possible to calculate a range of siphon diameters for each section, with final selection based upon siphon diameters that achieved a velocity within the range of 5 to 8 ft/s. This provides a conservative design, since the lower velocity siphons require a larger diameter than the higher velocity siphons. As with the pressure pipes, the combination of more than one standard diameter siphons provided the equivalent capacity of non-standard, large diameter siphons.

2.3.4 CANALS

The equation used to calculate canal sections in the 1980 Plan was the Manning open channel flow equation:

$$Q = (1.49/n)\ A\ R^{0.67}\ S^{0.5}$$

where:

Q = Capacity (ft^3/s)
n = Manning roughness coefficient
A = Area of flow (ft^2)
R = Hydraulic radius (ft)
S = Slope of energy line (ft/ft)

Figure 1 shows the typical canal cross-section, taken from the supporting documents, used in the design of the canals. The assumptions made in the 1980 Plan to calculate canal sections are as follows:

- The Manning roughness coefficient is either 0.014 or 0.015
- The slope of the canals (S) is 0.001 ft/ft

- The canal sides have a slope of 1.5 to 1, and have a 3-inch thick concrete lining
- The canal width to depth of flow ratio is in the range 1.2 to 1.5
- The seepage loss through the canal is 0.15 ft^3 per ft^2 of wetted perimeter
- Water conveyance occurs over an 11-month (330 day) period

2.3.5 DIVERSION DAMS

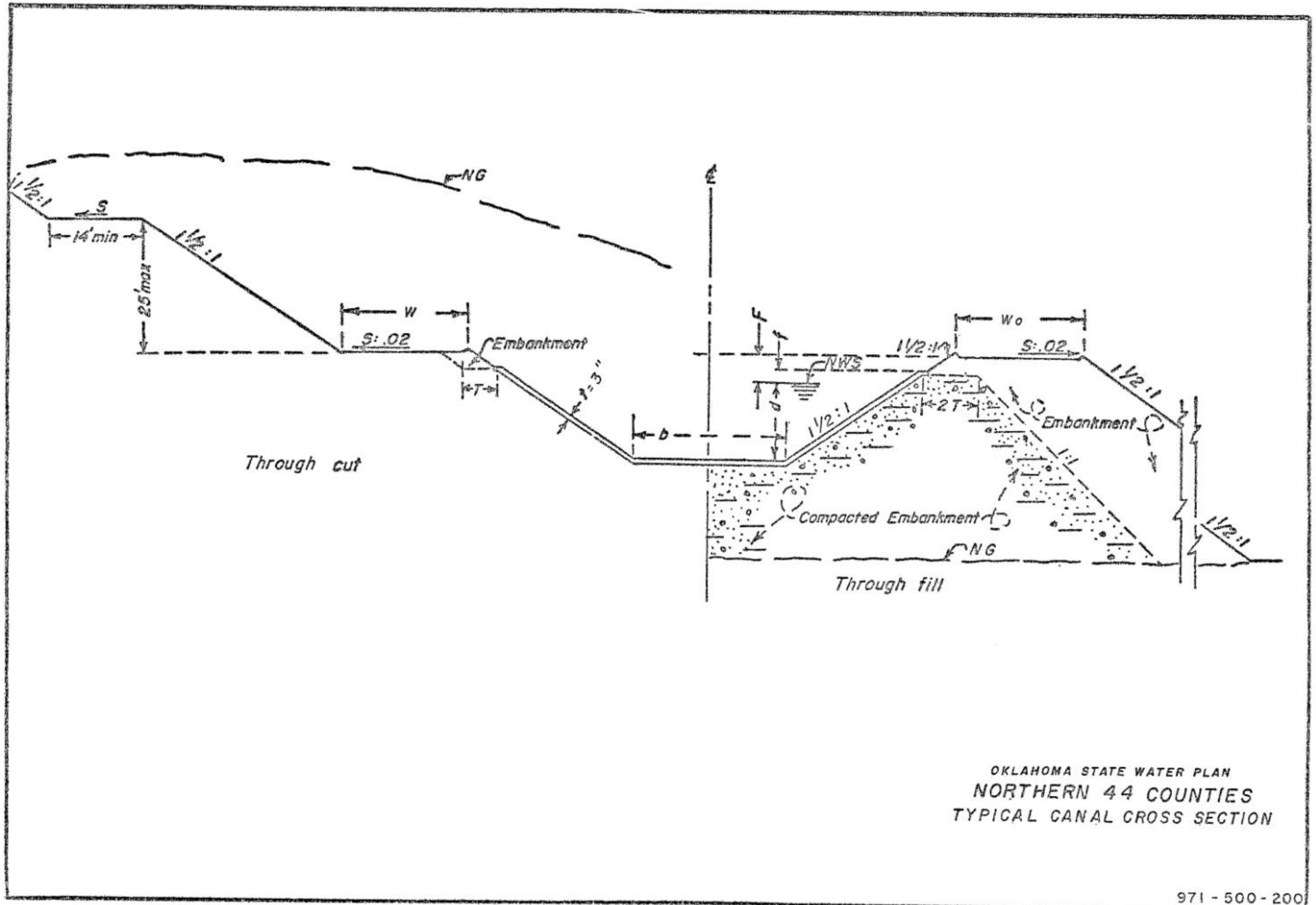
The 1980 Plan and the supporting documents do not state the design criteria for diversion dams, other than the amount of water provided to the conveyance system.

2.3.6 RESERVOIRS

The assumptions used in the design of reservoirs in the 1980 Plan are as follows:

- Dam and reservoir geology are adequate
- Dam embankments have a crest width of 30 feet, an upstream slope of 3 to 1, and a downstream slope of 2 to 1
- Dam embankment construction consists of rolled earth fill
- Spillway sizing based on routing the appraisal design flood using the Modified Puls Method (undertaken by USACE), and using automatic float controlled radial gates with a 10 to 1 opening ratio. Routing of floods started at the top of the flood control pool for reservoirs with flood control, and at the top of the conservation pool for reservoirs without flood control.
- Spillway size and elevation provides 6 feet of freeboard to dam crest at maximum water elevation
- River outlet works sizing based on evacuating the reservoir volume below the spillway crest in approximately four weeks
- Municipal, industrial and irrigation outlet works sizing based on individual demands
- Acres of cleared land estimated as a percentage of the area at the top of the conservation pool, or obtained from previous studies
- Relocate or abandon all facilities, except pipelines, as identified by previous studies or on USGS topographical sheets. Alter pipelines located within the reservoir.
- Right-of-way estimated by increasing the maximum water surface area by 50%

FIGURE 1 - TYPICAL CANAL CROSS-SECTION



The supporting documents provide the storage volumes and surface areas at different elevations for individual reservoirs. The 1980 Plan includes the modification of some existing reservoirs. The supporting documents for the Northern Water Conveyance System state the nature of the modifications for each affected reservoir, but the supporting documents for the Southern Water Conveyance System provide no such information.

2.4 STANDARDIZED COST ELEMENTS

To complement the consistent use of design parameters, the 1980 Plan also uses consistent cost parameters to derive the estimated costs of the individual water conveyance elements. These cost estimates cover not only construction costs, but also include, where appropriate, operational, maintenance, energy, and replacement costs.

This section describes the cost parameters used to estimate the cost of each element in the 1980 Plan, and changes to those cost parameters used to update the costs to present day (2010) costs and to derive costs for the alternative conveyance system alignments.

2.4.1 PUMPING PLANT

The 1980 Plan used a computer program to estimate the pumping plant construction cost with data taken from a BOR manual (Reclamation Instructions, Series 150, Appendix A). Neither the 1980 Plan nor the supporting documents identify the used data, so the cost parameters used to estimate the construction cost are unknown.

To estimate right-of-way (ROW) costs, the 1980 Plan assumed a fee simple purchase at $500/acre, based on the land requirements given in Table 3.

TABLE 3 - PUMPING PLANT ROW REQUIREMENTS

PUMPING PLANT CAPACITY (ft^3/s)	LAND REQUIRED (ACRES)
< 100	5
100 – 200	10
201 – 1000	15
> 1000	25

To estimate operation and maintenance (O&M) costs, the 1980 Plan used another computer program, with data based on a publication entitled "Pumping Plant Operation and Maintenance Costs" by John M. Eyer, and dated May 1965. The O&M costs included replacement costs for pumping plants requiring less than 7,000 hp. Neither the 1980 Plan nor the supporting documents state the used data, so the cost parameters used to calculate O&M costs are unknown. For larger pumping plants, the replacement costs consisted of a three-mill rate ($0.003) per dollar of pump field cost.

To estimate energy costs, the 1980 Plan used a 30-mill rate ($0.030) per kilowatt-hour (kWh) of consumed electricity, and assumed that this rate covers the cost of installing transmission lines and substations to provide electricity to the pumping plants.

The equation used to calculate energy consumption is:

$$kWh = 1.025\ Q\ H\ (1.05) / \xi$$

where:

Q = Amount of water pumped per year (AF/yr)
H = Plant TDH (ft)
1.05 = Allowance of 5% for auxiliary power
ξ = Plant efficiency (72%)

2.4.2 PRESSURE PIPES

To estimate pipe construction costs, the 1980 Plan used two sets of cost curves to derive a unit base cost per linear foot of pipe. One set of curves is for pipe diameters in the range of 1 ft to 9 ft, and the other set of curves covers the range of 6 ft to 26 ft. Each curve set contains five curves, with each curve representing a pipe working pressure at 50 ft intervals over the range of 50 ft to 250 ft. In addition, one supporting document contained a table of costs for pipe diameters in the range of 18 inches to 120 inches for the five different working pressures. This document states that the costs assume the pipe has 5 ft of cover to the ground surface.

The unit base costs given in the cost curves include pipe, earthwork, and an allowance for structures and crossings. The unit field costs included the addition of allowances to the base unit cost of 10% for unlisted items and 20% for contingencies, but excluded ROW.

To estimate ROW costs, the 1980 Plan assumed a fee simple purchase at $500/acre, based on the land requirements given in Table 4.

TABLE 4 - PRESSURE PIPE ROW REQUIREMENTS

PIPE CAPACITY (ft^3/s)	ROW WIDTH (ft)
< 150	50
150 – 500	100
501 – 1000	150
> 1000	200

2.4.3 SIPHONS

The 1980 Plan used two methods for estimating unit base costs per linear foot of siphon; a computer program for siphon diameters of up to 10 ft, and a set of cost curves for siphon diameters over 10 ft. The curve set contains seven curves, with each curve representing a siphon working pressure over the range 25 ft to 250 ft. The unit base costs given in the curves include furnishings and placing. The unit field costs included the addition of allowances to the base unit cost of 10% for unlisted items and 20% for contingencies, but excluded ROW.

Neither the 1980 Plan nor the supporting documents state the data used in the computer program, so the cost parameters used to estimate the construction cost for the smaller diameter siphons are unknown. In addition, they do not state the siphon working pressures. For large diameter siphons, while it is possible to determine unit base costs from the cost estimates stated in the documents for each stated length of siphon, it is difficult to determine the exact siphon working pressure used in the cost curve. The sizing of a siphon (Section 2.3.3) permits a range of diameters; therefore, it is possible to derive the unit base cost from different combinations of pipe diameter and working pressure.

To estimate ROW costs, the 1980 Plan assumed a fee simple purchase at $500/acre, based on the same land requirements as pressure pipes (Table 4).

The 1980 Plan assumed that O&M costs for siphons are minimal and covered by the canal cost estimates.

2.4.4 CANALS

To estimate canal construction costs, the 1980 Plan used two cost curves to derive a unit field cost per mile of canal, since the curves include concrete lining, earthwork, structures, ROW, a 10% allowance for unlisted items, and a 20% allowance for contingencies. One cost curve is for cross-sectional areas of water in the range of zero to 2,500 ft^2, and the other cost curve covers the range of 2,000 ft^2 to 6,000 ft^2.

To estimate canal O&M costs, the 1980 Plan used a five-mill rate ($0.005) per dollar of canal field cost.

2.4.5 DIVERSION DAMS

The 1980 Plan and the supporting documents do not state the cost estimating criteria for diversion dams, other than the total cost of each dam.

2.4.6 RESERVOIRS

To estimate the construction cost of an earth dam structure, the 1980 Plan used a single cost curve that provides unit field costs per cubic yard of embankment for structures with total embankment volumes up to 100 million cubic yards. The cost curve represents average field costs based on obtaining embankment material within one mile of the dam site, and includes:

- Diversion and care of the river during construction
- Contingencies
- Allowance for foundation treatment

The items not included within the curve are:

- An allowance for hauling embankment material more than one mile
- Land and rights
- Relocations
- Clearing
- Access and service facilities
- Investigations
- Construction engineering
- Design and specification
- Construction supervision
- Other general expenses
- An allowance for unlisted items

The final unit field cost included an allowance of 10% to account for unlisted items.

To estimate the construction cost of a spillway for earth dams, the 1980 Plan uses a single cost curve that provides total unit field cost for a range of values of a spillway characteristic determined as follows:

$$\text{Head (feet)} \times \sqrt{\text{Capacity (ft}^3\text{/s)}}$$

where the head is assumed to be the difference in elevation between maximum reservoir water surface and a point 10 ft above stream bed. The final field cost included an allowance of 10% for unlisted items, and a 20% allowance for contingencies.

The estimation of construction costs for outlet works for earth dams followed the same procedure used for spillways, but using a different cost curve.

To estimate construction costs associated with clearing land, the 1980 Plan assumed a unit base cost of $250/acre. The final unit field cost included an allowance of 10% for unlisted items, and a 25% allowance for contingencies.

To estimate construction costs associated with relocations, the 1980 Plan used two different methods. Estimation of pipeline alteration costs used a cost curve for pipe diameters in the range of 6 ft to 30 ft to obtain unit field costs per linear foot of pipeline. For all other items, estimation used the following unit costs:

- Power lines: 69 kVA at $40,000/mile
138 kVA at $58,000/mile
- Cemetery: $750/grave
- Primary highways (2-lane): Insider reservoir at $440,000/mile
Outside reservoir at $350,000/mile
- County roads: Graveled (inside reservoir) at $150,000/mile
Graveled (outside reservoir) at $75,000/mile
- Bridges (H-20 loading): $32/ft^2
- Railroads (single track, 130 lb/ft rail): $490,000/mile, bridges at $900/ft
- Gas and oil production: $25,000 each

To estimate ROW costs, the 1980 Plan used an average cost per acre obtained from a US Department of Agriculture publication containing real estate values in Oklahoma, and then modified it by applying a percentage for different regions of the state. The unit base cost was $351, and Table 5 gives the percentages used. The unit field costs included the addition of allowances to the unit base costs of 10% for unlisted items, and 25% for contingencies.

TABLE 5 - RESERVOIR ROW PERCENTAGE MODIFIER

REGION	PERCENTAGE MODIFIER
Panhandle	64%
West Central	91%
Southwest	93%

REGION	PERCENTAGE MODIFIER
North Central	144%
Central	106%
South Central	83%
Northeast	105%
East Central	81%
Southeast	87%

To estimate reservoir OM&R costs, the 1980 Plan used a single cost curve that provides annual costs per acre-foot of controlled storage, which is derived from the 1970 Kansas State Water Plan, BOR Instructions, Series 150, Part 153, and existing Oklahoma reservoirs. The final annual costs used included an allowance of 25% for administrative and general expenses.

2.4.7 OTHER COSTS

In addition to the estimated field costs associated with the individual components of a water conveyance system, the 1980 Plan also estimated additional system construction costs. These costs include an allowance for automation and archeology. The automation allowance was 4% of the total field costs of the canals, siphons, pumping plants, pipelines and ROW, while the archeology allowance was 0.5% of the total field costs including automation. On top of the above, the final total cost estimate included an allowance of 25% of the total field costs for indirect costs.

2.5 UPDATE OF THE 1980 PLAN COSTS

The price base used in the 1980 Plan in the production of cost estimates is January 1978. Therefore, one method used to update the cost estimates to 2010 prices was the use of cost indexes. These provide a ratio for costs in one period in time against the costs of a base year.

2.5.1 USACE COST INDEX SYSTEM

One relevant index is the USACE Civil Works Construction Cost Index System (CWCCIS). The purpose of this document (updated every quarter) is to provide historical and forecasted cost indexes for use in escalating civil works project cost. The system provides indexes for 19 categories of civil engineering work undertaken by USACE, and a weighted average composite index based on these categories. The system base year is 1967, and the base cost index for each category is 100.

The system provides yearly cost indexes from fiscal year (FY) 1968, and quarterly cost indexes from first quarter of FY 1980. Since the 1980 Plan cost estimates occurred prior to 1980, the yearly cost indexes had to be used to update the costs. Table 6 shows the FY 1978 and FY 2010 cost indexes for four relevant civil engineering categories and the composite index. The ratio of the FY 2010 cost indexes to the FY 1978 cost indexes provides the multipliers (shown in Table 6) applied to the FY 1978 cost estimates to arrive at the FY 2010 cost estimates.

TABLE 6 - COST MULTIPLIERS, FY 2010: FY 1978

USACE CWCCIS COST INDEXES			COST MULTIPLIERS
FEATURE CODE	FY 1978	FY 2010	FY 2010 : FY 1978
03 Reservoirs	243.39	780.98	3.21
04 Dams	234.29	711.59	3.04
09 Channels & Canals	230.44	728.64	3.16
13 Pumping Plant	235.78	709.18	3.01
Composite Index	234.58	716.68	3.06

The assumptions associated with the use of cost multipliers to update the 1980 Plan costs are as follows:

- The cost multiplier used for pipe and siphon construction costs is the Channels & Canals cost multiplier
- The cost multiplier used for ROW construction costs is the composite cost multiplier
- The cost multipliers used for canal, pumping plant and reservoir OM&R costs are their respective cost multiplier
- The cost multiplier used for pumping plant energy costs is the composite cost multiplier

This last assumption leads to a 2010 energy rate of $0.0918 per kWh of consumed electricity. Validation of this rate involved comparing it against a range of estimated energy rates derived from the current charge structure of four Oklahoma rural electric cooperatives for six scenarios based on a combination of the following assumptions:

- A generation cost of either $0.05 or $0.065 per kWh
- A load factor of 30%, 50% or 70%

Appendix C presents the calculated energy rate of each cooperative, and the average rate of the four cooperatives, for each scenario. The highest average energy rate was $0.0795 per kWh, which is less than the estimated rate using the cost multiplier. Using the cost multiplier rate will cover the cost of installing transmission lines and substations.

2.5.2 RSMEANS CONSTRUCTION COST DATA

One of the sources used by USACE in developing and updating the CWCCIS is construction cost data published in books by RSMeans. These cost-estimating books, updated annually, contain information such as total cost and unit cost data for labor, materials, and equipment, for individual elements that make up a civil engineering task. This allows for the building of a cost estimate for a particular task from scratch. For example, the cost estimate to install a pipeline could consist of estimating the individual costs to clear the route, remove topsoil, excavate the trench, place the pipe and bedding, backfill the trench, replace the topsoil and re-seed the route.

Therefore, instead of updating the existing costs, this method used the latest edition of a relevant RSMeans publication, *Site Work & Landscape Cost Data*, to estimate 2010 construction costs from scratch. This allowed a comparison with the construction costs obtained using the USACE CWCCIS to see how realistic they were.

This publication is only relevant for the construction of the pipelines, siphons, and canals. This costing method required the assumption of certain parameters in addition to those stated in Sections 2.3 and 2.4.

Assumptions made in the derivation of base unit cost per linear foot of pressure pipes were:

- The pipe material is pre-stressed concrete cylinder pipe (PCCP) conforming to AWWA C301 standard, with a pressure rating of 150 psi
- For single pipes, the trench width is the pipe outside diameter, plus two feet (one foot either side of the pipe)
- For multiple pipes in the same trench, the trench width is the sum of the pipe outside diameters, plus three feet of separation between the pipes, plus two feet (one foot on the outer side of the outer pipes)
- Trench sides have a slope of 1 to 1
- Topsoil stripping of the full width of the ROW (Section 2.4.2) to a depth of 6 inches, and stockpiled on site
- The excavated material is common earth, with no sheeting or dewatering
- The pipes are backfilled and compacted in six-inch lifts, with minimal haul of backfill material
- Excess material is hauled a maximum of four miles
- The equipment size selected to carry out topsoil stripping, excavation, backfill and compaction can match or exceed the daily output of the pipe laying crew
- Costs include the installation contractor's overhead and profit. This consists of the sum of the bare material cost plus 10% for profit, the bare labor cost plus total overhead and profit, and the bare equipment cost plus 10% for profit.

The assumptions made in the derivation of base unit costs per linear foot of siphon are the same as those assumed for pressure pipe listed above, and that the depth of burial is also the same (5 ft) as that assumed for pressure pipes.

Assumptions made in the derivation of base unit costs per linear foot of canal were:

- The length of each canal section consisted of 75% of cut, and 25% of fill. The topographical maps used to determine the routes are not available (Section 2.2), therefore the exact lengths of cut and fill are unknown.
- For embankment sections, the depth of the canal below ground level would equal the depth to invert of the pressure pipe feeding the canal
- For fill sections, the depth of fill above ground level to the bottom of the canal would be 5 ft

- The freeboard from the top water level to the top of the concrete lining (dimension 'f' in Figure 1) would be 1 ft
- The width of the flat sections adjacent to the top of the canal (dimension 'W" in Figure 1) would equal the width of the channel
- From the outer edge of the flat sections, the cut or fill would have a slope of 1.5 to 1 until it reaches the original ground level
- The excavated material in cut sections is common earth, and re-used as fill material for embankment sections, with a two-mile haul cycle
- The concrete liner consists of 3 inches of fiber-reinforced shotcrete (wet-mix)
- Fill material in embankment sections is compacted in six-inch lifts

The unit costs data given in the RSMeans book are US national averages. However, the book provides location factors to adjust the cost data to account for the local economy; for Oklahoma, it gives material and installation factors for 15 cities throughout the state. For each conveyance system, the derivation of local costs involved averaging the location factors from the cities closest to the system route, and applying them to the base unit costs.

The final unit field costs for pressure pipes and siphons included an allowance of 20% for contingencies. This is the contingency recommended by RSMeans for conceptual stage cost estimates. The final unit field costs for canals included the same 20% allowance for contingencies, but a further 10% allowance for unlisted items, such as ROW costs, which are included within the unit field costs used in the 1980 Plan.

Estimation of field costs for pumping stations and reservoirs involved comparing the estimated field costs for the pipelines, siphons and canals using this method against the same costs estimated using the CWCCIS to derive a ratio between the two values, and applying it to the CWCCIS pumping station and reservoirs estimations. Final construction costs included the additional system construction costs listed in Section 2.4.7.

3.0 ALTERNATIVE WATER CONVEYANCE SYSTEM ALIGNMENTS

This section details the components and alignment of the conveyance systems given in the 1980 Plan, plus alternative conveyance systems considered in this study.

3.1 1980 PLAN - NORTHERN WATER CONVEYANCE SYSTEM

Figure 2 is a reproduction of Figure 97 from the 1980 Plan, and shows the components and alignment of the Northern Water Conveyance System. The split between the USACE and BOR in terms of design responsibility (Section 2.2) occurs at Pumping Plant #28, located in Lincoln County.

The Northern Water Conveyance System involves “scalping” and conveying surplus flows from the Canadian River and Arkansas River basins (initially obtained from Lake Eufaula and then supplemented from Robert S. Kerr Lake) through north central and northwestern Oklahoma to the North West and North Central Planning Regions. Surplus flows are only available at certain parts of the year; therefore maintaining a dependable water source for the system involves conveying these flows to a proposed regulating storage reservoir, the 800,000 acre-feet Welty Lake, which will meet the conveyance demands. Due to the loss of storage through sedimentation at Lake Eufaula, available surplus flows will decrease over time. To make up for this loss, the ultimate system involves diverting part of the surplus flows from Robert S. Kerr to a proposed regulating storage reservoir, the 200,000 acre-feet Vian Creek Lake, which would release flows back into Robert S. Kerr when conveyance of flows are dependent upon this release.

Conveyance from the supply and regulating reservoirs to nine terminal storage reservoirs requires a network of 42 pumping plants, and approximately 710 miles of canals and inverted siphons, and 140 miles of pipelines. Terminal storage consists of utilizing three existing reservoirs (Canton, Fort Supply, and Optima), and constructing six proposed reservoirs (Alva, Boise City, Cestos, Goodwell, Slapout, and Sheridan). Of the existing reservoirs, only Fort Supply requires modification (raising the dam three feet) to hold the volume of conveyed water.

A proposed supply reservoir at Englewood would complement the supply system by feeding into the Slapout reservoir.

Table 7 provides the projected 2040 water deficit for each county served by this conveyance system, with an overall deficit for the counties listed of 1,076,500 acre-feet per year. The system only serves Garfield County in the North Central planning region (the only county with a net deficit that cannot be supplied by local sources), and does not serve Blaine County in the North West planning region (supplied from the proposed non-system Hydro reservoir). The firm yield of the storage reservoirs provides a small percentage of the water required to meet the deficit. The required conveyance capability of the system is 1,070,400 acre-feet per year, with 1,034,000 acre-feet per year supplied by the main conveyance system and 36,000 acre-feet per year supplied by Englewood reservoir to Slapout reservoir. Considering conveyance losses, the design capacity of the conveyance system is 1,209,800 acre-feet per year (1,172,800 acre-feet per year for the main conveyance system, 37,000 acre-feet per year from the Englewood reservoir). Englewood would also supply 31,200 acre-feet per year to Harper County, which would not require the use of the conveyance system.

FIGURE 2 - STATEWIDE WATER CONVEYANCE SYSTEM

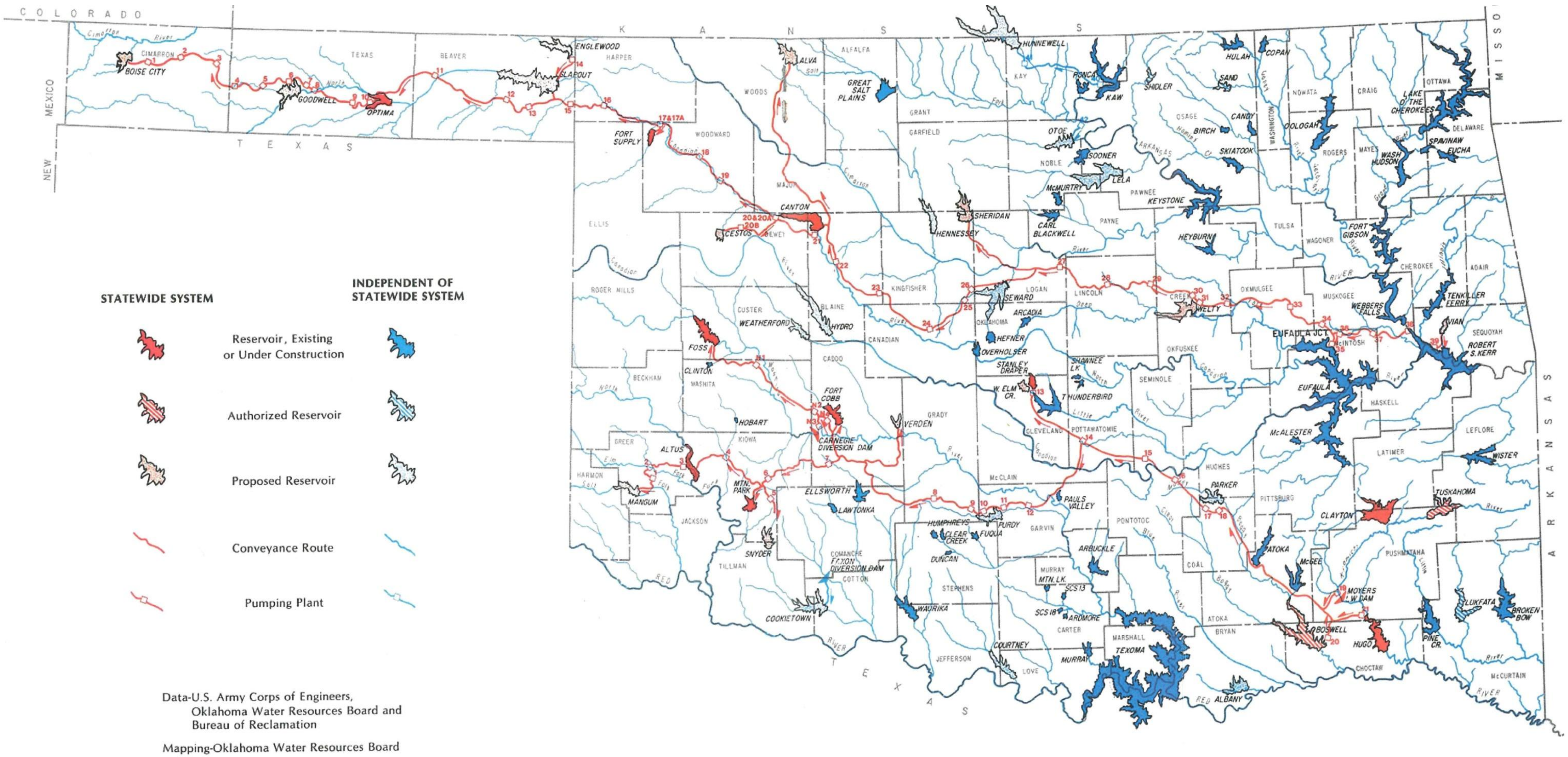


FIGURE V- STATEWIDE WATER CONVEYANCE SYSTEM

Including Proposed Local Projects

TABLE 7 - 1980 PLAN, PROJECTED 2040 DEFICIT BY COUNTY, NORTHERN WATER CONVEYANCE SYSTEM

REGION	COUNTY	DEFICIT (AF/Yr)	SUPPLY RESERVOIR
North Central	Garfield	98,200	Sheridan
North West	Alfalfa	49,000	Alva
	Beaver	113,800	Optima & Slapout
	Cimarron	342,000	Boise City
	Dewey	6,600	Canton
	Ellis	52,400	Cestos
	Harper	31,200	Englewood
	Major	8,000	Canton
	Texas	323,500	Goodwell
	Woods	35,500	Alva
	Woodward	16,300	Fort Supply
TOTAL		**1,076,500**	

Table 8 contains information on the individual components of the conveyance system. The table shows the system capacities to Welty Lake both with and without chloride control, which requires a greater capacity because suitable quality water would be available on a less frequent basis, requiring a greater diversion of flows over a shorter period.

TABLE 8 - 1980 PLAN, CONVEYANCE DETAILS, NORTHERN WATER CONVEYANCE SYSTEM

REACH	CAPACITY[1] (ft^3/s)	PIPE LENGTH (MILES)	SIPHON LENGTH (MILES)	CANAL LENGTH (MILES)	TOTAL LENGTH (MILES)
#1 – Goodwell Turnout to Boise City Reservoir	566	37.5	1.0	41.5	80.0
#2 – Optima Reservoir to Goodwell Turnout	1,108	15.0	2.8	16.0	33.8
#3 – Slapout Junction to Optima Reservoir	1,174	16.8	13.0	50.0	79.8
#4 – Fort Supply Junction to Slapout Junction	1,247	12.7	0.2	34.8	47.7
#5 – Cestos Junction to Fort Supply Junction	1,303	7.9	0.2	58.8	66.9
#6 – Canton Reservoir to Cestos Junction	1,412	0.7	0.8	10.8	12.3
#7 – PP #26 to near Canton Reservoir	1,606	16.4	7.1	72.4	95.9
#8 – Triple Junction to PP #26	1,606	-	6.9	27.4	34.3
#9 – PP #28 to Triple Junction	1,790	1.7	1.7	40.4	43.8
#10 – PP #31 to PP #28	1,830	2.8	6.8	51.3	60.9
#11 – PP #35 to PP #31	4,000[1]	5.0	11.1	49.6	65.7
#12 – PP #38 to Eufaula Junction	4,000[2]	2.2	6.1	24.3	32.6
#13 – PP #39 to Vian Creek Lake	1,000[3]	0.6	1.1	2.4	4.1
#14 – Englewood Reservoir to Slapout Reservoir	57	6.1	0.1	10.0	16.2
#15 – Fort Supply Junction to Fort Supply Res.	26	5.1	-	-	5.1
#16 – Cestos Junction to Cestos Reservoir	105	8.2	0.3	26.8	35.3
#17 – Near Canton Reservoir to Alva Reservoir	90	-	17.2	69.2	86.4
#18 – Triple Junction to Sheridan Reservoir	160	-	6.4	42.2	48.6
TOTAL		**138.7**	**82.8**	**627.9**	**849.4**

[1] With chloride control
[2] Design capacity without chloride control 5,180 ft^3/s
[3] Design capacity without chloride control 5,200 ft^3/s
[4] Design capacity without chloride control 1,300 ft^3/s

Table 9 contains information on the conveyance system pumping stations. The table shows the pumping capacities both with and without chloride control. Although the pumping capacities are greater without chloride control, having to pump a greater flow over a shorter period, the total volume of pumped water remains the same as with chloride control.

TABLE 9 - 1980 PLAN, PUMPING PLANT DETAILS, NORTHERN WATER CONVEYANCE SYSTEM

PUMPING PLANT No.	STATIC HEAD (ft)	TOTAL HEAD (ft)	CAPACITY WITH Cl CONTROL (ft^3/s)	CAPACITY WITHOUT Cl CONTROL (ft^3/s)	AVERAGE PUMPED FLOWS (AF)	ANNUAL ENERGY CONSUMPTION (1,000 kWh)
1	206	255	566	-	350,000	133,410
2	124	168	566	-	352,374	88,490
3	185	247	566	-	353,448	130,498
4	263	321	566	-	355,822	170,733
5	166	195	566	-	357,396	104,175
6	112	149	566	-	359,395	80,046
7	81	108	1,108	-	690,470	111,468
8	150	174	1,108	-	691,014	179,728
9	113	181	1,108	-	694,372	187,867
10	210	247	1,108	-	695,587	256,820
11	121	180	1,174	-	725,051	195,084
12	170	216	1,174	-	729,872	235,657
13	145	169	1,174	-	733,873	185,391
14	265	311	57	-	37,047	17,222
15	216	268	1,247	-	769,785	308,379
16	140	176	1,247	-	773,858	203,589
17	133	154	1,247	-	781,499	179,899
17-A	73	113	26	-	13,300	2,247
18	146	169	1,303	-	789,682	199,489
19	72	90	1,303	-	793,569	106,760
20	98	142	1,303	-	801,547	170,137
20-A	193	216	104	-	60,271	19,460
20-B	122	169	104	-	57,059	14,414
21	120	139	1,412	-	878,917	182,618
22	96	123	1,606	-	954,262	175,450
23	314	356	1,606	-	960,638	511,200
24	50	75	1,606	-	970,295	108,779
25	113	148	1,606	-	974,128	215,506
26	79	108	1,606	-	976,045	157,570
27	90	111	1,790	-	1,068,981	177,367
28	96	113	1,790	-	1,080,439	182,499
29	104	127	1,810	-	1,090,000	182,000

PUMPING PLANT No.	STATIC HEAD (ft)	TOTAL HEAD (ft)	CAPACITY WITH Cl CONTROL (ft^3/s)	CAPACITY WITHOUT Cl CONTROL (ft^3/s)	AVERAGE PUMPED FLOWS (AF)	ANNUAL ENERGY CONSUMPTION (1,000 kWh)
30	64	83	1,820	-	1,100,000	120,000
31	124	142	1,830	-	1,100,000	206,000
32	68	89	1,970	5,150	1,300,000	152,000
33	53	72	3,980	5,160	1,310,000	124,000
34	75	100	3,990	5,170	1,320,000	173,000
35	105	124	4,000	-	682,000	111,000
36	44	65	3,980	5,180	644,000	55,000
37	84	103	3,990	5,190	652,000	88,000
38	121	137	4,000	5,200	660,000	118,000
39	200	308	1,000	1,300	211,000	92,000
TOTAL						**6,412,952**

3.2 1980 PLAN – SOUTHERN WATER CONVEYANCE SYSTEM

Figure 2 shows the components and alignment of the Southern Water Conveyance System. The split between the USACE and BOR in terms of design responsibility (Section 2.2) occurs at Pumping Plant #14, located in Pottawatomie County, with BOR deriving the conveyance system west of this pumping plant to southwest Oklahoma.

The Southern Water Conveyance System involves conveying surplus flows from the Kiamichi River basin, and from two reservoirs (the existing Hugo Lake and the authorized Boswell Lake) through central Oklahoma to the Central planning region, and through southwestern Oklahoma to the South Central and South West planning regions. The system involves supplying water to the Kiamichi River from the existing Sardis Lake and the authorized Tuskahoma Lake, and diverting it into the system near Moyers via a low-water diversion dam.

A proposed low-water diversion dam on the Washita River near Carnegie would complement the supply to the Foss reservoir by feeding into the system close to Fort Cobb reservoir.

Conveyance from the supply and regulating reservoirs to nine terminal storage reservoirs requires a network of 21 pumping plants, approximately 535 miles of canals and inverted siphons, and 40 miles of pipelines. Terminal storage consists of utilizing five existing reservoirs (Altus, Fort Cobb, Foss, Stanley Draper, and Tom Steed), and constructing four proposed reservoirs (Mangum, Snyder, Verden, and West Elm Creek). Of the existing reservoirs, only Lake Altus requires modification (provide an additional 70,000 acre-feet of conservation storage) to hold the volume of conveyed water. The 1980 Plan assumes "without" flood control storage as a project purpose.

Table 10 provides the projected 2040 water deficit for each county served by this conveyance system, with an overall deficit for the counties listed of 1,321,400 acre-feet per year. This deficit is divided between central Oklahoma (487,000 acre-feet per year) and southwest Oklahoma (834,000 acre-feet per year). The system only serves Grady County in the South Central planning region (the only county with a net deficit), and does not serve Cotton County (supplied from the proposed non-system Cookietown Reservoir) and Roger Mills County (no net deficit) in the South West planning region. The firm yield of the storage reservoirs provides a small percentage of the water required to meet the deficit.

The required conveyance capability of the system is 1,370,600 acre-feet per year, including conveyance losses. The water supplied by each water source is:

- Boswell Lake - 649,000 acre-feet per year
- Carnegie Diversion – 50,000 acre-feet per year
- Hugo Lake - 291,000 acre-feet per year
- Moyers Diversion – 380,000 acre-feet per year

Tables 11 and 12 provide information on the different components of the conveyance system. The water quality of the water sources is such that chloride control is not required.

TABLE 10 - 1980 PLAN, PROJECTED 2040 DEFICIT BY COUNTY, SOUTHERN WATER CONVEYANCE SYSTEM

REGION	COUNTY	DEMAND (AF/Yr)	SUPPLY RESERVOIR
Central	Canadian	48,000	West Elm Creek & Stanley Draper
	Cleveland	90,400	West Elm Creek & Stanley Draper
	McClain	36,100	West Elm Creek & Stanley Draper
	Oklahoma	285,600	West Elm Creek & Stanley Draper
	Pottawatomie	26,900	West Elm Creek & Stanley Draper
South Central	Grady	35,500	Verden
South West	Beckham	5,000	Foss
	Caddo	51,800	Fort Cobb
	Comanche	10,600	Snyder
	Custer	10,600	Foss
	Greer	44,400	Mangum
	Harmon	60,000	Mangum
	Jackson	228,800	Altus, Tom Steed & Snyder
	Kiowa	125,200	Fort Cobb, Foss & Tom Steed
	Tillman	224,600	Snyder
	Washita	37,900	Foss
TOTAL		**1,321,400**	

TABLE 11 - 1980 PLAN, CONVEYANCE DETAILS, SOUTHERN WATER CONVEYANCE SYSTEM

REACH	CAPACITY (ft^3/s)	PIPE LENGTH (MILES)	SIPHON LENGTH (MILES)	CANAL LENGTH (MILES)	TOTAL LENGTH (MILES)
#1 – Cooperton Diversion to Tom Steed Reservoir	140	-	-	6.1	6.1
#2 – Lake Altus to Mangum Reservoir	136	0.7	1.0	36.5	38.2
#3 – Cooperton Diversion to Lake Altus	220	1.4	1.7	33.4	36.5
#4 – Cooperton Diversion to Snyder Reservoir	537	0.6	1.5	12.6	14.7
#5 – Pine Ridge Diversion to Cooperton Diversion	915	2.5	1.3	39.6	43.4

REACH	CAPACITY (ft^3/s)	PIPE LENGTH (MILES)	SIPHON LENGTH (MILES)	CANAL LENGTH (MILES)	TOTAL LENGTH (MILES)
#6 – Carnegie Confluence to Foss Reservoir	290	4.8	9.9	57.4	72.1
#7 – Carnegie Diversion Dam to Carnegie Confl.	200	0.2	0.5	3.7	4.4
#8 – Fort Cobb Turnout to Carnegie Confluence	92	0.8	-	10.8	11.6
#9 – Fort Cobb Feeder	150	-	-	2.4	2.4
#10 – Pine Ridge Diversion to Fort Cobb Turnout	242	-	3.3	10.1	13.4
#11 – Verden Junction to Pine Ridge Diversion	1,166	-	-	11.5	11.5
#12 – Verden Junction to Verden Reservoir	46	-	7.1	21.6	28.7
#13 – Wayne Pickup to Verden Junction	1,250	1.2	9.1	81.6	91.9
#14 – Main Canal to Wayne Pickup	1,250	14.3	-	-	14.3
#15 – PP #14 to PP #13	681	0.8	-	27.9	28.7
#16 – Moyers Canal to PP #14	1,825	2.8	-	124.9	127.7
#17 – PP #19 to Main Canal	526	0.3	-	9.1	9.4
#18 – PP #20 to Moyers Canal	1,330	6.5	-	8.3	14.8
#19 – PP #21 to Boswell Pipeline	387	8.6	-	3.0	11.6
TOTAL		**45.5**	**35.4**	**500.5**	**581.4**

TABLE 12 - 1980 PLAN, PUMPING PLANT DETAILS, SOUTHERN WATER CONVEYANCE SYSTEM

PUMPING PLANT No.	STATIC HEAD (ft)	TOTAL HEAD (ft)	CAPACITY (ft^3/s)	AVERAGE PUMPED FLOWS (AF)	ANNUAL ENERGY CONSUMPTION (1,000 kWh)
1	50	66	150	89,000	8,780
2	74	92	150	89,000	12,239
3	40	56	150	89,000	7,450
4	70	92	244	145,300	19,982
5	33	51	591	351,500	26,796
6	50	66	1,006	602,200	59,411
7	147	173	1,006	602,200	155,728
N-1	220	255	319	189,800	72,346
N-2	79	98	319	189,800	27,804
N-3	186	202	220	50,000	15,097
N-4	80	99	101	60,200	8,909
8	131	148	1,375	818,200	181,010
9	78	94	1,375	818,200	114,966
10	39	55	1,375	818,200	67,267
11	131	148	1,375	818,200	181,010
12	40	56	1,375	818,200	68,490
13	98	110	680	493,000	65,000
14	105	120	680	493,000	71,000
-[1]	8	170	1,150	814,000	170,000
15	98	120	1,830	1,322,000	192,000
16	110	110	1,830	1,322,000	176,000
17	96	100	1,830	1,322,000	160,000

PUMPING PLANT No.	STATIC HEAD (ft)	TOTAL HEAD (ft)	CAPACITY (ft^3/s)	AVERAGE PUMPED FLOWS (AF)	ANNUAL ENERGY CONSUMPTION (1,000 kWh)
18	115	130	1,830	1,322,000	208,000
19	174	180	500	358,000	188,000
20	176	220	980	706,000	78,000
21	228	250	360	258,000	78,000
TOTAL					**2,413,285**

[1] Wayne pipeline

3.3 ALTERNATIVE SOUTHERN CONVEYANCE SYSTEM – LAKE TEXOMA

The 1980 Plan concluded that the proposed Southern Water Conveyance System was economically unfeasible under federal planning guidelines, and suggested dividing the system into two independent systems; one would supply central Oklahoma and one would supply southwestern Oklahoma. Due to recent efforts by communities in central Oklahoma (Section 1.1), the proposed Southern Water Conveyance System no longer has the requirement to convey water to the Central planning region. This means that only a system to supply southwestern Oklahoma is required. The 1980 Plan suggested using Lake Texoma as a water source for such a system, since it is closer to the areas of demand than water sources in southeastern Oklahoma, which would help reduce costs.

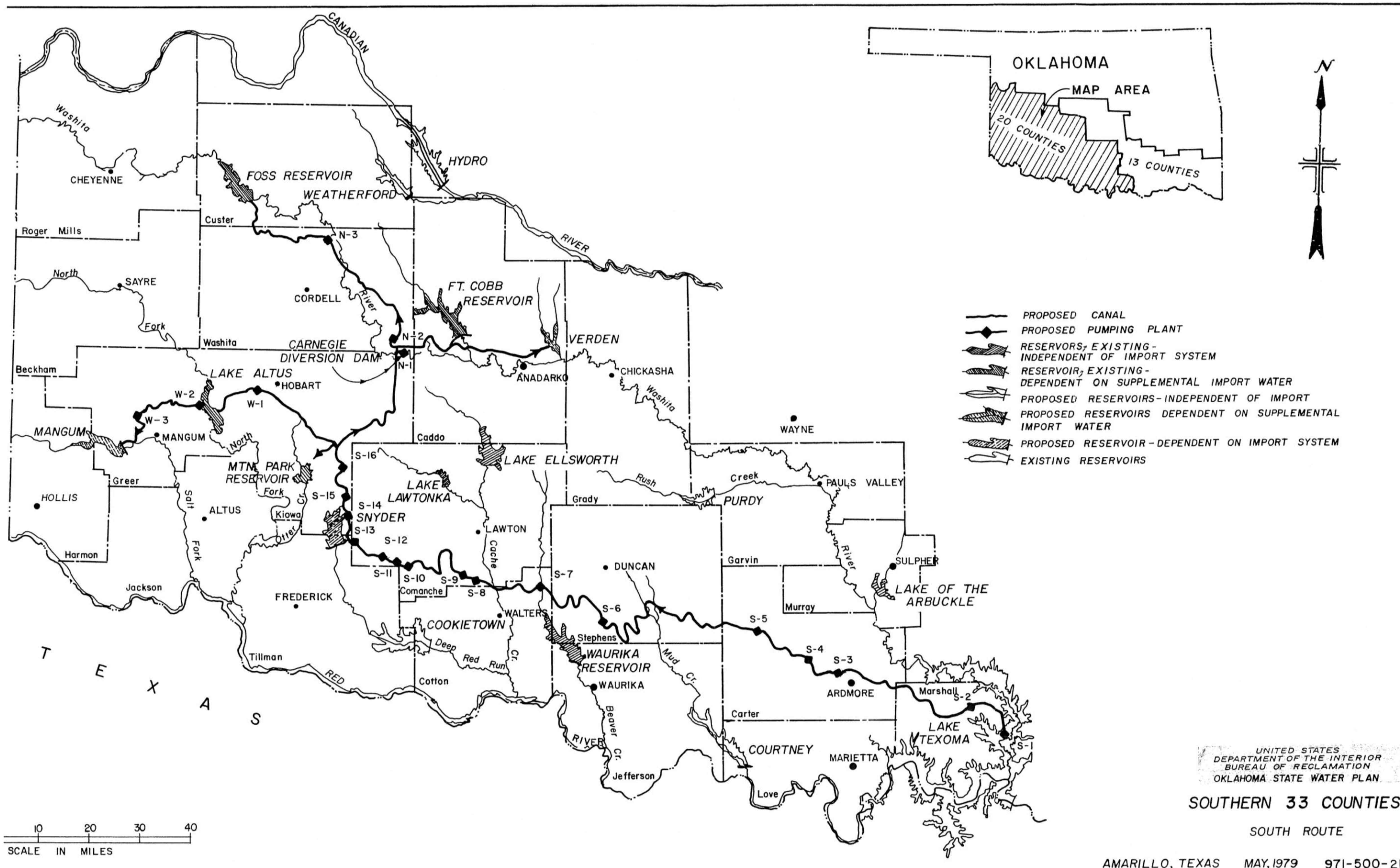
As reported in the 1980 Plan, the dependable yield from Lake Texoma, assuming the conversion of all of the hydroelectric and inactive storage to water supply, would be approximately 1,000,000 acre-feet per year, of which 500,000 acre-feet would be available to Oklahoma under the Red River Compact. This volume would not meet the deficit for the counties of the South Central and South West planning regions identified in Table 10 (834,000 acre-feet per year), therefore an additional water source would be required. One identified potential source is to construct the Gainesville Reservoir, with a dam site on the Red River approximately 70 miles upstream from the Denison Dam, and approximately two miles upstream of the I-35 bridge. According to the 1980 Plan, this reservoir would provide a water supply yield of 400,000 acre-feet per year allocated to Oklahoma, based on 80% dependability for irrigation purposes.

The 1980 Plan contains a conveyance route (Figure 115) based on conveying water from Lake Texoma and Gainesville Reservoir to southwestern Oklahoma, and one of the BOR supporting documents[2] provides detailed information on this conveyance system. The document contains two routes; a North Route, which was adopted by the 1980 Plan as the Southern Water Conveyance System route west of Pumping Plant #14 (Section 3.2), and a South Route, which is this Lake Texoma conveyance system.

Figure 3 is a reproduction from the support document that shows the components and alignment of the South Route. The document does not show the proposed location of the Gainesville dam, which would be located just above the flood pool elevation of Lake Texoma. Water released from Gainesville Reservoir for conveyance would flow into Lake Texoma via the Red River, and then conveyed from Lake Texoma via a pumping plant located on the northern arm of the lake.

[2] *Supporting Data, Oklahoma State Water Plan, Phase I, Southern 33 Counties*

FIGURE 3 - ALTERNATIVE SOUTHERN CONVEYANCE SYSTEM FROM LAKE TEXOMA



Conveyance from Lake Texoma to seven terminal storage reservoirs requires a network of 22 pumping plants, approximately 505 miles of canals and inverted siphons, and 28 miles of pipelines. Terminal storage consists of utilizing four existing reservoirs (Altus, Fort Cobb, Foss, and Tom Steed), and constructing three proposed reservoirs (Mangum, Snyder, and Verden). Of the existing reservoirs, only Lake Altus requires modification (provide an additional 70,000 acre-feet of conservation storage) to hold the volume of conveyed water. A proposed low-water diversion dam on the Washita River near Carnegie would complement the supply to Foss Reservoir by feeding into the system close to Fort Cobb Reservoir.

The required conveyance capability of the system is 796,500 acre-feet per year, with 746,000 acre-feet per year supplied by the main conveyance system and 50,000 acre-feet per year supplied by the Carnegie Diversion Dam. Considering conveyance losses, the design capacity of the main conveyance system is 857,600 acre-feet per year.

Tables 13 and 14 provide information on the different components of the conveyance system.

TABLE 13 - CONVEYANCE DETAILS, ALTERNATIVE SOUTHERN CONVEYANCE SYSTEM, LAKE TEXOMA

REACH	CAPACITY (ft^3/s)	PIPE LENGTH (MILES)	SIPHON LENGTH (MILES)	CANAL LENGTH (MILES)	TOTAL LENGTH (MILES)
#1 – Lake Texoma to Section 3, T3S, R3W	1,310	9.6	3.3	80.8	93.7
#2 – Section 3, T3S, R3W to Section 20, T2S, R8W	1,270	0.5	7.1	76.5	84.1
#3 – Section 20, T2S, R8W to Snyder Turnout	1,230	3.3	7.6	86.4	97.3
#4 – Snyder Turnout to Cooperton Bifurcation	660	4.4	1.8	19.3	25.5
#5 – Snyder Turnout to Snyder Reservoir	540	-	-	3.1	3.1
#6 – Cooperton Bifurcation to Tom Steed Res[1].	140	-	-	6.1[2]	6.1
#7 – Cooperton Bifurcation to Lake Altus	220	1.3	2.6	37.3	41.2
#8 – Lake Altus to Mangum Reservoir	135	2.3	1.1	25.4	28.8
#9 – Cooperton Bifurcation to Foss Bifurcation	290	-	10.9	21.7	32.6
#10 – Carnegie Diversion to Foss Bifurcation	200	1.8	-	-	1.8
#11 – Foss Bifurcation to Foss Reservoir	290	4.9	9.4	54.6	68.9
#12 – Foss Bifurcation to Fort Cobb Turnout	200	-	1.9	21.9	23.8
#13 – Fort Cobb Turnout to Verden Reservoir	50	-	8.4	17.7	26.1
TOTAL		**28.1**	**54.1**	**450.8**	**533.0**

[1] Shown as Mountain Park Reservoir in Figure 3
[2] Channelization of natural drainage channel

TABLE 14 - PUMPING PLANT DETAILS, ALTERNATIVE SOUTHERN CONVEYANCE SYSTEM, LAKE TEXOMA

PUMPING PLANT No.	STATIC HEAD (ft)	TOTAL HEAD (ft)	CAPACITY (ft^3/s)	AVERAGE PUMPED FLOWS (AF)	ANNUAL ENERGY CONSUMPTION (1,000 kWh)
S-1	150	177	1,441	857,530	226,884
S-2	160	200	1,441	857,530	256,366
S-3	53	76	1,441	857,530	97,419
S-4	67	84	1,441	857,530	107,674
S-5	84	101	1,441	857,530	129,465
S-6	85	103	1,396	830,366	127,846
S-7	48	65	1,353	804,904	78,206
S-8	41	60	1,353	804,904	72,190
S-9	52	71	1,353	804,904	85,425
S-10	25	41	1,353	804,904	49,330
S-11	48	64	1,353	804,904	77,003
S-12	53	70	1,353	804,904	84,222
S-13	74	92	1,353	804,904	110,691
S-14	38	55	720	426,979	35,104
S-15	113	138	720	426,979	88,077
S-16	110	135	720	426,979	86,163
W-1	57	78	242	144,015	16,791
W-2	40	56	149	87,600	7,333
W-3	136	162	149	87,600	21,213
N-1	153	177	220	50,000	13,229
N-2	90	110	319	104,641	17,206
N-3	224	259	319	104,641	40,512
TOTAL					**1,826,349**

The use of Lake Texoma and Gainesville Reservoir as a source of water for this alternative Southern Water Conveyance System is dependent upon several factors:

- Water quality is such that chloride control is required to be in place
- Reallocation of hydropower and inactive storage of Lake Texoma to water supply storage requires approval by Congress
- Meet the storage allocation provisions of the Red River Compact
- Further study is required to assess the feasibility of the proposed Gainesville Lake

Lake Texoma hydropower storage reallocation would eliminate power production, and reduce downstream flows that could affect fish and wildlife habitats, and the potential for navigation on the Red River. The alternative to reallocation would be to 'scalp' surplus flows from both lakes, but further studies are required to quantify available flows.

3.4 ALTERNATIVE WESTERN CONVEYANCE SYSTEM – LAKE TEXOMA

The Lake Texoma conveyance system described in Section 3.3 would meet the net deficits for the South Central and South West planning regions. The conveyance system borders the North

West planning region. One possible conveyance system to investigate is to expand this conveyance system north and west to serve this region as an alternative to supplying it from Lake Eufaula and Robert S. Kerr Lake.

As stated in the previous section, the combined potential water supply yielded by Lake Texoma and Gainesville Reservoir is approximately 900,000 acre-feet per year, and the conveyance requirements from these water sources to meet the net deficit in these two planning regions is 857,600 acre-feet per year. Therefore, the unused water supply available for conveyance to the North West planning region is 42,400 acre-feet per year.

The total 2040 net deficit for the North West planning region in the 1980 Plan is 978,300 acre-feet per year, therefore if is unfeasible to supply the entire western half of Oklahoma from Lake Texoma and Gainesville Reservoir. However, it may be possible to reduce some of the demand from Lake Eufaula and Robert S. Kerr, hence reducing the size and cost of the Northern Water Conveyance System.

The most logical extension of the Lake Texoma conveyance system would be from Foss Reservoir. The three counties closest to Foss Reservoir in the North West planning region are Ellis, Dewey, and Blaine. In the 1980 Plan, the proposed Cestos Reservoir would supply Ellis County with 52,400 acre-feet per year of water. The volume of available water from the south is less than the net deficit, so conveying this water to Ellis County will not eliminate the need for the Cestos Reservoir and its branch of the northern conveyance system. The existing Canton Reservoir would supply Dewey County with 6,000 acre-feet per year of water. While the volume of available water from the south is greater than the net deficit, Canton Reservoir is located partly in this county, and is closer to the demand centers than Foss Reservoir. The proposed non-system Hydro Reservoir would supply Blaine County with 60,500 acre-feet per year of water. The volume of available water from the south is less than the net deficit, so conveying this water to Blaine County will not eliminate the need for the Hydro Reservoir, and the location of the Hydro Reservoir is within the county and closer to the demand centers than Foss Reservoir.

It is worth noting that the proposed Hydro Reservoir would also provide 44,200 acre-feet per year to Caddo County in addition to the 51,800 acre-feet per year provided by the Fort Cobb reservoir in this conveyance system. Also, the proposed Weatherford Reservoir would provide 12,000 acre-feet per year to Custer County in addition to the 10,600 acre-feet per year provided by the Foss Reservoir in this conveyance system. It therefore appears more logical to use any unused water supply to increase the conveyance system capacity to supply additional water to both the Fort Cobb and Foss reservoirs, rather than extending the conveyance system north. This would have the effect of eliminating the need to construct the Weatherford Reservoir, whose sole purpose is to supply Custer County, and reducing the size and construction cost of Hydro Reservoir. However, the size of the Foss and Fort Cobb reservoirs may have to increase to store the additional flows.

3.5 ALTERNATIVE WESTERN CONVEYANCE SYSTEM – LAKE EUFAULA

The Northern Water Conveyance System described in Section 3.1 would meet the net deficits for the North Central and Northwest planning regions. The conveyance system borders the Southwest planning region. One possible conveyance system to investigate is to expand this conveyance system south to serve this region as an alternative to supplying it from Lake Texoma and Gainesville Reservoir.

The ultimate design capacity of the Northern Water Conveyance System is 1,172,800 acre-feet per year, designed just to meet the net deficits of the North Central and Northwest planning regions. Therefore, the system as currently designed does not have any additional flows for expanding the conveyance system.

One of the USACE supporting documents[3] suggests that additional surplus flows are available for 'scalping' from various lakes in eastern Oklahoma, including Lake Eufaula and Robert S. Kerr Lake. The document considers surplus flows to be those in excess of minimum requirements for hydroelectric power generation, navigation, or other established purposes. The document defines flows in excess of 10% of hydroelectric plant capacity to be surplus flows, although the use of the surplus would result in loss of power production. For Robert S. Kerr Lake, surplus flows (over 4,100 ft^3/s) occur 91% of the time, although this percentage reduces during drought periods, e.g. 30% of the time during the period July 1952 to June 1957. Considering water quality, suitable surplus flows only occur 61% of the time, but would increase to 86% with chloride control. For Lake Eufaula, surplus flows (over 1,300 ft^3/s) occur 53% of the time.

The capacity of the water conveyance system is dependent upon the diversion pumping capacity and the size of the storage provided by the regulating reservoirs. The document provides a series of regulating storage-diversion pumping capacity-yield curves that provide an estimate of gross yield for various diversion pumping capacities (2,000 ft^3/s, 5,000 ft^3/s, and 10,000 ft^3/s) over a range of regulating storage for various reservoirs. Net available yield is dependent upon transmission losses, and evaporation and seepage losses from the regulating reservoir.

The combined regulating storage of Welty Lake and Vian Creek Lake is 1,000,000 acre-feet. This regulating storage is fully available to Robert S. Kerr Lake, but only Welty Lake (800,000 acre-feet per year) is available to Lake Eufaula for regulation. Based on these regulating volumes, Table 15 provides the gross yield for both reservoirs for the three diversion pumping capacities. This shows that only Robert S. Kerr Lake would be suitable for obtaining additional surplus flows. In the current design, the diversion pumping capacity to Welty Lake from Robert S. Kerr Lake is 4,000 ft^3/s with chloride control, and 5,200 ft^3/s without chloride control. This suggests that a gross yield of approximately 1,350,000 acre-feet per year is required for a net yield of 1,172,800 acre-feet per year.

TABLE 15 - GROSS YIELD OF SURPLUS WATER, LAKE EUFAULA AND ROBERT S. KERR LAKE

	GROSS YIELD (ACRE-FEET PER YEAR)					
	WITH CHLORIDE CONTROL			WITHOUT CHLORIDE CONTROL		
Reservoir	**2,000 cfs**	**5,000 cfs**	**10,000 cfs**	**2,000 cfs**	**5,000 cfs**	**10,000 cfs**
Eufaula[1]	-	-	-	-	955,000	1,045,000
Robert S. Kerr	900,000	1,415,000	1,595,000	805,000	1,300,000	1,540,000

[1] No chloride control required.

[3] *Oklahoma Water Plan, Water Transfer System for the Northern 44 Counties, Eastern Portion*

There is therefore potential to supply an upsized and expanded conveyance system with additional flows, by increasing the diversion pumping capacity, to provide water to southwestern Oklahoma.

It is worth noting that the proposed Hydro Reservoir would provide 60,200 acre-feet per year to Blaine County, and that the system as designed is dependent upon the proposed Englewood Reservoir to provide 31,200-acre-feet to Harper County and 37,000 acre-feet to the proposed Slapout Reservoir via the conveyance system. It therefore appears more logical to use any additional water supply generated by increasing the diversion pumping capacity at Robert S. Kerr Lake to supply the water needs of both Blaine County and Harper County, rather than extending the conveyance system south. This would have the effect of eliminating the need to construct the Englewood Reservoir, and reducing the size and construction cost of the Hydro Reservoir. Instead, Slapout Reservoir and Canton Reservoir would supply water to Harper County and Blaine County respectively; this may require increasing the size of the reservoirs to store additional flows.

3.6 ALTERNATIVE NORTHERN CONVEYANCE SYSTEM – KAW LAKE

One of the potential water sources investigated in the USACE document referenced in Appendix B is Kaw Lake. This reservoir is closer to the North West planning region than Lake Eufaula and Robert S. Kerr Lake. One possible northern conveyance system is to use it as the water source, which would have the advantage of having a smaller conveyance system.

In the 1980 Plan, Kaw Water provides water to meet part of the net water deficit in the North Central planning region. It provides:

- 139,800 acre-feet per year to Kay County
- 40,000 acre-feet per year to Noble County
- 39,600 acre-feet per year to the proposed Hunnewell Reservoir via an independent conveyance system. Together with its yield, Hunnewell Reservoir would provide 72,600 acre-feet to Grant County.

Kaw Lake has water supply storage of 203,000 acre-feet and a water supply yield of 230,700 acre-feet per year. Since Kaw Lake would supply 219,400 acre-feet per year to the three counties mentioned above, 11,300 acre-feet per year of water supply yield would remain unused. This is insufficient to meet the net deficit of 98,200 acre-feet per year for Garfield County; instead, this county would obtain its water from Lake Eufaula and Robert S. Kerr in the 1980 Plan.

The main option to increase water supply out of Kaw Lake (other than reallocation of hydropower and inactive storage) is to 'scalp' surplus flows. The USACE document indicates that surplus flows (over 400 ft^3/s) occur 75% of the time. In addition, the document provides a curve that shows Kaw Lake could provide a potential average annual diversion of 1,850,000 acre-feet per year based on a maximum diversion of 10,000 ft^3/s. However, this curve assumes unlimited storage and does not reflect dependable yield. The USACE concluded that Kaw Lake showed less potential for diversion of large quantities of water when compared to other reservoirs. For this reason, USACE did not develop regulating storage-diversion pumping capacity-yield curves for Kaw Lake similar to the ones described in Section 3.1. Therefore, a reasonable estimate of the gross yield of surplus flows from Kaw Lake is not available without further hydraulic study, which is beyond the scope of this project.

4.0 COST ESTIMATES

This section provides a summary of the update of the cost estimates for the water conveyance systems contained in the 1980 Plan, and cost estimates for alternative water conveyance systems, where sufficient data exists. Appendix D contains details as to the derivation of the costs estimates based on the standardized design and cost elements stated in Sections 2.3 and 2.4, respectively.

The 1980 Plan contains not only cost estimates for conveying water from the water sources to the terminal storage reservoirs, but also for distribution systems from the terminal storage reservoirs to serve irrigation, municipal and industrial needs. For this project, only cost estimates associated with conveying water to the terminal storage reservoirs have been prepared.

4.1 1980 PLAN – NORTHERN WATER CONVEYANCE SYSTEM COSTS

The construction and operational and maintenance costs stated in the supporting documents to the 1980 Plan for the Northern Water Conveyance System as described in Section 3.1 are given in Tables 16 and 17. These tables give costs for the combination of the conditions:

- With or without chloride control at the water source
- With or without flood control at the terminal storage reservoirs

The 1980 Plan only states the costs for one of these combinations, namely with chloride control and without flood control.

These tables show that at January 1978 prices, the estimated construction costs are in the range of $4.2 billion to $4.5 billion depending upon the chloride and flood control combination, and for each combination the annual OM&R costs are approximately $179 million. Of these annual costs, the energy cost associated with the pumping stations account for approximately $171 million (or 95%) of the total OM&R cost.

Upgrading the 1980 Plan costs using the USACE Cost Index System (Section 2.5.1) provides the costs detailed in Tables 18 and 19. These tables show that at current (2010) prices, the estimated construction costs are in the range of $13.1 billion to $14.2 billion depending upon the chloride and flood control combination, and for each combination, annual OM&R costs are approximately $549 million. Of these annual costs, the energy cost associated with the pumping stations account for approximately $523 million (or 95%) of the total OM&R cost.

When comparing the costs derived in using the cost index system against the original costs, construction costs increased by a factor of 3.12, and by a factor of 3.06 for OM&R costs, which is the composite cost index (Table 6).

Using the RS Means Construction Cost Data book to estimate the construction costs from scratch (Section 2.5.2) provides the costs detailed in Table 20. This table shows that at current (2010) prices, the estimated construction costs are in the range $18.5 billion to $20.2 billion, depending upon the chloride and flood control combination. When compared to the costs derived using the cost index system to upgrade the original estimates, these construction costs estimates are 42% greater.

TABLE 16 - 1980 PLAN CONSTRUCTION COSTS, NORTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITH BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
BOR Conveyance System - Plan 3A	$2,124,430	$2,124,430	$2,124,430	$2,124,430
BOR Reservoirs - Plan 3A	$561,670	$463,810	$561,670	$463,810
USACE Conveyance System	$1,314,000	$1,314,000	$1,562,000	$1,562,000
USACE Reservoirs	$210,000	$210,000	$210,000	$210,000
Mitigation/Compensation	$85,000	$85,000	$85,000	$85,000
TOTAL CONSTRUCTION COSTS	**$4,295,100**	**$4,197,240**	**$4,543,100**	**$4,445,240**

TABLE 17 - 1980 PLAN ANNUAL OM&R COSTS, NORTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITH BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
BOR Conveyance - Canal OM&R	$1,762	$1,762	$1,762	$1,762
BOR Conveyance – Pumping Plants OM&R	$2,896	$2,896	$2,896	$2,896
BOR Conveyance – Energy	$149,759	$149,759	$149,759	$149,759
BOR Reservoirs	$364	$341	$364	$341
USACE Conveyance – OM&R	$2,260	$2,260	$2,580	$2,580
USACE Conveyance – Energy	$21,300	$21,300	$21,300	$21,300
USACE Reservoirs	$890	$890	$890	$890
Mitigation/Compensation	$200	$200	$200	$200
TOTAL ANNUAL OM&R COSTS	**$179,431**	**$179,408**	**$179,751**	**$179,728**

TABLE 18 - COST ESTIMATE, USACE COST INDEX, NORTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITH BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
BOR Conveyance System - Plan 3A	$6,610,819	$6,610,819	$6,610,819	$6,610,819
BOR Reservoirs - Plan 3A	$1,802,264	$1,488,255	$1,802,264	$1,488,255
USACE Conveyance System	$4,052,637	$4,052,637	$4,818,480	$4,818,480
USACE Reservoirs	$673,840	$673,840	$673,840	$673,840
Mitigation/Compensation	$260,100	$260,100	$260,100	$260,100
TOTAL CONSTRUCTION COSTS	**$13,399,660**	**$13,085,651**	**$14,165,503**	**$13,851,494**

TABLE 19 - OM&R COST, USACE COST INDEX, NORTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITH BOR FLOOD CONTROL and WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL and WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
BOR Conveyance - Canal OM&R	$5,572	$5,572	$5,572	$5,572
BOR Conveyance – Pumping Plants OM&R	$8,712	$8,712	$8,712	$8,712
BOR Conveyance – Energy	$457,537	$457,537	$457,537	$457,537
BOR Reservoirs	$1,168	$1,094	$1,168	$1,094
USACE Conveyance – OM&R	$6,905	$6,905	$7,882	$7,882
USACE Conveyance – Energy	$65,075	$65,075	$65,075	$65,075
USACE Reservoirs	$890	$890	$890	$890
Mitigation/Compensation	$611	$611	$611	$611
TOTAL ANNUAL OM&R COSTS	**$548,435**	**$548,361**	**$549,412**	**$549,339**

TABLE 20 - COST ESTIMATE, RSMEANS, NORTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITH BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
BOR Conveyance System - Plan 3A	$9,099,836	$9,099,836	$9,099,836	$9,099,836
BOR Reservoirs - Plan 3A	$2,478,976	$2,047,063	$2,478,976	$2,047,063
USACE Conveyance System	$6,230,814	$6,230,814	$7,391,948	$7,391,948
USACE Reservoirs	$926,852	$926,852	$926,852	$926,852
Mitigation/Compensation	$260,100	$260,100	$260,100	$260,100
TOTAL CONSTRUCTION COSTS	**$18,996,578**	**$18,564,665**	**$20,157,712**	**$19,725,799**

4.2 1980 PLAN – SOUTHERN WATER CONVEYANCE SYSTEM COSTS

The construction and operational and maintenance costs stated in the supporting documents to the 1980 Plan for the Southern Water Conveyance System, as described in Section 3.2, are given in Tables 21 and 22. As the USACE supporting documents for the conveyance system to the Central planning region are missing (Section 2.2), the information for this part of the system comes from the 1980 Plan, which does not state the cost breakdown.

These tables show that at January 1978 prices, the estimated construction costs are approximately $1.6 billion without flood control, and the annual OM&R costs are approximately $52 million.

Upgrading the 1980 Plan costs using the USACE Cost Index System (Section 2.5.1) provides the costs detailed in Tables 23 and 24. These tables show that at current (2010) prices, the estimated construction costs are $5.2 billion without flood control, and the annual OM&R costs are approximately $160 million. When comparing the costs derived in using the cost index system against the original costs, construction costs increased by a factor of 3.12, and by a factor of 3.06 for OM&R costs, which is the composite cost index (Table 6).

Using the RS Means Construction Cost Data book to estimate the construction costs from scratch (Section 2.5.2) provides the costs detailed in Table 25. This table shows that at current (2010) prices, the estimated construction costs are $6.9 billion. When compared to the costs derived using the cost index system to upgrade the original estimates, these construction costs estimates are 33% greater.

4.3 ALTERNATIVE SOUTHERN CONVEYANCE SYSTEM – LAKE TEXOMA COSTS

The construction and operational and maintenance costs stated in the supporting documents for the alternative southern conveyance system from Lake Texoma as described in Section 3.3 are given in Tables 26 and 27. These tables show that at January 1978 prices, the estimated construction costs are approximately $1.2 billion without flood control, and the annual OM&R costs are approximately $59 million. However, these estimates do not include costs associated with the construction of Gainesville Reservoir.

Upgrading the 1980 Plan costs using the USACE Cost Index System (Section 2.5.1) provides the costs detailed in Tables 28 and 29. These tables show that at current (2010) prices, the estimated construction costs are $3.8 billion without flood control, and the annual OM&R costs are approximately $177 million. When comparing the costs derived in using the cost index system against the original costs, the construction costs increased by a factor of 3.12, and the OM&R costs increase by a factor of 3.06, which is the composite cost index (Table 6). However, these estimates do not include costs associated with the construction of Gainesville Reservoir.

Using the RS Means Construction Cost Data book to estimate the construction costs from scratch (Section 2.5.2) provides the costs detailed in Table 30. This table shows that at current (2010) prices, the estimated construction costs are $5.9 billion. When compared to the costs derived using the cost index system to upgrade the original estimates, these construction costs estimates are 55% greater, but these estimates include costs associated with the construction of Gainesville Reservoir.

TABLE 21 - 1980 PLAN CONSTRUCTION COSTS, SOUTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$556,020
BOR Reservoirs	$118,370
USACE Conveyance System	$868,000
USACE Reservoirs	$104,000
Mitigation/Compensation	$18,000
TOTAL CONSTRUCTION COSTS	**$1,664,390**

TABLE 22 - 1980 PLAN ANNUAL OM&R COSTS, SOUTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance - Canal OM&R	$969
BOR Conveyance – Pumping Plants OM&R	$980
BOR Conveyance - Energy	$30,819
BOR Reservoirs	$113
USACE Conveyance	$19,500
USACE Reservoirs	-
Mitigation/Compensation	$100
TOTAL ANNUAL OM&R COSTS	**$52,481**

TABLE 23 - COST ESTIMATE, USACE COST INDEX, SOUTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$1,733,219
BOR Reservoirs	$379,968
USACE Conveyance System	$2,705,719
USACE Reservoirs	$333,840
Mitigation/Compensation	$54,993
TOTAL CONSTRUCTION COSTS	**$5,207,739**

TABLE 24 - OM&R COST, USACE COST INDEX, SOUTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance - Canal OM&R	$3,064
BOR Conveyance – Pumping Plants OM&R	$2,949
BOR Conveyance - Energy	$93,339
BOR Reservoirs	$363
USACE Conveyance	$59,576
USACE Reservoirs	-
Mitigation/Compensation	$306
TOTAL ANNUAL OM&R COSTS	**$159,597**

TABLE 25 - COST ESTIMATE, RSMEANS, SOUTHERN WATER CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$2,360,172
BOR Reservoirs	$383,463
USACE Conveyance System	$3,682,483
USACE Reservoirs	$454,356
Mitigation/Compensation	$54,993
TOTAL CONSTRUCTION COSTS	**$6,935,467**

TABLE 26 - 1980 PLAN CONSTRUCTION COSTS, LAKE TEXOMA CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$1,094,960
BOR Reservoirs	$118,370
TOTAL CONSTRUCTION COSTS	**$1,213,330**

TABLE 27 - 1980 PLAN ANNUAL OM&R COSTS, LAKE TEXOMA CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance - Canal OM&R	$1,535
BOR Conveyance – Pumping Plants OM&R	$1,537
BOR Conveyance - Energy	$54,850
BOR Reservoirs	$113
TOTAL ANNUAL OM&R COSTS	**$58,035**

TABLE 28 - COST ESTIMATE, USACE COST INDEX, LAKE TEXOMA CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$3,416,298
BOR Reservoirs	$379,968
TOTAL CONSTRUCTION COSTS	**$3,796,266**

TABLE 29 - OM&R COST, USACE COST INDEX, LAKE TEXOMA CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance - Canal OM&R	$4,857
BOR Conveyance – Pumping Plants OM&R	$4,623
BOR Conveyance - Energy	$167,575
BOR Reservoirs	$363
TOTAL ANNUAL OM&R COSTS	**$177,418**

TABLE 30 - COST ESTIMATE, RSMEANS, LAKE TEXOMA CONVEYANCE SYSTEM (IN $1,000)

DESCRIPTION	WITHOUT FLOOD CONTROL
BOR Conveyance System	$4,340,479
BOR Reservoirs	$1,545,521
TOTAL CONSTRUCTION COSTS	**$5,886,000**

5.0 FEASIBILITY ANALYSIS

One main factor in determining the feasibility of the conveyance systems studied is the cost per acre-foot to supply water to end users. The method used in this analysis was to derive two costs per acre-foot values for each costed conveyance system in the following manner:

- Divide the 2010 construction costs derived from the RSMeans Construction Cost Data book by the predicted maximum annual volume of water supplied (including conveyance losses) over a 100-year period to provide the present value for the construction cost per acre-foot of water supplied over the lifetime of the system
- Divide the 2010 OM&R costs derived from the USACE Cost Index System by the predicted maximum annual volume of water supplied (including conveyance losses) to provide the present value for the annual OM&R costs per acre-foot of water

The reason for developing two values is that funding for construction and OM&R activities most likely will be by different methods. Construction funding is most likely to occur through budget allocations from the federal government; whereas end users usually fund annual OM&R costs through the rate they pay to use the water, although federal (BOR) subsidies offset some of this cost.

Tables 31 to 33 provide the two cost per acre-foot values for the three costed conveyance systems. Of the three systems, the Northern Water Conveyance System has both the highest construction cost per acre-foot ($153-$167/AF) and annual OM&R cost per acre-foot ($454/AF), whereas the Southern Water Conveyance System has the lowest ($51/AF and $116/AF respectively). The main reason for this is that the southern system is conveying a greater volume (1,370,600 acre-feet, compared with 1,209,800 acre-feet) of water over a shorter distance than the northern system. Despite the shorter conveyance distance, the Lake Texoma Conveyance System has higher costs per acre-foot than the Southern Water Conveyance System due to the cost of constructing Gainesville Reservoir and the lower conveyance volume (856,700 acre-feet).

A comparison of these costs against the costs paid by irrigators for water supplied by the Lugert-Altus Irrigation District provides a gauge to the magnitude of the costs, since virtually all the water demand from the conveyance systems is for irrigation purposes. A Water Resources Research document[4] states a contract price of $18.58 per acre-foot and a full-cost (i.e., unsubsidized) price of $143.19, at 1978 prices. The Oklahoma State University Cotton Manual[5] and a 2005 newspaper article[6] both state a contract price of $27.50 per acre-foot. The manual gives a total cost of water per acre of $53.40, based upon 23.3 inches of irrigation water. The United States Environmental Protection Agency (USEPA) National Center for Environmental Economics website[7] states that BOR provides water subsidies of $675 per acre to the irrigation district, with the subsidy accounting for 90% of the cost. This would give a full-cost price of $750 per acre, or $386 per acre-foot based on the Cotton Manual's use of irrigation water.

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[4] *The Bureau of Reclamation's New Mandate for Irrigation Water Conservation: Purposes and Policy Alternatives*
[5] *Chapter 4, Economics of Cotton Production*
[6] Altus Times *Lake Lugert-Altus turned Southwest Oklahoma into a field of streams.*
[7] http://yosemite.epa.gov/ee/epalib/incent2.nsf/02139de58cd4f6e18525648c00670434/52560d7e8b805ba f85256acd0054e68a!OpenDocument

TABLE 31 - COST PER ACRE-FOOT SUPPLIED, NORTHERN WATER CONVEYANCE SYSTEM

DESCRIPTION	WITH BOR FLOOD CONTROL and WITH USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL and WITH USACE CHLORIDE CONTROL	WITH BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL	WITHOUT BOR FLOOD CONTROL AND WITHOUT USACE CHLORIDE CONTROL
Total Construction Costs	$18,996,578,000	$18,564,665,000	$20,157,712,000	$19,725,799,000
Construction Cost/ AF supplied	**$157**	**$153**	**$167**	**$163**
Annual OM&R Costs	$548,435	$548,361	$549,412	$549,339
Annual OM&R/ AF supplied	**$453**	**$453**	**$454**	**$454**

TABLE 32 - COST PER ACRE-FOOT SUPPLIED, SOUTHERN WATER CONVEYANCE SYSTEM

DESCRIPTION	WITHOUT FLOOD CONTROL
Total Construction Costs	$6,935,467,000
Construction Cost/ AF supplied	**$51**
Annual OM&R Costs	$159,597
Annual OM&R/ AF supplied	**$116**

TABLE 33 - COST PER ACRE-FOOT SUPPLIED, LAKE TEXOMA CONVEYANCE SYSTEM

DESCRIPTION	WITHOUT FLOOD CONTROL
Total Construction Costs	$5,886,000,000
Construction Cost/ AF supplied	**$69**
Annual OM&R Costs	$177,418
Annual OM&R/ AF supplied	**$207**

While the annual OM&R costs per acre-foot for the three conveyance systems appear reasonable when compared to the full-cost price of the Lugert-Altus Irrigation District (assuming that the full-cost price covers all of the district's OM&R costs), there are several issues with the derived costs for the conveyance systems, including:

- The cost estimates derived in Section 4.0 do not include the construction and OM&R costs of conveying water from the terminal storage reservoirs to the end users. In other words, a cost per acre-foot similar to those incurred by the Lugert-Altus Irrigation District would be in addition to the cost per acre-foot incurred to convey the water to the terminal storage reservoir using the conveyance system. The combined costs provide a more realistic full-cost price per acre-foot to convey water from the source to the end user. The final price ultimately paid by the end user would be dependent upon any BOR subsidies to help offset the costs associated with the conveyance system.

- The cost estimates derived for the Northern Water Conveyance System and the Lake Texoma Alternative Southern Conveyance System do not include the indirect costs associated with implementing chloride control

USACE is currently constructing the Red River Basin Chloride Control project to improve water quality for municipal, industrial, and agricultural uses along the Red River, which would increase the feasibility of the Lake Texoma alternative conveyance system. The first part of the system became operational in 1987, but funding issues have delayed the completion of the project. Under the Water Development Act of 2007, costs associated with the operation and maintenance of this project is to be the responsibility of the Federal government[8].

Despite the implementation of chloride control, there are still several hurdles to overcome for the Lake Texoma alternative conveyance system to be feasible. As noted in Section 3.3, the project is dependent upon Congressional reallocation of hydropower and inactive storage at Lake Texoma, and meeting the storage allocation provisions of the Red River compact for both Lake Texoma and the proposed Gainesville Lake.

USACE has recently completed a study of Lake Texoma for the reallocation of an additional 150,000 AF of water supply storage to Texas[9]. The Water Resources Development Act 1986 authorized reallocation of hydropower storage as needed up to 300,000 acre-feet, and the study follows requests from water districts in north Texas, who have a water need of 150,000 acre-feet. Under the terms of the Red River compact, half of the authorized reallocation is reserved for Oklahoma, although the report identified no current water need. Currently Lake Texoma provides 150,000 acre-feet of water supply storage to Texas, of which 148,585 acre-feet is under contract. This reallocation would bring the total allocation for Texas to 300,000 acre-feet. The total storage volume available to both states under the compact is 490,000 acre-feet. The study found that reallocation from the conservation (hydropower) storage was economically viable and had no significant environmental impacts.

The complete reallocation of hydropower storage at Lake Texoma to water supply storage required for the alternative conveyance system would eliminate power production, and reduce downstream flows that could affect fish and wildlife habitats, and the potential for navigation on the Red River. The alternative to reallocation would be to 'scalp' surplus flows from both Lake Texoma and Gainesville Reservoir, but further studies are required to quantify available flows. Further studies are also required to assess the feasibility of constructing Gainesville Reservoir.

The ability to obtain ROW could be a factor in the feasibility of the conveyance systems. Each conveyance system studied in the report is over 500 miles long, and the required width of ROW is up to 200 ft. Obtaining this ROW would require reaching agreements with a large variety of private property owners with surface or mineral rights, utility companies, municipalities, and

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[8] http://www.swt.usace.army.mil/projects/civil/civil_projects.cfm?number=86
[9] *Storage Reallocation Report, Lake Texoma, Oklahoma and Texas*

Federal and State governments. While the State can ultimately use eminent domain to obtain ROW from any unwilling owner, the process of obtaining ROW has the potential to be either politically or legally divisive.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This study has updated the costs of the Northern and Southern Water Conveyance Systems, and derived costs for an alternative Southern Water Conveyance System using Lake Texoma as a water source. Other alternatives, such as extending the Northern System south, extending the alternative Southern System north, or using Kaw Lake as a water source, were considered but not costed, being considered impracticable.

The 1980 Plan concluded that based on benefit-cost ratios of 0.16:1 and 0.34:1, both the Northern and Southern Water Conveyance Systems respectively were economically unfeasible under federal planning guidelines, and therefore ruled out their construction. The Plan did note that substantial indirect benefits would result from construction of the conveyance systems, namely those due to agricultural and agribusiness impacts, but they were not included in the analysis and would require consideration prior to a final assessment on the feasibility of the project.

Based upon the estimated construction and OM&R costs derived in Section 2.0 and the feasibility analysis carried out in Section 5.0, it is reasonable to assume that the conclusions of the 1980 Plan are still valid, and that the Northern and Southern Water Conveyance Systems are still economically unfeasible under federal planning guidelines. In addition, the Lake Texoma alternative Southern Water Conveyance System has higher costs per acre-foot to supply water than the original Southern Water Conveyance System; therefore, it is reasonable to consider that this conveyance system is also economically unfeasible to warrant the funding of construction.

In addressing this study, the sizing and costing of the conveyance systems used the projected 2040 water deficits contained within the 1980 Plan. During the study, new water deficit data became available from CDM. According to this data, the projected 2060 maximum annual water deficit for the whole of Oklahoma is 244,712 acre-feet per year. Table 34 provides the split in the deficit between surface water, alluvial groundwater and bedrock groundwater.

TABLE 34 - PROJECTED 2060 MAXIMUM ANNUAL WATER DEFICIT (FROM CDM)

WATER SOURCE	SURFACE WATER	ALLUVIAL GROUNDWATER	BEDROCK GROUNDWATER
Deficit (AF/year)	100,202	37,087	107,423

The combined water deficit met by the conveyance systems in the 1980 Plan is 2,297,900 acre-feet per year (1,076,500-acre-feet per year by the Northern Water Conveyance System, and 1,321,400 acre-feet per year by the Southern Water Conveyance System). Therefore, the revised water deficit is only 11% of that assumed in the 1980 Plan.

A consequence of this is that not only do the conveyance systems need to be much smaller than originally sized in the 1980 Plan, but other reservoirs now have the potential to become a water source to a conveyance system. This includes not only Kaw Lake, but also other potential reservoirs deemed viable under the reservoir viability study currently underway (undertaken as part of the update to the Plan) that could facilitate water supply for areas of water shortage. Given the much reduced volume of water deficit, there is the possibility that it may be more economically viable to have a series of regional conveyance systems, fed from reservoirs located closer to the deficit centers, than to have two state-wide conveyance systems.

A recommendation of this study is therefore to undertake a further study to evaluate both statewide and regional conveyance systems based upon the new water deficit data. The study will require a review of the results from the water deficit analysis and the reservoir viability study. The study should focus on not just identifying potential statewide conveyance systems using Lake Eufaula, Lake Texoma and Kaw Lake as water sources, but also using these and other reservoirs as water sources for regional conveyance systems. The study should provide an analysis of the various alternatives to supply water to different regions of the state, leading to the ranking of viable concepts based on a cost/benefit measure. This will lead to a preferred conveyance concept (either regionally or statewide) for meeting the water deficit in each region.

APPENDIX A

KICK-OFF MEETING AGENDA

AND NOTES

AGENDA
KICK-OFF MEETING
RESERVOIR VIABILITY STUDY AND WATER TRANSFER STUDY
OKLAHOMA WATER RESOURCES BOARD (OWRB)
C. H. GUERNSEY & COMPANY (GUERNSEY)
September 28, 2009

1. **Introduction of Project Personnel**
   - OWRB
   - GUERNSEY (Karl Stickley, Larry Roach, Mike Dewings, Ken Senour)
2. **Reservoir Viability Study**
   - Goals & Objectives
   - Project Implementation/Flow Chart
   - Reservoir Characteristics Matrices
   - Website Mock-up
   - Proposed Report Table of Contents
   - Project Schedule
3. **Water Transfer Study**
   - Goals & Objectives
   - Project Implementation/Flow Chart
   - Preliminary Approach to Data Analysis/Presentation
   - Proposed Report Table of Contents
   - Project Schedule
4. **Additional Discussion**

MEETING SUMMARY
PROJECT KICK-OFF MEETING
OKLAHOMA WATER RESOURCES BOARD (OWRB)
C. H. GUERNSEY & COMPANY (GUERNSEY)
RESERVOIR VIABILITY STUDY & WATER CONVEYANCE STUDY
September 30, 2009

PARTICIPANTS:

- Kyle Arthur, OWRB
- Mike Melton, OWRB
- Dave Dillon, OWRB
- Terri Sparks, OWRB
- Bob Sanbo, OWRB
- Brian Vance, OWRB
- Julie Cunningham, OWRB
- Bryan Mitchell, CDM
- Karl Stickley, GUERNSEY
- Mike Dewings, GUERNSEY
- Larry Roach, GUERNSEY
- Ken Senour, GUERNSEY

MEETING HIGHLIGHTS:

1. Kyle Arthur began the meeting by recognizing it as our official kick-off meeting for the project. Attendee introductions were requested and addressed. See the participants list above.

2. Kyle turned the meeting over to Ken Senour. Ken had GUERNSEY personnel further address their backgrounds and relevant experience. Notebooks were provided to all participants with pertinent project information included for the meeting. Ken provided an agenda for the meeting. The agenda was as follows:

   a. *Introduction of Project Personnel*

      - OWRB
      - GUERNSEY (Karl Stickley, Larry Roach, Mike Dewings, Ken Senour)

   b. *Reservoir Viability Study*

      - Goals & Objectives
      - Project Implementation/Flow Chart
      - Reservoir Characteristics Matrices
      - Website Mock-up
      - Proposed Report Table of Contents

- Project Schedule

c. *Water Conveyance Study*

- Goals & Objectives
- Project Implementation/Flow Chart
- Preliminary Approach to Data Analysis/Presentation
- Proposed Report Table of Contents
- Project Schedule

d. Additional Discussion

RESERVOIR VIABILITY STUDY

1. Larry Roach identified project Goals & Objectives (G&O).

2. Kyle indicated a key to G&O #1 is the end users. We need to be focused on our audience and their importance (i.e., legislators, OML, rural water). Be aware of municipalities, irrigators, and recreational users, but we cannot invite them all to the public meetings.

3. Kyle inquired about the intent of G&O #11. It was agreed our focus should change to stakeholders—rural water districts, OML, conservancy districts, etc. We need to discuss further before we address the meeting at the end of the project.

4. Larry addressed the flow chart and the various project activities.

5. Terri Sparks indicated the 1995 water plan update identified additional reservoirs.

6. Mike Melton added that NRCS may have additional large reservoir sites that will provide opportunities.

7. Mike also mentioned to consider the new Holdenville Lake being financed by OWRB.

8. Terri prefers we use the term "potential" reservoirs, not "future."

9. Karl Stickley asked the question 'What does "viability" mean?' Kyle offered that viability indicates that the reservoir can produce its own water (as compared to a terminal reservoir, which cannot). Terri thought that our priorities should be non-terminal reservoirs. Non-viable reservoirs should be eliminated quickly and mapped separately.

10. Terri offered that we should use the term "conveyance" instead of "transfer" for the water movement (east to west) project.

WATER CONVEYANCE STUDY

1. Karl introduced the water conveyance project and addressed the various components.

2. Bryan Mitchell indicated the *Supply and Demand Handbook* should be available in the next few weeks.

3. Kyle indicated the 1980 Water Plan had inflated demand scenarios (agricultural use inflated). There has been a substantial increase in irrigation usage since 2007.

4. Bob Sanbo indicated that water quality might be an issue regarding transfer, but not so much regarding terminal reservoirs.

5. We must look at water yields statewide. Data will be available statewide by county and basin. There are defined shortages in the Panhandle and Southwestern Oklahoma.

Prepared by: Ken Senour, GUERNSEY

Date: October 11, 2009

GOALS AND OBJECTIVES
STUDY OF WATER TRANSFER ALTERNATIVES
OKLAHOMA WATER RESOURCES BOARD
C. H. GUERNSEY & COMPANY
September 30, 2009

The 1980 Oklahoma Comprehensive Water Plan presented a proposed Statewide Water Conveyance System. In general, this system transferred water from eastern Oklahoma to western Oklahoma. C. H. Guernsey & Company (GUERNSEY) has been selected by the Oklahoma Water Resources Board (OWRB) to evaluate and revise this state-wide water transfer system. The following are the goals and objectives of the study to determine viable alternatives for a water transfer system:

1. Identify the potential end-users of this study and format the deliverables to be responsive to their needs.
2. Review the 1980 Water Plan, other pertinent reports, and any available back-up information relating to water transfer.
3. Identify viable water shortage quantities, beginning with the amounts used in 1980 and modifying as necessary.
4. Prepare conceptual, high level layouts of alternative interconnected system routes based upon the revised water usage quantities. These layouts will not include conveyance to Central Oklahoma.
    1. Western Interconnected System Alternative One – Water from Lake Eufaula and the Arkansas River.
    2. Western Interconnected System Alternative Two – Water from Lake Texoma.
    3. Western Interconnected System Alternative Three – Water from Kaw Lake.
5. Prepare conceptual cost estimates for the identified alternatives.
    a. Conveyance system from the 1980 Plan
    b. Western Interconnected System Alternative One
    c. Western Interconnected System Alternative Two
    d. Western Interconnected System Alternative Three
6. Coordinate activities with the OWRB (and CDM?) to gain synergy and collaboration while concurrently avoiding duplication of efforts.
7. Produce the report in a graphic style that is consistent with the recent OWRB work products.
8. Optimize communication between stakeholders to keep the OWRB staff informed, but with a minimum of inefficiency/disruption.

9. Maintain the objective of making this project enjoyable and professionally rewarding. Strive to earn a long-term professional relationship with OWRB.

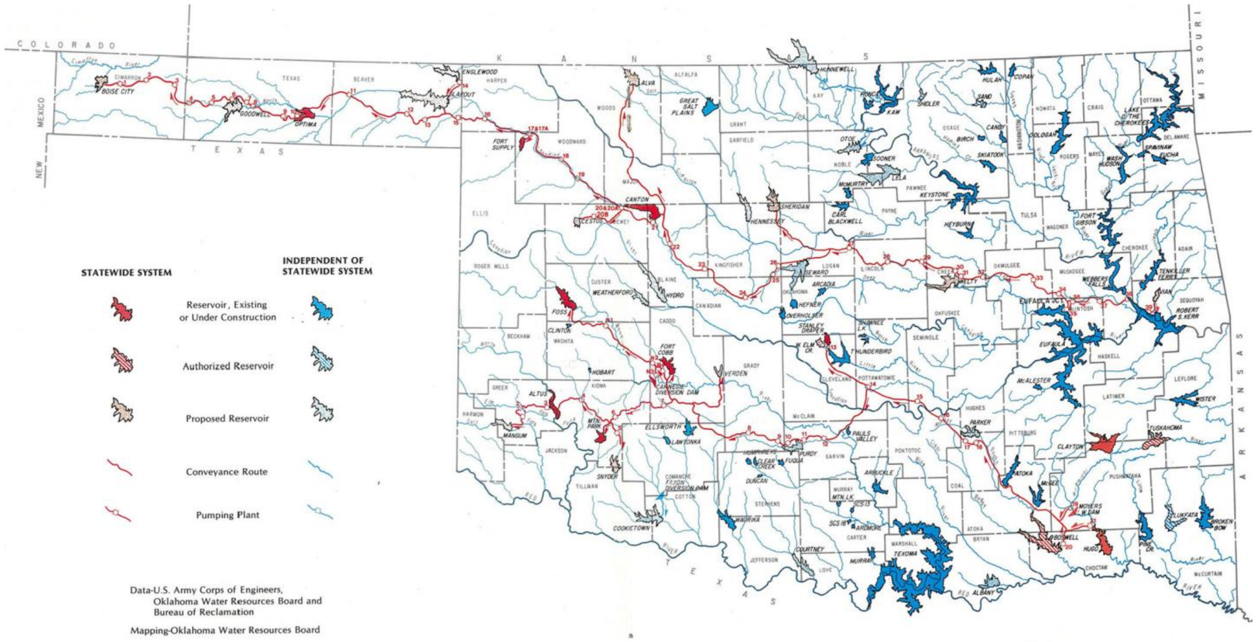

FIGURE V- STATEWIDE WATER CONVEYANCE SYSTEM
Including Proposed Local Projects

STUDY OF WATER TRANSFER ALTERNATIVES
OKLAHOMA WATER RESOURCES BOARD
September 30, 2009

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APPENDIX B

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APPENDIX C

ENERGY COST ESTIMATIONS

TABLE C-1 - SUMMARY

ESTIMATED COST PER kWh (BASED ON 1,000 KW)										
		LOAD FACTOR @ 30.00%			LOAD FACTOR @ 50.00%			LOAD FACTOR @ 70.00%		
	kW	kWh	BILLING	$/kWh	kWh	BILLING	$/kWh	kWh	BILLING	$/kWh
GENERATION COST @ $0.050 per kWh										
Cooperative 1	1,000	219,000	$ 13,930.76	$ 0.063611	365,000	$ 22,384.60	$ 0.061328	511,000	$ 30,838.43	$ 0.060349
Cooperative 2	1,000	219,000	$ 14,317.67	$ 0.065377	365,000	$ 22,629.45	$ 0.061998	511,000	$ 30,941.23	$ 0.060550
Cooperative 3	1,000	219,000	$ 12,645.00	$ 0.057740	365,000	$ 20,675.00	$ 0.056644	511,000	$ 28,705.00	$ 0.056174
Cooperative 4	1,000	219,000	$ 15,585.55	$ 0.071167	365,000	$ 23,389.25	$ 0.064080	511,000	$ 31,192.95	$ 0.061043
AVERAGE				**$ 0.064474**			**$ 0.061013**			**$ 0.059529**
GENERATION COST @ $0.065 per kWh										
Cooperative 1	1,000	219,000	$ 17,215.76	$ 0.078611	365,000	$ 27,859.60	$ 0.076328	511,000	$ 38,503.43	$ 0.075349
Cooperative 2	1,000	219,000	$ 17,602.67	$ 0.080377	365,000	$ 28,104.45	$ 0.076998	511,000	$ 38,606.23	$ 0.075550
Cooperative 3	1,000	219,000	$ 15,930.00	$ 0.072740	365,000	$ 26,150.00	$ 0.071644	511,000	$ 36,370.00	$ 0.071174
Cooperative 4	1,000	219,000	$ 18,870.55	$ 0.086167	365,000	$ 28,864.25	$ 0.079080	511,000	$ 38,857.95	$ 0.076043
AVERAGE				**$ 0.079474**			**$ 0.076013**			**$ 0.074529**

Estimated Hours of Operation in Month:

LOAD FACTOR @ 30.00% 219

LOAD FACTOR @ 50.00% 365

LOAD FACTOR @ 70.00% 511

TABLE C-2 - GENERATION COST @ $0.05 PER kWh

	Rate	Load Factor @ 30.00%			Load Factor @ 50.00%			Load Factor @ 70.00%		
		Load Factor	Annual Usage	Billing	Load Factor	Annual Usage	Billing	Load Factor	Annual Usage	Billing
Cooperative 1										
Customer Charge	$ 0.00		1	$ 0.00		1	$ 0.00		1	$ 0.00
Demand Charge	$ 1.25	30.00%	1,000 kW	$ 1,250.00	50.00%	1,000 kW	$ 1,250.00	70.00%	1,000 kW	$ 1,250.00
Energy Charge	$ 0.007903		219,000 kWh	$ 1,730.76		365,000 kWh	$ 2,884.60		511,000 kWh	$ 4,038.43
Power Cost	$ 0.050000		219,000 kWh	$ 10,950.00		365,000 kWh	$ 18,250.00		511,000 kWh	$ 25,550.00
TOTAL				**$ 13,930.76**			**$ 22,384.60**			**$ 30,838.43**
Cooperative 2										
Customer Charge	$ 100.00		1	$ 100.00		1	$ 100.00		1	$ 100.00
Demand Charge	$ 1.75	30.00%	1,000 kW	$ 1,750.00	50.00%	1,000 kW	$ 1,750.00	70.00%	1,000 kW	$ 1,750.00
Energy Charge	$ 0.006930		219,000 kWh	$ 1,517.67		365,000 kWh	$ 2,529.45		511,000 kWh	$ 3,541.23
Power Cost	$ 0.050000		219,000 kWh	$ 10,950.00		365,000 kWh	$ 18,250.00		511,000 kWh	$ 25,550.00
TOTAL				**$ 14,317.67**			**$ 22,629.45**			**$ 30,941.23**
Cooperative 3										
Customer Charge	$ 150.00		1	$ 150.00		1	$ 150.00		1	$ 150.00
Demand Charge	$ 0.45	30.00%	1,000 kW	$ 450.00	50.00%	1,000 kW	$ 450.00	70.00%	1,000 kW	$ 450.00
Energy Charge	$ 0.005000		219,000 kWh	$ 1,095.00		365,000 kWh	$ 1,825.00		511,000 kWh	$ 2,555.00
Power Cost	$ 0.050000		219,000 kWh	$ 10,950.00		365,000 kWh	$ 18,250.00		511,000 kWh	$ 25,550.00
TOTAL				**$ 12,645.00**			**$ 20,675.00**			**$ 28,705.00**
Cooperative 4										
Customer Charge	$		1	$		1	$		1	$
Demand Charge	$ 3.88	30.00%	1,000 kW	$ 3,880.00	50.00%	1,000 kW	$ 3,880.00	70.00%	1,000 kW	$ 3,880.00
Energy Charge	$ 0.003450		219,000 kWh	$ 755.55		365,000 kWh	$ 1,259.25		511,000 kWh	$ 1,762.95
Power Cost	$ 0.050000		219,000 kWh	$ 10,950.00		365,000 kWh	$ 18,250.00		511,000 kWh	$ 25,550.00
TOTAL				**$ 15,585.55**			**$ 23,389.25**			**$ 31,192.95**

TABLE C-3 - GENERATION COST @ $0.065 PER kWh

	Rate	Load Factor @ 30.00%			Load Factor @ 50.00%			Load Factor @ 70.00%		
		Load Factor	Annual Usage	Billing	Load Factor	Annual Usage	Billing	Load Factor	Annual Usage	Billing
Cooperative 1										
Customer Charge	$ 0.00		1	$ 0.00		1	$ 0.00		1	$ 0.00
Demand Charge	$ 1.25	30.00%	1,000 kW	$ 1,250.00	50.00%	1,000 kW	$ 1,250.00	70.00%	1,000 kW	$ 1,250.00
Energy Charge	$ 0.007903		219,000 kWh	$ 1,730.76		365,000 kWh	$ 2,884.60		511,000 kWh	$ 4,038.43
Power Cost	$ 0.065000		219,000 kWh	$ 14,235.00		365,000 kWh	$ 23,725.00		511,000 kWh	$ 33,215.00
TOTAL				**$ 17,215.76**			**$ 27,859.60**			**$ 38,503.43**
Cooperative 2										
Customer Charge	$ 100.00		1	$ 100.00		1	$ 100.00		1	$ 100.00
Demand Charge	$ 1.75	30.00%	1,000 kW	$ 1,750.00	50.00%	1,000 kW	$ 1,750.00	70.00%	1,000 kW	$ 1,750.00
Energy Charge	$ 0.006930		219,000 kWh	$ 1,517.67		365,000 kWh	$ 2,529.45		511,000 kWh	$ 3,541.23
Power Cost	$ 0.065000		219,000 kWh	$ 14,235.00		365,000 kWh	$ 23,725.00		511,000 kWh	$ 33,215.00
TOTAL				**$ 17,602.67**			**$ 22,629.45**			**$ 38,606.23**
Cooperative 3										
Customer Charge	$ 150.00		1	$ 150.00		1	$ 150.00		1	$ 150.00
Demand Charge	$ 0.45	30.00%	1,000 kW	$ 450.00	50.00%	1,000 kW	$ 450.00	70.00%	1,000 kW	$ 450.00
Energy Charge	$ 0.005000		219,000 kWh	$ 1,095.00		365,000 kWh	$ 1,825.00		511,000 kWh	$ 2,555.00
Power Cost	$ 0.065000		219,000 kWh	$ 14,235.00		365,000 kWh	$ 23,725.00		511,000 kWh	$ 33,215.00
TOTAL				**$ 15,930.00**			**$ 26,150.00**			**$ 36,370.00**
Cooperative 4										
Customer Charge	$		1	$		1	$		1	$
Demand Charge	$ 3.88	30.00%	1,000 kW	$ 3,880.00	50.00%	1,000 kW	$ 3,880.00	70.00%	1,000 kW	$ 3,880.00
Energy Charge	$ 0.003450		219,000 kWh	$ 755.55		365,000 kWh	$ 1,259.25		511,000 kWh	$ 1,762.95
Power Cost	$ 0.065000		219,000 kWh	$ 14,235.00		365,000 kWh	$ 23,725.00		511,000 kWh	$ 33,215.00
TOTAL				**$ 18,870.55**			**$ 28,864.25**			**$ 31,192.95**

APPENDIX D

COST ESTIMATE DETAILS

TABLE D-1 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 16, (IN $1,000)

REACH		CANALS			SIPHONS				PUMPING PLANTS	PIPING				ROW			AUTOMATION	ARCHEOLOGY	FY78 TOTAL FIELD COST	FY78 INDIRCET COST	FY78 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY78 COST/LF[1]	FY78 COST	LENGTH (ft)	DIAMETER (ft)[2]	FY78 Cost/LF[3]	FY78 COST	FY78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF[3]	FY78 COST	ACRES	FY78 COST/ACRE	FY 78 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#1 - Goodwell Turnout to Boise City Reservoir	566	219,120	$121	$26,431	5,250	10.00	$402	$2,744	$64,659	197,750	10.66	$531	$136,580	790	$500	$395	$9,232	$1,200	$241,241	$60,309	$301,550
#2 - Optima Reservoir to Goodwell Turnout	1,108	84,480	$154	$13,010	14,900	12.25	$574	$11,122	$73,679	79,300	13.71	$824	$84,980	530	$500	$265	$7,322	$952	$191,330	$47,830	$239,160
#3 - Slapout Junction to Optima Reservoir	1,174	264,000	$152	$40,220	68,800	13.05	$631	$56,435	$55,774	88,500	14.01	$824	$94,790	796	$500	$398	$9,905	$1,288	$258,810	$64,700	$323,510
#4 - Fort Supply Junction to Slapout Junction	1,247	183,744	$160	$29,423	1,100	14.20	$713	$1,020	$60,660	67,400	14.33	$888	$77,830	390	$500	$195	$6,765	$879	$176,772	$44,198	$220,970
#5 - Cestos Junction to Fort Supply Junction	1,303	306,240	$163	$49,843	1,300	13.65	$678	$1,146	$50,561	41,450	14.57	$852	$45,910	272	$500	$136	$5,904	$768	$154,268	$38,572	$192,840
#6 - Canton Reservoir to Cestos Junction	1,412	57,024	$157	$8,936	4,050	14.90	$766	$4,034	$23,516	3,950	15.02	$898	$4,610	62	$500	$31	$1,645	$214	$42,986	$10,744	$53,730
#7 - Pumping Plant 26 to near Canton Reservoir	1,606	382,272	$175	$66,740	37,400	14.90	$768	$37,318	$110,656	86,800	15.76	$1,030	$116,220	860	$500	$430	$13,250	$1,720	$346,334	$86,586	$432,920
#8 - Tri-Junction to Pumping Plant 26	1,606	144,672	$176	$25,487	36,300	16.50	$873	$41,201	-	-	15.76	-	-	-	$500	-	$2,672	$350	$69,710	$17,430	$87,140
#9 - Pumping Plant 28 to Tri-Junction	1,790	213,312	$178	$37,972	8,600	17.50	$950	$10,623	$40,933	8,800	16.41	$1,098	$12,560	128	$500	$64	$4,086	$531	$106,769	$26,691	$133,460
#14 - Englewood Reservoir to Slapout Reservoir	57	52,800	$63	$3,334	300		$85	$33	$14,696	32,400	4.51	$108	$4,530	44	$500	$22	$905	$118	$23,638	$5,912	$29,550
#15 - Fort Supply Junction to Ft. Supply Reservoir	26	-	-	-	-	-	-	-	$560	26,800	3.36	$61	$2,140	32	$500	$16	$109	$14	$2,839	$711	$3,550
#16 - Cestos Junction to Cestos Reservoir	105	141,504	$67	$9,457	1,650	<10.00	$126	$271	$4,553	42,100	5.67	$131	$7,190	120	$500	$60	$861	$112	$22,504	$5,626	$28,130
#17 - Near Canton Reservoir to Alva Reservoir	90	365,376	$67	$24,409	90,900	<10.00	$109	$12,896	-	-	5.36	-	-	104	$500	$52	$1,494	$194	$39,045	$9,765	$48,810
#18 - Tri-Junction to Sheridan Reservoir	160	222,816	$75	$16,765	34,000	<10.00	$124	$5,476	-	-	6.64	-	-	8	$500	$39	$891	$116	$23,287	$5,823	$29,110
TOTAL				**$352,027**				**$184,319**	**$500,247**				**$587,340**	**4,136**		**$2,103**	**$65,041**	**$8,456**	**$1,699,533**	**$424,897**	**$2,124,430**

[1]Cost derived from Plate 5, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE. FY78 Cost/LF = FY78 Cost/(1.3* Canal Length)
[2]Diameter derived from Plate 6, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE.
[3]FY78 Cost/LF = FY78 Cost/(1.3* Length). The 1.3 factor includes 10% unknowns and 20% contingencies.

TABLE D-2 - BOR RESERVOIRS COST BUILDUP FOR TABLE 16, (IN $1,000)

RESERVOIR	WITH FLOOD CONTROL	WITHOUT FLOOD CONTROL
Alva City	$86,150	$77,030
Boise City	$82,540	$81,900
Canton (Modified)	$9,730	-
Cestos	$18,320	$18,320
Englewood	$119,550	$68,800
Fort Supply (Modified)	$2,450	$200
Goodwell	$103,390	$97,460
Sheridan	$67,450	$58,800
Slapout	$72,090	$61,300
TOTAL	**$561,670**	**$463,810**

TABLE D-3 - USACE CONVEYANCE SYSTEM WITH CHLORIDE CONTROL COST BUILDUP FOR TABLE 16, (IN $1,000)

REACH		CANALS			SIPHONS				PUMPING PLANTS	PIPING				ROW			AUTOMATION	ARCHEOLOGY	FY78 TOTAL FIELD COST	FY78 INDIRCET COST	FY78 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY78 COST/LF[1]	FY78 COST	LENGTH (ft)	DIAMETER (ft)[2]	FY78 COST/LF	FY78 COST[3]	FY78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF	FY78 COST[3]	ACRES	FY78 COST/ACRE	FY 78 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#10 - Pumping Plant 31 to Pumping Plant 28	1,830	270,864	$181	$49,100	35,904	16.15	$853	$39,800	$87,700	14,784	16.55	$1,119	$21,500	620	$500	$310	$7,900	$1,050	$207,360	$51,940	$259,300
#11 - Pumping Plant 35 to Pumping Plant 31	4,000	261,888	$244	$64,000	58,608	>24.0	$1,771	$134,900	$208,600	26,400	22.18	$1,722	$59,100	940	$500	$470	$18,700	$2,430	$488,200	$122,100	$610,300
#12 - Pumping Plant 38 to Eufaula Junction	4,000	128,304	$245	$31,400	32,208	>24.0	$1,758	$73,600	$164,400	11,616	22.18	$1,709	$25,800	580	$500	$290	$11,800	$1,540	$308,830	$77,270	$386,100
#13 - Pumping Plant 39 to Vian Creek Lake	1,000	12,672	$150	$1,900	5,808	12.50	$583	$4,400	$34,400	3,168	13.20	$947	$3,900	80	$500	$40	$1,800	$230	$46,670	$11,630	$58,300
TOTAL				**$146,400**				**$252,700**	**$495,100**				**$110,300**	**2,220**		**$1,110**	**$40,200**	**$5,250**	**$1,051,060**	**$262,940**	**$1,314,000**

[1]Cost derived from Plate 5, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE. FY78 Cost/LF = FY78 Cost/(1.3* Canal Length)
[2]Diameter derived from Plate 6, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE.
[3]FY78 Cost/LF = FY78 Cost/(1.3* Length). The 1.3 factor includes 10% unknowns and 20% contingencies.

TABLE D-4 - USACE CONVEYANCE SYSTEM WITHOUT CHLORIDE CONTROL COST BUILDUP FOR TABLE 16 - (In $1,000)

REACH		CANALS			SIPHONS				PUMPING PLANTS	PIPING				ROW			AUTOMATION	ARCHEOLOGY	FY78 TOTAL FIELD COST	FY78 INDIRCET COST	FY78 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY78 COST/LF[1]	FY78 COST	LENGTH (ft)	DIAMETER (ft)[2]	FY78 COST/LF	FY78 COST[3]	FY78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF	FY78 COST[3]	ACRES	FY78 COST/ACRE	FY 78 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#10 - Pumping Plant 31 to Pumping Plant 28	1,830	270,864	$181	$49,100	35,904	16.15	$853	$39,800	$87,700	14,784	16.55	$1,119	$21,500	620	$500	$310	$7,900	$1,050	$207,360	$51,940	$259,300
#11 - Pumping Plant 35 to Pumping Plant 31	5,180	261,888	$269	$70,500	58,608	>24.0	$2,104	$160,300	$245,000	26,400	24.44	$2,643	$90,700	940	$500	$470	$22,700	$2,900	$592,570	$148,130	$740,700
#12 - Pumping Plant 38 to Eufaula Junction	5,200	128,304	$27	$34,800	32,208	>24.0	$2,109	$88,300	$208,000	11,616	24.47	$2,841	$42,900	580	$500	$290	$15,000	$1,900	$391,190	$97,810	$489,000
#13 - Pumping Plant 39 to Vian Creek Lake	1,300	12,672	$150	$1,900	5,808	12.50	$742	$5,600	$43,400	3,168	14.56	$1,190	$4,900	80	$500	$40	$2,200	$290	$58,330	$14,670	$73,000
TOTAL				**$156,300**				**$294,000**	**$584,100**				**$160,000**	**2,220**		**$1,110**	**$47,800**	**$6,140**	**$1,249,450**	**$312,550**	**$1,562,000**

[1]Cost derived from Plate 5, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE. FY78 Cost/LF = FY78 Cost/(1.3* Canal Length)
[2]Diameter derived from Plate 6, "Oklahoma State Water Plan, Northern 44 Counties, Engineering Index, October 1979", USACE.
[3]FY78 Cost/LF = FY78 Cost/(1.3* Length). The 1.3 factor includes 10% unknowns and 20% contingencies.

TABLE D-5 - USACE RESERVOIRS COST BUILDUP FOR TABLE 16, (IN $1,000)

RESERVOIR	WITH FLOOD CONTROL	WITHOUT FLOOD CONTROL
Vian Creek	$55,000	$55,000
Welty	$155,000	$155,000
TOTAL	**$210,000**	**$210,000**

TABLE D-6 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 17, (IN $1,000)

REACH	CANALS OM&R	PUMPING PLANTS OM&R	ENERGY COSTS	ANNUAL OPERATING COSTS
	FY78	FY78	FY78	FY78
#1 - Goodwell Turnout to Boise City Reservoir	$132.2	$494.3	$21,220.6	$21,847
#2 - Optima Reservoir To Goodwell Turnout	$65.0	$410.9	$22,076.4	$22,552
#3 - Slapout Junction to Optima Reservoir	$201.1	$326.3	$18,483.9	$19,011
#4 - Fort Supply Junction to Slapout Junction	$147.1	$342.8	$20,756.1	$21,246
#5 - Cestos Junction to Fort Supply Junction	$249.2	$297.8	$14,291.6	$14,839
#6 - Canton Reservoir to Cestos Junction	$44.7	$105.9	$5,478.5	$5,629
#7 - Pumping Plant 26 to near Canton Reservoir	$333.7	$568.1	$35,055.1	$35,957
#8 - Tri-Junction to Pumping Plant 26	$127.4	-	-	$127
#9 - Pumping Plant 28 to Tri-Junction	$192.0	$192.4	$10,796.0	$11,180
#14 - Englewood Reservoir to Slapout Junction	$16.7	$44.5	$516.7	$578
#15 - Fort Supply Junction to Fort Supply Reservoir	$0.0	$26.8	$67.4	$94
#16 - Cestos Junction to Cestos Reservoir	$47.3	$86.6	$1,016.2	$1,150
#17 - Near Canton Reservoir to Alva Reservoir	$122.0	-	-	$122
#18 - Tri--Junction to Sheridan Reservoir	$83.8	-	-	$84
TOTAL	**$1,762**	**$2,896**	**$149,759**	**$154,417**

TALE D-7 - BOR RESERVOIRS OM& R COST BUILDUP FOR TABLE 17, (IN $1,000)

RESERVOIR	OM&R w/ FLOOD CONTROL	OM&R w/o FLOOD CONTROL
	FY78	FY78
Alva	$54	$52
Boise City	$52	$52
Canton (Modified)	$5	$5
Cestos	$35	$36
Englewood	$59	$46
Fort Supply (Modified)	$5	$5
Goodwell	$52	$50
Optima	$5	$5
Sheridan	$47	$44
Slapout	$50	$46
TOTAL	**$364**	**$341**

TABLE D-8 - USACE CONVEYANCE OM&R COST BUILDUP FOR TABLE 17, (IN $1,000)

DESCRIPTION	OM&R	ENERGY	ENERGY COSTS ($0.030/kWh)	ANNUAL OPERATING COSTS
	FY78	kWh	FY78	FY78
Water Conveyance System w/Chloride Control	$2,260	710,000,000	$21,300	**$23,560**
Water Conveyance System w/o Chloride Control	$2,580	710,000,000	$21,300	**$23,880**

TABLE D-9 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 18, (IN $1,000)

REACH	CANALS			SIPHONS			PUMPING PLANTS			PIPE		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 - Goodwell Turnout to Boise City Reservoir	$26,431	3.16	$83,574	$2,744	3.16	$8,676	$64,659	3.01	$194,482	$136,580	3.16	$431,859
#2 - Optima Reservoir to Goodwell Turnout	$13,010	3.16	$41,137	$11,122	3.16	$35,167	$73,679	3.01	$221,612	$84,980	3.16	$268,703
#3 - Slapout Junction to Optima Reservoir	$40,220	3.16	$127,174	$56,435	3.16	$178,445	$55,774	3.01	$167,757	$94,790	3.16	$299,721
#4 - Fort Supply Junction to Slapout Junction	$29,423	3.16	$93,034	$1,020	3.16	$3,225	$60,660	3.01	$182,453	$77,830	3.16	$246,095
#5 - Cestos Junction to Fort Supply Junction	$49,843	3.16	$157,601	$1,146	3.16	$3,624	$50,561	3.01	$152,078	$45,910	3.16	$145,165
#6 - Canton Reservoir to Cestos Junction	$8,936	3.16	$28,255	$4,034	3.16	$12,755	$23,516	3.01	$70,732	$4,610	3.16	$14,577
#7 - Pumping Plant 26 to near Canton Reservoir	$66,740	3.16	$211,029	$37,318	3.16	$117,998	$110,656	3.01	$332,832	$116,220	3.16	$367,482
#8 - Tri-Junction to Pumping Plant 26	$25,487	3.16	$80,589	$41,201	3.16	$130,276	-	3.01	-	-	3.16	-
#9 - Pumping Plant 28 to Tri-Junction	$37,972	3.16	$120,066	$10,623	3.16	$33,589	$40,933	3.01	$123,118	$12,560	3.16	$39,714
#14 - Englewood Reservoir to Slapout Reservoir	$3,334	3.16	$10,542	$33	3.16	$104	$14,696	3.01	$44,203	$4,530	3.16	$14,324
#15 - Fort Supply Junction to Ft. Supply Reservoir	-	3.16	-	-	3.16	-	$560	3.01	$1,684	$2,140	3.16	$6,767
#16 - Cestos Junction to Cestos Reservoir	$9,457	3.16	$29,903	$271	3.16	$857	$4,553	3.01	$13,695	$7,190	3.16	$22,734
#17 - Near Canton Reservoir to Alva Reservoir	$24,409	3.16	$77,180	$12,896	3.16	$40,777	-	3.01	-	-	3.16	-
#18 - Tri-Junction to Sheridan Reservoir	$16,765	3.16	$53,010	$5,476	3.16	$17,315	-	3.01	-	-	3.16	-
TOTAL	**$352,027**		**$1,113,092**	**$184,319**		**$582,808**	**$500,247**		**$1,504,645**	**$587,340**		**$1,857,140**

REACH	ROW			AUTOMATION			ARCHEOLOGY		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 - Goodwell Turnout to Boise City Reservoir	$395	3.06	$1,207	$9,232	3.06	$28,205	$1,200	3.06	$3,666
#2 - Optima Reservoir to Goodwell Turnout	$265	3.06	$810	$7,322	3.06	$22,370	$952	3.06	$2,909
#3 - Slapout Junction to Optima Reservoir	$398	3.06	$1,216	$9,905	3.06	$30,261	$1,288	3.06	$3,935
#4 - Fort Supply Junction to Slapout Junction	$195	3.06	$596	$6,765	3.06	$20,668	$879	3.06	$2,685
#5 - Cestos Junction to Fort Supply Junction	$136	3.06	$416	$5,904	3.06	$18,038	$768	3.06	$2,346
#6 - Canton Reservoir to Cestos Junction	$31	3.06	$95	$1,645	3.06	$5,026	$214	3.06	$654
#7 - Pumping Plant 26 to near Canton Reservoir	$430	3.06	$1,314	$13,250	3.06	$40,481	$1,720	3.06	$5,255
#8 - Tri-Junction to Pumping Plant 26	-	3.06	-	$2,672	3.06	$8,163	$350	3.06	$1,069
#9 - Pumping Plant 28 to Tri-Junction	$64	3.06	$196	$4,086	3.06	$12,483	$531	3.06	$1,622
#14 - Englewood Reservoir to Slapout Reservoir	$22	3.06	$67	$905	3.06	$2,765	$118	3.06	$361
#15 - Fort Supply Junction to Ft. Supply Reservoir	$16	3.06	$49	$109	3.06	$333	$14	3.06	$43
#16 - Cestos Junction to Cestos Reservoir	$60	3.06	$183	$861	3.06	$2,630	$112	3.06	$342
#17 - Near Canton Reservoir to Alva Reservoir	$52	3.06	$159	$1,494	3.06	$4,564	$194	3.06	$593
#18 - Tri-Junction to Sheridan Reservoir	$39	3.06	$119	$891	3.06	$2,722	$116	3.06	$354
TOTAL	**$2,103**		**$6,425**	**$65,041**		**$198,711**	**$8,456**		**$25,834**

REACH	TOTAL FIELD COST			INDIRCT COST			CONSTRUCTION COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 - Goodwell Turnout to Boise City Reservoir	$241,241		$751,669	$60,309		$187,917	$301,550		$939,586
#2 - Optima Reservoir to Goodwell Turnout	$191,330		$592,707	$47,830		$148,177	$239,160		$740,884
#3 - Slapout Junction to Optima Reservoir	$258,810		$808,509	$64,700		$202,127	$323,510		$1,010,637
#4 - Fort Supply Junction to Slapout Junction	$176,772		$548,757	$44,198		$137,189	$220,970		$685,946
#5 - Cestos Junction to Fort Supply Junction	$154,268		$479,267	$38,572		$119,817	$192,840		$599,084
#6 - Canton Reservoir to Cestos Junction	$42,986		$132,093	$10,744		$33,023	$53,730		$165,116
#7 - Pumping Plant 26 to near Canton Reservoir	$346,334		$1,076,389	$86,586		$269,097	$432,920		$1,345,487
#8 - Tri-Junction to Pumping Plant 26	$69,710		$220,097	$17,430		$55,024	$87,140		$275,121
#9 - Pumping Plant 28 to Tri-Junction	$106,769		$330,789	$26,691		$82,697	$133,460		$413,486
#14 - Englewood Reservoir to Slapout Reservoir	$23,638		$72,365	$5,912		$18,091	$29,550		$90,457
#15 - Fort Supply Junction to Ft. Supply Reservoir	$2,839		$8,876	$711		$2,219	$3,550		$11,095
#16 - Cestos Junction to Cestos Reservoir	$22,504		$70,344	$5,626		$17,586	$28,130		$87,931
#17 - Near Canton Reservoir to Alva Reservoir	$39,045		$123,273	$9,765		$30,818	$48,810		$154,091
#18 - Tri-Junction to Sheridan Reservoir	$23,287		$73,521	$5,823		$18,380	$29,110		$91,901
TOTAL	**$1,699,533**	**3.11**	**$5,288,655**	**$424,897**	**3.11**	**$1,322,164**	**$2,124,430**	**3.11**	**$6,610,819**

TABLE D-10 - BOR RESERVOIRS COST BUILDUP FOR TABLE 18, (IN $1,000)

RESERVOIRS	WITH FLOOD CONTROL			WITHOUT FLOOD CONTROL		
	FY78	INDEX	FY10	FY78	INDEX	FY10
Alva City	$86,150	3.21	$276,435	$77,030	3.21	$247,171
Boise City	$82,540	3.21	$264,851	$81,900	3.21	$262,797
Canton (Modified)	$9,730	3.21	$31,221	-	3.21	-
Cestos	$18,320	3.21	$58,784	$18,320	3.21	$58,784
Englewood	$119,550	3.21	$383,607	$68,800	3.21	$220,763
Fort Supply (Modified)	$2,450	3.21	$7,861	$200	3.21	$642
Goodwell	$103,390	3.21	$331,754	$97,460	3.21	$312,726
Sheridan	$67,450	3.21	$216,431	$58,800	3.21	$188,675
Slapout	$72,090	3.21	$231,319	$61,300	3.21	$196,697
TOTAL	**$561,670**		**$1,802,264**	**$463,810**		**$1,488,255**

TABLE D-11 - USACE CONVEYANCE SYSTEM WITH CHLORIDE CONTROL COST BUILDUP FOR TABLE 18, (IN $1,000)

REACH	CANALS			SIPHONS			PUMPING PLANTS			PIPE			ROW			AUTOMATION			ARCHEOLOGY			TOTAL FIELD COST			INDIRECT COST			CONSTRUCTION COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#10 - Pumping Plant 31 to Pumping Plant 28	$49,100	3.16	$155,252	$39,800	3.16	$125,846	$87,700	3.01	$263,784	$21,500	3.16	$67,982	$310	3.06	$947	$7,900	3.06	$24,136	$1,050	3.06	$3,208	$207,360		$641,155	$51,940		$160,289	$259,300		$801,443
#11 - Pumping Plant 35 to Pumping Plant 31	$64,000	3.16	$202,365	$134,900	3.16	$426,547	$208,600	3.01	$627,428	$59,100	3.16	$186,871	$470	3.06	$1,436	$18,700	3.06	$57,132	$2,430	3.06	$7,424	$488,200		$1,509,203	$122,100		$377,301	$610,300		$1,886,503
#12 - Pumping Plant 38 to Eufaula Junction	$31,400	3.16	$99,285	$73,600	3.16	$232,720	$164,400	3.01	$494,483	$25,800	3.16	$81,578	$290	3.06	$886	$11,800	3.06	$36,051	$1,540	3.06	$4,705	$308,830		$949,708	$77,270		$237,427	$386,100		$1,187,135
#13 - Pumping Plant 39 to Vian Creek Lake	$1,900	3.16	$6,008	$4,400	3.16	$13,913	$34,400	3.01	$103,468	$3,900	3.16	$12,332	$40	3.06	$122	$1,800	3.06	$5,499	$230	3.06	$703	$46,670		$142,045	$11,630		$35,511	$58,300		$177,556
TOTAL	**$146,400**		**$462,910**	**$252,700**		**$799,025**	**$495,100**		**$1,489,164**	**$110,300**		**$348,763**	**$1,110**		**$3,391**	**$40,200**		**$122,818**	**$5,250**		**$16,040**	**$1,051,060**	**3.08**	**$3,242,110**	**$262,940**	**3.08**	**$810,527**	**$1,314,000**	**3.08**	**$4,052,637**

TABLE D-12 - USACE CONVEYANCE SYSTEM WITHOUT CHLORIDE CONTROL COST BUILDUP FOR TABLE 18, (IN $1,000)

REACH	CANALS			SIPHONS			PUMPING PLANTS			PIPE			ROW			AUTOMATION			ARCHEOLOGY			TOTAL FIELD COST			INDIRECT COST			CONSTRUCTION COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#10 - Pumping Plant 31 to Pumping Plant 28	$49,100	3.16	$155,252	$39,800	3.16	$125,846	$87,700	3.01	$263,784	$21,500	3.16	$67,982	$310	3.06	$947	$7,900	3.06	$24,136	$1,050	3.06	$3,208	$207,360		$641,155	$51,940		$160,289	$259,300		$801,443
#11 - Pumping Plant 35 to Pumping Plant 31	$70,500	3.16	$222,918	$160,300	3.16	$506,861	$245,000	3.01	$736,912	$90,700	3.16	$286,789	$470	3.06	$1,436	$22,700	3.06	$69,352	$2,900	3.06	$8,860	$592,570		$1,833,127	$148,130		$458,282	$740,700		$2,291,409
#12 - Pumping Plant 38 to Eufaula Junction	$34,800	3.16	$110,036	$88,300	3.16	$279,200	$208,000	3.01	$625,623	$42,900	3.16	$135,648	$290	3.06	$886	$15,000	3.06	$45,827	$1,900	3.06	$5,805	$391,190		$1,203,025	$97,810		$300,756	$489,000		$1,503,782
#13 - Pumping Plant 39 to Vian Creek Lake	$1,900	3.16	$6,008	$5,600	3.16	$17,707	$43,400	3.01	$130,539	$4,900	3.16	$15,494	$40	3.06	$122	$2,200	3.06	$6,721	$290	3.06	$886	$58,330		$177,476	$14,670		$44,369	$73,000		$221,846
TOTAL	**$156,300**		**$494,213**	**$294,000**		**$929,614**	**$584,100**		**$1,756,858**	**$160,000**		**$505,912**	**$1,110**		**$3,391**	**$47,800**		**$146,037**	**$6,140**		**$18,759**	**$1,249,450**	**3.09**	**$3,854,784**	**$312,550**	**3.08**	**$963,696**	**$1,562,000**	**3.08**	**$4,818,480**

TABLE D-13 - USACE RESERVOIRS COST BUILDUP FOR TABLE 18, (IN $1,000)

DESCRIPTION	RESERVOIR		
	FY78	INDEX	FY10
Vian Creek	$55,000	3.21	$176,482
Welty	$155,000	3.21	$497,358
TOTAL	**$210,000**		**$673,840**

TABLE D-14 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 19, (IN $1,000)

REACH	CANALS OM&R			PUMPING PLANTS OM&R			ENERGY COSTS			ANNUAL OPERATING COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 - Goodwell Turnout to Boise City Reservoir	$132.2	3.16	$418.0	$494.3	3.01	$1,486.8	$21,220.6	3.06	$64,832.4	$21,847		$66,737
#2 - Optima Reservoir To Goodwell Turnout	$65.0	3.16	$205.5	$410.9	3.01	$1,235.9	$22,076.4	3.06	$67,447.0	$22,552		$68,888
#3 - Slapout Junction to Optima Reservoir	$201.1	3.16	$635.9	$326.3	3.01	$981.4	$18,483.9	3.06	$56,471.3	$19,011		$58,089
#4 - Fort Supply Junction to Slapout Junction	$147.1	3.16	$465.1	$342.8	3.01	$1,031.1	$20,756.1	3.06	$63,413.3	$21,246		$64,909
#5 - Cestos Junction to Fort Supply Junction	$249.2	3.16	$788.0	$297.8	3.01	$895.7	$14,291.6	3.06	$43,663.2	$14,839		$45,347
#6 - Canton Reservoir to Cestos Junction	$44.7	3.16	$141.3	$105.9	3.01	$318.5	$5,478.5	3.06	$16,737.7	$5,629		$17,198
#7 - Pumping Plant 26 to near Canton Reservoir	$333.7	3.16	$1,055.1	$568.1	3.01	$1,708.7	$35,055.1	3.06	$107,099.0	$35,957		$109,863
#8 - Tri-Junction to Pumping Plant 26	$127.4	3.16	$402.8	$0.0	3.01	$0.0	$0.0	3.06	$0.0	$127		$403
#9 - Pumping Plant 28 to Tri-Junction	$192.0	3.16	$607.1	$192.4	3.01	$578.7	$10,796.0	3.06	$32,983.5	$11,180		$34,169
#14 - Englewood Reservoir to Slapout Junction	$16.7	3.16	$52.8	$44.5	3.01	$133.8	$516.7	3.06	$1,578.6	$578		$1,765
#15 - Fort Supply Junction to Fort Supply Reservoir	$0.0	3.16	$0.0	$26.8	3.01	$80.6	$67.4	3.06	$205.9	$94		$287
#16 - Cestos Junction to Cestos Reservoir	$47.3	3.16	$149.6	$86.6	3.01	$260.5	$1,016.2	3.06	$3,104.7	$1,150		$3,515
#17 - Near Canton Reservoir to Alva Reservoir	$122.0	3.16	$385.8	$0.0	3.01	$0.0	$0.0	3.06	$0.0	$122		$386
#18 - Tri-Junction to Sheridan Reservoir	$83.8	3.16	$265.0	$0.0	3.01	$0.0	$0.0	3.06	$0.0	$84		$265
TOTAL	**$1,762**		**$5,572**	**$2,896**		**$8,712**	**$149,759**		**$457,537**	**$154,417**	**3.06**	**$471,820**

TABLE D-15 - BOR RESERVOIRS OM&R COST BUILDUP FOR TABLE 19, (IN $1,000)

RESERVOIR	OM&R w/ FLOOD CONTROL			OM&R w/o FLOOD CONTROL		
	FY78	INDEX	FY10	FY78	INDEX	FY10
Alva	$54	3.21	$173	$52	3.21	$167
Boise City	$52	3.21	$167	$52	3.21	$167
Canton (Modified)	$5	3.21	$16	$5	3.21	$16
Cestos	$35	3.21	$112	$36	3.21	$116
Englewood	$59	3.21	$189	$46	3.21	$148
Fort Supply (Modified)	$5	3.21	$16	$5	3.21	$16
Goodwell	$52	3.21	$167	$50	3.21	$160
Optima	$5	3.21	$16	$5	3.21	$16
Sheridan	$47	3.21	$151	$44	3.21	$141
Slapout	$50	3.21	$160	$46	3.21	$148
TOTAL	**$364**		**$1,168**	**$341**		**$1,094**

TABLE D-16 - USACE CONVEYANCE OM&R COST BUILDUP FOR TABLE 19, (IN $1,000)

DESCRIPTION	OM&R	INDEX	OM&R	ENERGY	INDEX	ENERGY	ANNUAL OPERATING COSTS
	FY78		FY10	FY78		FY10	FY10
Water Conveyance System w/Chloride Control	$2,260	3.06	$6,905	$21,300	3.06	$65,075	**$71,980**
Water Conveyance System w/o Chloride Control	$2,580	3.06	$7,882	$21,300	3.06	$65,075	**$72,957**

TABLE D-17 - USACE RESERVOIRS OM&R COST BUILDUP FOR TABLE 19, (IN $1,000)

RESERVOIR	OM&R		
	FY78	INDEX	FY10
Welty Lake & Vian Creek Lake	$890	3.21	$2,856
TOTAL	$890		$2,856

TABLE D-18 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 20, (IN $1,000)

REACH		CANALS			SIPHONS					PUMPING PLANTS	PIPING					ROW			AUTOMATION	ARCHEOLOGY	FY10 TOTAL FIELD COST	FY10 INDIRCET COSTS	FY10 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY10 COST/LF	FY10 COST	LENGTH (ft)	DIAMETER (ft)	VELOCITY (ft/s)	FY10 COST/LF	FY10 COST	FY10 COST	LENGTH (ft)	DIAMETER (ft)	Q AVAILABLE (cfs)	FY10 COST/LF	FY10 COST	ACRES	FY10 COST/ACRE	FY10 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#1 - Goodwell Turnout to Boise City Reservoir	566	219,120	$485	$106,278	5,250	10'	7.21	$2,385	$12,523	$267,701	197,750	11.5'	689	2,743	$542,360	790	1,528	$1,207	$37,203	$4,836	$972,108	$243,027	$1,215,135
#2 - Optima Reservoir to Goodwell Turnout	1,108	84,480	$580	$49,034	14,900	2 x 10'	7.05	$4,724	$70,390	$305,045	79,300	1 x 10' & 1 x 11.5'	1163	5,085	$403,269	530	1,528	$810	$33,142	$4,308	$865,999	$216,500	$1,082,498
#3 - Slapout Junction to Optima Reservoir	1,174	264,000	$605	$159,618	68,800	2 x 10'	7.47	$4,724	$325,022	$230,915	88,500	1 x 10' & 1 x 12'	1246	5,228	$462,644	796	1,528	$1,216	$47,177	$6,133	$1,232,725	$308,181	$1,540,906
#4 - Fort Supply Junction to Slapout Junction	1,247	183,744	$615	$112,979	1,100	2 x 10'	7.94	$4,724	$5,197	$251,144	67,400	1 x 10' & 1 x 12'	1246	5,228	$352,341	390	1,528	$596	$28,890	$3,756	$754,903	$188,726	$943,629
#5 - Cestos Junction to Fort Supply Junction	1,303	310,464	$612	$189,983	1,300	1 x 10' & 1 x 11.5'	7.14	$5,085	$6,611	$209,705	41,450	2 x 11.5'	1378	5,433	$225,187	272	1,528	$416	$25,276	$3,286	$660,464	$165,116	$825,580
#6 - Canton Reservoir to Cestos Junction	1,412	57,024	$633	$36,095	4,050	1 x 10' & 1 x 11.5'	7.74	$5,433	$22,003	$97,361	3,950	2 x 12'	1543	5,712	$22,562	62	1,528	$95	$7,125	$926	$186,167	$46,542	$232,708
#7 - Pumping Plant 26 to near Canton Reservoir	1,606	382,272	$660	$252,115	37,400	2 x 11.5'	7.73	$5,433	$203,185	$458,137	86,800	2 x 12' & 1 x 5'	1618	6,217	$539,642	860	1,528	$1,314	$58,176	$7,563	$1,520,132	$380,033	$1,900,164
#8 - Tri-Junction to Pumping Plant 26	1,606	144,672	$660	$95,414	36,300	2 x 11.5'	7.73	$5,433	$197,209	-	-	-	-	-	-	-	1,528	-	$11,705	$1,522	$305,850	$76,462	$382,312
#9 - Pumping Plant 28 to Tri-Junction	1,790	213,312	$675	$144,031	8,600	2 x 12'	7.91	$5,712	$49,123	$169,470	8,800	2 x 12' & 1 x 8'	1805	6,848	$60,266	128	1,528	$196	$16,923	$2,200	$442,210	$110,552	$552,762
#14 - Englewood Reservoir to Slapout Reservoir	57	52,800	$196	$10,325	300	3	8.06	$246	$74	$60,844	32,400	5	75	510	$16,512	44	1,528	$67	$3,513	$457	$91,792	$22,948	$114,740
#15 - Fort Supply Junction to Fort Supply Reservoir	26	-	-	-	-	-	-	-	-	$2,319	26,800	4	41	340	$9,116	32	1,528	$49	$459	$60	$12,003	$3,001	$15,003
#16- Cestos Junction to Cestos Reservoir	105	141,504	$244	$34,469	1,650	5	5.35	$510	$841	$18,850	42,100	6	122	625	$26,333	120	1,528	$183	$3,227	$420	$84,323	$21,081	$105,404
#17 - Near Canton Reservoir to Alva Reservoir	90	365,376	$227	$82,893	90,900	-	-	-	-	-	-	-	-	-	-	104	1,528	$159	$3,322	$432	$86,806	$21,701	$108,507
#18 - Tri-Junction to Sheridan Reservoir	160	222,816	$276	$61,487	34,000	-	-	-	-	-	-	-	-	-	-	78	1,528	$119	$2,464	$320	$64,391	$16,098	$80,488
TOTAL				$1,334,721					$892,178	$2,071,491					$2,660,232	4,206		$6,427	$278,602	$36,218	$7,279,869	$1,819,967	$9,099,836

Total Cost of Canals, Siphons & Piping (RS Means) = $4,887,131,000
Total Cost of Canals, Siphons & Piping (USACE Cost Index) = $3,553,040,000
Factor (RSMeans/USACE Cost Index) = 1.375

TABLE D-19 - BOR RESERVOIRS COST BUILDUP FOR TABLE 19, (IN $1,000)

RESERVOIR	WITH FLOOD CONTROL			WITHOUT FLOOD CONTROL		
	FY10 USACE	FACTOR	FY10 RSMeans	FY10 USACE	FACTOR	FY10 RSMeans
Alva City	$276,435	1.375	$380,230	$247,171	1.375	$339,978
Boise City	$264,851	1.375	$364,297	$262,797	1.375	$361,472
Canton (Modified)	$31,221	1.375	$42,944	-	1.375	-
Cestos	$58,784	1.375	$80,875	$58,784	1.375	$80,857
Englewood	$383,607	1.375	$527,644	$220,763	1.375	$303,654
Fort Supply (Modified)	$7,861	1.375	$10,813	$642	1.375	$883
Goodwell	$331,754	1.375	$456,320	$312,726	1.375	$430,148
Sheridan	$216,431	1.375	$318,175	$188,675	1.375	$270,552
Slapout	$231,319	1.375	$297,696	$196,697	1.375	$259,519
TOTAL	**$1,802,264**		**$2,478,976**	**$1,488,255**		**$2,047,063**

TABLE D-20 - USACE CONVEYANCE SYSTEM WITH CHLORIDE CONTROL COST BUILDUP FOR TABLE 20, (IN $1,000)

REACH		CANALS			SIPHONS					PUMPING PLANTS	PIPING					ROW			AUTOMATION	ARCHEOLOGY	FY10 TOTAL FIELD COST	FY10 INDIRECT COST	FY10 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY10 COST/LF	FY10 COST	LENGTH (ft)	DIAMETER (ft)	VELOCITY (ft/s)	FY10 Cost/LF	FY10 COST	FY10 COST	LENGTH (ft)	DIAMETER (ft)	Q AVAILABLE (cfs)	FY10 COST/LF	FY10 COST	ACRES	FY10 COST/ACRE	FY10 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#10 - Pumping Plant 31 to Pumping Plant 28	1,830	270,864	$680	$184,317	35,904	2 x 12'	8.09	$5,712	$205,081	$363,095	14,784	2 x 12' & 1 x 9'	1902	$7,228	$106,861	620	1,528	$947	$34,412	$4,474	$899,186	$224,797	$1,123,983
#11 - Pumping Plant 35 to Pumping Plant 31	4,000	261,888	$878	$229,929	58,608	5 x 11.5'	7.70	$13,458	$788,748	$863,644	26,400	6 x 11.5'	4133	$16,141	$426,116	940	1,528	$1,436	$92,395	$12,011	$2,414,279	$603,570	$3,017,849
#12 - Pumping Plant 38 to Eufaula Junction	4,000	128,304	$878	$112,646	32,208	5 x 11.5'	7.70	$13,458	$433,456	$680,647	11,616	6 x 11.5'	4133	$16,141	$187,491	580	1,528	$886	$56,605	$7,359	$1,479,090	$369,773	$1,848,863
#13 - Pumping Plant 39 to Vian Creek Lake	1,000	12,672	$568	$7,193	5,808	2 x 9'	7.86	$3,089	$17,941	$142,423	3,168	1 x 10' & 1 x 11.5'	1163	$5,085	$16,110	80	1,528	$122	$7,352	$956	$192,096	$48,024	$240,120
TOTAL				$534,085					$1,445,226	$2,049,809					$736,578	2,220		$3,391	$190,764	$24,799	$4,984,651	$1,246,163	$6,230,814

TABLE D-21 - USACE CONVEYANCE SYSTEM WITHOUT CHLORIDE CONTROL COST BUILDUP FOR TABLE 20, (IN $1,000)

REACH		CANALS			SIPHONS					PUMPING PLANTS	PIPING					ROW			AUTOMATION	ARCHEOLOGY	FY10 TOTAL FIELD COST	FY10 INDIRCET COSTS	FY10 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY10 C0ST/LF	FY10 COST	LENGTH (ft)	DIAMETER (ft)	VELOCITY (ft/s)	FY10 COST/LF	FY10 COST	FY10 COST	LENGTH (ft)	DIAMETER (ft)	Q AVAILABLE (cfs)	FY10 COST/LF	FY10 COST	ACRES	FY10 COST/ACRE	FY10 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#10 - Pumping Plant 31 to Pumping Plant 28	1,830	270,864	$680	$184,317	35,904	2 x 12'	8.09	$5,712	$205,081	$363,095	14,784	2 x 12' & 1 x 9'	1902	$7,228	$106,861	620	$1,528	$947	$34,412	$4,474	$899,186	$224,797	$1,123,983
#11 - Pumping Plant 35 to Pumping Plant 31	5,180	261,888	$995	$260,512	58,608	6 x 12'	7.63	$16,971	$994,656	$1,014,347	26,400	7 x 12'	5402	$19,886	$524,984	940	$1,528	$1,436	$111,837	$14,539	$2,922,311	$730,578	$3,652,889
#12 - Pumping Plant 38 to Eufaula Junction	5,200	128,304	$995	$127,630	32,208	6 x 12'	7.66	$16,971	$546,613	$861,160	11,616	7 x 12'	5402	$19,886	$230,993	580	$1,528	$886	$70,691	$9,190	$1,847,163	$461,791	$2,308,954
#13 - Pumping Plant 39 to Vian Creek Lake	1,300	12,672	$612	$7,754	5,808	1 x 10' + 1 x 11.5'	7.13	$5,085	$29,536	$179,684	3,168	2 x 11.5'	1378	$5,433	$17,211	80	$1,528	$122	$9,372	$1,218	$244,898	$61,224	$306,122
TOTAL				$580,213					$1,775,886	$2,418,286					$880,049	2,220		$3,391	$226,313	$29,421	$5,913,558	$1,478,390	$7,391,948

Table D-22 - USACE RESERVOIRS COST BUILDUP FOR TABLE 20, (In $1,000)

DESCRIPTION	RESERVOIR		
	FY10 USACE	FACTOR	FY10 RSMeans
Vian Creek	$176,482	1.375	$242,747
Welty	$497,358	1.375	$684,105
TOTAL	**$673,840**		**$926,852**

TABLE D-23 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 21, (IN $1,000)

REACH		CANALS			CHANNELIZATION			DIVERSION DAM	SIPHONS				PUMPING PLANTS	PIPING				ROW			AUTOMATION	ARCHEOLOGY	FY78 TOTAL FIELD COST	FY78 INDIRECT COST	FY78 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY78 COST/LF	FY78 COST	LENGTH (ft)	FY78 COST/LF	FY78 COST	FY 78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF^3	FY78 COST	FY78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF	FY78 COST	ACRES	FY78 COST/ACRE	FY 78 COST	4% OF TFC	0.5% OF TFC	(TFC)	25% of TFC	
#1 Near Wayne to Verden Junction	1,255	430,848	124	$69,264	-	-	-	-	48,200	13.80	$660	$41,328	$69,859	6,340	14.37	$856	$7,057	372	$500	$186	$7,508	$976	$196,178	$49,045	$245,223
#2 Verden Junction to Verden Reservoir	50	112,728	43	$6,316	-	-	-	-	37,650	<10.00	$71	$3,490	-	-	-	-	-	44	$500	$22	$393	$51	$10,272	$2,568	$12,840
#3 Verden Junction to Pine Ridge Bifurcation	1,165	60,878	121	$9,549	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$500	-	$382	$50	$9,981	$2,495	$12,476
#4 Pine Ridge Bifurcation to Fort Cobb Turnout	245	53,117	71	$4,923	-	-	-	-	17,200	<10.00	$172	$3,852	-	-	-	-	-	40	$500	$20	$352	$46	$9,193	$2,298	$11,491
#5 Fort Cobb Turnout to Fort Cobb Reservoir	155	12,514	61	$986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$500	-	$39	$5	$1,030	$258	$1,288
#6 Fort Cobb Turnout to Carnegie Confluence	95	57,024	50	$3,735	-	-	-	-	-	-	-	-	$1,431	4,300	5.47	$119	$668	10	$500	$5	$234	$30	$6,103	$1,526	$7,629
#7 Carnegie Diversion to Carnegie Confluence	200	19,536	66	$1,666	-	-	-	$2,250	2,600	<10.00	$159	$537	$3,009	1,000	7.22	$216	$281	18	$500	$9	$310	$40	$8,102	$2,026	$10,128
#8 Carnegie Confluence to Foss Reservoir	290	304,128	73	$28,828	-	-	-	-	52,200	<10.00	$198	$13,446	$10,456	25,200	8.30	$305	$10,000	208	$500	$104	$2,513	$327	$65,674	$16,419	$82,093
#9 Pine Ridge Bifurcation to Cooperton Bifurcation	920	208,877	110	$29,988	-	-	-	-	7,000	11.40	$496	$4,517	$23,124	13,150	12.79	$712	$12,170	100	$500	$50	$2,794	$363	$73,006	$18,252	$91,258
#10 Cooperton Bifurcation to Snyder Reservoir	555	66,422	91	$7,818	-	-	-	-	7,950	10.00	$290	$2,992	$4,993	3,100	10.59	$441	$1,778	52	$500	$26	$704	$92	$18,403	$4,601	$23,004
#11 Cooperton Bifurcation to Altus Reservoir	225	176,088	68	$15,647	-	-	-	-	8,870	<10.00	$155	$1,793	$2,991	7,600	7.55	$210	$2,074	52	$500	$26	$901	$117	$23,549	$5,887	$29,436
#12 Altus Reservoir to Mangum Reservoir	140	192,720	60	$14,932	-	-	-	-	5,280	<10.00	$123	$843	$5,582	3,600	6.32	$157	$736	42	$500	$21	$885	$115	$23,114	$5,779	$28,893
#13 Cooperton Bifurcation to Tom Steed Reservoir	140	-	-	-	32,208	$6	$202	-	-	-	-	-	-	-	-	-	-	-	$500	-	$8	$1	$211	$53	$264
TOTAL				**$193,652**			**$202**	**$2,250**				**$72,798**	**$121,445**				**$34,764**	**938**		**$469**	**$17,023**	**$2,213**	**$444,816**	**$111,204**	**$556,020**

TABLE D-24 - BOR RESERVOIRS COST BUILDUP FOR TABLE 21, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL
Altus (Modified)	$19,000
Mangum (Upper)	$39,870
Snyder	$42,160
Verden	$17,340
TOTAL	**$118,370**

TABLE D-25 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 22, (IN $1,000)

REACH	CANAL OM&R		CHANNELIZATION OM&R		COMBINED OM&R
	FY78 FIELD COST	FY78 OM&R[1]	FY78 FIELD COST	FY78 OM&R[1]	FY78 OM&R[1]
#1 - Near Wayne to Verden Junction	$69,264	$346.3	-	-	$346.3
#2 - Verden Junction to Verden Reservoir	$6,316	$31.6	-	-	$31.6
#3 - Verden Junction to Pine Ridge Bifurcation	$9,549	$47.7	-	-	$47.7
#4 - Pine Ridge Bifurcation to Fort Cobb Turnout	$4,923	$24.6	-	-	$24.6
#5 - Fort Cobb Turnout to Fort Cobb Reservoir	$986	$4.9	-	-	$4.9
#6 - Fort Cobb Turnout to Carnegie Confluence	$3,735	$18.7	-	-	$18.7
#7 - Carnegie Diversion to Carnegie Confluence	$1,666	$8.3	-	-	$8.3
#8 - Carnegie Confluence to Foss Reservoir	$28,828	$144.1	-	-	$144.1
#9 - Pine Ridge Bifurcation to Cooperton Bifurcation	$29,988	$149.9	-	-	$149.9
#10 - Cooperton Bifurcation to Snyder Reservoir	$7,818	$39.1	-	-	$39.1
#11 - Cooperton Bifurcation to Altus Reservoir	$15,647	$78.2	-	-	$78.2
#12 - Altus Reservoir to Mangum Reservoir	$14,932	$74.7	-	-	$74.7
#13 - Cooperton Bifurcation to Tom Steed Reservoir	-	-	$202	$1	$1
TOTAL	**$193,652**	**$968**	**$202**	**$1**	**$969**

TABLE D-26 - BOR PUMPING PLANT OM&R COST BUILDUP FOR TABLE 22, (IN $1,000)

DESCRIPTION		PUMP PLANT
REACH	PLANT #	FY78 OM&R
#1 - Near Wayne to Verden Junction	8, 9, 10, 11, 12	$435.2
#2 - Verden Junction to Verden Reservoir		-
#3 - Verden Junction to Pine Ridge Bifurcation		-
#4 - Pine Ridge Bifurcation to Fort Cobb Turnout		-
#5 - Fort Cobb Turnout to Fort Cobb Reservoir		-
#6 - Fort Cobb Turnout to Carnegie Confluence	N4	$34.9
#7 - Carnegie Diversion to Carnegie Confluence	N3	$39.8
#8 - Carnegie Confluence to Foss Reservoir	N1, N2	$115.5
#9 - Pine Ridge Bifurcation to Cooperton Bifurcation	6, 7	$160.2
#10 - Cooperton Bifurcation to Snyder Reservoir	5	$47.4
#11 - Cooperton Bifurcation to Altus Reservoir	4	$43.3
#12 - Altus Reservoir to Mangum Reservoir	1, 2, 3	$104
#13 - Cooperton Bifurcation to Tom Steed Reservoir		-
TOTAL		**$980**

TABLE D-26 - BOR ENERGY COST BUILDUP FOR TABLE 22, (IN $1,000)

DESCRIPTION		PUMP PLANT ENERGY
REACH	PLANT #	FY78 COST
#1 Near Wayne to Verden Junction	8, 9, 10, 11, 12	$18,382.3
#2 Verden Junction to Verden Reservoir		-
#3 Verden Junction to Pine Ridge Bifurcation		-
#4 Pine Ridge Bifurcation to Fort Cobb Turnout		-
#5 Fort Cobb Turnout to Fort Cobb Reservoir		-
#6 Fort Cobb Turnout to Carnegie Confluence	N4	$267.3
#7 Carnegie Diversion to Carnegie Confluence	N3	$452.9
#8 Carnegie Confluence to Foss Reservoir	N1, N2	$3,004.5
#9 Pine Ridge Bifurcation to Cooperton Bifurcation	6, 7	$6,454.1
#10 Cooperton Bifurcation to Snyder Reservoir	5	$803.9
#11 Cooperton Bifurcation to Altus Reservoir	4	$599.5
#12 Altus Reservoir to Mangum Reservoir	1, 2, 3	$854.1
#13 Cooperton Bifurcation to Tom Steed Reservoir		-
TOTAL		**$30,819**

TABLE D-27 - BOR RESERVOIRS OM&R COST BUILDUP FOR TABLE 22, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL
	FY78 OM&R
Altus (Modified)	$5
Mangum (Upper)	$43
Snyder	$36
Verden	$29
TOTAL	**$113**

TABLE D-28 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 23, (IN $1,000)

REACH	DAMS			CANALS			CHANNELIZATION			SIPHONS			PUMPING PLANTS			PIPE		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 Near Wayne to Verden Junction	-	3.04	-	$69,264	3.16	$219,009	-	3.16	-	$41,328	3.16	$130,677	$69,859	3.01	$210,122	$7,057	3.16	$22,314
#2 Verden Junction to Verden Reservoir	-	3.04	-	$6,316	3.16	$19,971	-	3.16	-	$3,490	3.16	$11,035	-	3.01	-	-	3.16	-
#3 Verden Junction to Pine Ridge Bifurcation	-	3.04	-	$9,549	3.16	$30,193	-	3.16	-	-	3.16	-	-	3.01	-	-	3.16	-
#4 Pine Ridge Bifurcation to Fort Cobb Turnout	-	3.04	-	$4,923	3.16	$15,566	-	3.16	-	$3,852	3.16	$12,180	-	3.01	-	-	3.16	-
#5 Fort Cobb Turnout to Fort Cobb Reservoir	-	3.04	-	$986	3.16	$3,118	-	3.16	-	-	3.16	-	-	3.01	-	-	3.16	-
#6 Fort Cobb Turnout to Carnegie Confluence	-	3.04	-	$3,735	3.16	$11,810	-	3.16	-	-	3.16	-	$1,431	3.01	$4,304	$668	3.16	$2,112
#7 Carnegie Diversion to Carnegie Confluence	$2,250	3.04	$6,834	$1,666	3.16	$5,268	-	3.16	-	$537	3.16	$1,698	$3,009	3.01	$9,050	$281	3.16	$889
#8 Carnegie Confluence to Foss Reservoir	-	3.04	-	$28,828	3.16	$91,153	-	3.16	-	$13,446	3.16	$42,516	$10,456	3.01	$31,450	$10,000	3.16	$31,620
#9 Pine Ridge Bifurcation to Cooperton Bifurcation	-	3.04	-	$29,988	3.16	$94,821	-	3.16	-	$4,517	3.16	$14,283	$23,124	3.01	$69,552	$12,170	3.16	$38,481
#10 Cooperton Bifurcation to Snyder Reservoir	-	3.04	-	$7,818	3.16	$24,720	-	3.16	-	$2,992	3.16	$9,461	$4,993	3.01	$15,018	$1,778	3.16	$5,622
#11 Cooperton Bifurcation to Altus Reservoir	-	3.04	-	$15,647	3.16	$49,475	-	3.16	-	$1,793	3.16	$5,669	$2,991	3.01	$8,996	$2,074	3.16	$6,558
#12 Altus Reservoir to Mangum Reservoir	-	3.04	-	$14,932	3.16	$47,214	-	3.16	-	$843	3.16	$2,666	$5,582	3.01	$16,790	$736	3.16	$2,327
#13 Cooperton Bifurcation to Tom Steed Reservoir	-	3.04	-	-	3.16	-	$202	3.16	$639	-	3.16	-	-	3.01	-	-	3.16	-
TOTAL	**$2,250**		**$6,834**	**$193,652**		**$612,318**	**$202**		**$639**	**$72,798**		**$230,184**	**$121,445**		**$365,283**	**$34,764**		**$109,922**

REACH	RIGHT OF WAY			AUTOMATION			ARCHEOLOGY			TOTAL FIELD COST			INDIRCET COST			CONSTRUCTION COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 Near Wayne to Verden Junction	$186	3.06	$568	$7,508	3.10	$23,308	$976	3.10	$3,030	$196,178	[redacted]	$609,028	$49,044	[redacted]	$152,257	$245,222	[redacted]	$761,286
#2 Verden Junction to Verden Reservoir	$22	3.06	$67	$393	3.16	$1,243	$51	3.17	$162	$10,272	[redacted]	$32,478	$2,568	[redacted]	$8,119	$12,840	[redacted]	$40,597
#3 Verden Junction to Pine Ridge Bifurcation	-	3.06	-	$382	3.16	$1,208	$50	3.14	$157	$9,981	[redacted]	$31,558	$2,495	[redacted]	$7,890	$12,476	[redacted]	$39,448
#4 Pine Ridge Bifurcation to Fort Cobb Turnout	$20	3.06	$61	$352	3.16	$1,112	$46	3.14	$145	$9,193	[redacted]	$29,064	$2,298	[redacted]	$7,266	$11,491	[redacted]	$36,330
#5 Fort Cobb Turnout to Fort Cobb Reservoir	-	3.06	-	$39	3.16	$125	$5	3.24	$16	$1,030	[redacted]	$3,259	$258	[redacted]	$815	$1,288	[redacted]	$4,073
#6 Fort Cobb Turnout to Carnegie Confluence	$5	3.06	$15	$234	3.12	$730	$30	3.16	$95	$6,103	[redacted]	$19,066	$1,526	[redacted]	$4,767	$7,628	[redacted]	$23,833
#7 Carnegie Diversion to Carnegie Confluence	$9	3.06	$27	$310	3.07	$951	$40	3.09	$124	$8,102	[redacted]	$24,840	$2,026	[redacted]	$6,210	$10,128	[redacted]	$31,050
#8 Carnegie Confluence to Foss Reservoir	$104	3.06	$318	$2,513	3.14	$7,882	$327	3.13	$1,025	$65,674	[redacted]	$205,962	$16,419	[redacted]	$51,491	$82,093	[redacted]	$257,453
#9 Pine Ridge Bifurcation to Cooperton Bifurcation	$50	3.06	$153	$2,794	3.11	$8,692	$363	3.11	$1,130	$73,006	[redacted]	$227,111	$18,251	[redacted]	$56,778	$91,257	[redacted]	$283,888
#10 Cooperton Bifurcation to Snyder Reservoir	$26	3.06	$79	$704	3.12	$2,196	$92	3.10	$285	$18,403	[redacted]	$57,382	$4,601	[redacted]	$14,345	$23,004	[redacted]	$71,727
#11 Cooperton Bifurcation to Altus Reservoir	$26	3.06	$79	$901	3.14	$2,831	$117	3.15	$368	$23,549	[redacted]	$73,977	$5,887	[redacted]	$18,494	$29,437	[redacted]	$92,472
#12 Altus Reservoir to Mangum Reservoir	$21	3.06	$64	$885	3.12	$2,762	$115	3.12	$359	$23,114	[redacted]	$72,182	$5,778	[redacted]	$18,046	$28,892	[redacted]	$90,228
#13 Cooperton Bifurcation to Tom Steed Reservoir	-	3.06	-	$8	3.16	$26	$1	3.32	$3	$211	[redacted]	$668	$53	[redacted]	$167	$264	[redacted]	$834
TOTAL	**$469**		**$1,433**	**$17,023**		**$53,064**	**$2,213**		**$6,898**	**$444,816**	**3.12**	**$1,386,575**	**$111,204**	**3.12**	**$346,644**	**$556,020**	**3.12**	**$1,733,219**

TABLE D-29 - BOR RESERVOIRS COST BUILDUP FOR TABLE 23, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL		
	FY78	INDEX	FY10
Altus (Modified)	$19,000	3.21	$60,990
Mangum (Upper)	$39,870	3.21	$127,983
Snyder	$42,160	3.21	$135,334
Verden	$17,340	3.21	$55,661
TOTAL	**$118,370**		**$379,968**

TABLE D-30 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 24, (IN $1,000)

REACH	CANAL OM&R			CHANNELIZATION OM&R			COMBINED OM&R
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY10 OM&R
#1 - Near Wayne to Verden Junction	$346.3	3.16	$1,095	-	3.16	-	$1,095
#2 - Verden Junction to Verden Reservoir	$31.6	3.16	$99.9	-	3.16	-	$99.9
#3 - Verden Junction to Pine Ridge Bifurcation	$47.7	3.16	$150.8	-	3.16	-	$150.8
#4 - Pine Ridge Bifurcation to Fort Cobb Turnout	$24.6	3.16	$77.8	-	3.16	-	$77.8
#5 - Fort Cobb Turnout to Fort Cobb Reservoir	$4.9	3.16	$15.5	-	3.16	-	$15.5
#6 - Fort Cobb Turnout to Carnegie Confluence	$18.7	3.16	$59.1	-	3.16	-	$59.1
#7 - Carnegie Diversion to Carnegie Confluence	$8.3	3.16	$26.2	-	3.16	-	$26.2
#8 - Carnegie Confluence to Foss Reservoir	$144.1	3.16	$455.6	-	3.16	-	$455.6
#9 - Pine Ridge Bifurcation to Cooperton Bifurcation	$149.9	3.16	$474	-	3.16	-	$474
#10 - Cooperton Bifurcation to Snyder Reservoir	$39.1	3.16	$123.6	-	3.16	-	$123.6
#11 - Cooperton Bifurcation to Altus Reservoir	$78.2	3.16	$247.3	-	3.16	-	$247.3
#12 - Altus Reservoir to Mangum Reservoir	$74.7	3.16	$236.2	-	3.16	-	$236.2
#13 - Cooperton Bifurcation to Tom Steed Reservoir	-	3.16	-	$1	3.16	$3.2	$3.2
TOTAL	**$968**		**$3,061**	**$1,000**		**$3**	**$3,064**

TABLE D-31 - BOR PUMPING PLANT OM&R COST BUILDUP FOR TABLE 24, (IN $1,000)

DESCRIPTION		PUMP PLANT OM&R		
REACH	PLANT #	FY78	INDEX	FY10
#1 - Near Wayne to Verden Junction	8, 9, 10, 11, 12	$435.2	3.01	$1,309
#2 - Verden Junction to Verden Reservoir		-	3.01	-
#3 - Verden Junction to Pine Ridge Bifurcation		-	3.01	-
#4 - Pine Ridge Bifurcation to Fort Cobb Turnout		-	3.01	-
#5 - Fort Cobb Turnout to Fort Cobb Reservoir		-	3.01	-
#6 - Fort Cobb Turnout to Carnegie Confluence	N4	$34.9	3.01	$105
#7 - Carnegie Diversion to Carnegie Confluence	N3	$39.8	3.01	$119.7
#8 - Carnegie Confluence to Foss Reservoir	N1, N2	$115.5	3.01	$347.4
#9 - Pine Ridge Bifurcation to Cooperton Bifurcation	6, 7	$160.2	3.01	$481.9
#10 - Cooperton Bifurcation to Snyder Reservoir	5	$47.4	3.01	$142.6
#11- Cooperton Bifurcation to Altus Reservoir	4	$43.3	3.01	$130.2
#12 - Altus Reservoir to Mangum Reservoir	1, 2, 3	$104	3.01	$312.8
#13 - Cooperton Bifurcation to Tom Steed Reservoir		-	3.01	-
TOTAL		**$980**		**$2,949**

TABLE D-32 - BOR ENERGY COST BUILDUP FOR TABLE 24, (IN $1,000)

DESCRIPTION		PUMP PLANT ENERGY		
REACH	**PLANT #**	**FY78**	**INDEX**	**FY10**
#1 - Near Wayne to Verden Junction	8, 9, 10, 11, 12	$18,382.3	3.06	$56,160.9
#2 - Verden Junction to Verden Reservoir		-	3.06	-
#3 - Verden Junction to Pine Ridge Bifurcation		-	3.06	-
#4 - Pine Ridge Bifurcation to Fort Cobb Turnout		-	3.06	-
#5 - Fort Cobb Turnout to Fort Cobb Reservoir		-	3.06	-
#6 - Fort Cobb Turnout to Carnegie Confluence	N4	$267.3	3.06	-
#7 - Carnegie Diversion to Carnegie Confluence	N3	$452.9	3.06	$1,383.7
#8 - Carnegie Confluence to Foss Reservoir	N1, N2	$3,004.5	3.06	$9,179.2
#9 - Pine Ridge Bifurcation to Cooperton Bifurcation	6, 7	$6,454.1	3.06	$19,718.3
#10 - Cooperton Bifurcation to Snyder Reservoir	5	$803.9	3.06	$2,456
#11 - Cooperton Bifurcation to Altus Reservoir	4	$599.5	3.06	$1,831.6
#12 - Altus Reservoir to Mangum Reservoir	1, 2, 3	$854.1	3.06	$2,609.4
#13 - Cooperton Bifurcation to Tom Steed Reservoir		-	3.06	-
TOTAL		**$30,819**		**$93,339**

TABLE D-33 - BOR RESERVOIRS OM&R COST BUILDUP FOR TABLE 24, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL		
	FY78 OM&R	**INDEX**	**FY10 OM&R**
Altus (Modified)	$5	3.21	$16.1
Mangum (Upper)	$43	3.21	$138
Snyder	$36	3.21	$115.6
Verden	$29	3.21	$93.1
TOTAL	**$113**		**$363**

TABLE D-34 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 25, (IN $1,000)

REACH		CANALS			CHANNELIZATION		DIVERSION DAM	SIPHONS					PUMPING PLANTS	PIPING					ROW			AUTOMATION	ARCHEOLOGY	FY10 TOTAL FIELD COST	FY10 INDIRECT COSTS	FY10 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY10 COST/LF	FY10 COST	LENGTH (ft)	FY10 COST	FY 10 COST	LENGTH (ft)	DIAMETER (ft)	VELOCITY (ft/s)	FY10 COST/LF	FY10 COST	FY10 COST	LENGTH (ft)	DIAMETER (ft)	Q AVAILABLE (cfs)	FY10 COST/LF	FY10 COST	ACRES	FY10 COST/ACRE	FY10 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#1 Near Wayne to Verden Junction	1,255	430,848	$677	$291,887	-	-	-	48,200	2 x 10'	8.0	$4,815	$232,063	$286,230	6,340	2 x 11.5'	1378	$5,525	$35,027	372	1,528	$568	$33,831	$4,398	$884,004	$221,001	$1,105,005
#2 Verden Junction to Verden Reservoir	50	112,728	$215	$24,213	-	-	-	37,650	3'	7.1	$256	$9,629	-	-	-	-	-	-	44	1,528	$67	$1,356	$176	$35,442	$8,860	$44,302
#3 Verden Junction to Pine Ridge Bifurcation	1,165	60,878	$666	$40,560	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,528	-	$1,622	$211	$42,393	$10,598	$52,992
#4 Pine Ridge Bifurcation to Fort Cobb Turnout	245	53,117	$369	$19,623	-	-	-	17,200	7'	6.4	$853	$14,665	-	-	-	-	-	-	40	1,528	$61	$1,374	$179	$35,902	$8,975	$44,877
#5 Fort Cobb Turnout to Fort Cobb Reservoir	155	12,514	$311	$3,896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,528	-	$156	$20	$4,072	$1,018	$5,090
#6 Fort Cobb Turnout to Carnegie Confluence	95	57,024	$263	$14,993	-	-	-	-	-	-	-	-	$5,863	4,300	6'	122	$640	$2,754	10	1,528	$15	$945	$123	$25,562	$6,390	$31,952
#7 Carnegie Diversion to Carnegie Confluence	200	19,536	$347	$6,781	-	-	$9,311	2,600	6'	7.1	$640	$1,665	$12,329	1,000	8'	262	$1,199	$1,199	18	1,528	$27	$1,252	$163	$32,727	$8,182	$40,908
#8 Carnegie Confluence to Foss Reservoir	290	302,861	$397	$120,251	-	-	-	52,200	7'	7.5	$853	$44,507	$42,841	25,200	9'	358	$1,590	$40,062	208	1,528	$318	$9,919	$1,289	$259,188	$64,797	$323,984
#9 Pine Ridge Bifurcation to Cooperton Bifurcation	920	208,877	$584	$122,068	-	-	-	7,000	2 x 9'	7.2	$3,139	$21,973	$94,745	13,150	2 x 10'	949	$4,815	$63,312	100	1,528	$153	$12,090	$1,572	$315,913	$78,978	$394,891
#10 Cooperton Bifurcation to Snyder Reservoir	555	67,584	$519	$35,057	-	-	-	7,950	10'	7.1	$2,435	-	$20,458	3,100	11.5'	689	$2,793	$8,659	52	1,528	$79	$2,570	$334	$67,157	$16,789	$83,946
#11 Cooperton Bifurcation to Altus Reservoir	225	176,088	$361	$63,621	-	-	-	8,870	6'	8.0	$640	$5,680	$12,255	7,600	8'	262	$1,199	$9,111	52	1,528	$79	$3,630	$472	$94,848	$23,712	$118,559
#12 Altus Reservoir to Mangum Reservoir	140	192,720	$298	$57,361	-	-	-	5,280	5'	7.1	$524	$2,766	$22,871	3,600	7'	183	$853	$3,069	42	1,528	$64	$3,445	$448	$90,024	$22,506	$112,530
#13 Cooperton Bifurcation to Tom Steed Reservoir	140	-	-	-	32,208	$869	-	-	-	-	-	-	-	-	-	-	-	-	-	1,528	-	$35	$5	$908	$227	$1,135
TOTAL				**$800,311**		**$869**	**$9,311**					**$332,948**	**$497,591**					**$163,193**	**938**		**$1,431**	**$72,226**	**$9,389**	**$1,888,138**	**$472,034**	**$2,360,172**

Total Cost of Canals, Siphons & Piping (RS Means) = $1,296,452,000
Total Cost of Canals, Siphons & Piping (USACE Cost Index) = $952,424,000
Factor (RSMeans/USACE Cost Index) = 1.361

TABLE D-35 - BOR RESERVOIRS COST BUILDUP FOR TABLE 25, (IN $1,000)

RESERVOIR	UNIT COST FOR DAM SITE					UNIT QUANTITY								ITEM COSTS					COST ESTIMATE		
	LAND COST ($/AC)	CLEAR/GRUB BRUSH ($/AC)	EARTHWORK ($/CY)	GATES ($/EA)	CONCRETE ($/CY)	LAND (AC)	CLEARING ~50% (AC)	EMBANKMENT VOLUME (CY)	DAM HEIGHT (LF)	SPILLWAY GATES (EA)	SPILLWAY PILLARS (EA)	SPILLWAY LENGTH (LF)	CONCRETE (CY)	LAND PURCHASE	CLEARING	EARTHWORK	GATES	CONCRETE	TOTAL OF LISTED ITEMS	% OF COST ACCOUNTED	TOTAL COST ESTIMATE
Altus (Modified)																					$60,990
Mangum (Lower)	$1.5	$6	$0.018	$1,500	$0.25	6,248	3,124	1,860,226	80	3	4	320	25,481	$9,372	$18,744	$33,484	$4,500	$6,370	$72,470	75%	$96,627
Snyder	$1.5	$6	$0.018	$1,500	$0.25	6,800	3,400	4,069,409	72	3	4	320	23,111	$10,200	$20,400	$73,249	$4,500	$5,778	$114,127	75%	$152,169
Verden	$1.5	$6	$0.018	$1,500	$0.25	3,160	1,580	1,536,076	47	5	6	480	23,556	$4,740	$9,480	$27,649	$7,500	$5,889	$55,258	75%	$73,677
TOTAL														**$24,312**	**$48,624**	**$134,382**	**$16,500**	**$18,037**	**$241,855**		**$383,463**

TABLE D-36 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 26, (IN $1,000)

REACH		CANALS			CHANNELIZATION			DIVERSION DAM	SIPHONS				PUMPING PLANTS	PIPING				ROW			AUTOMATION	ARCHEOLOGY	FY78 TOTAL FIELD COST	FY78 INDIRECT COST	FY78 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY78 COST/LF	FY78 COST	LENGTH (ft)	FY78 COST/LF	FY78 COST	FY 78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/ft	FY78 COST	FY78 COST	LENGTH (ft)	DIAMETER (ft)	FY78 COST/LF	FY78 COST	ACRES	FY78 COST/ACRE	FY 78 COST	4% OF TFC	0.5% OF TFC	(TFC)	25% of TFC	
#1 Lake Texoma to Sec 3, T3S, R3W	1,310	426,730	$127	$70,200	-	-	-	-	17,200	16.80	$880	$19,669	$82,185	50,600	14.60	$947	$62,283	438	$500	$219	$9,380	$1,220	$245,160	$61,290	$306,450
#2 Sec 3, T3S, R3W to Sec 20, T2S, R8W	1,270	403,920	$124	$65,340	-	-	-	-	37,600	17.30	$862	$42,124	$14,500	2,900	14.43	$921	$3,474	212	$500	$106	$5,020	$653	$131,220	$32,810	$164,030
#3 Sec 20, T2S, R8W to Snyder Turnout	1,230	456,350	$123	$73,250	-	-	-	-	39,900	16.60	$804	$41,690	$80,390	17,200	14.26	$810	$18,110	438	$500	$219	$8,550	$1,110	$223,320	$55,830	$279,150
#4 Snyder Turnout to Cooperton Bifurcation	660	102,010	$98	$12,965	-	-	-	-	23,100	<10.00	$234	$7,020	$24,845	23,100	11.30	$592	$17,770	158	$500	$79	$2,510	$325	$65,510	$16,380	$81,890
#5 Snyder Turnout to Snyder Reservoir	540	16,421	$95	$2,030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$500	-	$80	$11	$2,121	$529	$2,650
#6 Cooperton Bifurcation to Tom Steed Reservoir	140	-	-	-	32,208	$6	$205	-	-	-	-	-	-	-	-	-	-	-	$500	-	$8	$1	$214	$54	$270
#7 Cooperton Bifurcation to Altus Reservoir	220	197,050	$69	$17,800	-	-	-	-	13,500	<10.00	$276	$4,850	$2,750	6,700	7.48	$206	$1,798	62	$500	$31	$1,090	$140	$28,460	$7,120	$35,580
#8 Altus Reservoir to Mangum Reservoir	135	133,901	$60	$10,420	-	-	-	-	5,700	<10.00	$196	$1,450	$4,598	12,000	6.23	$179	$2,789	40	$500	$20	$770	$100	$20,150	$5,040	$25,190
#9 Cooperton Bifurcation to Foss Bifurcation	290	114,576	$73	$10,870	-	-	-	-	57,500	10.75	$405	$30,240	-	-	-	-	-	132	$500	$66	$1,650	$215	$43,040	$10,760	$53,800
#10 Carnegie Diversion to Foss Bifurcation	200	-	-	-	-	-	-	$2,250	-	-	-	-	$4,893	9,500	7.22	$236	$2,909	32	$500	$16	$403	$52	$10,520	$2,630	$13,150
#11 Foss Bifurcation to Foss Reservoir	290	299,059	$72	$27,909	-	-	-	-	49,800	10.00	$402	$26,020	$10,746	25,900	8.30	$318	$10,699	204	$500	$102	$3,020	$390	$78,890	$19,720	$98,610
#12 Foss Bifurcation to Fort Cobb Turnout	200	115,632	$66	$9,975	-	-	-	-	9,900	10.00	$303	$3,900	-	-	-	-	-	24	$500	$12	$560	$70	$14,520	$3,630	$18,150
#13 Fort Cobb Turnout to Verden Reservoir	50	93,456	$50	$6,120	-	-	-	-	44,300	<10.00	$106	$6,100	-	-	-	-	-	102	$500	$51	$490	$65	$12,830	$3,210	$16,040
TOTAL				**$306,879**			**$205**	**$2,250**				**$183,063**	**$224,907**				**$119,832**	**1,842**		**$921**	**$33,531**	**$4,352**	**$875,955**	**$219,003**	**$1,094,960**

TABLE D-37 - BOR RESERVOIRS COST BUILDUP FOR TABLE 26, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL
Altus (Modified)	$19,000
Mangum (Upper)	$39,870
Snyder	$42,160
Verden	$17,340
TOTAL	**$118,370**

TABLE D-38 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 27, (IN $1,000)

REACH	CANAL OM&R		CHANNELIZATION OM&R		COMBINED OM&R
	FY78 FIELD COST	FY78 OM&R	FY78 FIELD COST	FY78 OM&R	FY78 OM&R
#1 - Lake Texoma to Sec 3, T3S, R3W	$70,200	$351	-	-	$351
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	$65,340	$326.7	-	-	$326.7
#3 - Sec 20, T2S, R8W to Snyder Turnout	$73,250	$366.3	-	-	$366.3
#4 - Snyder Turnout to Cooperton Bifurcation	$12,965	$64.8	-	-	$64.8
#5 - Snyder Turnout to Snyder Reservoir	$2,030	$10.2	-	-	$10.2
#6 - Cooperton Bifurcation to Tom Steed Reservoir	-	-	$205	$1	$1
#7 - Cooperton Bifurcation to Altus Reservoir	$17,800	$89	-	-	$89
#8 - Altus Reservoir to Mangum Reservoir	$10,420	$52.1	-	-	$52.1
#9 - Cooperton Bifurcation to Foss Bifurcation	$10,870	$54.4	-	-	$54.4
#10 - Carnegie Diversion to Foss Bifurcation	-	-	-	-	-
#11 - Foss Bifurcation to Foss Reservoir	$27,909	$139.5	-	-	$139.5
#12 - Foss Bifurcation to Fort Cobb Turnout	$9,975	$49.9	-	-	$49.9
#13 - Fort Cobb Turnout to Verden Reservoir	$6,120	$30.6	-	-	$30.6
TOTAL	**$306,879**	**$1,534**	**$205**	**$1**	**$1,535**

TABLE D-39 - BOR PUMPING PLANT OM&R COST BUILDUP FOR TABLE 27, (IN $1,000)

DESCRIPTION		PUMP PLANT
REACH	PLANT #	FY78 OM&R
#1 - Lake Texoma to Sec 3, T3S, R3W	S-1, S-2, S-3, S-4, S-5	$482
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	S-6	$89
#3 - Sec 20, T2S, R8W to Snyder Turnout	S-7, S-8, S-9, S-10, S-11, S-12, S-13	$517
#4 - Snyder Turnout to Cooperton Bifurcation	S-14, S-15, S-16	$199
#5 - Snyder Turnout to Snyder Reservoir		-
#6 - Cooperton Bifurcation to Tom Steed Reservoir		-
#7 - Cooperton Bifurcation to Altus Reservoir	W-1	$41
#8 - Altus Reservoir to Mangum Reservoir	W-2, W-3	$77
#9 - Cooperton Bifurcation to Foss Bifurcation		-
#10 - Carnegie Diversion to Foss Bifurcation	N-1	$34
#11 - Foss Bifurcation to Foss Reservoir	N-2, N-3	$98
#12 - Foss Bifurcation to Fort Cobb Turnout		-
#13 - Fort Cobb Turnout to Verden Reservoir		-
TOTAL		**$1,537**

TABLE D-40 - BOR ENERGY COST BUILDUP FOR TABLE 27, (IN $1,000)

DESCRIPTION		PUMP PLANT ENERGY
REACH	PLANT #	FY78 COST
#1 - Lake Texoma to Sec 3, T3S, R3W	S-1, S-2, S-3, S-4, S-5	$24,534.2
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	S-6	$3,835.4
#3 - Sec 20, T2S, R8W to Snyder Turnout	S-7, S-8, S-9, S-10, S-11, S-12, S-13	$16,712
#4 - Snyder Turnout to Cooperton Bifurcation	S-14, S-15, S-16	$6,280.3
#5 - Snyder Turnout to Snyder Reservoir		-
#6 - Cooperton Bifurcation to Tom Steed Reservoir		-
#7 - Cooperton Bifurcation to Altus Reservoir	W-1	$503.7
#8 - Altus Reservoir to Mangum Reservoir	W-2, W-3	$856.4
#9 - Cooperton Bifurcation to Foss Bifurcation		-
#10 - Carnegie Diversion to Foss Bifurcation	N-1	$396.9
#11 - Foss Bifurcation to Foss Reservoir	N-2, N-3	$1,731.5
#12 - Foss Bifurcation to Fort Cobb Turnout		-
#13 - Fort Cobb Turnout to Verden Reservoir		-
TOTAL		**$54,850**

TABLE D-41 - BOR RESERVOIRS OM&R COST BUILDUP FOR TABLE 27, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL
	FY78 OM&R
Altus (Modified)	$5
Mangum (Upper)	$43
Snyder	$36
Verden	$29
TOTAL	**$113**

TABLE D-42 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 28, (IN $1,000)

REACH	DAMS			CANALS			CHANNELIZATION			SIPHONS			PUMPING PLANTS		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 Lake Texoma to Sec 3, T3S, R3W	-	3.04	-	$70,200	3.16	$221,969	-	3.16	-	$19,669	3.16	$62,192	$82,185	3.01	$247,196
#2 Sec 3, T3S, R3W to Sec 20, T2S, R8W	-	3.04	-	$65,340	3.16	$206,602	-	3.16	-	$42,124	3.16	$133,194	$14,500	3.01	$43,613
#3 Sec 20, T2S, R8W to Snyder Turnout	-	3.04	-	$73,250	3.16	$231,613	-	3.16	-	$41,690	3.16	$131,822	$80,390	3.01	$241,797
#4 Snyder Turnout to Cooperton Bifurcation	-	3.04	-	$12,965	3.16	$40,995	-	3.16	-	$7,020	3.16	$22,197	$24,845	3.01	$74,729
#5 Snyder Turnout to Snyder Reservoir	-	3.04	-	$2,030	3.16	$6,419	-	3.16	-	-	3.16	-	-	3.01	-
#6 Cooperton Bifurcation to Tom Steed Reservoir	-	3.04	-	-	3.16	-	$205	3.16	$648	-	3.16	-	-	3.01	-
#7 Cooperton Bifurcation to Altus Reservoir	-	3.04	-	$17,800	3.16	$56,283	-	3.16	-	$4,850	3.16	$15,335	$2,750	3.01	$8,271
#8 Altus Reservoir to Mangum Reservoir	-	3.04	-	$10,420	3.16	$32,948	-	3.16	-	$1,450	3.16	$4,585	$4,598	3.01	$13,830
#9 Cooperton Bifurcation to Foss Bifurcation	-	3.04	-	$10,870	3.16	$34,370	-	3.16	-	$30,240	3.16	$95,617	-	3.01	-
#10 Carnegie Diversion to Foss Bifurcation	$2,250	3.04	$6,834	-	3.16	-	-	3.16	-	-	3.16	-	$4,893	3.01	$14,717
#11 Foss Bifurcation to Foss Reservoir	-	3.04	-	$27,909	3.16	$88,247	-	3.16	-	$26,020	3.16	$82,274	$10,746	3.01	$32,322
#12 Foss Bifurcation to Fort Cobb Turnout	-	3.04	-	$9,975	3.16	$31,540	-	3.16	-	$3,900	3.16	$12,332	-	3.01	-
#13 Fort Cobb Turnout to Verden Reservoir	-	3.04	-	$6,120	3.16	$19,351	-	3.16	-	$6,100	3.16	$19,288	-	3.01	-
TOTAL	**$2,250**		**$6,834**	**$306,879**		**$970,336**	**$205**		**$648**	**$183,063**		**$578,836**	**$224,907**		**$676,476**

REACH	PIPE			RIGHT OF WAY			AUTOMATION			ARCHEOLOGY			TOTAL FIELD COST			INDIRCET COST			CONSTRUCTION COST		
	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10	FY78	INDEX	FY10
#1 Lake Texoma to Sec 3, T3S, R3W	$62,283	3.16	$196,936	$219	3.06	$669	$9,380	3.11	$29,159	$1,220	3.11	$3,791	$245,156	[redacted]	$761,912	$61,289	[redacted]	$190,478	$306,445	[redacted]	$952,390
#2 Sec 3, T3S, R3W to Sec 20, T2S, R8W	$3,474	3.16	$10,985	$106	3.06	$324	$5,020	3.15	$15,789	$653	3.14	$2,053	$131,217	[redacted]	$412,559	$32,804	[redacted]	$103,140	$164,021	[redacted]	$515,698
#3 Sec 20, T2S, R8W to Snyder Turnout	$18,110	3.16	$57,263	$219	3.06	$669	$8,550	3.10	$26,527	$1,110	3.11	$3,448	$223,319	[redacted]	$693,139	$55,830	[redacted]	$173,285	$279,149	[redacted]	$866,424
#4 Snyder Turnout to Cooperton Bifurcation	$17,770	3.16	$56,188	$79	3.06	$241	$2,510	3.10	$7,774	$325	3.11	$1,011	$65,514	[redacted]	$203,134	$16,379	[redacted]	$50,784	$81,893	[redacted]	$253,918
#5 Snyder Turnout to Snyder Reservoir	-	3.16	-	-	3.06	-	$80	3.21	$257	$11	3.03	$33	$2,121	[redacted]	$6,709	$530	[redacted]	$1,677	$2,651	[redacted]	$8,386
#6 Cooperton Bifurcation to Tom Steed Reservoir	-	3.16	-	-	3.06	-	$8	3.24	$26	$1	3.37	$3	$214	[redacted]	$677	$54	[redacted]	$169	$268	[redacted]	$847
#7 Cooperton Bifurcation to Altus Reservoir	$1,798	3.16	$5,685	$31	3.06	$95	$1,090	3.14	$3,427	$140	3.18	$445	$28,459	[redacted]	$89,542	$7,115	[redacted]	$22,385	$35,574	[redacted]	$111,927
#8 Altus Reservoir to Mangum Reservoir	$2,789	3.16	$8,819	$20	3.06	$61	$770	3.13	$2,410	$100	3.13	$313	$20,147	[redacted]	$62,965	$5,037	[redacted]	$15,741	$25,184	[redacted]	$78,706
#9 Cooperton Bifurcation to Foss Bifurcation	-	3.16	-	$66	3.06	$202	$1,650	3.16	$5,208	$215	3.15	$677	$43,041	[redacted]	$136,074	$10,760	[redacted]	$34,019	$53,801	[redacted]	$170,093
#10 Carnegie Diversion to Foss Bifurcation	$2,909	3.16	$9,198	$16	3.06	$49	$403	3.06	$1,232	$52	3.08	$160	$10,523	[redacted]	$32,190	$2,631	[redacted]	$8,047	$13,154	[redacted]	$40,237
#11 Foss Bifurcation to Foss Reservoir	$10,699	3.16	$33,830	$102	3.06	$312	$3,020	3.14	$9,479	$390	3.16	$1,232	$78,886	[redacted]	$247,696	$19,722	[redacted]	$61,924	$98,608	[redacted]	$309,620
#12 Foss Bifurcation to Fort Cobb Turnout	-	3.16	-	$12	3.06	$37	$560	3.14	$1,756	$70	3.26	$228	$14,517	[redacted]	$45,893	$3,629	[redacted]	$11,473	$18,146	[redacted]	$57,367
#13 Fort Cobb Turnout to Verden Reservoir	-	3.16	-	$51	3.06	$156	$490	3.17	$1,552	$65	3.10	$202	$12,826	[redacted]	$40,548	$3,207	[redacted]	$10,137	$16,033	[redacted]	$50,685
TOTAL	**$119,832**		**$378,903**	**$921**		**$2,814**	**$33,531**		**$104,594**	**$4,352**		**$13,597**	**$875,940**	**3.12**	**$2,733,039**	**$218,985**	**3.12**	**$683,260**	**$1,094,925**	**3.12**	**$3,416,298**

TABLE D-43 - BOR RESERVOIRS COST BUILDUP FOR TABLE 28, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL		
	FY78	INDEX	FY10
Altus (Modified)	$19,000	3.21	$60,990
Mangum (Upper)	$39,870	3.21	$127,983
Snyder	$42,160	3.21	$135,334
Verden	$17,340	3.21	$55,661
TOTAL	**$118,370**		**$379,968**

TABLE D-44 - BOR CONVEYANCE OM&R COST BUILDUP FOR TABLE 29, (IN $1,000)

REACH	CANAL OM&R			CHANNELIZATION OM&R			COMBINED OM&R
	FY78 OM&R	INDEX	FY10 OM&R	FY78 OM&R	INDEX	FY10 OM&R	FY10 OM&R
#1 - Lake Texoma to Sec 3, T3S, R3W	$351	3.16	$1,109.8	-	3.16	-	$1,109.8
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	$327	3.16	$1,034	-	3.16	-	$1,034
#3 - Sec 20, T2S, R8W to Snyder Turnout	$366	3.16	$1,157.3	-	3.16	-	$1,157.3
#4 - Snyder Turnout to Cooperton Bifurcation	$65	3.16	$205.5	-	3.16	-	$205.5
#5 - Snyder Turnout to Snyder Reservoir	$10	3.16	$31.6	-	3.16	-	$31.6
#6 - Cooperton Bifurcation to Tom Steed Reservoir	-	3.16	-	$1	3.16	$3.2	$3.2
#7 - Cooperton Bifurcation to Altus Reservoir	$89	3.16	$281.4	-	3.16	-	$281.4
#8 - Altus Reservoir to Mangum Reservoir	$52	3.16	$164.4	-	3.16	-	$164.4
#9 - Cooperton Bifurcation to Foss Bifurcation	$54	3.16	$170.7	-	3.16	-	$170.7
#10 - Carnegie Diversion to Foss Bifurcation	-	3.16	-	-	3.16	-	-
#11 - Foss Bifurcation to Foss Reservoir	$140	3.16	$442.7	-	3.16	-	$442.7
#12 - Foss Bifurcation to Fort Cobb Turnout	$50	3.16	$158.1	-	3.16	-	$158.1
#13 - Fort Cobb Turnout to Verden Reservoir	$31	3.16	$98	-	3.16	-	$98
TOTAL	**$1,535**		**$4,854**	**$1**		**$3**	**$4,857**

TABLE D-45 - BOR PUMPING PLANT OM&R COST BUILDUP FOR TABLE 29, (IN $1,000)

DESCRIPTION		PUMP PLANT OM&R		
REACH	PLANT #	FY78	INDEX	FY10
#1- Lake Texoma to Sec 3, T3S, R3W	S-1, S-2, S-3, S-4, S-5	$482	3.01	$1,449.8
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	S-6	$89	3.01	$267.7
#3 - Sec 20, T2S, R8W to Snyder Turnout	S-7, S-8, S-9, S-10, S-11, S-12, S-13	$517	3.01	$1,555
#4 - Snyder Turnout to Cooperton Bifurcation	S-14, S-15, S-16	$199	3.01	$598.6
#5 - Snyder Turnout to Snyder Reservoir		-	3.01	-
#6 - Cooperton Bifurcation to Tom Steed Reservoir		-	3.01	-
#7 - Cooperton Bifurcation to Altus Reservoir	W-1	$41	3.01	$123.3
#8 - Altus Reservoir to Mangum Reservoir	W-2, W-3	$77	3.01	$231.6
#9 - Cooperton Bifurcation to Foss Bifurcation		-	3.01	-
#10 - Carnegie Diversion to Foss Bifurcation	N-1	$34	3.01	$102.3
#11 - Foss Bifurcation to Foss Reservoir	N-2, N-3	$98	3.01	$294.8
#12 - Foss Bifurcation to Fort Cobb Turnout		-	3.01	-
#13 - Fort Cobb Turnout to Verden Reservoir		-	3.01	-
TOTAL		**$1,537**		**$4,623**

TABLE D-46 - BOR ENERGY COST BUILDUP FOR TABLE 29, (IN $1,000)

DESCRIPTION		PUMP PLANT ENERGY		
REACH	PLANT #	FY78	INDEX	FY10
#1 - Lake Texoma to Sec 3, T3S, R3W	S-1, S-2, S-3, S-4, S-5	$24,535	3.06	$74,958.4
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	S-6	$3,835	3.06	$11,716.5
#3 - Sec 20, T2S, R8W to Snyder Turnout	S-7, S-8, S-9, S-10, S-11, S-12, S-13	$16,713	3.06	$51,060.9
#4 - Snyder Turnout to Cooperton Bifurcation	S-14, S-15, S-16	$6,280	3.06	$19,186.4
#5 - Snyder Turnout to Snyder Reservoir		-	3.06	-
#6 - Cooperton Bifurcation to Tom Steed Reservoir		-	3.06	-
#7 - Cooperton Bifurcation to Altus Reservoir	W-1	$503	3.06	$1,536.7
#8 - Altus Reservoir to Mangum Reservoir	W-2, W-3	$856	3.06	$2,615.2
#9 - Cooperton Bifurcation to Foss Bifurcation		-	3.06	-
#10 - Carnegie Diversion to Foss Bifurcation	N-1	$397	3.06	$1,212.9
#11 - Foss Bifurcation to Foss Reservoir	N-2, N-3	$1,731	3.06	$5,288.5
#12 - Foss Bifurcation to Fort Cobb Turnout		-	3.06	-
#13 - Fort Cobb Turnout to Verden Reservoir		-	3.06	-
TOTAL		**$54,850**		**$167,575**

TABLE D-47 - BOR RESERVOIRS OM&R COST BUILDUP FOR TABLE 29, (IN $1,000)

RESERVOIR	WITHOUT FLOOD CONTROL		
	FY78 OM&R	INDEX	FY10 OM&R
Altus (Modified)	$5	3.21	$16.1
Mangum (Upper)	$43	3.21	$138
Snyder	$36	3.21	$115.6
Verden	$29	3.21	$93.1
TOTAL	**$113**		**$363**

TABLE D-48 - BOR CONVEYANCE SYSTEM COST BUILDUP FOR TABLE 30, (IN $1,000)

REACH		CANALS			CHANNELIZATION		DIVERSION DAM	SIPHONS					PUMPING PLANTS	PIPING						ROW			AUTOMATION	ARCHEOLOGY	FY10 TOTAL FIELD COST	FY10 INDIRECT COSTS	FY10 CONSTRUCTION COST
	Q (cfs)	LENGTH (ft)	FY10 COST/LF	FY10 COST	LENGTH (FT)	FY10 COST	FY 10 COST	LENGTH (ft)	DIAMETER (ft)	VELOCITY (ft/s)	FY10 COST/LF	FY10 COST	FY10 COST	LENGTH (ft)	NO. OF PIPES	DIAMETER (ft)	Q AVAILABLE (cfs)	FY10 COST/LF	FY10 COST	ACRES	FY10 COST/ACRE	FY10 COST	4% of FC	0.5% of FC	(TFC)	25% of TFC	
#1 - Lake Texoma to Sec 3, T3S, R3W	1,310	426,730	$683	$291,503	-	-	-	17,200	2 x 11.5'	6.3	$5,525	$95,027	$314,309	50,600	2	11.5	1378	$5,525	$279,555	438	1,528	$669	$39,243	$5,102	$1,025,407	$256,352	$1,281,759
#2 - Sec 3, T3S, R3W to Sec 20, T2S, R8W	1,270	403,920	$677	$273,644	-	-	-	37,600	2 x 10'	8.1	$4,815	$181,029	$55,454	2,900	2	11.5	1378	$5,525	$16,022	212	1,528	$324	$21,059	$2,738	$550,270	$137,567	$687,837
#3 - Sec 20, T2S, R8W to Snyder Turnout	1,230	456,350	$681	$310,924	-	-	-	39,900	2 x 10'	7.8	$4,815	$192,102	$307,445	17,200	1	1 x 10 & 1 x 12	1246	$5,320	$91,512	438	1,528	$669	$36,106	$4,694	$943,451	$235,863	$1,179,314
#4 - Snyder Turnout to Cooperton Bifurcation	660	102,010	$559	$56,985	-	-	-	23,100	11.5'	6.4	$2,793	$64,522	$95,018	23,100	1	11.5	689	$2,793	$64,522	158	1,528	$241	$11,252	$1,463	$294,002	$73,500	$367,502
#5 - Snyder Feeder to Snyder Reservoir	540	16,421	$526	$8,642	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,528	-	$346	$45	$9,033	$2,258	$11,291
#6 - Cooperton Bifurcation to Tom Steed Reservoir	140	-	-	-	32,208	$823	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,528	-	$33	$4	$860	$215	$1,075
#7 - Cooperton Bifurcation to Altus Reservoir	220	197,050	$353	$69,478	-	-	-	13,500	6'	7.8	$640	$8,645	$10,517	6,700	1	8	262	$1,199	$8,032	62	1,528	$95	$3,871	$503	$101,141	$25,285	$126,426
#8 - Altus Reservoir to Mangum Reservoir	135	133,901	$295	$39,491	-	-	-	5,700	5'	6.9	$524	$2,986	$17,585	12,000	1	7	183	$853	$10,231	40	1,528	$61	$2,814	$366	$73,534	$18,383	$91,917
#9 - Cooperton Bifurcation to Foss Bifurcation	290	114,576	$397	$45,493	-	-	-	57,500	7'	7.5	$853	$49,025	-	-	-	-	-	-	-	132	1,528	$202	$3,789	$493	$99,001	$24,750	$123,752
#10 - Carnegie Diversion to Foss Bifurcation	200	-	-	-	-	-	$8,691	-	-		-	-	$18,713	9,500	1	8	262	$1,199	$11,388	32	1,528	$49	$1,554	$202	$40,596	$10,149	$50,745
#11 - Foss Bifurcation to Foss Reservoir	290	299,059	$397	$118,742	-	-	-	49,800	7'	7.5	$853	$42,460	$41,097	25,900	1	9	358	$1,590	$41,175	204	1,528	$312	$9,751	$1,268	$254,805	$63,701	$318,507
#12 - Foss Bifurcation to Fort Cobb Turnout	200	115,632	$344	$39,824	-	-	-	9,900	6'	7.1	$640	$6,340	-	-	-	-	-	-	-	24	1,528	$37	$1,848	$240	$48,289	$12,072	$60,362
#13 - Fort Cobb Turnout to Verden Reservoir	50	93,456	$205	$19,124	-	-	-	44,300	3'	7.1	$256	$11,330	-	-	-	-	-	-	-	102	1,528	$156	$1,224	$159	$31,994	$7,998	$39,992
TOTAL				**$1,273,850**		**$823**	**$8,691**					**$653,466**	**$860,137**						**$522,437**	**1,842**		**$2,815**	**$132,889**	**$17,276**	**$3,472,383**	**$868,096**	**$4,340,479**

TABLE D-49 - BOR RESERVOIRS COST BUILDUP FOR TABLE 30, (IN $1,000)

RESERVOIR	UNIT COST FOR DAM SITE					UNIT QUANTITY								ITEM COSTS					COST ESTIMATE		
	LAND COST ($/AC)	CLEAR/GRUB BRUSH ($/AC)	EARTHWORK ($/CY)	GATES ($/EA)	CONCRETE ($/CY)	LAND (AC)	CLEARING ~50% (AC)	EMBANKMENT VOLUME (CY)	DAM HEIGHT (LF)	SPILLWAY GATES (EA)	SPILLWAY PILLARS (EA)	SPILLWAY LENGTH (LF)	CONCRETE (CY)	LAND PURCHASE	CLEARING	EARTHWORK	GATES	CONCRETE	TOTAL OF LISTED ITEMS	% OF COST ACCOUNTED	TOTAL COST ESTIMATE
Altus																					$60,990
Gainesville	$1.5	$6	$0.018	$1,500	$0.25	141,375	70,688	8,880,825	144	17	18	1440	200,000	$212,063	$424,125	$159,855	$25,500	$50,000	$871,542	75%	$1,162,056
Mangum (Lower)	$1.5	$6	$0.018	$1,500	$0.25	6,248	3,124	1,860,226	80	3	4	320	25,481	$9,372	$18,744	$33,484	$4,500	$6,370	$72,470	75%	$96,627
Snyder	$1.5	$6	$0.018	$1,500	$0.25	6,800	3,400	4,069,409	72	3	4	320	23,111	$10,200	$20,400	$73,249	$4,500	$5,778	$114,127	75%	$152,170
Verden	$1.5	$6	$0.018	$1,500	$0.25	3,160	1,580	1,536,076	47	5	6	480	23,556	$4,740	$9,480	$27,649	$7,500	$5,889	$55,258	75%	$73,678
TOTAL														**$236,375**	**$472,749**	**$294,238**	**$42,000**	**$68,037**	**$1,113,398**		**$1,545,521**