OKLAHOMA COMPREHENSIVE WATER PLAN

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OKLAHOMA WATER RESOURCES BOARD

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FOREWORD

Just as an infinite number of possibilities exist for the utilization of water, so are there virtually countless approaches to water resources planning unless general guidance is outlined in advance. The democratic process charges the public with the ultimate responsibility for establishing these policy guidelines, which in turn are translated into specific objectives, thus giving the planning process the direction and momentum necessary to resolve identified problems.

To accomplish selected goals, rules are typically delineated through a series of legislative or administrative policy decisions. Such basic public policies are already set forth in some detail in existing law, primarily having come about in response to previously identified needs. However, planning for the future requires anticipating future problems, while at the same time realizing that problems can occur in the present. Recognition and resolution of major policy issues at the onset of detailed planning allows the planning process to concentrate on the preparation of alternatives which satisfy the goals and objectives in an acceptable fashion.

The Oklahoma Comprehensive Water Plan is designed to accomplish the water-related goals of the State of Oklahoma by setting forth for consideration by the Governor, the Legislature and the people of Oklahoma a strategy for the orderly control, protection, conservation, development and utilization of the state's water resources.

This publication, printed by Mercury Press, Inc., Oklahoma City, Oklahoma, is issued and published by the Oklahoma Water Resources Board as authorized by Title 82 O.S. 1974, §1086.2. Five thousand copies have been prepared at a cost to the taxpayers of the State of Oklahoma of $30,130.

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OKLAHOMA WATER RESOURCES BOARD

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The Honorable George Nigh
Governor of Oklahoma

Members of the Legislature
State of Oklahoma

Citizens of Oklahoma

It is with pleasure that the Oklahoma Water Resources Board submits for your consideration the Oklahoma Comprehensive Water Plan, an orderly, long-range strategy for managing the state's water resources.

Today Oklahoma is faced with the immense task of making critical decisions regarding the wisest use of its most precious natural resource, water. The Board, recognizing the importance of water to our state now and in the future, urges all governmental agencies to consider the construction of additional dams and lakes for the purposes of water storage, flood protection and hydroelectric power generation wherever feasible and practical.

The Board, also cognizant of its responsibility to the environment, urges the solemn stewardship of the state's water resources and the enhancement of the total environment for the benefit and enjoyment of future generations.

The Board concurs with the concern of many Oklahomans that eastern Oklahoma be assured an adequate water supply for industry, agriculture and human consumption, not only for the present, but also for the near and distant future. Such concerns played a pivotal role in the Plan's formulation.

In discharging its responsibility to plan for the development and protection of the state's waters, the Oklahoma Water Resources Board adopted the Oklahoma Comprehensive Water Plan on January 8, 1980. The Board urges the adoption of the Plan and implementation of the recommendations therein as a means of fulfilling all of Oklahoma's present and future water requirements through the year 2040.

GERALD E. BORELLI, Chairman

EARL WALKER, Vice-Chairman

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CHAPTER I
DEVELOPMENT OF THE OKLAHOMA COMPREHENSIVE WATER PLAN

PROBLEM AND PROPOSED SOLUTION

Oklahoma has prospered to a remarkable degree in the years since statehood, but the future is clouded by the unwelcome prospect of depletion of the state's natural resources. The need for responsible management of water, the most precious of these natural resources, grows more urgent every day as the state's expanding population places ever greater demands on limited available supplies.

Oklahoma has plenty of water within the state's boundaries to meet all future requirements, but such water is unevenly distributed. Eastern Oklahoma boasts an abundance of stream and ground water resources and rainfall, while western Oklahoma is threatened by droughts and frequently suffers severe water shortages. All areas of the state have at some time been subject to spot shortages caused by water quantity and/or quality problems.

Unless a viable plan for the management of her waters is implemented soon, Oklahoma's vibrant agricultural economy is expected to suffer damaging setbacks and the state's bright potential for further industrial development dim.

The Oklahoma Comprehensive Water Plan is intended to serve as a planning tool for formulation of policy guidelines for managing and developing Oklahoma's water resources. It is believed flexible enough to meet this end, yet rigid enough to provide a solution in itself. In whatever way it is used, immediate steps must be taken to ensure that Oklahoma continues to prosper and grow, and that all her citizens have good quality water in the quantities they need — for today and tomorrow.

AUTHORIZATION AND HISTORY

In 1957 the Oklahoma Legislature created the Oklahoma Water Resources Board, a water authority separate and distinct from precedent agencies, and awarded the Board general statutory authority to begin long-range water resource planning. Title 82 O.S. Supp. 1957, Section 1072(d) directed the Board "...to develop statewide and local plans to assure the best and most effective use and control of water to meet both the current and long-range needs of the people of Oklahoma, and to cooperate in such planning with any public or private agency, entity or person interested in water, and is directed to prepare such plans for consideration and approval by the Legislature."

Although the Oklahoma Water Resources Board had early authority to prepare such plans, limited staff and appropriations impeded this task until 1965, when Congress passed the Water Resources Planning Act (PL 89-80: 70 Stat. 244), which provided grants to states for the specific purpose of preparing state water plans. Pursuant to this act, the Oklahoma Water Resources Board prepared 11 reports which comprise the foundation of the Oklahoma Comprehensive Water Plan. These reports, the "Appraisal of the Water and Related Land Resources of Oklahoma," contained extensive assessments of the hydrologic, economic, geologic and social characteristics of each of the planning regions. Local water problems were identified, and potential water development projects to meet future water needs were outlined.

Upon completion of the regional appraisals, further planning was initiated to compile those reports into a truly statewide plan. In 1974 Senate Bill 510 gave specific statutory authority to the Oklahoma Water Resources Board "to prepare a comprehensive state water plan...including feasibility and cost studies on designated projects within the plan and on the plan itself, for submission to the Legislature...

"Said plan (for 33 southern counties) shall include findings and conclusions for an investigation to determine the economics and engineering feasibility for the development of the land, water and related resources of all proposed projects...(and) shall be of sufficient detail to serve as a basic document for securing legislative authorization. For the balance of the state, the plan shall include office studies of existing data and sufficient reconnaissance field surveys, to indicate whether further detailed investigations are justified, and if so, the scope of such investigations."

Phase I of the Oklahoma Comprehensive Water Plan was developed to meet the projected water needs of southern Oklahoma through the year 2030. It emphasized Oklahoma's southern 33 counties because of the immediate water needs of central Oklahoma and the wealth of information available for the Red River Basin. Phase I featured an interconnected system designed to convey 1.3 million acre-feet of surplus water from southeastern Oklahoma to water-deficient central and southwestern areas of the state. It proposed a network of canals, pipelines, conduits and pumping plants for the conveyance of 487,000 acre-feet of water per year to central Oklahoma for municipal and industrial purposes, and 821,000 acre-feet per year to southwestern Oklahoma, primarily for irrigation.

Phase I of the Oklahoma Comprehensive Water Plan was submitted to the Legislature in 1975, and the Board received further funding to prepare a similar plan for the northern 44 counties through the year 2040. Using legislative appropriations of approximately $100,000 per year, the Board, with assistance from federal, local and other state agencies, continued development of a state water plan.

In September 1977, the Oklahoma Water Resources Board published an Interim Report on the Plan providing preliminary information on the northern 44 counties and evaluating potential funding mechanisms for implementing a state water plan.

During the next two years, the Board's Planning Division worked closely with federal planners to complete hydrologic, economic, engineering and environmental studies necessary to produce a truly comprehensive statewide plan.

Since the authorizing legislation required feasibility and cost studies on projects within the Plan, projects and facilities included in the Regional Plans of Development and those in the conveyance system fulfill this mandate. It should be emphasized that the Oklahoma Comprehensive Water Plan does not advocate redistribution of surplus water to water-deficient areas until and unless additional studies demonstrate the feasibility of such redistribution to the satisfaction of the Governor, the Legislature and the citizens of Oklahoma.

PARTICIPATION

Preparation of a plan as immense in scope as the Oklahoma Comprehensive Water Plan required the expertise of individuals of diverse academic disciplines and the efforts of those at all levels of government. In the initial phase of development, state agencies including the Employment Security Commission, Wildlife Conservation Department, Department of Agriculture as well as the substate planning districts provided data helpful in assessing current water supplies and projecting future water requirements.

As the Plan evolved, the Oklahoma Water Resources Board, along with several federal agencies authorized and funded by Congressional action, became the principal participants in the Oklahoma Comprehensive Water Plan Planning Committee.

The U.S. Army Corps of Engineers has been involved in major water projects in Oklahoma for over 20 years, but the Water Resources Development Act of 1974 first authorized the Corps of Engineers to cooperate with the states in the preparation of plans for the development, utilization and conservation of water and related resources of drainage basins within each state. The Act authorized annual appropriations up to $2 million, and limited funding to $200,000 per state per year.

Among recent water resource planning activities of the Corps are the Central Oklahoma Project (COP) and the Tulsa Urban Study, two investigations significant in the development of the Plan. Planning efforts on the Central Oklahoma Project were initiated over 20 years ago to develop plans to meet the growing municipal and industrial needs of the Oklahoma City metropolitan area. One COP alternative considered was the use of a pipeline to bring surplus water from southeastern Oklahoma to central Oklahoma, a modification of which is included in the Oklahoma Comprehensive Water Plan.

The Tulsa Urban Study is a comprehensive assessment of numerous water resource problems facing Tulsa and the surrounding area. Although vast amounts of stream water are available, much of it is allocated to hydropower generation, and poor quality renders other waters unacceptable for municipal and industrial use. Preliminary information from the study, which is scheduled for completion in 1981, has been incorporated in this Plan. Alternative plans are presently being investigated for meeting regional needs for flood control and floodplain management, recreation, fish and wildlife conservation, navigation, bank stabilization and water supply, with the latter being of particular importance to the Oklahoma Comprehensive Water Plan.

The Bureau of Reclamation participated in the Plan under the general authority of the Federal Reclamation Laws with funds appropriated pursuant to special write-in requests from the Oklahoma Congressional delegation.

In 1966 the Bureau published a reconnaissance appraisal of Oklahoma's water needs entitled, "Water, the Key to Oklahoma's Future." This report presented 100-year water demand projections for Oklahoma, and proposed an extensive water distribution system to carry surplus water from eastern Oklahoma to central and western areas of the state. Major elements of this report were utilized in the present Plan.

The United States Department of Agriculture participated in the Plan's formulation under the authority of Public Law 83-566, as amended. The United States Senate, in a report prepared by the Committee on Appropriations regarding USDA's Environmental and Consumer Protection Bill, directed the Soil Conservation Service to cooperate with the Oklahoma Water Resources Board in developing a comprehensive state water plan to the extent allowed by available funds.

The Soil Conservation Service has funded continuing programs of soil and water conservation throughout the state, with SCS multipurpose structures having long provided protection from floods as well as affording municipal, industrial, irrigation and recreation water supplies in Oklahoma. Optimum utilization of such multipurpose structures is an integral component of the Plan.

The United States Geological Survey, principally a data-gathering agency, also has long provided support to the state with its stream and ground water data-gathering and analysis efforts. Its participation in the planning effort was provided by annual matching fund cooperative agreements with the Board.

All water-related planning studies by federal agencies must include an analysis of a proposed project's environmental impacts. Such analysis includes an assessment of potential adverse effects on critical habitats of fish and wildlife, as well as the project's environmental enhancement features. The United States Fish and Wildlife Service made valuable contributions in evaluating potential environmental impacts of the projects proposed in the Oklahoma Comprehensive Water Plan.

Local participation was achieved primarily through the 11 substate planning districts which assisted in developing projections of local population growth and future water requirements. Meetings were held throughout the state in the early stages of the Plan's development to solicit input for use in the formulation of the Plan. Later meetings focused on the eastern Oklahoma substate

planning districts in order to ensure area of origin water needs were adequately provided for.

The Oklahoma Water Resources Board also received input from the Economic Resources Development Association (ERDA), a 24-county organization formed to promote the development of economic, social and industrial potential in eastern Oklahoma. All of ERDA's comments were considered, and where appropriate, incorporated in the Plan.

Many other local, state, regional and federal agencies, boards and commissions provided information in development of the Plan, and still more organizations have an interest or responsibility in water resources or related programs. Appendix C, Figures 6-9, lists those agencies and organizations, defines their functions and summarizes their water-related responsibilities.

GOALS AND OBJECTIVES

Most states have two major goals regarding water resources development; one being the promotion of economic development, and the other, the preservation and enhancement of environmental resources. Although diverse in nature, both goals can be achieved through proper planning. The Oklahoma Water Resources Board has carefully weighed both goals in preparing this Plan, seeking to achieve optimum social and economic growth while at the same time minimizing adverse environmental influences.

The alignment of goals and objectives with established policy guidelines is particularly important in water resources management and development. These goals must be considered both individually and as they may relate to each other for Oklahoma's water resources to be utilized to their maximum potential and to the benefit of all Oklahomans.

From inception through completion, the following goals (which are not listed in order of importance) shaped the Oklahoma Comprehensive Water Plan:

(1) Promotion of economic opportunity and development;
(2) Preservation and enhancement of the environment;
(3) Protection of lives and property from floods;
(4) Expansion of agricultural production and agribusiness activity;
(5) Development of recreational potential;
(6) Maintenance and improvement of water quality;
(7) Encouragement of conservation;
(8) Beneficial use of excess and surplus water; and
(9) Encouragement of and provision for public participation in water resource planning.

POLICIES AND PLANNING GUIDELINES

The Plan to be a Flexible Guide

In order for planning to serve its intended purpose effectively, it must be a dynamic process, reflecting a multitude of economic and social conditions. This characteristic is vitally important to water resource planning, where water demands correlate to residential, commercial and industrial growth, which in turn determine a community's overall economic and social appeal. A plan intended to meet future water needs cannot be "cast in concrete," but rather must remain flexible enough to accommodate events which could cause demands or supplies to vary from those projected.

The Oklahoma Comprehensive Water Plan is designed to meet anticipated water demands through the year 2040, which demands were developed utilizing historical economic and population data. It must be acknowledged that when working toward a 50 to 60-year planning horizon projected needs may or may not occur, thus requiring any plan be updated continuously if it is to remain responsive to changing water needs.

The Plan is intended to and is only capable of serving as a strategy for managing Oklahoma's water resources. Alterations in economic conditions, water requirements, federal and state legislation, and the state of the nation and the world will influence the specific provisions of the Plan as it evolves over the years.

Stream Water Development

Oklahoma's policy regarding surface water development is addressed in 82, O.S. Supp. 1979, Section 1085.31, which states: "It is hereby declared to be the policy of the State of Oklahoma to encourage and promote the optimum development and utilization of all feasible reservoir sites or areas within this state which may be suitable and usable for the conservation storage of the waters of this state by the construction or enlargement of dams, reservoirs or other structures." and further that: "Water management in Oklahoma requires the storage of water during periods of surplus supply for use during periods of short supply" (and) "...it is imperative that the reservoir sites be developed to the full potential of the site and the net water yield of the drainage area after all present and future needs and beneficial uses of water are satisfied above said site. The conservation of soil and water in Oklahoma requires the continuation of watershed protection and flood prevention programs on an accelerated priority basis with consideration given to future water needs of the area."

Reservoirs are constructed for a variety of purposes with large federal reservoirs typically being authorized and accruing benefits for six or seven purposes, and smaller structures sometimes being authorized for only a single purpose.

The purposes for which a reservoir is constructed largely depend on the needs of the area in which it is to be located. In many cases, an area will experience not a single water-related problem, but several, so most reservoirs of recent construction are authorized to fulfill as many purposes as are engineeringly and economically feasible. Certain purposes with nonvendible benefits, such

as flood control, fish and wildlife enhancement, recreation and water quality control, are regarded as beneficial to the national interest, and thus are authorized as purposes complementary to revenue-producing purposes. Numerous existing single-purpose structures have a potential for expansion and modification to accommodate additional purposes in order that their beneficial uses can be maximized.

It makes sound economic and engineering sense to design and construct a reservoir to a dam site's maximum potential capacity, which is normally determined by the stream's drainage area. In these times of escalating prices of land and the increasing scarcity of suitable dam sites, reservoirs must be planned for eventual development to their maximum capacity. When it is not economical to initially build facilities to optimum limits, development should be planned to accommodate subsequent enlargement.

In accordance with existing Oklahoma law, the Plan assumes development to maximum capacity of all of western Oklahoma's existing and potential reservoirs prior to the importation of water from another area.

The necessity of utilizing storage reservoirs is made clear by analyses of historical streamflow records. Such records indicate that there are periods when stream water of adequate quality is not available in most of Oklahoma's streams on a dependable basis. (Dependable basis for municipal water supply is defined as water available 98 percent of the time.) Therefore, storage must be provided to capture water when it is available for utilization when it is not. Thus, direct diversion from streams is not a viable alternative and was not included in either the regional plans or the statewide plan unless dependable storage in upstream reservoirs was provided for.

Area of Origin Protection and Excess and Surplus Water

The policies of the state regarding area of origin protection and utilization of surplus water were major considerations in the development of the Oklahoma Comprehensive Water Plan. The Plan presupposes that no transfer of water from any area will be considered unless and until all the reasonably foreseeable future water needs of such areas are assured.

Area of origin protection is provided twice in the Oklahoma Statutes. Title 82, O.S. Supp. 1972, Section 105.12 reads in pertinent part: "In the granting of water rights for the transportation of water for use outside the stream system wherein water originates, applicants within such stream system shall have a right to all of the water required to adequately supply the beneficial needs of the water users therein. The Board shall review the needs within such area of origin every five (5) years." Also, 82 O.S., Supp. 1974, Section 1086.1 states in part that, "Only excess and surplus water should be utilized outside of the areas of origin and citizens within the areas of origin have a prior right to water originating therein to the extent that it may be required for beneficial use therein." These sections make it abundantly clear that it is the mandatory duty of the Board to provide for the needs of an area of origin first, and to review such needs on at least a 5-year basis. It is thus apparent that any future growth in the water requirements of eastern Oklahoma is specifically provided for and protected by existing law.

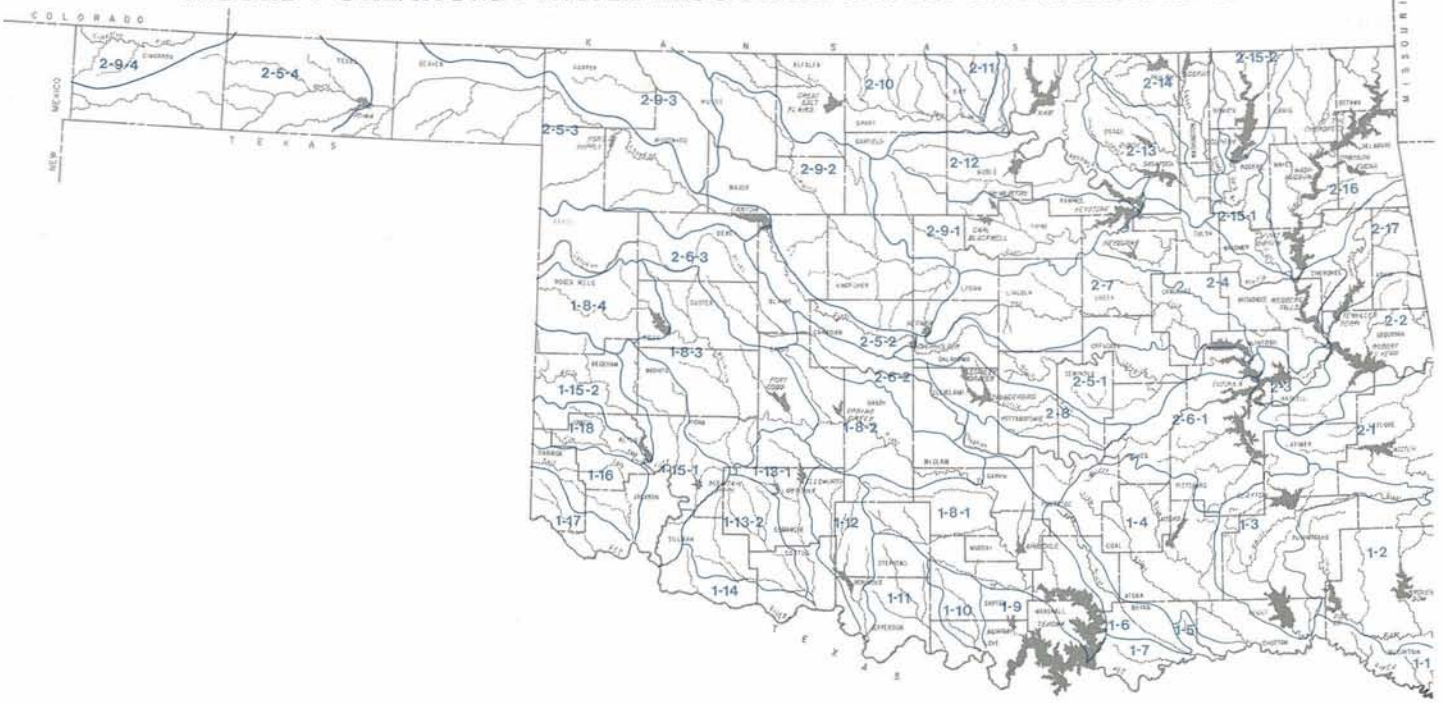
Defining the terms "excess or surplus water" and "area of origin" has been a difficult and controversial issue in Oklahoma. Numerous definitions have been proposed, not only by the Board, but in provisions of various bills which were considered by the 36th and 37th Oklahoma Legislatures. The Oklahoma Water Resources Board believes the definitions and explanations presented below, when viewed in the context of existing legislation, adequately insure that the future water needs of areas of origin will be satisfied prior to any diversion of water for use outside such areas.

Excess or surplus water is defined in part in the Oklahoma Water Resources Board's "Rules, Regulations and Modes of Procedure, 1979 Revision," as follows: "'Excess or surplus water' shall mean that amount of water which is greater than the present or reasonably foreseeable future water requirements needed to satisfy all beneficial uses within an area of origin."

The term "reasonably foreseeable" in this definition has, for purposes of the Oklahoma Comprehensive Water Plan, been considered to be 50 years. The 50-year period was chosen not only because it represents the planning horizon used in the development of the Oklahoma Comprehensive Water Plan, but also because it is consistent with the present state of the art in population and water requirement forecasting, i.e., it marks the outer limits of reliable forecasting capabilities.

In regard to the term "area of origin", the Oklahoma Statutes provide as follows: "The Oklahoma Water Resources Board shall, from time to time as may be necessary for the economical and satisfactory apportionment of the water, divide the state in conformity with the drainage areas, into water districts to be designated by name and to comprise, as far as possible, one or more distinct stream systems in each district. The districts may be changed from time to time as may in its opinion by necessary for the economical and satisfactory apportionment of the water." (82 O.S. Supp. 1972, Section 1085.3). Under the provisions of this statute the Oklahoma Water Resources Board in 1963 divided the state's two major river basins, the Arkansas and Red River Basins, into 35 subdivisions or stream systems. The original 35 stream systems have recently been expanded to 49 as shown in Figure 1 , with seven of the larger original stream systems being subdivided into 14 smaller units in order to provide better regulation and management of the state's stream water resources. These stream sytems are the basic hydrological units which

FIGURE 1 OKLAHOMA WATER RESOURCES BOARD STREAM SYSTEMS



RED RIVER AND TRIBUTARIES

Stream System	
1-1	Main stem from Arkansas state line to mouth of Kiamichi River
1-2	Little River
1-3	Kiamichi River
1-4	Muddy Boggy River
1-5	Main stem from mouth of Muddy Boggy to mouth of Blue River
1-6	Blue River
1-7	Main stem from mouth of Blue River to mouth of Washita River
1-8-1	Washita River from the confluence with the Red River to USGS Gage Number 07328500 just west of Pauls Valley.
1-8-2	Washita River from the USGS Gage Number 07328500 just west of Pauls Valley to USGS Gage Number 07326500 near Anadarko.
1-8-3	Washita River from the USGS Gage Number 07326500 near Anadarko to Foss Dam
1-8-4	Washita River from Foss Dam to Texas state line
1-9	Main stem from mouth of Washita River to mouth of Walnut Bayou
1-10	Walnut Bayou
1-11	Mud Creek
1-12	Beaver Creek
1-13-1	Cache Creek and Red River between the mouths of Beaver and Cache Creeks
1-13-2	Deep Red Run and West Cache Creek to the confluence with Cache Creek
1-14	Main stem from Cache Creek to North Fork Red River
1-15-1	North Fork Red River from the confluence with the Red River to Altus Dam near Lugert
1-15-2	North Fork Red River from Altus Dam near Lugert to the Texas state line
1-16	Salt Fork Red River
1-17	Prairie Dog Town Fork Red River
1-18	Elm Fork Red River

ARKANSAS RIVER AND TRIBUTARIES

Stream System	
2-1	Poteau River
2-2	Main stem from Arkansas state line to mouth of Canadian River
2-3	Canadian River from mouth, to mouth of North Canadian River
2-4	Main stem from mouth of Canadian River to Keystone Dar
2-5-1	North Canadian River from the confluence with the Canadian River to the diversion dam at Lake Overholser
2-5-2	North Canadian River from the diversion dam at Lake Overholser to Canton Dam
2-5-3	North Canadian River from Canton Dam to Optima Dam
2-5-4	North Canadian River from Optima Dam to the New Mexic state line
2-6-1	Canadian River from the mouth of the North Canadian Riv to the mouth of Walnut Creek near Purcell
2-6-2	Canadian River from the mouth of Walnut Creek near Purc to the USGS Gage Number 07228500 near Bridgeport
2-6-3	Canadian River from the USGS Gage Number 07228500 ne Bridgeport to the Texas state line
2-7	Deep Fork River
2-8	Little River
2-9-1	Cimarron River from its mouth to the USGS Gage Number 07160000 near Guthrie
2-9-2	Cimarron River from the USGS Gage Number 07160000 ne Guthrie to the USGS Gage Number 07158000 near Way
2-9-3	Cimarron River from the USGS Gage Number 07158000 ne Waynoka to the Kansas state line
2-9-4	Cimarron River from the Colorado state line to the New Mexico state line
2-10	Salt Fork Arkansas River
2-11	Chikaskia River
2-12	Main stem from Keystone Dam to Kansas state line
2-13	Bird Creek
2-14	Caney River
2-15-1	Verdigris River from mouth to Oologah Dam
2-15-2	Verdigris River from Oologah Dam to the Kansas state line
2-16	Grand (Neosho) River
2-17	Illinois River

the Board utilizes in managing and accounting for the stream water resources of the state. They are utilized in reviewing the needs of an area of origin as required under 82 O.S. Supp. 1972, Section 105.12 quoted previously.

In view of "area of origin" being used interchangeably with "stream system" in Section 105.12 and the fact that the Board has established and is using 49 designated stream systems in administering the stream water laws of the state, it is clear that the designated stream systems are the statutorily referenced "areas of origin". As an additional assurance to eastern Oklahoma, various mechanisms have been proposed to provide compensation to areas of origin. Of these, payment in lieu of taxes to local governments appears to be the most appropriate, with existing statutes already providing for such compensation. Title 82 O.S. Supp. 1974, Section 1086.1 further states in part that: "In such cases where storage in the area of origin may be permitted, the purchasing entities shall pay to the county of origin, in lieu of ad valorem taxes and as part of the total cost of the purchase of the water, an amount computed by averaging the tax on land similar to the land taken off the tax rolls as a result of the construction of such storage facilities within the county of origin." This law is quite similar to existing federal "payments in lieu of taxes" provided by Public Law 94-565 which requires the Bureau of Land Management of the Department of Interior to make payments over a 5-year period to local units of government (counties) to help alleviate the financial burdens created by federal ownership of tax-free lands upon which ad valorem taxes cannot be collected by reason of such ownership. Compensation to the area of origin will be further examined in the Board's continued planning activities to insure that a policy is provided for adequate and equitable protection to the area of origin.

Water Quality

Regarding water quality, 82 O.S. Supp. 1972, Section 926.2 states: "Whereas the pollution of the waters of this state constitutes a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life, and impairs domestic, agricultural, industrial, recreational and other legitimate beneficial uses of water..., it is hereby declared to be the public policy of this state to conserve the waters of the state and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses; to provide that no waste be discharged into any waters of the state without first being given the degree of treatment necessary to protect the legitimate beneficial uses of such waters; to provide for the prevention, abatement and control of new or existing water pollution; and to cooperate with other agencies of this state, agencies of other states and the federal government in carrying out these objectives."

Pursuant to this declaration, the Oklahoma Water Resources Board promulgates Oklahoma's Water Quality Standards which are the basis upon which all the state's water quality regulation and planning activities are predicated.

As important as assessing the quantity of available water supplies is in the design of a comprehensive water plan, the task of supplying all of the state with water of high quality is just as important. To assure high quality water supplies an intricate balance must be maintained between influences on quality such as runoff, climate, geology, urban and rural development, vegetation and natural and man-made pollution. Waters of poor quality have not been considered in the Plan for use either in areas of origin or for conveyance to water-deficient areas.

The anti-degradation policy included as part of the Oklahoma Water Quality Standards protects all waters from degradation in quality, and declares that existing instream water uses shall be maintained and protected.

The beneficial uses assigned to Oklahoma streams include public and private water supplies, emergency public and private water supplies, fish and wildlife propagation, agriculture (livestock watering and irrigation), hydroelectric power generation, industrial and municipal cooling water, primary body contact recreation, secondary body contact recreation, navigation, aesthetics, smallmouth bass fisheries and trout fisheries. The standards serve as a reference in determining the designated beneficial uses of a specific stream and set numerical and descriptive limits on the waters intended for each beneficial use.

The Clean Water Act (PL 92-500) decrees that "where attainable" all waters in the United States shall be fishable and swimmable by July 1, 1983, and that the discharge of pollutants into the nation's lakes and streams shall cease by 1985. Section 208 of the Act requires that Oklahoma and all the states develop plans to achieve these goals. Accordingly, Oklahoma's 208 Areawide Waste Treatment Management Plan divided the state into 59 segments, whose quality characteristics were discussed in seven basin plans describing man-made pollution problems within each basin by categorizing discharges as point or nonpoint sources.

Point sources are basically of two types, municipal and industrial, with municipal discharges attributed to wastewater treatment plants and industrial discharges to private enterprise. The quantity and nature of point source discharges are regulated through the issuance of wasteload discharge permits and subsequent monitoring to assure compliance with such permits. One of the goals of the 208 Areawide Waste Treatment Management Plan is to assure appropriate wasteload allocations in order to protect the beneficial uses assigned to the state's waters. Reasonable wasteload allocations facilitate the

writing of permits that are practical and enforceable.

Nonpoint sources are categorized into rural and urban pollution, with rural pollution caused primarily by agricultural and silvaculture practices. The Oklahoma Water Resources Board's approach to solving nonpoint source rural pollution problems will be to emphasise a nonregulatory program aimed at controlling such pollution.

Urban nonpoint sources are primarily due to stormwater runoff — that water from a recent rainfall which moves over natural or manmade terrain, accumulating pollutants in its course. Urban pollutants include litter, nutrients, pesticides, salts, heavy metals and oil and grease, all of which affect the quality of nearby streams and lakes. Although regulatory measures are not considered necessary at this time, it would appear in the state's best interest for Oklahoma's cities and towns to voluntarily initiate stormwater runoff controls.

Since the 208 Areawide Waste Treatment Management Plan is an ongoing effort, any additional problems identified will be considered in subsequent revisions of the Oklahoma Comprehensive Water Plan.

Scenic Rivers

The Legislature enacted the Scenic Rivers Act (82 O.S. Supp. 1979, Section 1452, et seq.) to preserve and protect the natural aesthetic beauty of designated streams. Sections 1452 and 1453 of the Act contain the following language: "The Oklahoma Legislature finds that some of the free-flowing streams and rivers of Oklahoma possess such unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values of present and future benefit to the people of the State that it is the policy of the Legislature to preserve these areas for the benefit of the people of Oklahoma. Once an area is designated as a 'scenic river area', it is an expression of legislative intent that the stream or river in the area designated be preserved in its free-flowing condition and that the stream or river shall not be impounded by any large dam or structure except as specifically authorized by the Legislature..."

As important as preserving the natural beauty of Oklahoma's "scenic rivers" is protecting the water quality. Pollution of streams designated as "scenic rivers" is specifically prohibited by the anti-degradation policy included as part of Oklahoma's Water Quality Standards. Such streams are protected by prohibition of any new point source discharge of wastes or an increased load from an existing point source at the time of the standards' adoption.

Each of the state's six streams designated as "scenic rivers" are located in eastern Oklahoma. They are the Illinois and Upper Mountain Fork Rivers and Flint, Barren Fork, Big Lee and Little Lee Creeks. Such designation precludes any federal, state or local governmental agency from constructing a dam on the stream without legislative consent, but local communities can build such reservoirs as may be necessary to supply municipal and domestic needs, as long as the structure will not significantly interfere with the preservation of the stream as a scenic, free-flowing stream.

In recognition of these restrictions on scenic rivers, the Oklahoma Comprehensive Water Plan does not propose to impound water on these streams. However, if a municipality located in the counties or in the immediate vicinity of the scenic river area should become interested in developing a reservoir site on any of the six streams, and appropriate legislative authorization were obtained, the Plan could be modified to incorporate such a source.

Environmental Considerations

The Fish and Wildlife Service of the U.S. Department of the Interior has cooperated with the Oklahoma Water Resources Board in the Plan's development in order to ensure the preservation and enhancement of the state's fish and wildlife resources. Although reservoir and canal construction may in some instances be expected to adversely affect local fish and wildlife, conscientious efforts have been made to minimize these effects through appropriate mitigation procedures. To further minimize these effects, downstream releases to maintain suitable streamflows and provide enhanced habitat are planned for as many reservoirs as feasible.

Broad environmental considerations must be assigned high priority in the development of any major water resource project, especially one of the scope of the Oklahoma Comprehensive Water Plan. To assess the environmental impact of the proposed water conveyance system, the Fish and Wildlife Service cooperated closely with the Planning Committee. Parameters evaluated included loss of scarce habitat, reduction in habitat diversity, loss of wetlands, impact on unique Oklahoma fauna, loss of stream fisheries and effect on existing wildlife areas. Preliminary estimates of mitigation/compensation needs have been developed and are included.

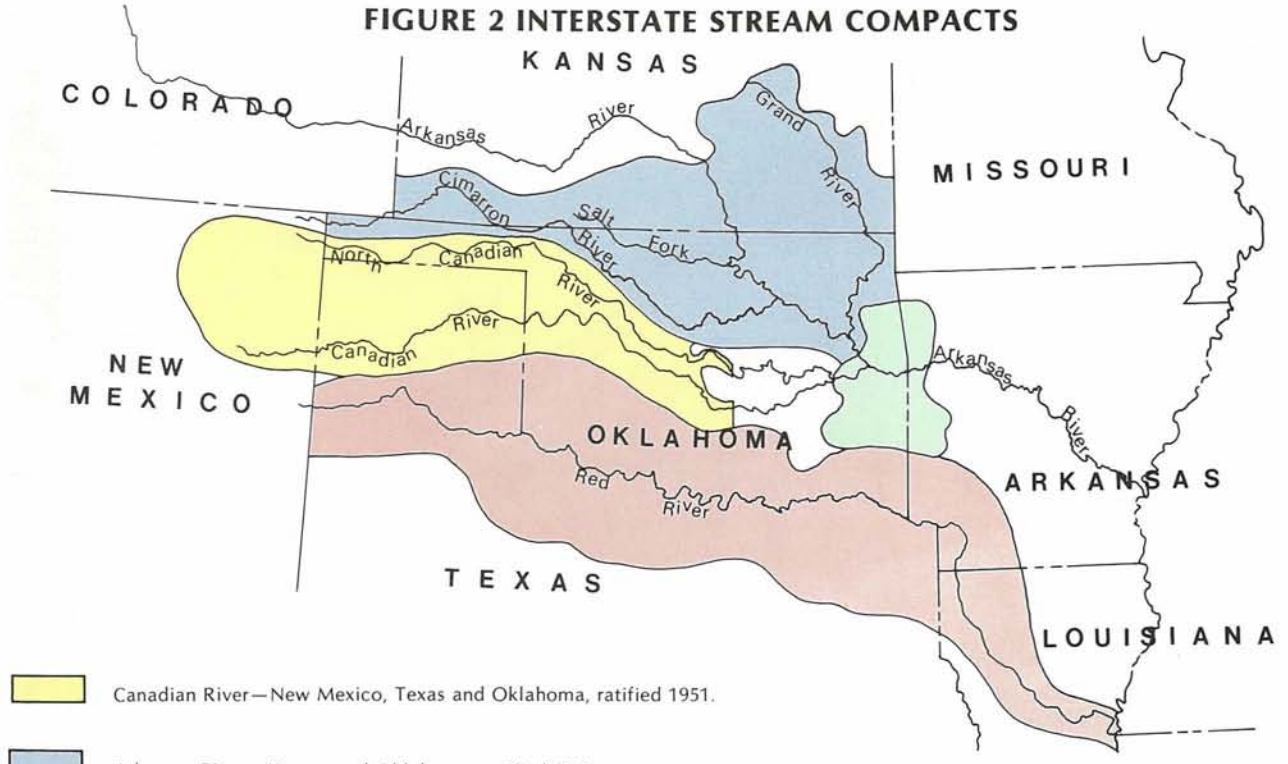
Due to the level of the planning involved in the preparation of the Plan, an environmental impact statement is not required or included. As more detailed planning continues, environmental damages at specific reservoirs and along the proposed distribution canals will be considered more thoroughly so potential adverse effects can be minimized.

Interstate Waters and Stream Compacts

An important consideration in assessing the available water of any area must be those interstate waters apportioned to the signatory states through interstate stream compact agreements. By virtue of four such compacts authorized by Congress, Oklahoma and its neighboring states share in the waters of the Canadian, Arkansas and Red Rivers. See Figure 2.

The Canadian River Compact involving the States of Oklahoma,

FIGURE 2 INTERSTATE STREAM COMPACTS



Canadian River—New Mexico, Texas and Oklahoma, ratified 1951.

Arkansas River—Kansas and Oklahoma, ratified 1966.

Arkansas River—Arkansas and Oklahoma, ratified 1973.

Red River—Arkansas, Louisiana, Texas and Oklahoma, ratified by respective states.

Data—Oklahoma Water Resources Board
Mapping—Oklahoma Water Resources Board

Texas and New Mexico was ratified by Congress in 1951, and apportions the waters in the Canadian and North Canadian River Basins among the states on the basis of conservation storage limitations.

The Arkansas River and its major tributaries are compacted in two separate agreements. The Arkansas River Compact between Oklahoma and Kansas was ratified by Congress in 1966, and includes the basins of the Cimarron River, the Salt Fork of the Arkansas River, the main stem of the Arkansas from its confluence with the Grand (Neosho) River to the Little Arkansas River in Kansas and the Verdigris and Grand (Neosho) Rivers. The compact divides the water by limiting reservoir conservation storage capacities and sets appropriate limits on new storage for each tributary, as well as on the main stem of the Arkansas.

The Arkansas River Compact between Oklahoma and Arkansas was ratified by Congress in 1973, and apportions waters of the Arkansas River and its tributaries from Fort Smith, Arkansas, to the Arkansas' confluence with the Grand (Neosho) River at Muskogee. This compact allots the water according to streamflow, rather than reservoir storage capacities.

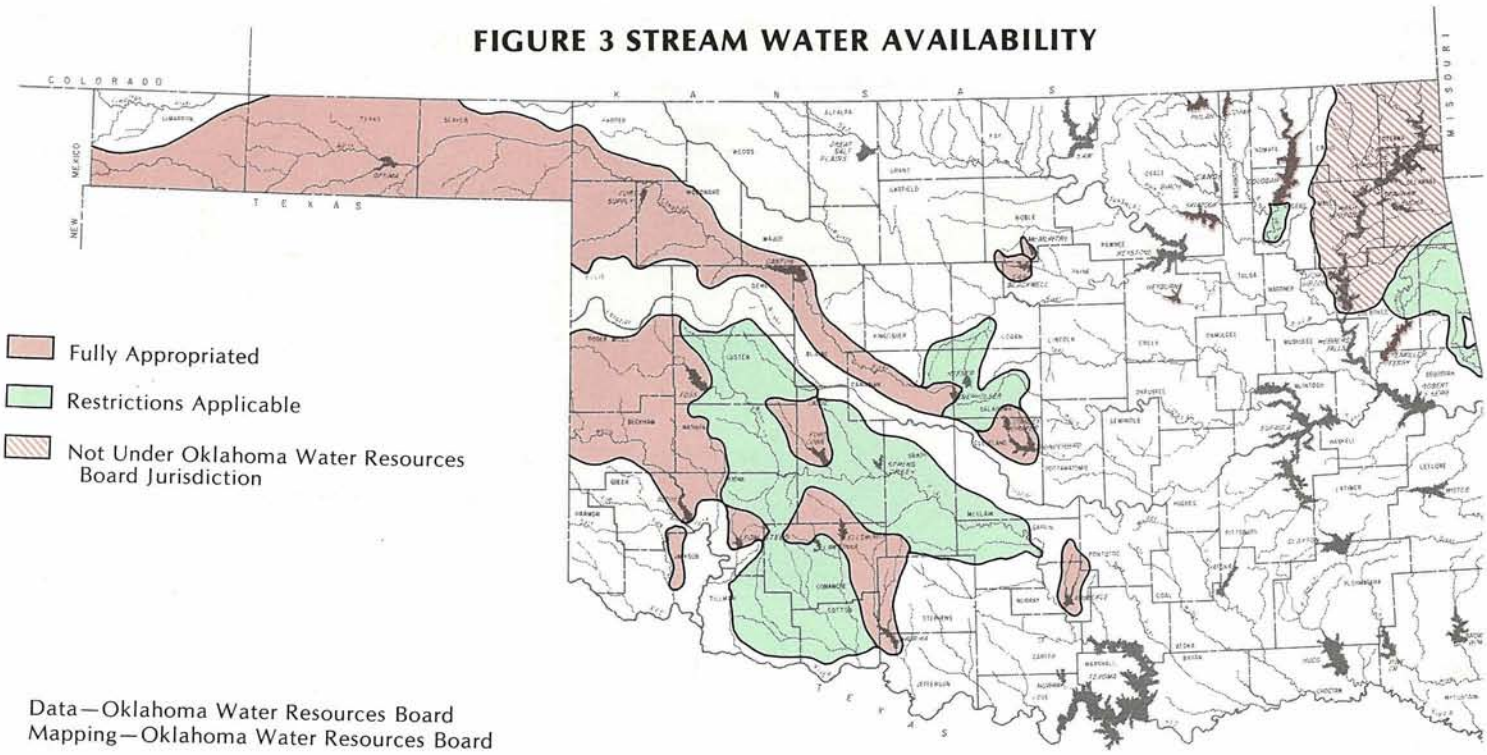
For 23 years compact commissioners representing Oklahoma, Arkansas, Louisiana and Texas worked toward an agreement apportioning the waters of the Red River and its tributaries. Finally, on May 12, 1978, Oklahoma signed its fourth and final interstate stream compact, an agreement dividing the waters of the Red River Basin, primarily according to streamflow allocations. The Red River Compact has been approved by all four states' legislatures and awaits ratification by Congress and approval by the President in order to become final.

Grand River Dam Authority

A special consideration in the development of the Oklahoma Comprehensive Water Plan was exemption of the waters of the Grand (Neosho) River Basin from consideration by the Oklahoma Water Resources Board in developing water conveyance plans under the provisions of 82 O.S. Supp. 1974, Section 1086.6.

The Grand River Dam Authority was established as a state agency in 1935 with authority to control, store and preserve the river and to use, distribute and sell the waters of the Grand (Neosho) River and its tributaries to the point of confluence with Fort Gibson Dam, but has no jurisdiction below the dam. See Figure 3.

FIGURE 3 STREAM WATER AVAILABILITY



Data—Oklahoma Water Resources Board
Mapping—Oklahoma Water Resources Board

No water from the Grand River can be considered for out-of-basin transfer or for use outside the basin of origin until such water has passed through Fort Gibson Dam. However, for the Plan to be a comprehensive assessment of all the state's water resources, the Oklahoma Water Resources Board has included inbasin studies and water distribution plans for the 24-county area under the jurisdiction of the Grand River Dam Authority.

Ground Water Development

Title 82, O.S. Supp. 1972, Section 1020.2 presents the policy of the state regarding Oklahoma's ground water resources by stating: "It is hereby declared to be the public policy of this State, in the interest of agricultural stability, domestic, municipal, industrial and other beneficial uses, general economy, health and welfare of the State and its citizens to utilize the ground water resources of the State, and for that purpose to provide reasonable regulations for the allocation for reasonable use..."

Although ground water is considered the property of the landowner, the Oklahoma Water Resources Board is authorized to regulate rates of withdrawal in order to conserve and protect limited ground water resources and ensure their equitable allocation.

Interbasin Transfer of Ground Water

While ground water offers an excellent source for certain local municipal, industrial and agricultural water supplies, it is not a practical or viable option as a source for large-scale transfer. Besides being impracticable, its use for transfer would be antithetical to the philosophy of the Oklahoma ground water law, which recognizes ground water as being the private property of the overlying landowner. The maximum annual yield of each ground water basin in the state is allocated to each acre of land overlying the basin. The cost of obtaining ground water rights from the multitude of landowners overlying a basin or basins would be enormous, and a network of feeder lines connecting each well to the primary conveyance system and the easements required for such lines would substantially add to such cost.

Studies to date show that no single ground water basin in the state has sufficient storage capacity, recharge rates and maximum annual yield (aquifer characteristics) to maintain the sustained pumping requirements necessary to produce the quantities of water required to meet the projected future water supply deficits of central and western Oklahoma. A combination of two or more high-yielding basins possibly could provide the quantities necessary, but these basins are situated in central and eastern parts of the state, thus requiring approximately the same amount of conveyance pumping as stream waters from eastern Oklahoma, with additional costs for pumping lifts ranging from a minimum of 200 feet to a maximum of 2,000 feet for bringing the ground water to the surface. Such additional pumping cost would be substantial.

The combination of these negative factors convinced the Planning Committee that transfer of ground water was not a viable option and further study was not warranted.

Sale of Water Across State Lines

The question of the sale and transport of water across state lines has generaged controversy both in

Oklahoma and surrounding states. In this regard, Oklahoma statutes provide specific guidance in two different places. Title 82 O.S. Supp. 1972, Section 1085.2 provides that no contract shall be made conveying the title or use of any waters of the state to any person, firm, corporation or other state or subdivision of government, unless the contract is specifically authorized by the Legislature.

Such contracts are authorized by 11 O.S. 1977, Section 37-127, which provides that an incorporated municipality of an adjoining state may own a reservoir in Oklahoma, albeit only under extremely limited circumstances.

A plain reading of these sections renders the inescapable conclusion that there are substantial limitations and conditions under which water may be used, transported or sold outside Oklahoma.

Conservation

Recognizing the increasing demand on Oklahoma's renewable natural resources, the Oklahoma Legislature emphasized the importance of conservation in 82 O.S. 1971, Section 1501-102: "...it is hereby declared to be the policy of the State of Oklahoma to provide for the conservation of the renewable natural resources of this state, and for the control and prevention of soil erosion, and for the prevention of floodwater and sediment damages, and for furthering the conservation, development, utilization and disposal of water, and thereby to preserve and develop natural resources, control floods, conserve and develop water resources and water quality, prevent impairment of dams and reservoirs, preserve wildlife, preserve natural beauty, promote recreational development, protect the tax base, protect public lands and protect and promote the health, safety and general welfare of the people of this state." To implement this policy the Legislature created conservation districts as a primary local unit of government responsible for the conservation of renewable natural resources.

Although water conservation in agriculture, municipal, industrial and domestic usage allows limited supplies to last longer, it simply delays the need for additional water supplies in water-deficient areas. It does not in itself create any new supply of water. The Plan recognizes the significance of a state conservation program and includes a guide to water conservation in Chapter III.

Special-Purpose Districts

Special-purpose districts — master conservancy, irrigation, weather modification and rural water districts — are local legal entities authorized to distribute, regulate, contract and pay for water used for municipal, industrial and irrigation purposes. These districts often serve the function of supplying water to areas that would otherwise be deprived of adequate supplies.

Since special-purpose districts will aid in distributing the additional water supplied by the conveyance system and in providing repayment through assessment of district participants, their role will assume even greater importance upon implementation of the Plan.

Indian and Federal Reserved Water Rights

The Oklahoma Comprehensive Water Plan was developed with due consideration of federal reserved and Indian water rights.

Generally, Oklahoma acknowledges as a matter of law that a federal reserved water right is established when the Federal Government withdraws its land from the public domain and reserves it for a federal purpose. The key factor in determining the existence of a reserved right is to ascertain whether or not the government intended to reserve then unappropriated and thus available accompanying water at the time the federal enclave was created.

In regard to Indian water rights, the State of Oklahoma recognizes the Winters Doctrine derived from the U.S. Supreme Court ruling in Winters vs. the United States (1908), which doctrine maintains that water rights may be attached to Indian reservations created by lawful means, i.e., treaties, acts of Congress or executive orders. However, it should be noted that no Indian reservations presently exist in Oklahoma, with those previously existing being substantially dissolved by allotment of lands in severalty during the period of time from 1891 through 1906.

The future water needs of Oklahoma's substantial Indian population have been considered within the water requirement projections included in the Oklahoma Comprehensive Water Plan.

Federal Programs

Throughout the development of the Plan, the Oklahoma Water Resources Board has remained cognizant of federal programs underway in the state, and has integrated all appropriate federally authorized projects and study proposals into the total water development program.

Reclamation Law

Due to the magnitude of the Plan, it is almost certain that federal planning and financial assistance will be required in its implementation. Such federal participation will necessitate adherence to certain laws and regulations, including the Reclamation Act of 1902. Certain provisions of this law could potentially hinder water planning efforts in Oklahoma, as well as all western states.

The intent of the Reclamation Act was to encourage and facilitate the development of vast areas of public land in semi-arid regions of the western United States by providing for the development of irrigation water supplies. The original version of the law did not require water users to pay interest on their share of the cost to construct irrigation facilities, nor did it allow a private landowner to obtain water from a Bureau of Reclamation project for use on a plot larger than 160 acres.

Essentially, this rule excludes today's average or large farm owner from participating in an irrigation pro-

ject constructed by the Bureau of Reclamation. When the law was passed in 1902, farming practices relied exclusively on human and animal power using crude farm implements. The years since have brought revolutions in the farming industry, which require costly and complicated machines for the planting, cultivation and harvesting of agricultural products which cannot be justified by the returns on a small farm.

In 1977 the average Oklahoma farm size was an estimated 428 acres — over three times the average size at the turn of the century. Studies of farm economics set the optimum farm size in most areas at 640 acres or more.

Considering the necessity of heavy capital investment by the farmer and the emphasis on increased food production for a starving world, realistic modification of the "160-Acre Limitation Rule" would appear imperative. Even with the practice of allowing the farmer and his wife to claim 160 acres each, totaling 320 acres per family, the amount remains insufficient to make the operation cost-effective. At the present time, Congress is considering raising the 160-acre limitation.

Proposed National Water Policy

National water policy plays an important role in state water resource management, particularly in areas requiring federal technical assistance and construction priorities. Policy direction is provided through the U.S. Water Resources Council (WRC), an independent administrative agency created in 1965 under Public Law 89-80. In May 1977, President Carter initiated a National Water Policy Study which culminated in the following stated initiatives:

—Improve planning and efficient management of federal water resource programs to prevent waste and to permit necessary water projects which are cost-effective, safe and environmentally sound to move forward expeditiously.

—Prove a new, national emphasis on water conservation.

—Enhance federal-state cooperation and improved state water resource planning.

—Increase attention to environmental quality.

The Water Resources Council was directed to improve the implementation of the Principles and Standards governing the planning of federal water projects by: (1) adding water conservation as a specific component of both the economic and environmental objectives; (2) requiring the explicit formulation and consideration of a primary nonstrucural plan as one alternative whenever structural water projects or programs are planned; (3) preparation of a planning manual designed to institute consistent cost-benefit analyses among federal water agencies; and (4) creation of a project review function within the Council to ensure water projects have been planned in accordance with the Principles and Standards. These provisions would apply to all federal projects (and separable project features) not yet authorized.

Federal agencies with programs affecting water supply or consumption were directed to encourage water conservation by:

—developing water conservation programs in federal facilities;

—requiring conservation measures as a condition for certain water supply and wastewater treatment grant and loan programs;

—providing technical assistance to the public; and

—requiring conservation as a condition of contracts for storage or delivery of municipal and industrial water supplies from federal projects.

The Bureau of Reclamation was specifically directed to renegotiate new and renewable irrigation repayment and water service contracts every five years to replace previous 40-year contracts; add provisions to recover operation and maintenance costs; and calculate and implement more precisely the "ability to pay" provision.

All federal agencies were requested to adhere vigorously to appropriate environmental statutes in water resource development and to arrange funding for environmental mitigation. Certain agencies were directed to acquire flood-prone property to reduce flood damages and discourage utilization of floodplain areas.

The Soil Conservation Service was directed to take more effective conservation measures by encouraging accelerated land treatment practices prior to funding of structural facilities on watershed projects and establishing periodic post-project monitoring to ensure implementation of land treatment and operation and maintenance activities specified in the work plan.

Initiatives directly impacting on the states include new cost-sharing arrangements, the option to charge higher prices for municipal and industrial water (provided that revenues in excess of federal costs be returned to municipalities for use in conservation or water supply systems), increased federal funding for water resource planning and new funding for water conservation programs.

Since unveiling of the new national water policy, many state water officials have expressed concern regarding the new cost-sharing agreements, the federal agencies have grown apprehensive of the revised Principles and Standards and Congress has not been supportive of enhanced funding levels in an era of spiraling inflation rates.

Oklahoma's reaction has also been apprehensive, principally since the state does not possess a financing program capable of funding major water resource projects and thus the proposed cost-sharing arrangements could restrict the state's future water resource development. Senate Bill 215 (82 O.S. Supp. 1979, Section 1085.31 et seq.) passed by the First Session of the 37th Legislature does provide funding for small water-related projects, but its loan limitation of $1.5 million per project

precludes the financing of major reservoirs. Texas, Arkansas, California and other states which already possess an adequate funding mechanism will have a distinct advantage over Oklahoma, since they will be immediately able to provide any required state funding share.

Concerns have also been expressed that the revised Principles and Standards could adversely affect all western states producing irrigated agricultural crops by including new methods of determining project benefits which would deflate benefits from other water supply purposes, thus severely retarding water resource development in the west.

In spite of these concerns, water conservation in the context of wisely managing and using the state's limited water resources is clearly necessary, and thus the national emphasis on water conservation is welcomed in Oklahoma. Additional funding through the proposed technical assistance programs could expedite the preparation of state conservation programs and allow further study and possible implementation of the water conservation recommendations included in the Oklahoma Comprehensive Water Plan.

ALTERNATIVES TO WATER TRANSFER

In the development of the Oklahoma Comprehensive Water Plan, various nontransfer alternatives possibly capable of meeting Oklahoma's projected water demands were analyzed. These were of both a structural and nonstructural nature and included weather modification, artificial recharge, desalination, wastewater reuse, chloride control and water management. In addition, a no-action scenario was evaluated to project the consequences of present trends continuing into the future without material alteration.

Conclusions from such analyses strongly indicate that, while these alternatives may individually and/or collectively provide additional water, the amount is insignificant compared to Oklahoma's total future water needs. Therefore, nontransfer alternatives were considered only as supplemental sources of water, not capable of wholly fulfilling the state's long-range water requirements. Nonetheless, these alternatives should receive continued emphasis on a local basis as ongoing planning efforts continue.

Each of the nontransfer alternatives is influenced by certain constraints imposed by technology, economics and institutional and political limitations. These constraints make extremely difficult a precise quantification of the water made available from such methods. However, a brief assessment of some nontransfer alternatives, as well as the no-action scenario, follows and they should be further considered in future planning efforts.

Weather Modification

Recurrent droughts in Oklahoma have sustained interest in weather modification, but real technological advances in the field have only recently been recorded. Although weather modification appears to be a promising means of supplementing water supplies, potential adverse effects and legal problems have caused concern and threaten to hinder the effectiveness of future efforts. Opponents have attributed tornados, local flooding and hail to weather management activities and charge that storms intensified in one area may rob another area of rain. However, due to the difficulty in establishing substantive evidence between weather modification efforts and alleged injuries, court decisions have most often favored proponents of the practice.

The most common form of weather modification is cloud seeding — injecting silver iodide particles into rain clouds from ground-based dispensers or aircraft. Although opinions vary widely, the potential for increasing annual precipitation has been estimated at 10 to 30 percent. However, for any program of weather management to be a significant factor in water development, it would have to embrace several counties, if not the entire state, and include adequate guidelines and direction from professional meteorologists and hydrologists.

Interest in producing or supplementing rainfall by artificial means caused the State Legislature to pass the Oklahoma Weather Modification Act (2 O.S. Supp. 1972, Section 1401 et seq.). The Act provided for the encouragement and regulation of weather modification activities, and as amended in 1973, assigned the responsibility of its admininstration to the Oklahoma Water Resources Board. The Act also authorized local entities to hold elections and assess themselves in order to contract for weather modification services.

The Oklahoma Water Resources Board appointed an advisory committee composed of 10 members knowledgeable in the field to advise the Board in matters of policy, administration, research and legislation pertaining to weather modification. The Board regulates operations and exercises its powers to promote continued research and development of the technology.

The Board is sponsoring the preparation of a state weather modification plan which will make recommendations regarding state policy on weather management, determine proper utilization of the technology and address legal implications to ensure minimal adverse effects.

Although weather modification may eventually offer a means of supplementing water supplies, the present state of the art limits the precision of rainmaking efforts, and legal questions concerning use of the technology remain unresolved. At best, weather modification can be relied on to produce only limited quantities of supplemental water, and then only when appropriate weather conditions exist.

Artificial Recharge

Artificial recharge is the process of replenishing a ground water aquifer with fresh water by diverting

Artificial Recharge

Artificial recharge is the process of replenishing a ground water aquifer with fresh water by diverting stream water and/or irrigation runoff into abandoned wells and natural depressions, which then act as recharge sites. Induced recharge reduces the amount of water lost to evaporation and transpiration, as well as decreasing the possibility of encroachment by salt water from beneath an overdrafted aquifer.

The only extensive artificial recharge project in Oklahoma is located in the Dog Creek Shale and Blaine Gypsum Formation in southwestern Oklahoma, where it has proven to be a fairly successful augmentation program. It has enabled the local farmers to sustain irrigation in an area where irrigation water supplies had been threatened by overdevelopment of ground water resources.

Although the Dog Creek project has proven somewhat successful, there have been concerns regarding possible pesticide, herbicide and nitrate contamination from agricultural runoff water being diverted into the formation. Since the Blaine Gypsum is used almost exclusively for irrigation, this problem is not considered critical, however there is a possibility that the contaminated recharged water could infiltrate other local aquifers which provide drinking water supplies. Any further recharge operations in the area should incorporate appropriate water quality monitoring to insure that existing municipal and industrial water sources are not contaminated.

Few other areas in the state are considered geologically suitable for the development of artificial recharge projects. These natural limitations, along with the high costs of pilot projects, test drilling and hydrologic studies which must lay the groundwork, have discouraged further experimentation. The lack of dependable recharge sources, escalating energy costs and sediment problems in recharge water also make it unlikely that artificial recharge will prove a practical solution to water supply problems. At best, the technique can be relied upon to provide a few areas with supplemental water, and then only if the costs can be justified.

Desalination and Chloride Control Projects

Much of Oklahoma's water is unavailable for beneficial use due to its poor quality. High concentrations of minerals, particularly chlorides, are emitted into streams, rendering both the stream and adjacent alluvium and terrace ground water deposits unfit for use. This problem attains critical proportions in water-deficient areas of the state, such as the Southwest and Northwest Planning Regions. In the northwest, streams polluted by chlorides provide the only stream water available, and the area's primary ground water aquifer, the Ogallala, is threatened by depletion. In western Oklahoma large quantities of brackish stream and ground water remain unusable. If such waters could be purified at reasonable cost and minimal adverse environmental impact, significant additional quantites of water would be available for beneficial use.

Two major methods, desalination and chloride control, have been suggested to cope with this salt pollution. Desalination involves purifying heavily salt-polluted water in order that its quality becomes appropriate for beneficial use. Chloride control does not alter the quality of the water at its source, but rather diverts fresh and usable water around identified salt flats and natural brine springs by means of dikes, dams and retention reservoirs, i.e. allowing the better quality water to bypass pollution sources and thus retain its quality.

Research and development activities have brought desalination technology to a point where its importance as a source for municipal and industrial water supply is widely recognized. However, under the present state of the art, the unit cost of storage and desalination is cost-prohibitive to the production of irrigation water.

DESALINATION

The feasibility of desalination in Oklahoma will depend heavily upon the environmental and economic aspects of the Foss Reservoir desalination plant located in Custer County. After completion of Foss Reservoir in 1961, it was discovered that water captured in the lake was of poorer quality than expected. The inferior quality of the water was attributed to an unprecendented depletion of inflow caused by prolonged drought and extensive upstream watershed development. It was also determined that conventional treatment would not produce a water supply of sufficient quality to meet U.S. Public Health Service standards. Studies were conducted to identify alternate water sources and to determine the most feasible method of alleviating the water quality problems. The study recommended construction of a desalination plant as the most practical and economical solution for an area with virtually no other stream water sources and only limited ground water supplies available. A desalination plant at the Foss site was begun in 1972, funded by a grant and loan from the U.S. Department of Housing and Urban Development, and began operation in 1974.

Desalination of brackish water may provide an alternative solution to future water supply problems. However, the high cost of treatment and environmental problems involved with disposal of the highly concentrated brine effluent from the conversion process could preclude desalination as a feasible solution, except in areas without alternative water sources. Ongoing studies by the Oklahoma Water Resources Board concerning the effects of the brine effluent discharged from the Foss Reservoir desalination plant on the quality of the Washita River should be of assistance in ascertaining the magnitude of the problem.

Although the cost of proper disposal may be the determining fac-

tor as to whether desalination is feasible or not, satisfactory effluent disposal to prevent stream and ground water pollution is imperative. Disposal methods include evaporation ponds lined to prevent seepage, subsurface injection, use of the effluent for secondary oil recovery, and discharge into streams in compliance with state water quality standards.

Advances in desalination technology should be closely monitored and further studies conducted to determine the feasibility of the process. Financial assistance from federal and state sources could provide incentives, especially in areas experiencing a shortage of good quality water, but an abundance of poor quality water.

CHLORIDE CONTROL

If constructed, the authorized Arkansas-Red River Basin Chloride Control projects would make available for beneficial use large quantities of stream water currently unusable due to natural chloride pollution. However, studies indicate that the chloride control projects cannot be considered an alternative to water transfer, but would reduce the amount required by making higher quality water available in water-deficient areas.

Surplus water from the Arkansas River suitable for municipal, industrial and irrigation uses is presently available only during periods of high stream flow. High flows (flood waters) dilute the excessive chloride concentrations that occur during periods of low flow, thus enabling water of adequate quality to be diverted during such high flow periods.

Alternative transfer systems were formulated for water quality conditions that would exist with operational Arkansas River Basin Chloride Control projects and without such measures.

With the projects operational, the availability of surplus water suitable for municipal, industrial and irrigation uses would be greatly increased. Thus, a given volume of good quality surplus water could be more economically diverted from the Arkansas River, due to more frequent diversions of smaller quantities.

Future planning efforts will address additional water transfer alternatives in the Red River Basin assuming that the chloride control projects are operational. Preliminary studies indicate that water of suitable quality for irrigation purposes in southwestern Oklahoma could be developed from the Red River in south central Oklahoma, thereby significantly reducing the need for water sources in eastern Oklahoma. Such an alternative is briefly discussed in Chapter VI, which describes the southern water conveyance system.

Since the effective solution of salt pollution problems in western Oklahoma could make significant quantities of good quality water available in those areas, desalination and chloride control should be addressed in more detail in future planning efforts.

Conservation

Many water conservation measures are available to prolong the life of limited supplies, including mechanical techniques, water management, wastewater reuse, conjunctive use of stream and ground water, and water pricing practices. The potential of each of these methods is discussed in greater detail in Chapter III, "Water Conservation in Oklahoma."

No Action

One of the options available to the State of Oklahoma is simply to take no action in implementing a comprehensive statewide water plan. Such a scenario assumes current trends will continue in water demand and supply management, i.e., the state will make no new efforts to reduce demands or augment supplies. All water users — domestic, municipal, rural, industrial, agricultural and others — would continue to rely on available local ground and stream water resources, regardless of the quantity and/or quality of those waters.

Adverse consequences of this no-action alternative seem predictable. After developing available local supplies, the larger, more affluent cities would continue to obtain water from other areas of the state, despite the high cost of constructing the necessary independent transfer systems. If urban areas were given priority due to their ability to fund major water projects, and local supplies were to be allocated to them, some towns, smaller cities and rural areas could be deprived of adequate water supplies.

Areas which do not presently have adequate fresh water supplies would be denied growth because they could neither support agricultural development nor attract business and industry. Irrigation farmers in western Oklahoma would be forced to revert to dryland farming as depleting ground water supplies become too costly to use. As a result, per-acre crop yields would decline, requiring an increase in the number of acres planted to maintain current production levels. Increased costs would reduce profit margins, placing many farmers in a tenuous financial position.

Oklahoma is presently experiencing healthy and balanced growth and expansion, but it is obvious from the rate at which water consumption is exceeding supply, that by the turn of the century some areas could decline into an economic recession with profound economic effects on the entire state.

The Statewide Economic Impact Study, discussed more fully in Chapter VIII, is assessing the economic effects on the state "without water conveyance." The study, scheduled for completion in early 1981, will evaluate the impacts of inaction on local, regional and state economies. Preliminary appraisals project severe reprecussions, not only in agriculture, but in all sectors of the state's economy, unless Oklahomans possess the vision to begin providing now for future water supplies.

CONCLUDING NOTE

Oklahoma's history is illuminated by its dramatic record of success in water resource development, even though and perhaps in spite of the fact that the state has thus far lacked a plan to insure the orderly control, protection, conservation, development and utilization of its precious water resources. It would seem unlikely that such a record can continue without adoption of a plan for future growth as growing population and expanding industry press new and greater demands on Oklahoma's dwindling water supplies.

The Oklahoma Comprehensive Water Plan, prepared in cognizance of state and federal policies and guidelines and advancing the goals and objectives set forth herein, fulfills this need for a flexible guide to the development of Oklahoma's water resources on regional and statewide basis. Only with such guidance can the State of Oklahoma attain the bright destiny its history would portend.