CHAPTER VI
STATEWIDE WATER CONVEYANCE SYSTEM

INTRODUCTION

Most of the state's water resources are located in eastern Oklahoma, where abundant rainfall and runoff provide excellent potential for water resources development. The state has developed only a small portion of the estimated 34 million acre-feet of water which annually flows unused out of eastern Oklahoma into Arkansas and Louisiana, ultimately to the Gulf of Mexico. Water resources vastly exceeding any foreseeable demands remain available for development in this area.

On the other hand, central Oklahoma, which possesses the resources favorable for large-scale industrial expansion, is approaching the limit of development permitted by its available water resources and projected population growth is expected to place further pressure on existing supplies.

In western Oklahoma additional sources of water will soon be required to supplement or replace the depleting ground water resources presently used to irrigate fertile farmlands and to expand irrigation. It is estimated that some areas will expend their water supplies in 20 years or less, thus causing farmers to revert to dryland farming.

The preceding chapter proposed local water develpment projects utilizing local stream and ground water supplies necessary for each of the eight planning regions to meet future water needs through the year 2040. As indicated in Figure 96 , the three eastern Oklahoma planning regions have sufficient water resources, to meet their projected needs, although some have not been developed, and still have a surplus of water. However, the Central, Southwest, South Central, North Central and Northwest Planning Regions are expected to experience future water shortages of varying degrees, even after all local sources are developed. These regions must rely on other areas of the state to provide additional water supplies.

State and federal studies to date indicate that the only viable means of providing additional water to these water-deficient areas appears to be the transfer of surplus water from eastern Oklahoma. The two water conveyance systems proposed as integral parts of the Oklahoma Comprehensive Water Plan would accomplish such a redistrubution.

The statewide water conveyance system is based upon specific assumptions which include: (1) existing multipurpose reservoirs are tied into the system to maximize the use of existing development; (2) all good quality ground and stream water resources in western Oklahoma are developed to the maximum extent practical; and (3) all proposed local projects are encouraged for development so that the import requirements of each region are minmized.

In the formulation of the statewide water conveyance system, it was determined that the Corps of Engineers would be the lead agency in developing draft plans and cost estimates for the central and eastern parts of the state and the Bureau of Reclamation would have the responsibility for planning conveyance facilities in western Oklahoma. During the course of work, the Planning Committee coordinated the activities of all participants in order to utilize the results of their studies to formulate the water conveyance systems presented herein.

GENERAL DESCRIPTION

Figure 97 shows the two conveyance systems proposed as a means of assuring the entire state of adequate amounts of water through the year 2040.

The northern conveyance system would utilize surplus flows at Lake Eufaula and Robert S. Kerr Reservoir. Off-stream regulating storage would be provided at Welty and Vian Creek Reservoirs. The surplus water would then be conveyed to nine terminal reservoirs in north central and northwestern Okla homa. The total amount of water transferred through the northern conveyance system would be 1.2 million acre-feet annually, primarily for irrigation purposes.

The southern water conveyance system, updated from Phase I of the Oklahoma Comprehensive Water Plan, would divert surplus yields from existing and authorized reservoirs in southeastern Oklahoma to central and southwestern Oklahoma. The Central Planning Region would receive 487,000 acre-feet per year for municipal and industrial use, with the proposed West Elm Creek Reservoir serving as a terminal reservoir. A turnoff near Wayne would carry 823,000 acre-feet per year of largely irrigation water southwestward to seven terminal reservoirs. Total water delivered would be 1,310,000 acre-feet per year.

Both systems would include pumping plants, pipelines and ac-

FIGURE 96 YEAR 2040 STATEWIDE WATER RESOURCES AND REQUIREMENTS (In 1,000 Af/Yr)

REGION	PROJECTED 2040 REQUIREMENTS	POTENTIAL DEVELOPMENT	SURPLUS (DEFICIT)
SOUTHEAST	548.7	4,120.0	3,571.3
CENTRAL	819.7	332.7	(487.0)
SOUTH CENTRAL	228.8	193.3	(35.5)
SOUTHWEST	1,392.8	593.9	(798.9)
EAST CENTRAL	365.1	1,957.6	1,592.5
NORTHEAST	971.0	3,062.8	2,091.8
NORTH CENTRAL	659.9	561.7	(98.2)
NORTHWEST	1,953.5	1,006.4	(947.1)
STATE TOTAL	6,939.5	11,828.4	4,888.9

cessories to deliver municipal and industrial water from terminal reservoirs to identified demand centers. Costs of facilities to further distribute water from these demand centers and cost for water treatment facilities are not included here.

The proposed irrigation distribution facilities from terminal reservoirs have been designed so that all the irrigated lands served by the system lie within one mile of proposed facilities. Lands identified for irrigation are those classified as those most suitable for long-term project-type irrigation.

STAGING

In order to minimize the cost of construction, each conveyance system is proposed to be built in stages coordinated with the increased water needs of the import regions. The initial stage of development of each system would include construction of a portion of the source components and a major segment of their respective conveyance canals, so that water would be available for use in some areas of the import regions at the end of the first stage of development. In succeeding stages additional sources of water would be developed and the import capabilities of terminal reservoirs in western Oklahoma increased until the ultimate capactiy of each system is achieved. The northern water conveyance system is proposed for construction in three stages over a 30-year period, while the southern system would be completed in four stages over the same period. The systems have been designed so that by the end of the thirteenth year after initiation of construction, all counties requiring imported water will have sufficient amounts available to meet their projected demands.

COST METHODOLOGY

Preliminary cost estimates for the statewide water conveyance system are based on January 1978 price levels and a 100-year period of analysis. These include (1) construction costs; (2) average annual operation, maintenance, replacement and energy (OMR&E) costs; and (3) average annual equivalent cost. No costs are included for local delivery and/or treatment of municipal and industrial water.

Construction costs include construction of proposed dams and reservoirs; water supply storage in existing, under construction and authorized reservoirs; conveyance facilities; irrigation distribution and municipal and industrial delivery facilities; and environmental mitigation/compensation costs.

Annual OMR&E costs include expenses necessary for effective operation, regular maintenance, major replacement and required energy or pumping costs. Upon completion, assurances would be obtained from a legal entity of the State of Oklahoma to accept maintenance of water conveyance system, including recreation facilities, in order to insure operation, maintenance and major replacements. Operation would include providing all personnel, equipment and materials required to operate and maintain the system. In addition, the operating entity would be responsible for the purchase of all electrical energy required to operate the system.

Maintenance, performed at the operating entity's expense, would include adequate measures to prevent significant impairment of the design capacity of the water conveyance system and to insure the safety and integrity of its various components. It would also include maintenance of public use areas and measures to safeguard their aesthetic qualities.

Replacement of large pumps, motors, valves and other major equipment, as well as repair and replacement of miscellaneous items, would be accomplished at the expense of the operating entity.

Initially, consideration was given to utilizing "off-peak" energy to reduce pumping costs, however, depending on the duration of the off-peak period, such a system would require approximately two to four times the conveyance capacity of one designed for uninterrupted pumping. Since the greater capital costs required for this increased capacity would negate any savings in energy costs, operation of the system is based on continuous pumping at an average demand rate.

Pumping plants in the system would be operated on an as-needed basis. Upon completion of each stage of the project, the installed pumping capacity would exceed the immediate requirements, and the pumps would be operated intermittently as required. However, as demands increased, the idle periods would become fewer and of shorter duration until additional pumping capacity is required or until the ultimate capacity of the system is reached.

Average annual equivalent costs are presented to allow aessment of individual project features as well as the entire system on a comparative basis. This cost includes interest and amortization as well as annual OMR&E costs. It reflects the average annual amount of repayment of construction costs and interest during construction, along with OMR&E costs over a 100-year period. Except for water supply storage in existing, under construction and authorized federal reservoirs, interest during construction was computed at the federal discount rate of 6 5/8 percent. Cost estimates for storage in these reservoirs were calculated according to the federal discount rate applicable to each reservoir.

Construction Costs

DAMS AND RESERVOIRS

Cost estimates were prepared for proposed dams and reservoirs with and without flood control. Costs of clearing, relocations and rights-of-way were included in these estimates.

CONVEYANCE FACILITIES

Field cost estimates were made for each segment of the canal based upon the following features: canals, siphons, pumping plants, discharge conduits, pipelines, rights-of-way, automation and archeology. Total

FIGURE 98 SUMMARY OF COSTS STATEWIDE WATER CONVEYANCE SYSTEM (In $1,000)

WATER CONVEYANCE SYSTEM	CONSTRUCTION COST	TOTAL AVERAGE ANNUAL EQUIVALENT COST[3]
Northern System[1]		
Reservoirs[2]	$ 600,000	$ 32,500
Conveyance Facilities	3,440,000	264,100
Irrigation Distribution	1,100,000	58,300
M & I Distribution	71,000	4,300
Mitigation/Compensation	85,000	5,600
Subtotal	$5,296,000	$364,800
Southern System		
Reservoirs[2]	$ 225,000	$ 8,900
Conveyance Facilities	1,425,000	129,900
Irrigation Distribution	765,000	45,400
M & I Distribution	75,000	4,400
Mitigation/Compensation	18,000	1,300
Subtotal	$2,508,000	$189,900
TOTAL	$7,804,000	$554,700

[1]Cost estimates shown for northern system assume Arkansas River Basin Chloride Control Projects operational. Costs without the chloride control projects would be $5.6 billion for construction and $375 million for average annual equivalent costs.

[2]Reflects cost of proposed reservoirs, modifications to existing lakes and water supply storage in existing, under construction and authorized federal reservoirs.

[3]Includes interest and amortization at 6 5/8 percent interest and 100-year period of analysis. Also includes average annual OMR&E expenses and mitigation/compensation costs.

field costs also included 10 percent for miscellaneous unlisted items and 20 percent for contingencies. Total construction costs for conveyance facilities also included indirect costs calculated at 25 percent of the total field costs.

IRRIGATION DISTRIBUTION SYSTEM

The irrigation distribution system provides for installation of pumping plants, canals, laterals and underground pipe from terminal reservoirs to the irrigable lands in each section. Due to the magnitude of acres involved, detailed designs and estimates were not prepared for the entire irrigation distribution system. Therefore, a per-acre cost for distribution was derived from four sample areas considered typical and results indicated an average cost of $2,150 per acre. This cost reflects top-of-the-line equipment and a small canal to each farm and under ground pipe distribution facility in the field. Since $2,150 per acre represents an average expenditure, it is anticipated that actual costs in some areas may be substantially lower.

MUNICIPAL AND INDUSTRIAL DELIVERY SYSTEM

The projected 2040 municipal and industrial water requirements from the import canal for each county were distributed to municipalities based on population projections and feasiblity for a delivery system. Communities with the largest projected populations were selected to be served. Where smaller communities were located near the selected routes, they were also served.

The aqueducts were sized to deliver the required demand 365 days a year, plus 50 percent for peaking. Communities adjacent to the canal would be served from the canal, however, no costs have been developed for such diversions.

Mitigation/Compensation Costs

Major water development projects almost always result in drastic alterations in fish and wildlife habitat. Such alteration often results in a net negative impact on the fish and wildlife resources of the affected area. Mitigation of such losses ranges from measures to alleviate negative impacts to partial or total compensation based on land acquisition and management. The degree of mitigation or compensation considered appropriate for a particular project is usually commensurate with the severity of the project's unavoidable impacts. The justification for measures to prevent, mitigate or compensate for losses is based on the principle that those resources which suffer loss are made whole to the extent that is possible and reasonable. Specifically, net losses should be prevented; if that is not possible, mitigated (lessened in severity); or, as a last resort, compensated for; and in that order of priority. Since impacts resulting from inundation of habitats cannot be prevented, the remaining avenue is either mitigation or compensation. Offsetting project losses often entails land acquisition and management to increase the fish and wildlife-supporting capacity. Mitigation/compensation costs were estimated on the basis of predicted net losses of fish and wildlife habitat. These cost estimates were provided by U.S. Fish and Wildlife Service.

Operation, Maintenance, Replacement and Energy (OMR&E) Costs

Annual operation, maintenance and replacement (OM&R) costs were estimated for proposed reservoirs and proposed modifications to existing reservoirs, the main aqueduct and pertinent distribution facilities. These were based upon a rate per dollar of field costs, while those for the irrigation distribution system are based on a unit cost per acre. The municipal and industrial delivery system's OM&R costs reflect a rate per dollar of pipeline field cost.

Energy costs were estimated using a 30-mil power rate ($0.030 per kilowatt hour). Construction costs for facilities such as transmission lines

FIGURE 99
MITIGATION/COMPENSATION COSTS
(In $1,000)

CONVEYANCE SYSTEM	ACRES	DEVELOPMENT COST	ANNUAL OM&R	TOTAL AVG. ANNUAL EQUIVALENT COST
Northern System	173,328	$ 84,700	$250	$5,645
Southern System	26,300	18,000	100	1,295
TOTAL	199,628	$102,700	$350	$6,940

and substations were assumed to be covered by the power rate.

Energy requirements would be met by privately owned utility companies. Officials of major utility companies in the state have indicated that initial power requirements could be readily supplied and that future energy needs could be met as new generating facilities are constructed.

Average Annnual Equivalent Cost

The average annual equivalent cost was estimated by amortizing construction costs (including the cost of future installations) plus interest at the federal discount rate of 6 5/8 percent for a 100-year period. Interest during construction at 6 5/8 percent was included in the investment cost used in determining the average annual equivalent cost.

COST ESTIMATES

As shown in Figure 98, total estimated construction cost of the northern and southern conveyance systems is approximately $7.8 billion (assuming the authorized Arkansas River chloride control projects are operational), with an average annual equivalent cost of $555 million. Construction of the northern system is estimated to cost $5.3 billion, with $365 million in average annual equivalent costs. The southern system is estimated at $2.5 billion and $190 million for construction and average annual costs, respectively.

Figure 99 summarizes mitigation/compensation costs for both systems. A total of 199,628 acres would be purchased at a development cost of just over $100 million and an average annual cost of almost $7 million.

Estimated Value of Water

The estimated cost or value of the water conveyed through the system actually reflects the cost of conveyance and storage facilities required to provide the water. Existing Oklahoma law declares that stream water has no cost, or is essentially free, since the water belongs to the state. Therefore, the term "cost of water" discussed below implies the cost of facilities to provide a unit amount of water.

An accurate estimate of the cost (value) of municipal and industrial water conveyed through the system can be calculated only when an actual repayment schedule is agreed upon and appropriate contracts negotiated. However, a rough estimate of the average unit value of water for the 100-year period of analysis can be obtained by dividing the average annual equivalent cost attributable to municipal and industrial water by the ultimate municipal and industrial capacity of the system. This method indicates an average value per thousand gallons of 30 cents in the southern system and $1.60 in the northern system. However, this represents only the average value, and does not reflect the high unit cost during the early years of the project, when a substantial portion of the first cost would be incurred and the capacity of the system would be relatively small. The cost of water to users would increase as distance from the source increases, and the consumers' cost would further ncrease as charges for local distribution and treatment are included.

A rough estimate of the value of irrigation water can be obtained by dividing the cost attributable to irrigation by the amount of water conveyed through the system for irrigation purposes (less conveyance losses). This crude estimation method presents a cost per acre-foot of $200 in the southern system and $335 in the northern system. This value includes the allocated cost for transportation and storage of irrigation water as well as irrigation distribution facilities from terminal reservoirs to the irrigated areas. Again, this value reflects merely an average over the life of the project, and would vary depending on the point of diversion from the canal and the distance from reservoir to farm. During the initial phases of the project, the unit cost would be substantially higher.

BENEFITS OF THE STATEWIDE SYSTEM

To determine the economic feasibility of the system, the benefits accruing to the project must be estimated, then compared to the project cost. At this early planning stage, a detailed benefit evaluation to determine the overall economic feasibility of the project has not been prepared. However, a rough approach can be utilized to estimate project benefits. This approach asesses only primary benefits, while in reality indirect or secondary and tertiary benefits would also accrue from a water conveyance system.

Average annual direct benefits from both systems are estimated at $122.6 million, with municipal and industrial benefits totaling $97.9 million and irrigation benefits $24.7 million.

Municipal and Industrial Benefits

The assumption utilized in determining an estimate of municipal and industrial benefits is that the benefits equal the average annual equivalent cost of the least costly alternative capable of providing the amount of water necessary to fulfill user requirements. This assumption reflects the philosophy that delivered municipal and industrial water is worth at least the cost of developing and delivering it to the users. Therefore, the average equivalent costs and benefits are assumed to be equal, giving the municipal and industrial component of both systems a 1:1 benefit-cost ratio. More detailed municipal and industrial benefit analyses may indicate that benefits would actually exceed cost, in which case, the benefit-cost ratio would be greater than 1:1.

Irrigation Benefits

Irrigation benefits were estimated according to federal planning guidelines, which involves determining net farm incomes without water conveyance (dryland farming) and with water conveyance (irrigation farming). The difference between the two represents the primary benefits attributable to the cnveyance systems, and although secondary and tertiary benefits would also occur they are not included in this analysis.

Calculation of irrigation benefits was based on agricultural areas defined by the Oklahoma State University Extension Service. Historical data from the "Census of Agriculture" and "Oklahoma Irrigation Survey" were utilized to estimate cropping patterns and irrigation changes. Oklahoma State University farm management specialists in each area provided projections on probable future cropping patterns and yields. Farm budgets from Oklahoma State University were used to assess current farming and irrigation pratices.

In the future "without" analysis, the approximately 900,000 acres projected for irrigation from the conveyance system were assumed to be under dryland farming. To determine benefits under dryland conditions, an enterprise budget analysis was prepared which developed per-acre crop net farm returns. These returns were then prorated to arrive at an average per-acre net farm income. In the analysis, it was assumed that cropping patterns and yields would remain relatively constant. Prices received were October 1977 Current Normalized Prices, while prices paid were current 1977 prices as reported by the farm management specialists. Total farm production expenses were increased by the same percentage as the increase in crop production.

In the future "with project" analysis, over 1.6 million acre-feet of water per year would be supplied for irrigation purposes from both systems combined. Irrigation benefits were determined utilizing similar enterprise budgets as above to derive average per-acre net farm income. Assumptions in this analysis included: (1) irrigation would be accomplished through the existing mix of gravity, side-roll and center pivot systems; (2) irrigation development would be timed so that whenever water became available, the lands would be prepared; (3) crop yields would be equivalent to the present yields obtained by the best farmers, which would be typical in the future; (4) production costs would increase by the same percentage as the increase in crop production; and (5) no appreciable double-cropping would occur.

Primary annual benefits were then calculated as the increase in net returns between the "without" and "with" project alternatives. Results of this method indicated total annual irrigation benefits of $35.2 million and $34.2 million for the northern and southern systems, respectively. These benfits were calculated assuming all project facilities were completed and in full operation. To reach a more realistic analysis, benefits were discounted to allow for a development period, which decreased primary annual benefits to $16.7 million (or $32.60 per acre) in the northern system and $8 million (or $20.20 per acre) in the southern system.

The smaller average annual equivalent benefits from the southern conveyance system are the result of the acreages irrigated with import water coming on line later in southwestern Oklahoma than in the northwest. Thus, benefits from the southern system cannot be counted for as long a period as those from the northern system.

BENEFITS-COST ANALYSIS

A comparison of benefits with costs enables the economic feasibility of a project to be determined. Under federal guidelines, benefits must equal or exceed costs in order for a project to be considered economically justified and thus eligible for construction. Average annual equivalent benefits accruing from the northern water conveyance system and the southern conveyance system indicate that neither system is economically justified under federal criteria, which recognize only primary benefits.

More specifically, the irrigation component of each system is economically unjustified since the returns from irrigation are not sufficient to completely offset the cost of water.

Indirect benefits from the system will most assuredly occur, although they have not been assessed at this time. These indirect impacts take the form of stimulated agribussiness activities such as increased sales of agricultural chemicals and farm machinery and higher production by food processors. In addition, local retail sales would increase, land values probably would rise and fiscal services probably would increase to meet growing demands.

A Statewide Economic Impact Study currently underway by the University of Oklahoma and Oklahoma State University, under the direction of the Oklahoma Water Resources Board, will quantify these indirect impacts, thus increasing the benefits of the system. Further evaluation may show the system to be of sufficeint economic benefit to justify the state's subsidizing that portion of the project's cost which is not considered feasible under federal guidelines, or perhaps to wholly assume the cost of the water conveyance system.

PAYMENT CAPACITY ANALYSIS

The payment capacity analysis involves determining the amount from net farm income under the "with" project (or irrigation alternative) that would be available to the farmer for payment of the project water cost. An allowance for increases in equity, family labor, and management and dryland net farm income is deducted from the irrigated income to arrive at an estimate of payment capacity.

This analysis reflects a short-term transition period which represents the period necessary for the farmer to become adapted to irrigated farming. Therefore, it was assumed that crop yields in each region would be somewhat lower that those projected for the benefit analysis.

Results of this evaluation indicate the average payment capacity for the farmer would be appoximately $44 per acre in the northern system and $30 per acre in the southern system.

SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS

Initial environmental impacts of the proposed statewide water conveyance system would be attributable to construction activities, which would temporarily or permanently disrupt or destroy vegetation and natural habitat. Most seriously affected would be the floodplains lying within the proposed construction areas, especially those of eastern Oklahoma which support diverse forests and a variety of habitat. Due to fewer plant and animal species and the previous conversion of virgin land to highly developed agricultural lands, the enviromental impact on western Oklahoma could be somewhat less.

The noise and dust attendant to construction, the disturbance of vegetation and wildlife, and the disruption of aesthetic values would be temporary, and therefore would terminate with the completion of construction.

The canals, siphons and pipelines required by the statewide water conveyance system would extend approximately 1,130 miles in total length and require an estimated 24,000 acres of land. Rights-of-way for the system would have to be acquired by purchase of federal, state and private lands which would change land use and convert private ownership to public.

The extensive inundation of land by reservoirs is inevitable in any major water development project. Conservation storage in proposed new source and terminal reservoirs proposed as parts of the water conveyance system would inundate approximately 177,000 acres of land, including broad expanses of productive bottomland. The significant loss of tax revenues from such land is expected to be at least partially offset by income from increased recreational and commercial opportunities provided by the reservoirs. Assuming federal participation in construction of the system, provisions of P.L. 565 which provide "payments in lieu of taxes" to local governments for land removed from the ad valorem tax base, would also partially offset losses.

In addition to federal compensation, Oklahoma Statues provide for similar payments to the local area. Title 82 O.S. Supp. 1974, Section 1086.1 requires that the purchasing entity pay to the county of origin, in lieu of ad valorem taxes, an amount equal to the existing taxes on land removed from the tax rolls as a result of construction of storage facilities.

Preliminary investigations indicate that numerous archaeological sites lie within the proposed rights-of-way. More comprehensive planning will identify those sites and develop measures to minimize losses. The removal and preservation of finds possessing significant scientific or social value would somewhat mitigate losses of archaeological sites.

Although numerous Oklahoma historical sites are listed in the National Register of Historic Places, none would be affected by the statewide water conveyance system.

Completion of the proposed system would make available to central and western Oklahoma additional water of significantly higher quality than that presently provided by local streams and ground water basins. While much of the local water presently exceeds standards for total dissolved solids, chlorides, sulfates and other parameters, the import water would meet existing criteria for drinking water. A water supply augmented by additional quantities of high quality water would enhance social and economic development by insuring a more dependable agricultural and industrial economy. Releases of high quality water from terminal storage reservoirs could improve the water quality downstream and thereby enhance downstream fisheries.

Although the evaporation of water during transit would vary with the amount of water diverted and the season, such losses are expected to have only insignificant effects on the concentration of dissolved solids in the imported water. The amounts of water lost annually to evaporation along the water conveyance route should remain relatively uniform.

The selected water conveyance system would not have an appreciable short-term effect on property values, although some land speculation can be anticipated. Land severed by a canal may decrease in value, but lands underlain by pipeline should not experience depreciation.

Although the system would require the relocation of some families presently living along the canal route and in the areas proposed for reservoir sites, adverse effects on owners and residents would be mitigated. Assuming federal participation, such compensation would be determined and paid for lands, improvements and moving costs according to the Uniform Relocation and Land Acquisition Policies Act of 1970 (Public Law 91-646). Displacements would have only short-term effects, and no families would be displaced after project construction.

Community cohesion could be disrupted temporarily by the influx of construction workers and their families and by the resettlement of families displaced by the project. Project workers would be expected to distribute themselves throughout the construction periphery, and other impacts would be minimized by their spread over such a large area.

Some long-term disruption in community cohesion could be expected as a result of severance of land ownerships by the canal. However, construction of the water conveyance system could increase stability in central and western Oklahoma, where families pressured by water shortages might otherwise abandon their farmlands. Oklahoma's agricultural economy would be enhanced by the increased crop yields made possible by the availability of irrigation water.

The construction of the canal and associated reservoirs would stimulate local economies and provide local residents with greater employment opportunities, through planning and construction activities and into the maintenance and operation period. Such strong favorable effects could be expected to continue through construction and into the operation stage.

Construction of the system would increase tax revenues, with the influx of construction workers contributing income and sales taxes. Long-term sales tax and property tax revenues should rise also.

As population densities increase, shopping and service centers would be built, and industrial complexes would develop. Homes, streets, roads, power facilities and water and sanitary systems would be needed by growing populations. Taxing entities would experience increases in tax rolls, property evaluations and revenues, offset somewhat by the costs of additional governmental, educational and public services.

Effects on Fish and Wildlife Resources

The U.S. Fish and Wildlife Service expressed concerns regarding the potential adverse impacts of the statewide water conveyance system on Oklahoma's fish and wildlife resources. A list and brief discussion of USFWS concerns follow.

1. Losses of fish and wildlife habitat

Of greatest concern is the inevitable loss of riparian, floodplain and wetland habitats resulting from construction and impoundment of proposed source and terminal reservoirs.

The USFWS Division of Refuges is considering the establishment of a National Wildlife Refuge along the Deep Fork River to protect and preserve portions of the wetlands and floodplain forests, one of the few stands of such forest remaining in Oklahoma. The refuge area under study includes the floodplain of the river from the Okmulgee Game Management Area upstream into Lincoln County. Of all sites considered on the Deep Fork River, the proposed Welty Lake was determined to have the least potential adverse impact on the proposed refuge.

Although the rights-of-way of the proposed canals, pipelines and pumping plants would affect almost all types of wildlife cover, upland cover would suffer greatest losses due to the ridgeline alignment of the conveyance facilities. Upland cover includes oak and hickory forest; postoak and blackjack oak forest; and stands of mesquite, juniper, hackberry, plum and other shrubs; native and imported grasses and croplands. Bottomland cover, riparian, floodplain forest and floodplain wetlands would also be altered along the canal routes, primarily at and adjacent to stream crossings. Wildlife habitats lying within the rights-of-way would be altered, and their value to land animals and birds reduced.

At many of the system's reservoir sites the major concern would involve stream habitat, rather than terrestrial habitat. Although direct and indirect losses of stream fisheries are expected to occur temporarily during reservoir construction, these lakes would provide increased fishing upon completion. Since most of the tributary streams in western Oklahoma have little or no flow and stream fishery is marginal at best, the largest direct losses to stream fishery would occur in eastern Oklahoma. Western Oklahoma's most abundant fish populations are found in manmade lakes and major streams such as the Red, Washita and Canadian Rivers.

2. Deleterious impacts on threatened or endangered species or their habitats

Several species classified threatened or endangered by federal wildlife authorities could be potentially affected by components of the water conveyance system.

The bald eagle has established important winter roosts and feeding sites at several of Oklahoma's large reservoirs, including Keystone, Eufaula, Kaw and Great Salt Plains. Changes in reservoir operation could have adverse effects on the eagles which depend on downstream released flows, shallower upstream reaches and river portions of these reservoirs for feeding habitat.

The peregrine falcon may also live in areas around the reservoirs, but a determination of possible impacts would require further investigation.

The general topography and limestone formations along Vian Creek suggest the possible presence of caves. Should caves inhabited by threatened or endangered bat species be discovered in this area, possible impacts on those rare species would require further investigation.

Although presence of the black-footed ferret in Oklahoma is uncertain, it may exist in association with larger prairie dog towns in the west. If its presence were established, the species could be adversely affected by further conversion of prairie dog habitat to irrigated croplands.

Salt Plains National Wildlife Refuge has been recently designated as critical habitat for the whooping crane. The construction of Alva Lake, proposed on the Salt Fork of the Arkansas River, could possibly exert adverse impacts on the whooping crane by reducing flows into Great Salt Plains Lake.

3. Impairment of the operational efficiency of existing public fish and wildlife installations

Game management and public hunting areas administered by the Oklahoma Department of Wildlife Conservation on many of the existing reservoirs included in the water conveyance system could be affected by the system.

Raising of pool level elevations proposed at Canton, Fort Supply and Altus Lakes would inundate parts of the Canton Game Management Area and Migratory Bird Refuge, Fort Supply Hunting Area and Altus Public Hunting Area, respectively. Optima Public Hunting Area and National Wildlife Refuge, Washita National Wildlife Refuge at Foss Reservoir and the Fort Cobb Public Hunting Area and Fish and Game Management Area could also be impacted by major deviations in pool levels.

Public hunting areas included in the Sequoyah National Wildlife Refuge on the upstream portion of Robert S. Kerr Lake are also maintained by the ODWC. Pumping plants, intake mechanisms and conveyance facilities locatd within these areas could conflict with ongoing management programs.

4. Loss of animals in open canals, coupled with blockage of movement patterns

Losses of individual animals to drowning and/or entrapment in the open canals could threaten the populations and community structure of some land animals. The canals could also prove barriers, limiting the natural movement patterns of certain animals. However, if the animals' ranging patterns can be ascertained, adequate provisions could be made for crossings and the losses to drowning could be minimized by fencing the rights-of-way.

5. Entrapment of aquatic organisms

Pumping plants and intake facilities would be located at all source and holding reservoirs and at intermediate points along the conveyance route. During the intake of water such installations may physically impinge and/or entrain fish eggs and fry, as well as other aquatic organisms. Close cooperation with the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation during advanced planning, design and operation of the intake and pumping facilities would be necessary in order to minimize adverse impacts.

6. Possible degradation of water quality

Construction of facilities in or across existing flowing streams would initially increase turbidity down stream, but such temorary turbidity would have no significant effect on sedimentation in down-stream lakes or on fish and wildlife. Quality of water could be reduced during such periods of turbidity, and recreational activities, where they are allowed, could be temporarily impaired.

Since the water conveyance system would increase irrigation opportunities, some concern has been expressed regarding the effects of irrigation return flows on water quality. Past studies have shown some deleterious effects from increased nutrient levels and salt loads in runoff entering natural aquatic systems. However, due to the excellent quality of the water proposed for transfer, this should not be a significant problem.

7. Fluctuation of water levels in source and terminal reservoirs

Rapid fluctuations in pool levels in source and terminal reservoirs could have profound effects on fisheries, especially during the spawning season. Rapidly lowered pool levels can drastically reduce the shallow peripheral waters required for spawning, thereby causing high mortality of eggs and fry left stranded. Such impacts could be at least partially alleviated by coordinating the pumping of water with spawning activities, thus maintaining stable water levels during critical periods.

8. Impacts on streamflows

Alteration of instream flow usually attends major development of stream water resources, and reductions in the volume or frequency of downstream releases below the proposed reservoirs in the water conveyance system should be anticipated. Such reductions of instream flows could adversely affect downstream aquatic and terestrial systems, causing losses in productivity and decreased diversity of fish and wildlife resources.

Serious impacts on tailwater and stream fisheries could occur, especially below Eufaula, where the striped bass fishery could be critically affected.

Moyers Dam, a low-water dam proposed on the Kiamichi River immediately downstream from the Moyers pumping plant, would be necessary to insure that pumping intakes would be adequately submerged. A major concern is the effect of the dam on a striped bass fishery proposed for the Kiamichi River and Hugo Lake. A fish passageway in conjuction with the dam is planned for inclusion in the southern conveyance system, so that the migration of striped bass and other species during spawning will not be affected.

Altered streamflow could also adversely impact segments of riparian habitat downstream from dam sites. Floodplain forests and associated wetlands, as well as other riparian cover, depend upon periodic flooding, and because some flood flows would be intercepted by the reservoirs, an alteration in the moisture regime of the downstream floodplains is to be expected. It could result in a lowering of the water table and thus a reduction in the extent and development of the riparian habitat. Decreases in frequency and volume of flooding would probably also prompt accelerated clearing and draining in downstream floodplains. The U.S. Fish and Wildlife Service has urged that storage be provided for minimumm instantaneous releases in all reservoir components.

Any significant effects on fish and wildlife resources attributable to construction and operation of the water conveyance system could be assessed by the USFWS, and where significant adverse effects are inevitable, mitigation measures incorporated. Otherwise, losses have been included in the costs of the system.

Recreational Potential

Interest and participation in Oklahoma's water-related recreation are high, as evidenced by growing numbers of visitors to the state's lakes each year. Surveys included in the Oklahoma Comprehensive Outdoor Recreation Plan show that an insufficient number of areas and facilities are available, and that existing areas will prove inadequate to accommodate the number of future visitors anticipated. Any new lake with recreational potential would attract additional visitors.

Although project roads or abandoned roads terminating at the water's edge would provide access in the absence of more complete facilities, developed public use areas would be a more desirable alternative. Such developments would concentrate visitors for more effective control, improve the recreational experience and preserve the environmental integrity of the project. Water conveyance via canal would require long, nearly level reaches and maintenance roads paralleling the canal. In planning the water conveyance system, consideration was given to the development of maintenance roads to serve the second purpose of recreational trails, with parking and sanitary facilities along the routes. Since the proposed system would extend through a variety of landscapes, such roads would offer excellent potential as hiking and bicycling trails.

Proposed recreational development, presently proposed only in the southern conveyance system, includes four public use areas on West Elm Lake and a 10-mile hiking and biking trail along the main aqueduct from Lake Stanley Draper and West Elm Lake to Lake Thunderbird.

Although no recreational facilities are included in other segments of the statewide water conveyance system, consideration of their benefits should be included in future evaluations.

THE NORTHERN WATER CONVEYANCE SYSTEM

Water Requirements

As discussed in the "Regional Analyses," two of the four regions in the northern 44 counties of Oklahoma are expected to experience future water deficits. Projections for the Northwest and North Central Planning Regions indicate an import need of approximately 1,050,000 feet per year by 2040. Nearly 1.2 million acre-feet of water would be imported annually via the northern conveyance system to meet this demand and provide for conveyance losses.

Potential Sources for Transfer

The projected water supply needs of northeastern and east central Oklahoma indicate that the majority of the water supply storage in the existing, under construction and authorized lakes, as well as other potential lakes, will be utilized locally by the year 2040, thus offering only limited prospect as a source of water for transfer to north central and northwestern Oklahoma. The scattered locations and relatively small dependable yields of other potential lakes limit their viability as sources for the large amounts involved in any water transfer plan. Preliminary work revealed that only those reservoirs with large amounts of hydroelectric power and inactive storage appropriate for reallocation to water supply storage, and the surplus flows on the Arkansas River and its tributaries, offered viable sources for the projected 1.2 million acre-feet annual requirements of northwestern and north central Oklahoma.

POWER AND INACTIVE STORAGE

Power and inactive storage in two existing reservoirs, Keystone and Eufaula Lakes, offer potential sources of large quantities of water for transfer, assuming that such storage could be reallocated to water supply. Tenkiller Ferry Lake was not considered, due to the expressed desire of local interests to utilize the power storage in that project for future water supplies within northeastern Oklahoma. Transfer of water from the Grand River above Fort Gibson Dam to areas outside GRDA jurisdiction is precluded by state statutes, so power and inactive storage in the Grand River lakes was not considered as a source of transfer water. Because projections indicate Kaw Lake will be needed to meet the surrounding area's future water requirements, its power storage was likewise not considered.

The power and inactive storage in Keystone and Eufaula Lakes is expected to be essentially depleted by sedimentation by about the year 2060. If the storage were reallocated to water supply, Eufaula could supply the import requirements of northwestern Oklahoma until approximately 2020. The addition of Keystone, assuming the Arkansas River chloride control projects to be operational and quality improvements accomplished, would extend that time frame to about 2025. After that, additional sources would be necessary to meet the export requirements. Reallocation of power and inactive storage would essentially eliminate hydroelectric power production from Keystone and Eufaula Lakes, as well as significantly reducing downstream flows.

The loss of dependable yield from the reallocated power and inactive storage caused by sedimentation of Keystone and Eufaula could be offset by providing sufficient pumping capacity at the diversion site and off-site regulating storage. Surplus flows could be diverted when available ("scalping"), with the declining yield from converted power and inactive storage gradually replaced by increasing the capacity of the "scalping" facilities.

SURPLUS FLOWS ON ARKANSAS RIVER

Approximately 22 million acre-feet of water annually flows out of Oklahoma into Arkansas via the Arkansas River. Although much of it has been used for hydroelectric power generation and navigation flows, stream flows in excess of plant capacity at the hydroelectric plants on the river are not uncommon. A large part of the average flow leaving Oklahoma is the result of unused flood flows.

The importance assigned to hydroelectric power by state and Federal governments will be a primary factor in determining the availability of large quantities of water for diversion from the Arkansas River system. Decisions regarding amounts of water which can be diverted in conjunction with the hydroelectric power uses will depend on the need for and value of hydroelectric power, locations of diversion points and amounts and frequencies of diversions. If major diversions were made above a power plant only when flows exceeded plant capacity, the full generating capacity would be maintained, but the dependability of the diversions would be extremely limited. Diversions made during lower flows would reduce power generation downstream.

Present estimates of flow requirements for operation of the McClellan-Kerr Arkansas River Navigation System show that minimum flows of 530 cfs and 200 cfs will utlimately be required on the Arkansas and Verdigris Rivers, respectively. Therefore surplus flows for the purposes of this study were considered to be those in excess of the minimum requirements for hydroelectric power generation, navigation, or other established purposes. Flows in excess of 10 percent of plant capacity at the hydroelectric plants in the system were considered surplus, although the use of such surplus would necessarily result in minor losses of power production. The economic impact of such losses would have to be considered in the evaluation of any proposed diversion plan.

Water quality in parts of the study area greatly restricts the use of stream flows. The waters of the Canadian, North Canadian and Deep Fork Rivers above Eufaula Lake; the Cimarron River; and the Arkansas River from Tulsa to the mouth of the Salt Fork are of fair to poor quality for municipal and domestic uses. The water typically contains excessive amounts of dissolved minerals from natural sources upstream and/or polluted wastewater. These minerals also impair the chemical suitability of the water for irrigation, although water in the Canadian River Basin usually remains suitable. Because of dilution from higher quality flood flows, Eufaula Lake and impoundments on the Deep Fork River would provide raw water of acceptable quality for most purposes.

Water from the Verdigris and Caney Rivers and some of their tributaries does not meet accepted water quality standards because of occasional high concentrations of dissolved minerals. However, impoundments on these streams would provide raw water of acceptable quality for most purposes. In addition, many other area streams are of good quality and suitable for most uses. The Grand and Illinois Rivers produce an average of nearly six million acre-feet of usable water annually.

The quality of Arkansas River flows downstream from Keystone Dam is significantly improved by dilution from intervening runoff. At Muskogee, the quality is suitable as a source of municipal raw water supply about 65 percent of the time with chloride concentration, the controlling water quality parameter, exceeding 250 milligrams per liter (mg/L) about 35 percent of the time. Farther downstream, just past the Oklahoma-Arkansas state line (near Van Buren, Arkansas), the quality is suitable for municipal raw water supplies about 87 percent of the time, with the chloride concentration at Keystone and Van Buren meeting recommended limits for irrigation water about 83 and 95 percent of the time, respectively.

Surplus water from the Arkansas River suitable for municipal, industrial and irrigation uses is limited to periods of high stream flow. High flows (flood waters) dilute the excessive chloride concentrations which occur during low flow periods, making possible the diversion of water of adequate quality. With the Arkansas River chloride control project operational and the cleanup of man-made pollution sources, the availabiltiy of surplus water suitable for municipal, industrial and irrigation uses would be greatly increased. Such improvements would permit more frequent diversions at lower rates to obtain a given volume of surplus water of suitable quality.

If surplus waters are stored to provide a dependable source during periods of insufficient stream flows or when poor quality prohibits diversion, water of less desirable quality could be diverted, since it would be mixed with water of higher quality in the storage reservoir. For purposes of this study, waters with chloride, sulfate and total dissolved solids concentrations no greater than 300, 300 and 600 mg/L, respectively, were considered acceptable for diversion with the use of intermediate storage facilities. Use of these criteria provides water of suitable quality for municipal, industrial and irrigation use.

DIVERSION OF SURPLUS FLOWS

A comparison was made of the average annual diversions which could be made from surplus flows at 11 control points in the Arkansas River system. These control points were Hulah Dam, Oologah Dam, Fort Gibson Dam, Tenkiller Ferry Dam, Eufaula Dam, Wister Dam, Kaw Dam, Keystone Dam, Webbers Falls Lock and Dam, Robert S. Kerr Lock and Dam and Van Buren, Arkansas. The diversions would be made to regulating storage during periods when minimum required flow is exceeded and when chloride, sulfate and total dissolved solids concentrations are within acceptable limits.

Diversions from the Arkansas River at Van Buren, Arkansas, Robert S. Kerr Lock and Dam and Webbers Falls Lock and Dam could each provide the dependable yield (approximately 1.4 million acre-feet per year, including seepage and evaporation losses) projected to serve northwestern Oklahoma. Van Buren would provide the greatest potential because it would require the least regulating storage for a given diversion capacity. However, its greater distance from the demand area, resulting in greater costs of conveyance facilities, far outweighs this advantage. Therefore, it was not further considered as a viable alternative source for transfers. Webbers Falls would require the greatest amount of regulating storage for a given diversion capacity of the three alternatives, and would have only a slight location advantage over a diversion site in the upper limits of Robert S. Kerr Lake. Therefore, the latter was considered to have greater potential as a single source for transfer.

Diversion of surpluses at neither Eufaula nor Keystone alone could reasonably provide the dependable yield required for transfers to northwestern Oklahoma. However, with the Arkansas River chloride control projects operational and man-made sources of pollution eliminated, a combination of the two sources could meet the requirements, if sufficient storage were provided in conjunction with the pumping facilities. Due to severe water quality problems in the Cimarron River, diversions at Keystone would not be practical without the chloride control measures.

Because of their greater distances from the demand area and/or their relatively low potential for surplus diversion, the Kaw, Wister, Tenkiller Ferry, Fort Gibson, Oologah and Hulah control points were determined less desirable than the control points discussed above. In addition, the surplus flows at each of these control points contribute to the surpluses available at the more desirable downstream control points.

In summary, the most appropriate single source of surplus flows for transfer would be the Arkansas River near the Oklahoma-Arkansas line, Robert S. Kerr Lake or Webbers Falls Lake. Other sources considered worthy of further study would be surplus flows from the Canadian River system available at Eufaula Lake in combination with surpluses at either Keystone Lake or Robert S. Kerr Lake. The combination with surpluses from Kerr Lake would allow those flows contributing to the surpluses on the Arkansas River from the Canadian River system to be intercepted upstream at a consequent saving in pumping costs. The Eufaula-Keystone combination could offer some advantages due to staging of construction since Keystone, the closest to the demand area, could be tapped first. In addition, the Keystone-Eufaula combination could offer cost advantages, if the power and inactive storage were reallocated to water supply and fully utilized prior to developing a scalping system for surplus flows.

Alternative Water Transfer Systems Considered

In formulating alternative plans for the northern water conveyance system, the Planning Committee for the Oklahoma Comprehensive Water Plan agreed that the Bureau of Reclamation would develop all plans and cost estimates for the system from Pumping Plant 28 westward and the Corps of Engineers would develop plans and cost estimates for the portions of the system east of Pumping Plant 28 (source component).

The alignment of conveyance facilities from Pumping Plant 28 to terminal reservoirs in northwestern Oklahoma was based on alternative conveyance routes previously developed by the Bureau of Reclamation in their statewide appraisal studies published in "Water, the Key to Oklahoma's Future." The conveyance route selected to pick up surplus water from source facilities planned by the Corps of Engineers and convey it on westward was based on modifications to these alternatives.

Alternative plans developed by the Corps of Engineers to deliver surplus water for the northern conveyance system were formulated for the water quality conditions tha would exist if the Arkansas Rive chloride control projects were opera tional and with cleanup of man-mad pollution ("with" condition) and alte natively assuming continuation o present conditions without chlorid control and cleanup ("without" cor dition). Each alternative was form ulated to provide an ultimate dive sion of approximately 1.2 millio acre-feet annually and were based o preliminary estimates of net deper dable yield available from the variou sources and sizes of conveyanc facilities required. In addition, th time frame of development (construc tion) of each alternative was based o the assumption that the impor demands of northwestern Oklahom would increase over time. Furthe refinements in designs and cos estimates would be made upon selec tion of the most desirable plan(s).

Because the Arkansas River an its major tributaries in eastern Okla homa have been extensivel developed for navigation, hydrc electric power and other purposes, n suitable sites remain on these stream for the development of additiona large-scale reservoirs. Therefore, an new storage required to mak transfers to northwestern Oklahom dependable would have to be cor structed in watersheds of mino tributaries. Storage provided in thes reservoirs would be used to regulat surplus flows diverted (scalped) fron the alternative sources.

Potential regulating reservoi sites were inventoried prior to form ulation of the alternative transfe plans. These sites were then screenec based on their proximities to poten tial diverion points, storag capacities and potential environmen tal effects.

Several tentative plans wer screened to arrive at 14 alternative worthy of preparation of preliminar design and cost estimates. Thos alternatives are designated 1A through 8A, 1B, 2B, and 5B throug 8B. The "A" designates the "with" chloride control alternatives and the "B" "without". (The absence of 3

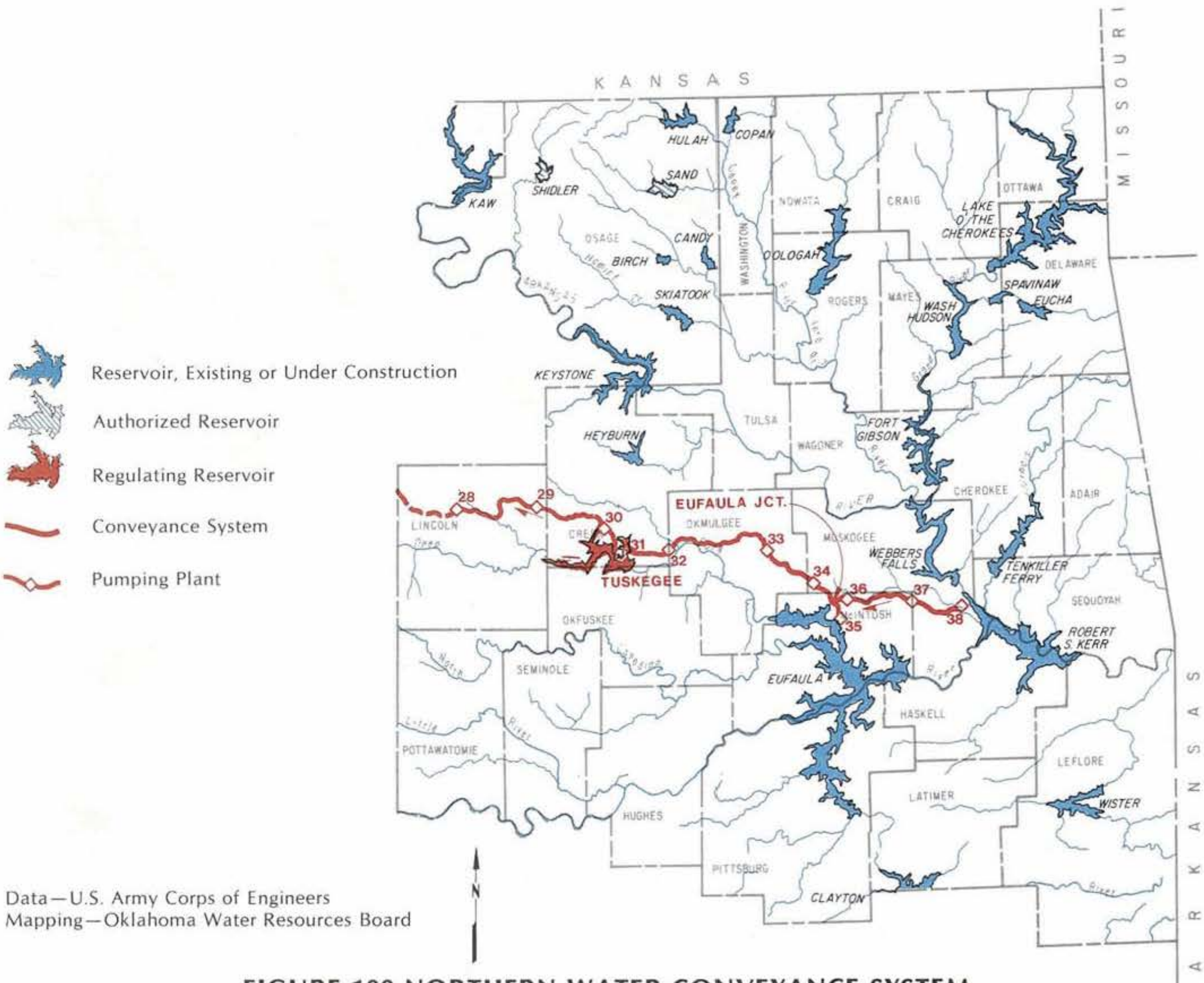


FIGURE 100 NORTHERN WATER CONVEYANCE SYSTEM SOURCE COMPONENT ALTERNATIVES 1A, 1B, 2A, 2B

and 4B is due to the lack of viable "without" chloride control alternatives to 3A and 4A.) The alternative plans are shown in Figures 100-103 and described in more detail in the following paragraphs.

Alternatives 1A and 1B (Figure 100)are based on the assumption that the power and inactive storage in Eufaula Lake would be reallocated to water supply for municipal and industrial uses and for irrigation. As discussed earlier, this source could meet the import requirements of northwestern Oklahoma until about the year 2020.

By providing regulating storage in Tuskegee Lake and increasing the pumping capacity at Eufaula Lake, surplus flows from the Canadian River system could be "scalped" at Eufaula Lake. This supply would steadily decrease because of the depletion of storage in Eufaula resulting from sedimentation. Shortly after the year 2040 the supply would fall below the northwestern Oklahoma import requirement and an additional source would be needed. To continue to meet the projected demand, a leg from the Arkansas River in the upper reaches of Robert S. Kerr Lake to the main conveyance system at Eufaula Junction would be added around year 2040. This leg would permit surplus flows at the Robert S. Kerr Lock and Dam to be diverted westward through Tuskegee Lake.

The conveyance capacity from Kerr Lake to Tuskegee would have to be greater under the "without" chloride control condition (Alternative 1B). The greater capacity is required because water of suitable quality would be available on a less frequent basis, and thus to provide the same gross yield as Alternative 1A, greater quantities would have to be diverted over shorter time periods.

Alternatives 2A and 2B (Figure 100)would be similar to 1A and 1B except that the power and inactive storage in Eufaula Lake would not be converted to water supply and a 10 percent plant factor would be maintained. These two alternatives rely on "scalping" of surplus flows, therefore regulating storage in Tuskegee Lake would be initially required in addition to the conveyance facilities from Eufaula Lake to Pumping Plant 26. The leg from Robert S. Kerr Lake would also need to be added earlier

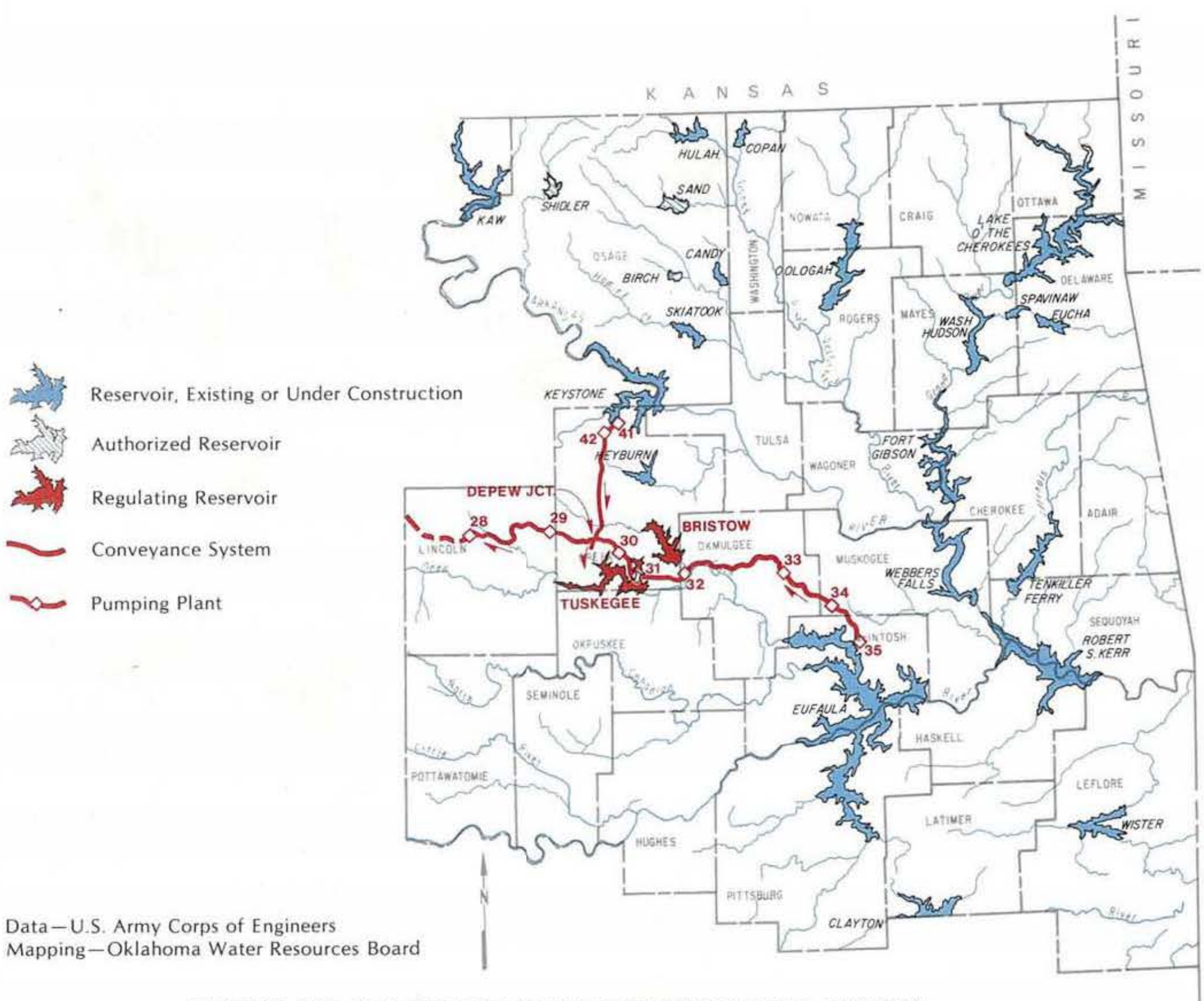


FIGURE 101 NORTHERN WATER CONVEYANCE SYSTEM SOURCE COMPONENT ALTERNATIVES 3A, 4A

(about the year 2010) because less surplus flow would be available at Eufaula Lake.

Alternative 3A (Figure 101) is based on the assumption that the power and inactive storage in both Keystone and Eufaula Lakes would be reallocated to water supply. Keystone Lake would be tapped first with regulating storage provided by Tuskegee Lake. The combination of converted storage in Keystone and added scalping capacity would provide sufficient yield of suitable quality to meet transfer requirements until about 2020, at which time the conveyance facilities from Eufaula Lake and additional regulation storage provided by Bristow Lake would be added to the system. The combined gross yield of the scalping system would ensure that the transfer requirements would continue to be met after the year 2060 when the water supply storage in Keystone and Eufaula Lakes would be depleted by sedimet.

Alternative 4A (Figure 101) would be similar to 3A except that storage in Keystone and Eufaula would not be utilized, and miminim flows for firm power generation would be maintained at the two projects. With the same level of storage available in the two regulating reservoirs, greater scalping capacity would be required at the two sources to divert equivalent volumes of surplus flows during the less frequent periods when surpluses would be available and the quality would be acceptable. Under this alternative, Bristow Lake and the conveyance facilities from Eufaula Lake to Bristow and Tuskegee Lakes could be deferred until about the year 2015.

Alternatives 5A and 5B (Figure 102), like Alternatives 1A and 1B, are based on the initial reallocation of the power and inactive storage in Eufaula Lake to water supply, with eventual total reliance on scalping of surpluses at Eufaula and Robert S. Kerr Lakes when the storage in Eufaula Lake is depleted.

The conveyance facilities from Eufaula Lake westward would be the only construction initially, with regulating storage at Tuskegee Lake added about the year 2020. This combination would satisfy the pro-

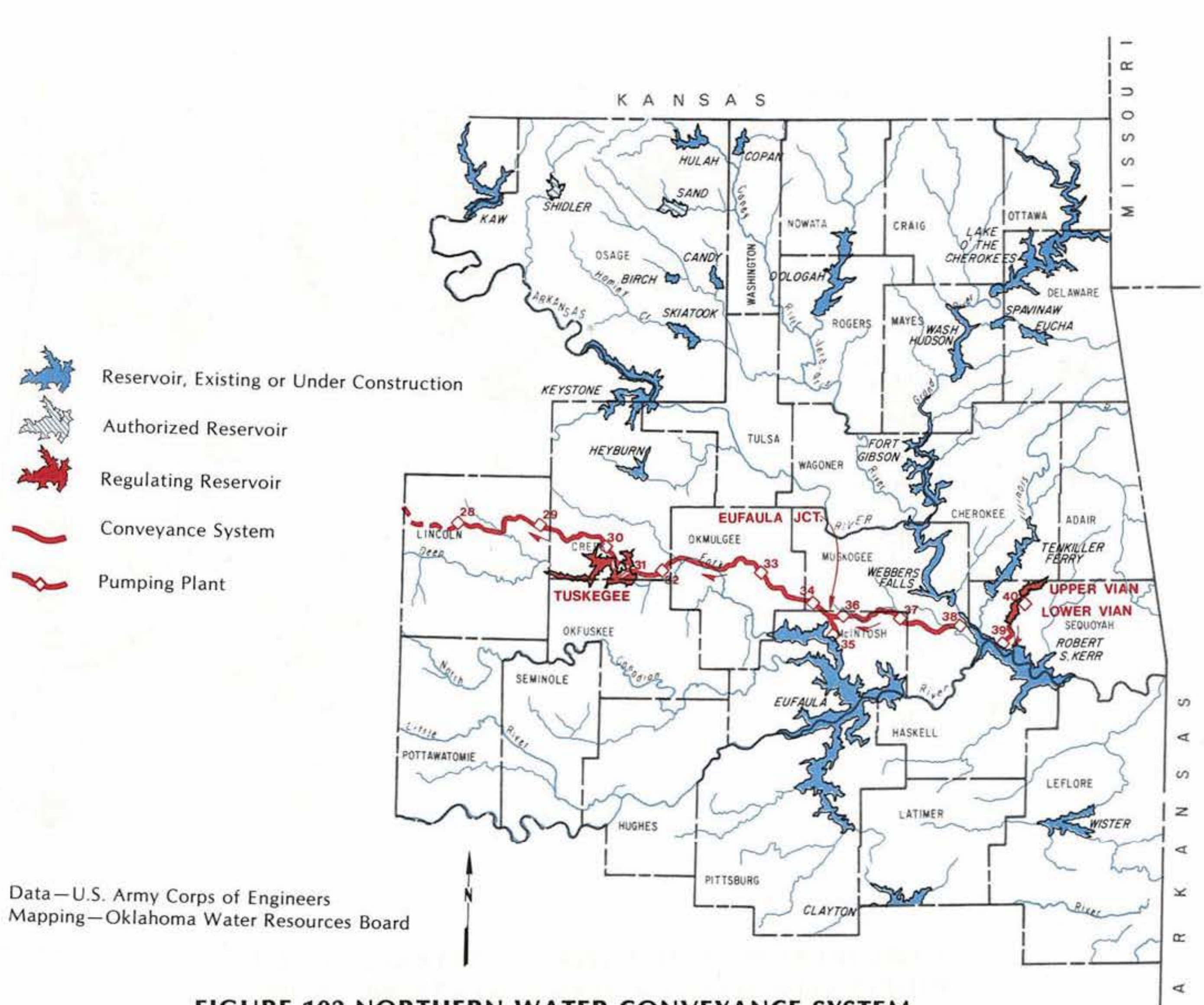
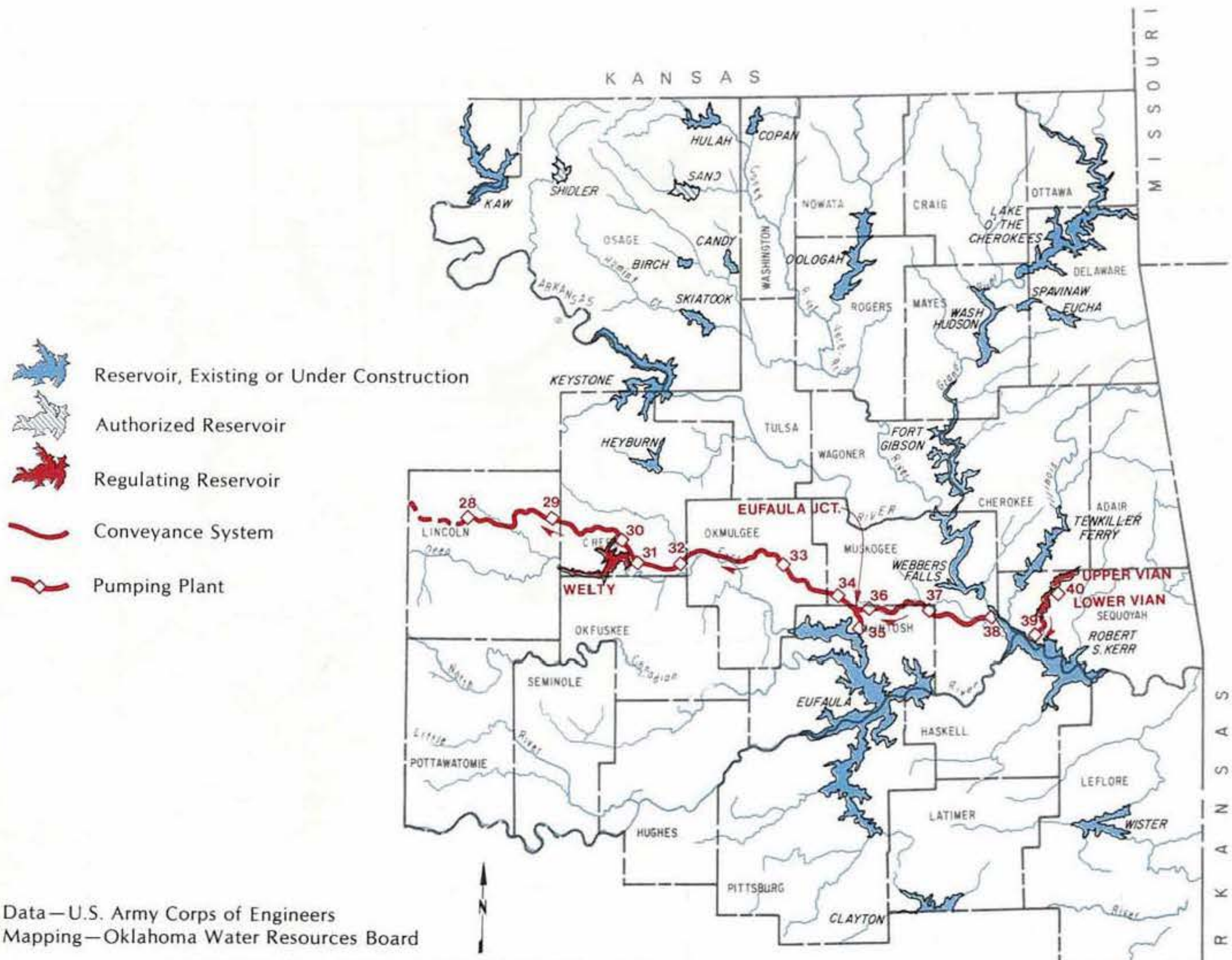


FIGURE 102 NORTHERN WATER CONVEYANCE SYSTEM SOURCE COMPONENT ALTERNATIVES 5A, 6A, 5B, 6B

jected demands of northwestern Oklahoma until about the year 2035. At that time, the leg from the Arkansas River at Robert S. Kerr Lake would be added to meet needs to the year 2040.

To continue to meet the demands beyond 2040 and make up for the depletion of storage in Eufaula Lake, two regulating storage reservoirs, Upper and Lower Vian Creek Lakes, and conveyance facilities from the Arkansas River at Kerr Lake to the regulating reservoirs would be constructed. This arrangement would also permit scalping of additional surpluses at Kerr Lake. During periods when surplus flows would be inadequate, water stored in the Vian Creek Lakes would be released to Kerr Lake via Vian Creek. Diversions equivalent to the releases would be made upstream through the main conveyance system. These two alternatives would allow part of the regulating storage to be located closer to the source, thereby reducing the capacity of a major portion of the conveyance facitlities. Greater conveyance capacity for Alternative 5B would be required because surplus water of suitable quality would be available less frequently at Robert S. Kerr Lake without chloride control. To provide the same gross yield as Alternative 5A, greater quantities would have to diverted during the less frequent periods when the quality would be acceptable.

Alternative 6A and 6B (Figure 102) would be similar to alternatives 5A and 5B except that the power and inactive storage in Eufaula Lake would not be utilized, and the releases required for a 10 percent plant factor would be maintained. Without the storage conversion and because greater minimum releases would be maintained, Tuskegee Lake would need to be constructed initially along with the full scalping capacity at Eufaula Lake. The conveyance facilities from Robert S. Kerr Lake to Eufaula Junction would be added about the year 2000, and the Vian Creek Lakes and the conveyance



Data—U.S. Army Corps of Engineers
Mapping—Oklahoma Water Resources Board

FIGURE 103 NORTHERN WATER CONVEYANCE SYSTEM SOURCE COMPONENT ALTERNATIVES 7A, 8A, 7B, 8B

facilities to those lakes would be added about 2015.

Alternatives 7A and 7B (Figure 103) would be the same as Alternatives 5A and 5B except that Welty Lake with 700,000 acre-feet of regulating storage would be constructed instead of Tuskegee Lake.

Alternatives 8A and 8B (Figure 103) would be the same as Alternatives 6A and 6B except that Welty Lake would replace Tuskegee Lake.

EVALUATION OF ALTERNATIVE PLANS

A comparison of project costs for the alternatives is presented in Figure104. The costs are based on January 1978 price levels. Average annual costs are based on 6 5/8 percent interest and a 100-year period of analysis. The average annual costs reflect staging of project components to meet preliminary estimates of northwestern Oklahoma import demands. No costs are included for transfer facilities from Pumping Plant 26westward, since those costs will be the same for all alternatives. See Figure 104 .

A comparsion of the first costs of the alternatives shows that 6A would be the least costly of the "with chloride control" plans, and 6B would be the least costly of the "without chloride control" plans. Alternatives 5A and 5B would have the least average annual equivalent costs for the "with" and "without" conditions, respectively. It should be noted, however, that the project costs shown in the preceding table do not include the costs of mitigation/compensation of fish and wildlife habitat losses.

Prior to selection of a plan for refinement and further study, the alternatives were coordinated with all members of the Planning Committee, including representatives of the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation. The wildlife agencies expressed major concerns about the potential impacts of several of the alternatives on fish and wildlife resources, particularly loss of unique habitats, possible deleterious effects on endangered species and potential degradation of several diverse aquatic and terrestrial habitat

FIGURE 104 ALTERNATIVE PLANS SUMMARY OF PROJECT COSTS
January 1978 Prices
(In $1,000,000)

	"With Chloride Control" Alternatives								"Without Chloride Control" Alternatives					
	1A	2A	3A	4A	5A	6A	7A	8A	1B	2B	5B	6B	7B	8B
Project First Cost														
Sources[1]	105	—	186	—	105	—	105	—	105	—	105	—	105	—
Reservoir(s)	124	124	173	173	172	172	172	172	124	124	172	172	172	172
Convey. Facilities	1,702	1,664	1,615	2,437	1,544	1,505	1,514	1,514	1,810	1,773	1,692	1,655	1,665	1,665
TOTAL	1,931	1,788	1,974	2,610	1,821	1,677	1,791	1,686	2,039	1,897	1,969	1,827	1,942	1,837
Avg. Ann. Cost														
Sources	6.8	—	6.5	—	6.8	—	6.8	—	6.8	—	6.8	—	6.8	—
Reservoir(s)	1.9	10.0	10.7	10.7	1.9	9.1	1.9	9.1	1.9	10.0	1.9	9.1	1.9	9.1
Convey. Facilities	109.9	123.9	90.8	123.8	94.1	111.6	97.7	112.4	113.0	129.5	99.0	119.8	107.4	123.6
OM&R	3.8	4.4	4.7	4.6	3.7	3.9	3.5	3.8	3.8	4.5	3.7	4.2	3.8	4.2
Energy	28.0	30.4	24.5	24.7	27.9	30.6	28.2	30.9	28.0	30.4	27.9	30.6	28.2	30.9
Benefits Foregone[2]	8.2	—	9.2	—	8.2	—	8.2	—	8.2	—	8.2	—	8.2	—
TOTAL	158.6	168.7	146.4	163.8	142.6	155.2	146.3	156.2	161.7	174.4	147.5	163.7	156.3	167.8

[1] Estimated value of hydroelectric power storage converted to water supply storage.
[2] Estimated value of hydroelectric power benefits foregone resulting from conversion of power storage to water supply storage.

parameters resulting from altered instream flows and increased lake level fluctuations, including direct impacts on stream fisheries and water quality, among others.

The U.S. Fish and Wildlife Service used a nonmonetary matrix analysis of the 14 alternatives to rank them according to their potential environmental impacts. This analysis indicated that of the alternatives considered, 8A and 8B would have the least adverse impacts on fish and wildlife resources. The alternatives with the least average annual equivalent costs (excluding mitigation costs), 5A and 5B, ranked sixth and eighth, respectively, primarily because they would severely reduce instream flows below Eufaula Lake and have greater adverse impacts on unique habitats in the Deep Fork River Basin (Tuskegee Lake area). Alternatives 7A and 7B rank seventh and tenth, respectively, for similar reasons. Although it would have a relatively high first cost, Alternative 3A would have a relatively low average annual cost, due to deferral of construction of Bristow Lake and the conveyance facilities from Eufaula Lake to Tuskegee Lake. However, Alternative 3A ranks fourteenth in the matrix analysis because it would severely reduce flows below Keystone Lake, as well as Eufaula Lake. The average annual equivalent cost of Alternatives 8A an 8B would be only 10 to 14 percent greater than the costs of 5A and 5B. The first costs would be only about five percent greater than for Alternatives 6A and 6B. In view of the preliminary nature of the cost estimates and the staging of construction for the alternatives, these fiscal differences were considered to be offset by the tangible and intangible adverse environmental effects which could be avoided if Alternatives 8A or 8B were implemented. Therefore, the Planning Committee selected Alternatives 8A and 8B to provide the base for further refinement and development of a water conveyance system for northwestern Oklahoma.

The Selected Northern System

The northern water conveyance system presented in this section is based on modification to and refinement of source Alternatives 8A and 8B and the Bureau of Reclamation portion discussed earlier. Further development of the two alternatives was coordinated with the Planning Committee for the Oklahoma Comprehensive Water Plan. Components of the system are presented for both the "with" and "without" assumptions regarding the Arkansas River chloride control project. Each component would provide the same ultimate diversion of water of suitable quality for municipal, industrial and irrigation supplies.

DESCRIPTION OF THE SYSTEM

The ultimate system as shown in Figure 97 would consist of modification of three existing reservoirs; construction of eight proposed reservoirs; approximately 710.5 miles of canals and inverted siphons; approximately 139.5 miles of pipeline; 42 pumping plants, including six with reservoir intakes; municipal and industrial delivery systems and irrigation distribution systems and all appurtenances.Figure 105presents pertinent data on the conveyance system and Figure 107shows pertinent pumping plant data. The system at ultimate development would provide a dependable water supply of 1,034,400 acre-feet annually plus conveyance losses of approximately 177,700 acre-feet from Welty Lake westward to ter-

FIGURE 105 NORTHERN WATER CONVEYANCE SYSTEM PERTINENT DATA

Reach	Design Capacity (FT^3/s)	Pipe Length (mi)	Siphon Length (mi)	Canal Length (mi)	Total Length (mi)
#1-Goodwell Turnout to Boise City Res.	566	37.5	1.0	41.5	80.0
#2-Optima Res. to Goodwell Turnout	1,108	15.0	2.8	16.0	33.8
#3-Slapout Jct. to Optima Res.	1,174	16.8	13.0	50.0	79.8
#4-Ft. Supply Jct. to Slapout Jct.	1,247	12.7	0.2	34.8	47.7
#5-Cestos Jct. to Ft. Supply Jct.	1,303	7.9	0.2	58.8	66.9
#6-Canton Res. to Cestos Jct.	1,412	0.7	0.8	10.8	12.3
#7-PP 26 to near Canton Res.	1,606	16.4	7.1	72.4	95.9
#8-Tri. Jct. to PP 26	1,606	—	6.9	27.4	34.3
#9-PP 28 to Tri. Jct.	1,851	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[2]	5.0	11.1	49.6	65.7
#12-PP 38 to Eufaula Jct.	4,000[3]	2.2	6.1	24.3	32.6
#13-PP 38 to Vian Creek Lake	1,000[4]	0.6	1.1	2.4	4.1
#14-Englewood Res. to Slapout Res.	57	6.1	0.1	10.0	16.2
#15-Ft. Supply Jct. to Ft. Supply Res.	26	5.1	—	—	5.1
#16-Cestos Jct. to Cestos Res.	105	8.2	0.3	26.8	35.3
#17-Near Canton Res. to Alva Res.	80	—	17.2	69.2	86.4
#18-Tri. Jct. to Sheridan Res.	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 cfs
[3]Design capacity "without" chloride control 5,200 cfs
[4]Design capacity "without" chloride control 1,300 cfs

minal reservoirs to meet the municipal, industrial and agricultural water demands of north central and northwestern Oklahoma in excess of available local sources.

Sources of water would be surplus flows from the Canadian River system at Eufaula Lake and the Arkansas River at Robert S. Kerr Lake. With the chloride control project operational and elimination of man-made pollution, the required maximum combined diversion capacity at the two sources would be 5,000 cfs. Without the chloride control project, the combined capacity would have to be 6,500 cfs. Up to 4,000 cfs of this capacity, depending upon available surplus flows and unused storage in Welty Lake during pumping periods, would be diverted at Eufaula Lake. At Robert S. Kerr Lake, diversions would be made up to maximum capacity (5,000 cfs with chloride control; 6,500 cfs without), depending upon available surplus flow, quantities diverted at Eufaula Lake and unused regulating storage.

Of the maximum diversion capacity at Robert S. Kerr Lake, 30 percent would be to Vian Creek Lake via Pumping Plan 39. During periods when transfers would depend upon water stored in Vian Creek Lake, releases would be made from the reservoir and allowed to flow into Robert S. Kerr Lake via Vian Creek. Withdrawals equivalent to those releases would be made at Pumping Plant 38 and transferred westward.

On westward the system would consist of three existing reservoirs — Optima, Fort Supply and Canton — and six proposed reservoirs — Boise City, Goodwell, Slapout, Cestos, Alva and Sheridan. The existing Optima, Fort Supply and Canton Reservoirs would be utilized for terminal storage in addition to their current uses. Optima and Canton Lakes would not require modifications, but Fort Supply dam would be raised three feet to hold additional storage. The six proposed reservoirs would serve as terminal reservoirs for import water. Englewood Reservoir, a proposed local project, would provide supplemental water to Slapout Reservoir as well as providing storage for irrigation in the local area. The actual conveyance system would consist of concrete-lined canals, siphons and pumping plant discharge pipelines, with capacities ranging from 26 cfs to 1,930 cfs. Average annual supply of water delivered through the system would be 1,034,400 acre-feet per year, primarily for irrigation purposes. Approximately 500,000 acres would be irrigated with import water. Figure 106 shows the counties to be served by

FIGURE 106 NORTHERN WATER CONVEYANCE SYSTEM ALLOCATION OF TERMINAL RESERVOIRS[1] (In 1,000 Af/Yr)

REGION	Sheridan		Optima		Fort Supply		Canton[3]		Alva		Cestos		Slapout[4]		Goodwell		Boise City		Total
	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	
County																			
NORTH CENTRAL																			
Garfield[2]	34.3	63.9																	98.2
Subtotal	34.3	63.9																	98.2
NORTHWEST																			
Alfalfa									2.6	46.4									49.0
Beaver			0	23.8									0	90.0					113.8
Blaine[5]																			
Cimarron																	0	342.0	342.0
Dewey							0	6.6											6.6
Ellis											0	52.4							52.4
Harper[5]																			
Major							0	8.0											8.0
Texas															2.9	320.6			323.5
Woods									0.7	34.8									35.5
Woodward					14.8	1.5													16.3
Subtotal			0	23.8	14.8	1.5	0	14.6	3.3	81.2	0	52.4	0	90.0	2.9	320.6	0	342.0	947.1
TOTAL	98.2		23.8		16.3		14.6		84.5		52.4		90.0		323.5		342.0		1,045.3[6]

[1]Maximum import capabilities.
[2]Only county in North Central Planning Region served by conveyance system.
[3]Preliminary operation studies indicate yield of Canton could be reduced with construction of upstream reservoirs.
[4]Includes 36,000 AF/YR of water received from Englewood.
[5]Not served by conveyance system.
[6]Total reflects firm yield of reservoirs as well as import supplies.

the system along with their source of supply and amount of water provided. Import water, plus the firm yield of the terminal reservoirs, would meet the projected deficits.

STAGING

Because water supply demands are projected to increase over the planning period, the northern conveyance system was designed to be constructed in three stages in order to minimize the unit cost of water supplied. The initial two stages would be development of the major portion of the system's source component and construction of the main aqueduct and proposed terminal reservoirs in western Oklahoma. The last stage would include additional development of the source component to increase the system to its ultimate capacity.

The first stage, requiring an estimated five years to complete, would require development of the initial phase of the source component and construction of the main canal from Eufaula Lake to Fort Supply Reservoir in Woodward County, as well as construction of three of the proposed reservoirs in western Oklahoma and their respective branch lines to the main canal. Development of the source component would include installation of pertinent pumping facilities at Eufaula and construction of the canal from Eufaula to Pumping Plant 28. In addition, the proposed Welty Lake on Deep Fork River would be built as a regulating reservoir. The 4,000 cfs diversion capability at Eufaula combined with the 800,000 acre-feet of active storage in Welty would provide a dependable supply of 590,000 acre-feet per year at Pumping Plant 28.

Extension of the system on west of Pumping Plant 28 would require further construction of the main aqueduct and branch lines to the proposed Sheridan, Alva and Cestos Reservoirs, which would also be constructed during the first stage. Completion of the branch lines would be scheduled so that they would be capable of tying into the reservoirs upon each lake's completion. The first stage would reach Fort Supply where modification of the dam would be necesssary to increase its import capability.

As indicated in Figure 108 , the first stage of the system would have the capability of supplying enough water to meet the import requirements of the north central and northwest regions. However, many of these demands exist in the three Panhandle counties of Cimarron, Texas and Beaver. Extension of the canal to this area is not possible within the 5-year construction period of the first stage, therefore the demands of the Panhandle cannot be met in the initial stage of development. This situation is depicted graphically in Figure 108 , which shows

FIGURE 107 NORTHERN WATER CONVEYANCE SYSTEM PUMPING PLANT PERTINENT DATA

Pumping Plant No.	Static Head (ft)	Total Head (ft)	Design Capacity (ft^3/s) with cc	without cc	Ultimate Average Annual Pumpage (1,000 AF)	Average Annual Energy Required (million KWH)
1	206	255	566	—	350	133
2	124	168	566	—	352	88
3	185	247	566	—	353	130
4	263	321	566	—	356	171
5	166	195	566	—	357	104
6	112	149	566	—	359	80
7	81	108	1,108	—	690	111
8	150	174	1,108	—	691	180
9	113	181	1,108	—	694	188
10[1]	210	247	1,108	—	696	257
11	121	180	1,174	—	725	195
12	170	216	1,174	—	730	236
13	145	169	1,174	—	734	185
14	265	311	57	—	37	17
15	216	268	1,247	—	770	308
16	140	176	1,247	—	774	204
17	133	154	1,247	—	782	180
17-A	73	113	26	—	13	2
18	146	169	1,303	—	790	199
19	72	90	1,303	—	794	107
20	98	142	1,303	—	802	170
20-A	193	216	104	—	60	19
20-B	122	169	104	—	57	14
21[1]	120	139	1,412	—	879	183
22	96	123	1,606	—	954	175
23	314	356	1,606	—	961	511
24	50	75	1,606	—	970	109
25	113	148	1,606	—	974	216
26	79	108	1,606	—	976	158
27	90	111	1,790	—	1,069	183
28	96	113	1,790	—	1,080	188
29	104	127	1,810	—	1,090	182
30	64	83	1,820	—	1,100	120
31[1]	124	142	1,830	—	1,100	206
32	68	89	1,970	5,150	1,300	152
33	53	72	3,980	5,160	1,310	124
34	75	100	3,990	5,170	1,320	173
35[1]	105	124	4,000	—	682	111
36	44	65	3,980	5,180	644	55
37	84	103	3,990	5,190	652	88
38[1]	121	137	4,000	5,200	660	118
39[1]	200	308	1,000	1,300	211	92
TOTAL						6,422

[1]Reservoir Pumping Plant
cc = chloride control

that the import capability of terminal reservoirs in western Oklahoma that can be developed initially is only about 400,000 acre-feet per year. This capability is sufficient to meet the import needs of northwestern and north central Oklahoma as projected at the end of the first stage, with the exception of the Oklahoma Panhandle.

The second stage of the conveyance system would require augmentation of the source component in eastern Oklahoma and extension of the main canal to the Panhandle area, along with construction of three additional proposed terminal reservoirs. During the second stage, the import capability of the western portion of the system would "catch up" with the import demand. Figure 108 shows that by the end of the eighth year, the import capability surpasses the demand curve.

As projected demands increase in western Oklahoma, tapping of an additional source would be required to supply the necessary water. The second phase of the source component includes development of pumping facilities at Robert S. Kerr Reservoir and conveyance facilities from Kerr to Eufaula junction. (See Figure 97.) Extending the system to Kerr allows additional water to be picked up so that the capacity of the system is increased to 1,070,000 acre-feet per year at Pumping Plant 28.

The second stage would also include extension of the main aqueduct from Fort Supply Reservoir to Boise City Reservoir, the system's westernmost point. Slapout, Goodwell and Boise City, all proposed reservoirs would be constructed in the second phase of development to serve as terminal reservoirs, primarily for irrigation purposes. Optima, an existing reservoir in Texas County, would also be tied into the conveyance system. In addition, a conveyance canal from the proposed Englewood to Slapout would be constructed during this stage to provide additional water to Beaver County.

The import capability of terminal reservoirs at the end of the second stage would be 1,034,400 acre-feet per year. This capability would be sufficient to receive enough import water to meet the ultimate demands of northwest and north central Oklahoma. It is estimated that completion of this stage would occur in the twelfth year of construction.

The third and final stage of the conveyance system would provide for an increase in capacity of the source component. This would be accomplished by construction of Vian Creek Lake as a regulating reservoir, and conveyance facilities from Robert S. Kerr Lake (Pumping Plant 39) to Vian Creek Lake. This final stage would provide for a maximum annual supply of 1,173,000 acre-feet. During periods when transfers would depend upon water stored in Vian Creek Lake, releases would be made from the reservoir and allowed to flow into Robert S. Kerr lake via Vian Creek. Withdrawals equivalent to those releases would be made at Pumping Plant 38 and transferred westward. It is anticipated that this stage would not be necessary until about the thirtieth year after initial operation.

COSTS

Preliminary cost estimates for the northern water conveyance system indicate total cost of construction for the system to be around \$5.3 billion with the chloride control projects in operation. This cost includes \$600 million for construction of new proposed reservoirs, \$3.44 billion for the conveyance canal from eastern Oklahoma to the extreme western Panhandle, \$1.1 billion for pertinent irrigation distribution facilities, \$71 million for municipal and industrial facilities and \$85 million for mitigation/compensation costs. The average annual equivalent cost would be approximately \$365 million, which includes \$117 million in average annual operation,

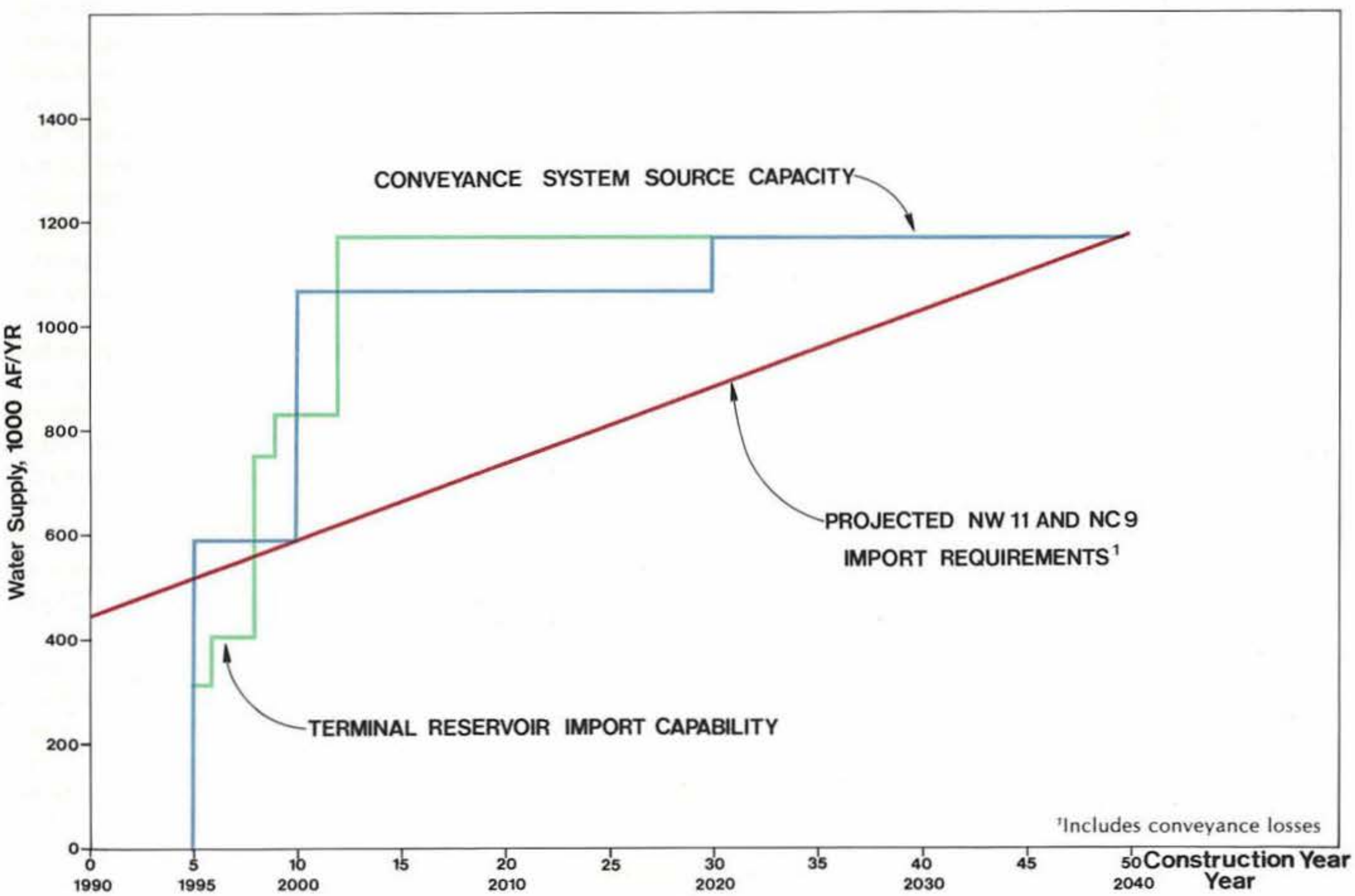


FIGURE 108 NORTHERN WATER CONVEYANCE SYSTEM CONSTRUCTION STAGING

FIGURE 109 NORTHERN WATER CONVEYANCE SYSTEM SUMMARY OF PROJECT COSTS (In $1,000)

FACILITY	CONSTRUCTION COST	AVERAGE ANNUAL OMR&E[2]	TOTAL AVERAGE ANNUAL EQUIVALENT COSTS[3]
SOURCE COMPONENT			
Conveyance Facilities (sources to pumping plant 28)	$1,314,000	$ 23,560	$ 95,600
Proposed Reservoirs (Welty and Vian Creek)	210,000	890	10,200
SUBTOTAL	$1,524,000	$ 24,450	$105,800
DELIVERY COMPONENT			
Conveyance Facilities (pumping plant 28 westward)	$2,125,000	$ 72,100	$168,540
Existing Reservoir (Fort Supply modification)	200	50	70
Proposed Reservoirs (Sheridan, Cestos, Alva, Slapout, Goodwell and Boise City)	390,800	4,270	22,190
Irrigation Distribution	1,100,000	14,980	58,320
M & I Distribution	71,000	690	4,280
SUBTOTAL	$3,687,800	$ 92,090	$253,400
MITIGATION/COMPENSATION COSTS	$ 85,000	$ 200	$ 5,600
TOTAL	$5,296,000	$116,740	$364,800

[1]Based on January 1978 prices.
[2]Energy computed at a 30-mil power rate.
[3]Includes interest and amortization as well as average annual OMR&E.

maintenance, replacement and energy (OMR&E) expenses and $5.6 million for average annual mitigation/compensation costs. OMR&E costs consist primarily of energy costs computed at a 30-mil power rate with annual requirements roughly estimated to be 6.4 billion KWH.

As shown in Figure 109, the source component of the northern system is estimated to cost approximately $1.5 billion, while the delivery component would cost an estimated $3.7 billion.

BENEFITS

Direct benefits accruing from the northern system were estimated $58 million annually, consisting of $17 million of irrigation benefits and $41 million of municipal and industrial benefits. Municipal and industrial benefits were assumed to equal the average annual equivalent costs attributable to the municipal and industrial component of the system. The irrigation benefits are of a primary nature, calculated as the difference in net income between dryland farming and irrigation farming.

BENEFIT-COST ANALYSIS

A rough comparison of direct annual benefits ($58 million) and costs ($365 million) indicates the northern water conveyance system exhibits a benefit-cost ratio of .16:1. Under federal planning guidelines, such a ratio renders a project economically infeasible and construction cannot be justified. However, considerable indirect benefits, particulary those due to agricultural and agribusiness impacts, would result from the transfer system, but which are not included in this analysis, would also need to be considered prior to a final assessment of the feasibility of the project.

SOUTHERN WATER CONVEYANCE SYSTEM

Water Requirements

Water requirement projections by the Planning Committee of the Oklahoma Comprehensive Water Plan indicate that by the year 2040, central Oklahoma will need to import 487,000 acre-feet of water annually for municipal and industrial purposes and southwestern and south central Oklahoma will require 728,500 and 28,000 acre-feet per year, respectively, primarily for irrigation purposes. A dependable supply of nearly 1,320,000 acre-feet annually would have to be developed in southeastern Oklahoma to meet the projected demands and provide for conveyance losses.

As indicated earlier, three of the four planning regions in the southern 33 counties of Oklahoma are projected to face severe water shortages in the foreseeable future. Even with full development of the proposed local water sources outlined for these three regions, they may still experience a combined import deficit of almost 1,240,000 acre-feet per year by 2040, which will have to be supplied from other areas of the state. Studies show that existing, planned and potential stream water development and ground water sources in southeastern Oklahoma could easily supply that region's projected water needs, meet the import demands of central and southwestern Oklahoma, and still produce an annual surplus of approximately 2.2 million acre-feet.

Potential Sources for Transfer

In selecting sources of water supply, potential reservoir development as well as existing and authorized reservoirs in southeastern Oklahoma were considered. These reservoirs were screened and alternatives considered which could meet the needs of all the southern 33 counties.

The abundance of water in southeastern Oklahoma provided many potential sources for evaluation. As with any water supply study, both water quality and quantity were important concerns. The major consideration in the analysis was to provide good quality water in the amount needed while minimizing the cost of conveyance facilities and storage in the overall system.

From the analysis it was determined that Clayton, Tuskahoma, Hugo and Boswell reservoirs offered the greatest potential as sources for transfer. Hugo is an existing reservoir, Clayton is under construction and scheduled for completion in 1981, and Tuskahoma and Boswell are authorized for construction.

Hugo Lake presently maintains a dependable yield of 165,760 acre-feet annually, however, once Clayton and Tuskahoma are constructed to complete the 3-lake system on the Kiamichi River, part of the flood control storage in Hugo could be converted to water supply, raising the ultimate yield to 302,800 acre-feet per year, including the yield from water quality control storage. The yield of Boswell Lake allocated for irrigation supplies (688,000 acre-feet per year) would be used in south central and southwestern Oklahoma.

Yields available for municipal and industrial water supply are based on a dependable yield through a 50-year frequency drought. Yields available for irrigation are based on a 10-year frequency drought.

Most of the water supply and irrigation storage allocated in the reservoirs would be for use in central and southwestern Oklahoma, however, some storage would be reserved in three of the four reservoirs to meet needs in the vicinity of the sources.

Alternative Water Transfer Plans Considered

The southern water conveyance system is a modification and expansion of an alternative plan developed by the Corps of Engineers in conjunction with their Central Oklahoma Project (COP) investigations. The COP water supply system investigation was authorized by congress in 1955 to determine the feasibility of transbasin diversion of surplus water from southeastern to central Oklahoma. The COP plans included alternative systems to provide municipal and industrial water to central Oklahoma via either a pipeline or open canal to meet 50-year water needs. Studies indicated that the pipeline method was actually more cost-effective than a canal when transferring water designated for central Oklahoma only. A pipeline alternative also would be less damaging to the natural environment than a canal, as well as lending itself more readily to staged development.

When the need for import water in southwestern Oklahoma became apparent, the Oklahoma Water Resources Board requested the Corps to assess the feasibiltiy of increasing the capacity of the COP plan in order to include municipal, industrial and irrigation water for southwestern Oklahoma. Consequently, the Corps designed an expanded version of the COP to provide water for southwestern and south central Oklahoma at a point where it could be picked up for utimate delivery. The Corps determined that with the increase in capacity, the pipeline alternative no longer held cost advantages over a canal alignment. Therefore, an open canal system was determined the most cost-effective means of transferring water to both areas of the state.

The Bureau of Reclamation formulated two alternatives to convey water to the Southwest and South Central Planning Regions from a pickup point near central Oklahoma. The first alternative picked up the water at Wayne and then headed northwest across northern Grady County, turning straight south at the Caddo County line. From this point it split, taking most of the water westward to southwestern Oklahoma and carrying a smaller amount south to south central Oklahoma. The second alternative headed due west through northern Garvin and extreme southern Grady Counties. Near the Grady-Comanche County line, the system proposed a leg turning south, with most of the water continuing to the Southwest Planning Region. Both alternatives had the same basic alignment from Caddo County to counties in the western part of the region.

Cost analyses of the two alternatives revealed the first alternative was more costly than the second, and thus the Planning Committee decided to continue further studies utilizing the latter route.

The Bureau had initially considered another alternative to provide water for southwest and south central Oklahoma. This alternative did not tie into the Corps' system, but rather went straight to the sources in southeastern Oklahoma. This southerly route tied directly into Hugo and Boswell Reservoirs, carrying water through the southern portion of the South Central Planning Region. Then the route turned north to the upper and far western parts of the southwest region. The attractive feature of the southerly route was its independence from the canal conveying water to central Oklahoma. However, the cost of this alternative was rendered cost-prohibitive by the longer canal route and the reduced economies of scale enjoyed by combining the two canals. It is believed that if a good quality source of water could be developed closer to southwestern Oklahoma, the cost of the southerly system might be decreased sufficiently to make it a feasible alternative. Such a system would also reduce the amount of surplus water to be diverted from southeastern Oklahoma.

The Selected Southern System

The selected water conveyance system proposed for the southern 33 counties is a modified version of a Corps alternative serving central Oklahoma, along with a distribution segment prepared by the Bureau of Reclamation to transport water to the southwest. The two segments of the system would converge just east of Wayne, Oklahoma. The system was formulated under the assumption of "without" flood control storage as a project purpose.

DESCRIPTION OF THE SYSTEM

The eastern segment of the conveyance system would consist of a network of canals, pipelines, conduits and pumping plants to transport surplus water from the Kiamichi River near Moyers, Oklahoma and Hugo and Boswell Lakes to central Oklahoma and to a point near Wayne. Water diverted from the Kiamichi River near Moyers would be supplied from Clayton and Tuskahoma Lakes. Water for central Oklahoma would be pumped into existing Lake Stanely Draper and additional terminal storage would be provided through construction of West Elm Lake on West Elm Creek, adjacent to Lake Stanley Draper. The two terminal reservoirs would be connected by a gated control structure which would allow flexibility in the operation of the terminal storage.

The main aqueduct would consist of a series of six nearly level canal reaches originating on a ridge between Boswell and Hugo Lakes and terminating at Lake Stanley Draper. Six intermediate pumping plants with short conduits would be provided between canal reaches and at Lake Stanley Draper to lift water from one level to the next.

Water to the main aqueduct would be supplied through the Moyers Pumping Plant and Canal, the Hugo Pumping Plant and Pipeline, and the Boswell Pumping Plant and Pipeline. The Moyers Canal would originate near the Kiamichi River about two miles downstream from the mouth of Tenmile Creek and join the main aqueduct near Darwin, Oklahoma. The canal would be approximately nine miles long, with an ultimate conveyance capactiy of 340 mgd or 380,800 acre-feet of water per year. Water released from Clayton and Tuskahoma Lakes would be withdrawn from the Kiamichi River at the Moyers Pumping Plant and pumped through the two large conduits to the head of the canal. Moyers Dam, a low water dam, would be constructed on the Kiamichi River immediately downstream from the pumping plant to insure adequate submergence of the pump intakes.

The Hugo Pumping Plant would be located on the Hugo Lake, and would have an ultimate capacity of 260 mgd or 291,200 acre-feet of water per year. The 9-mile Hugo Pipeline would connect the Hugo Pumping Plant with the lower end of the main aqueduct.

The Boswell Pumping Plant, on the Muddy Boggy Creek arm of Boswell Lake, would have an ultimate capacity of 580 mgd or 649,600 acre-feet of water per year. The Boswell Pipeline would consist of two parallel pipelines about seven miles in length connecting the pumping plant with the main aqueduct at a point approximately seven miles north of Soper, Oklahoma.

FIGURE 110 SOUTHERN WATER CONVEYANCE SYSTEM PERTINENT DATA

Reach	Design Capacity (cfs)	Pipe Length (mi)	Siphon Length (mi)	Canal Length (mi)	Total Length (mi)
#1-Cooperton Diversion to Tom Steed Res.	140	—	—	6.1	6.1
#2-Lake Altus to Mangum Res.	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 Res.	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
#6-Carnegie Confluence to Foss Res.	290	4.8	9.9	57.4	72.1
#7-Carnegie Diversion Dam to Carnegie Confluence	200	0.2	0.5	3.7	4.4
#8-Ft. Cobb Turnout to Carnegie Confluence	92	0.8	—	10.8	11.6
#9-Ft. Cobb Feeder	150	—	—	2.4	2.4
#10-Pine Ridge Diversion to Ft. Cobb Turnout	242	—	3.3	10.1	13.4
#11-Verden Jct. to Pine Ridge Diversion	1,166	—	—	11.5	11.5
#12-Verden Jct. to Verden Res.	46	—	7.1	21.6	28.7
#13-Wayne Pickup to Verden Jct.	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[1]	28.7
#16-Moyers Canal to PP 14	1,825	2.8	—	124.9[1]	127.7
#17-PP 19 to Main Canal	526	0.3	—	9.1[1]	9.4
#18-PP 20 to Moyers Canal	1,330	6.5	—	8.3[1]	14.8
#19-PP 21 to Boswell Pipeline.	387	8.6	—	3.0[1]	11.6
TOTAL		45.5	35.4	500.5	581.4

[1]Includes siphon length

The Wayne Pipeline would consist of two parallel pipelines from Pumping Plant 5 on the main aqueduct to the Wayne dropoff point, a distance of 12 miles. Pumps for the pipeline would be included in the intermediate pumping plant. The ultimate capacity of the pipeline would be 740 mgd or 828,800 acre-feet of water per year. Water for southwestern Oklahoma would be conveyed from the main aqueduct by the Wayne Pipeline to the Wayne drop-off point, from there it would be transferred to southwestern Oklahoma. The total length of the conveyance facilities to central Oklahoma would be 200 miles, and the overall lift from Hugo Lake to Lake Stanley Draper would be 800 feet. Pertinent data are presented in Figures 110 and 111 .

From the Wayne turnoff, water would be carried to southwestern Oklahoma through a conveyance system consisting of 327 miles of concrete-lined canal and 48 miles of conduit with a capacity ranging from 46 cfs to 1,250 cfs. Thirteen in-line

FIGURE 111 SOUTHERN WATER CONVEYANCE SYSTEM PUMPING PLANT PERTINENT DATA

Pumping Plant No.	Static Head (ft)	Total Head (ft)	Design Capacity (ft^3/s)	Ultimate Average Annual Pumpage (1,000 AF)	Average Annual Energy Required (million KWH)
1	50	66	150	89	9
2	74	92	150	89	9
3[1]	40	56	150	89	12
4	70	92	244	145	20
5	33	51	591	352	27
6	50	66	1,006	602	59
7	147	173	1,006	602	156
N-1	220	255	319	190	72
N-2	79	98	319	190	28
N-3[1]	186	202	220	50	15
N-4	80	99	101	60	9
8	131	148	1,375	818	181
9	78	94	1,375	818	115
10	39	55	1,375	818	67
11	131	148	1,375	818	181
12	40	56	1,375	818	68
13	98	110	680	493	65
14	105	120	680	493	71
—[2]	8	170	1,150	814	170
15	98	120	1,830	1,322	192
16	110	110	1,830	1,322	176
17	96	100	1,830	1,322	160
18	115	130	1,830	1,322	208
19[1]	174	180	500	358	188
20[1]	176	220	980	706	78
21[1]	228	250	360	258	78
TOTAL					2,414

[1]Reservoir Pumping Plant
[2]Wayne Pipeline

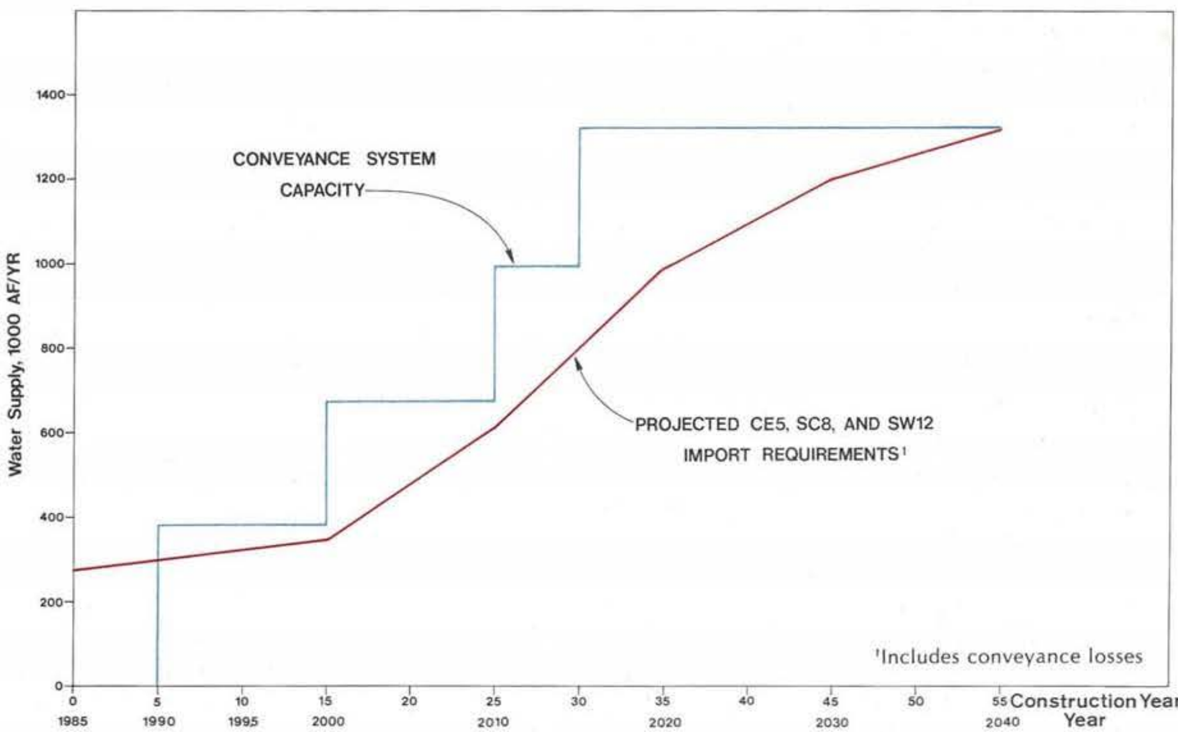


FIGURE 112 SOUTHERN WATER CONVEYANCE SYSTEM CONSTRUCTION STAGING

FIGURE 113 SOUTHERN WATER CONVEYANCE SYSTEM ALLOCATION OF TERMINAL RESERVOIRS[1] (In 1,000 Af/Yr)

PLANNING REGION	West Elm Creek and Draper		Verden		Fort Cobb		Foss		Tom Steed		Altus		Mangum		Snyder		Total
County	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	M&I	Irrigation	
CENTRAL																	
Canadian	48.0	0															48.0
Cleveland	90.4	0															90.4
McClain	36.1	0															36.1
Oklahoma	285.6	0															285.6
Pottawatomie	26.9	0															26.9
Subtotal	487.0	0															487.0
SOUTH CENTRAL																	
Grady[2]			18.5	17.0													35.5
Subtotal			18.5	17.0													35.5
SOUTHWEST																	
Beckham							5.0	0									5.0
Caddo					41.2	10.6											51.8
Comanche															10.6	0	10.6
Cotton[3]																	
Custer							0	10.6									10.6
Greer													1.9	42.5			44.4
Harmon													0	60.0			60.0
Jackson									9.8	62.6	0	65.0			0	91.4	228.8
Kiowa					0	48.2	2.1	45.3	1.9	27.7							125.2
Roger Mills[3]																	
Tillman															0	224.6	224.6
Washita							1.3	36.6									37.9
Subtotal					41.2	58.8	8.4	92.5	11.7	90.3	0	65.0	1.9	102.5	10.6	316.0	798.9
TOTAL	487.0		35.5		100.0		100.9		102.0		65.0		104.4		326.6		1,321.4[4]

[1]Maximum import capabilities.
[2]Only county in South Central Planning Region served by conveyance system.
[3]Not served by conveyance system.
[4]Total reflects firm yield of reservoirs as well as import supplies.

plants and three reservoir-type pumping plants would be required.

Terminal storage in southwestern Oklahoma would be provided by seven reservoirs, four of which are existing, and three proposed. (See Figure 97.) Altus Dam would require modification to accommodate an additional 70,000 acre-feet of conservation storage, a modification presently under study as part of the Safety of Dams Act. No other existing dams in the conveyance system would require modification. Grady County would be the only county in the South Central Planing Region to receive water from the proposed conveyance system. The proposed Verden Reservoir in the Southwest Planning Region would provide Grady County with 35,500 acre-feet of municipal, industrial and irrigation water per year, requiring an average conveyance of 28,000 acre-feet per year.

Ten of the 12 counties in the Southwest Planning Region would receive import water. Fort Cobb Reservoir would supply 100,000 acre-feet of water per year to Caddo and Kiowa Counties for municipal, industrial and irrigation purposes. Foss Reservoir would be operated in conjunction with the Carnegie Diversion Dam to supply Beckham, Custer, Kiowa and Washita Counties with 100,900 acre-feet of water per year. Tom Steed Reservoir, on the North Fork of the Red River, would yield 102,000 acre-feet of water per year to Jackson and Kiowa Counties, primarily for irrigation, and Altus Reservoir would supply Jackson County with an additional 60,000 acre-feet of water per year for irrigation. The two proposed reservoirs in the Southwest Planning Region, Mangum and Snyder, would provide 431,000 acre-feet annually to Comanche, Greer, Harmon, Jackson and Tillman Counties.

The southern water conveyance system in its entirety would supply approximately 1.3 million acre-feet of water annually to meet the future water deficits of central and southwestern Oklahoma. Figure 113 shows the counties served by the southern water conveyance system, their sources of supply and amounts of import water provided.

STAGING

Construction of the southern water conveyance system would require 30 years, staged in four segments to minimize the unit cost of water supplied. (See Figure112.) The initial stage would include development of a portion of the source component in southeastern Oklahoma, construction of the main aqueduct to central Oklahoma and development of the first phase of the western Oklahoma canal. The second stage would consist of an extension of the western canal to southwestern Oklahoma, as well as an increase in source supplies. The third and fourth stages would both include augmentation up to ultimate capacity of the source component in southeastern Oklahoma.

The first stage, requiring an estimated six years to complete, would include development of the eastern leg of the southern system, or one of the alternatives considered in the Corps of Engineers' Central Oklahoma Project (COP) investigations, and construction of the initial phase of the western canal to the main aqueduct. To develop the source component, the authorized Tuskahoma Reservoir and the Moyers Dam, Pumping Plant and Canal would be built, along with the main canal to Lake Stanley Draper. The proposed West Elm Creek Lake would also be constructed to serve as a terminal reservoir in central Oklahoma. The initial stage of the Wayne Pipeline would be built, then tied into the segment of the western canal from Wayne to Fort Cobb Reservoir. The proposed Verden Reservoir in Grady County would be required as terminal storage. Upon completion of the first stage, capacity of the system would be approximately 380,000 acre-feet per year, utilizing water from Clayton and Tuskahoma Reservoirs.

The second stage, scheduled for completion approximately 10 years later, would include extending the western conveyance canal to southwestern Oklahoma and construction of proposed Snyder and Mangum Reservoirs to provide terminal storage for imported water. In southeastern Oklahoma, pumping plants and pipelines tying Hugo Reservoir into the system as a major water supply source would be added, increasing the system's capacity to 672,000 acre-feet annually. By the seventh year of the second stage (or thirteenth year of the total construction period) sufficient water supply facilities would be completed so that all counties served by the conveyance system would have adequate water to meet their import requirements.

During the third stage of development, the capacity of the source component would be increased through the construction of authorized Boswell Lake in Choctaw County and addition of pumps and pipeline to the Wayne Pipeline to increase the amount of water supplied to south central and southwestern Oklahoma. Capacity at the end of the third stage would be approximately one million acre-feet annually. Construction of the third stage would require about two years with completion scheduled for the twenty-fifth year after the start of construction.

The fourth and final stage of the southern system would increase the capacity of the source component to its ultimate capacity by adding additional pumps and conduits to the sources. At the end of this stage, about the thirtieth year of the construction period, ultimate capacity of 1,320,000 acre-feet per year would be achieved.

COSTS

Cost estimates for the southern water conveyance system indicate a total construction cost of approximately $2.5 billion for proposed new reservoirs, conveyance canals, water supply storage in existing and authorized federal reservoirs and pertinent distribution facilities. The average annual equivalent cost would be approximately $190 million, which includes $53 million for annual OMR&E costs and $1.3 million for mitigation/compensation. A major portion of these costs consists of energy/pumping costs calculated at a 30-mil power rate with annual requirements estimated at 2.4 billion KWH. The construction cost includes $120 million for new dams and reservoirs, $105 million for water supply storage in existing and authorized reservoirs, $1.425 billion for conveyance facilities, $765 million for ir-

FIGURE 114 SOUTHERN WATER CONVEYANCE SYSTEM SUMMARY OF PROJECT COSTS[1] (In $1,000)

FACILITY	CONSTRUCTION COST	AVERAGE ANNUAL OMR&E[2]	TOTAL AVERAGE ANNUAL EQUIVALENT COSTS[3]
SOURCE COMPONENT (includes conveyance to Central Region)			
Conveyance Facilities	$ 868,000	$ 19,500	$ 75,000
Reservoir Storage	104,000	—	3,400
SUBTOTAL	$ 972,000	$ 19,500	$ 78,400
DELIVERY COMPONENT (Wayne turnout to South Central and Southwest Regions)			
Conveyance Facilities	$ 557,000	$ 28,090	$ 54,915
Existing Reservoir (Altus modification)	19,000	25	735
Proposed Reservoirs (Verden, Snyder and Mangum)	102,000	500	4,780
Irrigation Distribution	765,000	4,220	45,360
M & I Distribution	75,000	560	4,410
SUBTOTAL	$1,518,000	$ 33,395	$110,200
MITIGATION/COMPENSATION COSTS	$ 18,000	$ 100	$ 1,300
TOTAL	$2,508,000	$ 52,995	$189,900

[1]Based on January 1978 prices.
[2]Energy computed at a 30-mil power rate.
[3]Includes interest and amortization as well as average annual OMR&E.

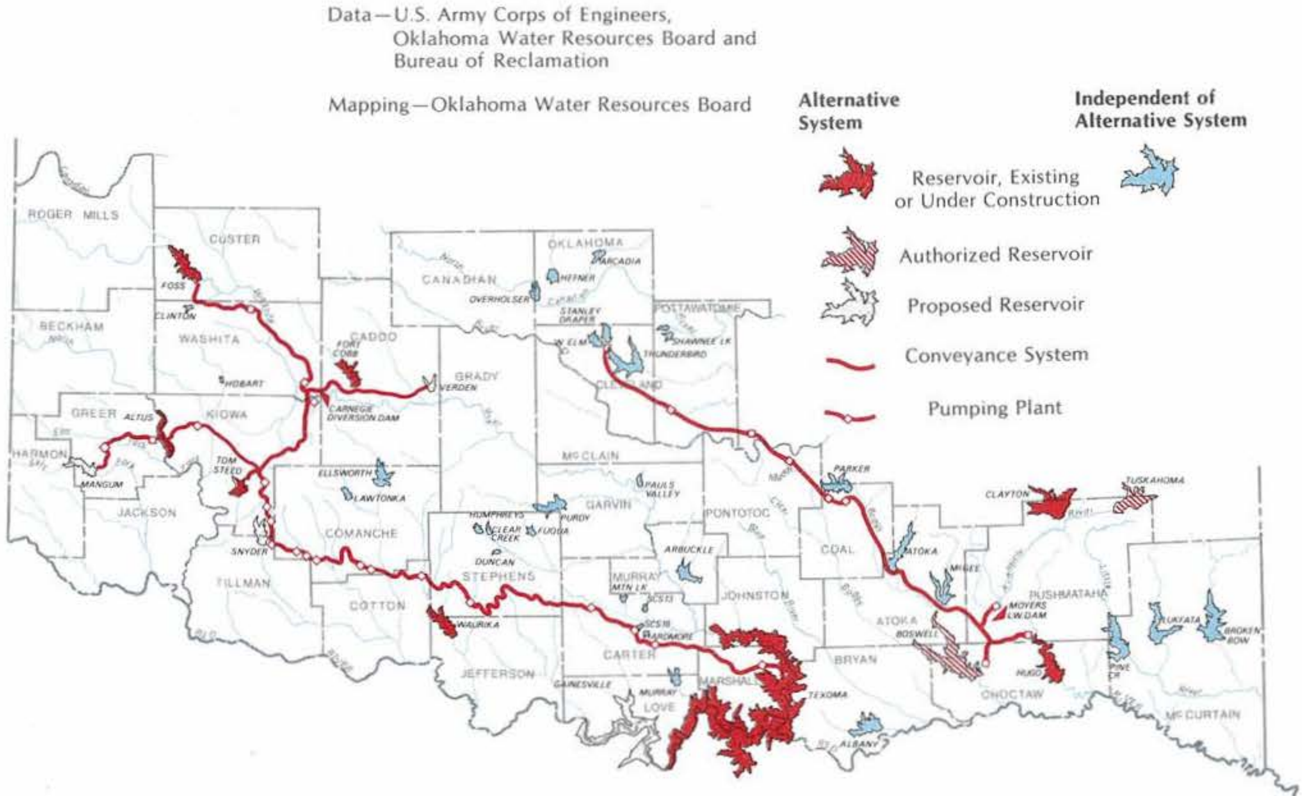


FIGURE 115 RED RIVER ALTERNATIVE WITH CHLORIDE CONTROL

rigation transmission lines, $75 million for municipal and industrial delivery facilities and $18 million for mitigation/compensation.

Figure 114 shows the estimated costs of source and delivery components of the southern system as well as mitigation/compensation costs. The source component, which includes the cost of the canal to central Oklahoma, is estimated to cost $972 million. The delivery component is estimated to cost $1.5 billion.

BENEFITS

Direct benefits accruing from the southern water conveyance system are estimated at $64.6 million, with $8 million attributable to irrigation and $56.6 million to municipal and industrial benefits.

BENEFIT-COST ANALYSIS

A comparison of annual benefits ($64.6 million) with costs ($190 million) indicates that the southern water conveyance system has a benefit-cost ratio of .34:1. Under federal planning guidelines, such a ratio renders a project infeasible and precludes its construction. Substantial indirect economic impacts which would occur, but which are not included in the analysis, would also need to considered prior to any final feasibility determination.

Red River Alternative With Chloride Control

The lack of economic feasibility under federal criteria for the irrigation component of the southern water conveyance system prompted a cursory assessment of an alternative utilizing water sources closer to the area of use. This alternative basically separates the proposed southern water conveyance system into two independent systems. One would furnish municipal, industrial and irrigation water to south central and southwestern Oklahoma from the Red River in south central Oklahoma, while the other would follow the same alignment as that previously discussed from southeastern to central Oklahoma.

By so doing, further planning of the municipal and indusrial water conveyance elements from southeastern Oklahoma to central Oklahoma possibly could proceed without reliance on transfers westward.

Preliminary studies for the Red River Basin Chloride Control Projects indicate that the Red River possesses the potential to be a suitable source of water after completion of the authorized chloride control projects located upstream. Natural brine springs and salt flats in the river's upper reaches currently render the water unfit for any beneficial purpose. However, control of those chloride emission zones would improve the quality of the water and make it suitable for most beneficial purposes.

Figure 115 shows the conveyance route of this alternative. Although containing a much different alignment than the southwestern leg of the proposed southern water conveyance system, this alternative would utilize the same existing and proposed terminal reservoirs in southwestern Oklahoma.

Lake Texoma and the potential Gainesville Lake would operate in tandem to provide the quantities of water required by southwestern Oklahoma. The alignment of the system to central Oklahoma would be the same as currently proposed in the southern conveyance system.

Utilization of Texoma and Gainesville Lakes as water sources for south central and southwestern Oklahoma is contingent upon several factors, among which are: (1) the chloride control projects would have to be completed and operational for the water in Lake Texoma to be of quality suitable for use; (2) Congressional reallocation of hydropower and inactive storage in the reservoir to water supply storage would be necessary; (3) storage allocation provisions of the Red River Compact would have to be met; (4) an assessment of a reduction in downstream releases would be required; and (5) further studies to assess the feasibility of the proposed Gainesville Lake would be necessary.

The Red River is an interstate stream subject to provisions of the compact between Oklahoma, Texas, Arkansas and Louisiana. Since the agreement requires Texas and Oklahoma to divide equally the storage from existing and proposed reservoirs on the main stem of the river, it would be necessary to coordinate this alternative with Texas water officials during early stages of additional planning.

Storage providing a yield of 857,600 acre-feet per year to Oklahoma would be required to meet southwestern and south central Oklahoma's projected deficits. The dependable yield from Texoma, assuming all the hydropower and inactive storage could be converted to water supply, would be about one million acre-feet annually, half of which or 500,000 acre-feet per year would be available for use in Oklahoma. Additional storage would be needed to offset increased sedimentation in Texoma and develop the supply necessary to meet the import requirements of southwestern Oklahoma during the planning period. Preliminary studies indicate that the potential Gainesville dam site, located about 70 miles upstream from Dension Dam, could be developed to operate in conjunction with Texoma to provide sufficient water of suitable quality to meet the import needs of southwestern Oklahoma. Gainesville, like Texoma would be subject to the terms of the Red River Compact and although no negotiations have as yet been initiated with Texas officials, this alternative would appear to be in accord with the State of Texas' water policy.

The conversion of Lake Texoma hydropower storage to water supply storage would eliminate all power production, and reduced downstream releases could have adverse impacts on fish and wildlife habitat, as well as potential navigation activity. The loss of the energy produced at Lake Texoma would have to be compensated for by either paying for the hydropower benefits foregone, or replacing the energy lost with energy produced from steam electric generating facilities. However, "scalping" operations on Lake Texoma and Gainesville similar to those employed in the northern water conveyance system could possibly provide sufficient quantities of water without loss of the hydroelectric power capability. More comprehensive studies will be necessary to address these issues and to determine the potential adverse environmental effects.

ADVANTAGES OF REGIONAL WATER DEVELOPMENT

Apparent advantages of the Red River alternative are multifaceted. Water obtained nearer the area of use would not only substantially reduce reliance on transfers from southeastern Oklahoma, but might result in cost savings. In addition, with two independent systems each conveyance element could be evaluated on its own merits. Preliminary studies by the Corps indicate that a plan for conveyance of surplus water from southeastern to central Oklahoma for municipal and industrial use may presently be economically feasible and removal of the irrigation features could facilitate the planning for the Central Oklahoma Project (COP).

Although the Corps of Engineers' COP study is currently inactive, earlier COP studies formulated alternatives based on both 50 and 100-year planning horizons.

If a 50-year plan of development for central Oklahoma were implemented, the conveyance system would be designed for a much smaller capacity than the proposed system and probably would not require construction of the authorized Boswell Reservoir as a source of supply. In addition, utilization of underground pipelines rather than an open canal would probably be more cost-effective for a 50-year plan. If a 100-year plan of development were chosen, the conveyance system would be similar to the canal proposed in the southern system, but probably would be designed for a slightly smaller capacity and still require construction of Boswell Reservoir.

Projections indicate that existing water supplies for central Oklahoma, including Arcadia and McGee Creek Lakes currently under construction, will satisfy the area's water needs only until the mid-1990's. With the lead time necessary for planning, design and construction, it appears unlikely even if work resumed today, that the COP could be completed in time to forestall water shortages in central Oklahoma. Additional planning, authorization, design and construction of COP facilities would require at least 15 years, but considering the project's magnitude, 20 years would probably be a more realistic time period.

In the absence of a major water conveyance plan, it is anticipated that communities would independently implement smaller water import plans of a piecemeal and short-range nature. Such uncoordinated development would undoubtedly result in substantially higher costs than a regional conveyance system such as COP, which takes advantage of economies of scale.