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OKLAHOMA RESOURCES FOR ECONOMIC DEVELOPMENT

Edited by
Hans-Joachim Späth
Gary L. Thompson
Henry Eisenhart





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Charles J. Mankin, *Director*

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The University of Oklahoma
Norman, Oklahoma

1998

SPECIAL PUBLICATION SERIES

The Oklahoma Geological Survey's Special Publication series is designed to bring timely geologic information to the public quickly and economically. Review and editing of this material has been minimized in order to expedite publication.

Cover Photo:

The Oklahoma State Flag depicts an Osage Indian war shield on a blue sky field. Small crosses on the buckskin face of the shield suggest stars. Hanging from the edge of the shield are seven eagle feathers. Crossing the shield are a calumet, including a pipestone bowl and tassel, and an olive branch; they symbolize peace among peoples.

The Flag was adopted in 1925 from a design by Mrs. George Fluke, Jr. It was slightly changed in 1988 and again in 1991.

This publication, printed by the Oklahoma Geological Survey, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes, 1981, Section 3310, and Title 74, Oklahoma Statutes, 1981, Sections 231–238. 750 copies have been prepared at a cost of \$6,996 to the taxpayers of the State of Oklahoma. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.

P R E F A C E

The State of Oklahoma has contributed uniquely to the history, traditions, resources, and productivity of the United States. Within the brief time span of a century, Oklahomans have created and sustained a diverse economy and a supportive human resource base that have served to generate a positive image of the state nationally. As Oklahoma approaches 100 years of statehood, it is time to stand back and take stock of Oklahomans' achievements and future possibilities.

Oklahoma Resources is a snapshot in time, portraying the state's assets at the close of the 1980s and the beginning of the 1990s. It was written and compiled to provide basic information for planning in both private industry and state government. Each chapter evaluates a different aspect of Oklahoma's natural and man-made resources in light of the state's histories and traditions, current business trends, and the public policies that have affected economic growth.

TOPICAL ORIENTATION

The focus of this book is on the resources that have made Oklahoma what it is today. Twenty-two authors have contributed chapters that include discussions of the state's natural environment, its people, energy, water, wheat farming, transportation and communication, education, recreation, health care, forests and minerals, utilities and industries, environmental regulation, finance industries, the fine arts, and the cities and the land. A brief documentation of the historic development up to 1989—in some cases where appropriate up to 1992—is included in most chapters. This is followed by inventories and assessments of current conditions. Where appropriate, the chapters are concluded by a general analysis of impact by current and past decisions and policies.

Each chapter in *Oklahoma Resources* reflects the individual approaches of its author(s). In a sense, each can stand alone. The common denominator is the uniform technical structure of the chapters and the design of the illustrations. Academic quotations have been sacrificed for the benefit of a broad public, yet a complete list of references following each chapter will guide the expert reader to the original data sources and to further information.

ACKNOWLEDGMENTS

The production of *Oklahoma Resources* was made possible through the combined efforts of many talented individuals throughout the University system, the state, regional, and local governments, and the private sector. Special recognition must be given, however, to certain people. Governor Henry Bellmon helped conceive the idea for a comprehensive review of Oklahoma's resource base at the conclusion of the first 100 years of the state's history, and has been especially supportive of all the fund-raising efforts. Continued endorsement by the President's office at the University of Oklahoma has helped secure broad support from the public and private sectors.

The Kerr Foundation, Inc., Oklahoma City, provided major financial support for this project. Other contributors were: the Oklahoma City Economic Development Foundation; Kerr-McGee Corporation of Oklahoma City; The Williams Companies of Tulsa; Holden Energy Corporation of Ardmore; Fowler Toyota Jeep/Eagle of Norman; Security National Bank and Trust Co. of Norman; Oklahoma Natural Gas Co. of Tulsa; Public Service Company of Oklahoma of Tulsa; Oklahoma Gas and Electric Company of Oklahoma City; Mr. Ed Barrett, geologist, Oklahoma City; The Spirit Shop of Norman; Mathis Brothers Furniture Co., Inc. of Oklahoma City; Big Red Sports/Imports of Norman; and Sterr's Groco. Inc. of Norman.

This document would not have come to life without the Oklahoma Geological Survey's efforts to publish, Laura Madden's and Barbara Taylor's patient and skillful word processing, Mike Sexton and Sue Kahre-Stradford's illustrations, and Nancy Hanks' assistance in technical editing.

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CONTENTS

	PREFACE	iii
	<i>Hans-Joachim Späth</i>	
	LIST OF CONTRIBUTORS	iv
Chapter 1	THE NATURAL ENVIRONMENT	1
	<i>Michael Roark and Hans-Joachim Späth</i>	
Chapter 2	POPULATION AND THE LABOR FORCE	15
	<i>Karen Selland and John McGraw, with assistance from Binita Sinha</i>	
Chapter 3	THE OUTLOOK FOR ENERGY	31
	<i>Edward J. Pugh</i>	
Chapter 4	WATER—OKLAHOMA'S VITAL RESOURCE	55
	<i>Chand Wije and Mark Meo</i>	
Chapter 5	THE WHEAT FARMING SYSTEM	73
	<i>Hans-Joachim Späth</i>	
Chapter 6	TRANSPORTATION AND COMMUNICATION	95
	<i>Michael E. Lewis, Gary L. Thompson, and Binita Sinha</i>	
Chapter 7	INVENTING THE FUTURE: EDUCATION IN OKLAHOMA	111
	<i>Herbert R. Hengst and Dan S. Hobbs</i>	
Chapter 8	RECREATION AND QUALITY OF LIFE	127
	<i>Henry Eisenhart</i>	
Chapter 9	THE HEALTH CARE DELIVERY SYSTEM	139
	<i>Ivan Hanson</i>	
Chapter 10	FOREST AND NONFUEL MINERAL RESOURCES	157
	<i>Mark Meo, Kenneth S. Johnson, and Kenneth V. Luza</i>	
Chapter 11	UTILITIES AND INDUSTRIAL LOCATION	177
	<i>Howard W. Motley, Jr.</i>	
Chapter 12	ENVIRONMENTAL REGULATION	197
	<i>Henry Eisenhart, Ellen Odle Bussert, and R. Fenton Rood</i>	
Chapter 13	THE FINANCE INDUSTRIES AND TAXES	215
	<i>Herbert O. Giles, with assistance from Binita Sinha</i>	
Chapter 14	THE FINE ARTS	231
	<i>Roger Rideout and Nat Eek</i>	
Chapter 15	THE CITIES AND THE LAND	249
	<i>Gary L. Thompson, Michael E. Lewis, and Binita Sinha</i>	
	CONCLUSION	265
	<i>Gary L. Thompson</i>	

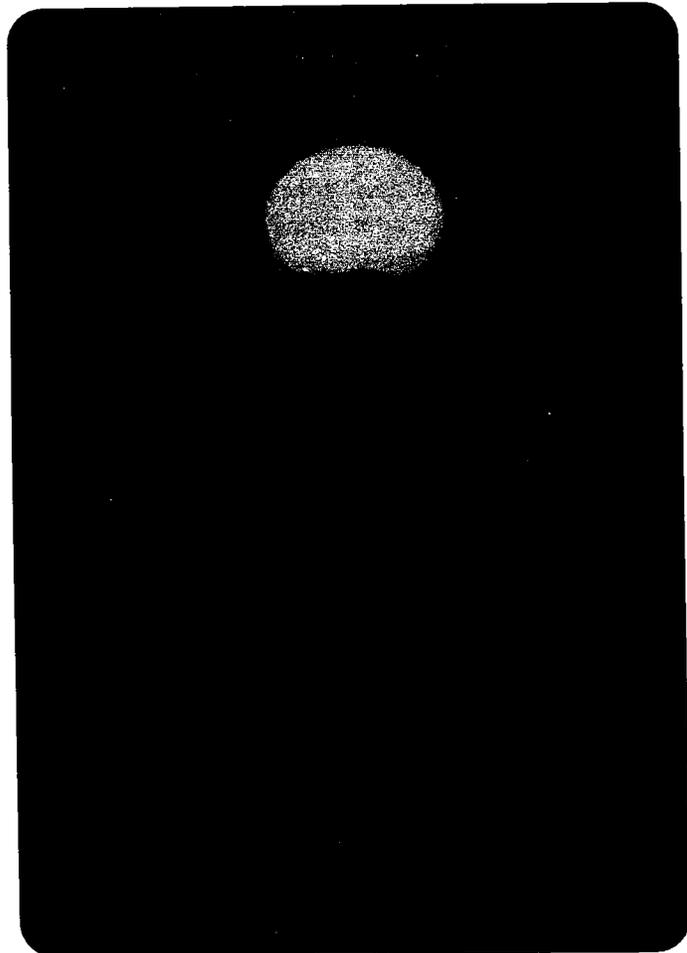
Oklahoma Resources

Chapter

1

The Natural Environment

by
Michael Roark
and
Hans-Joachim Späth



Contents

Executive Summary	3
Introduction	3
Climate and the Four Seasons	3
Precipitation and Evaporation	4
Temperature	5
Wind	6
Thunderstorms and Tornadoes	6
Dust Storms and Droughts	6
Climate and Economics	7
Vegetation and Soils	8
Landforms	9
Ozark Uplift	9
Arkansas Valley	9
Ouachita Mountains	9
Coastal Plains	10
Prairie Plains	10
Sandstone Hills	10
Central Redbed Plains	10
Arbuckle Upland	10
Great Plains Broken Lands	11
Wichita Mountains	11
High Plains	12
Raton Mesas	12
Conclusion	12
References	12
List of Illustrations	14

The Natural Environment

Michael Roark and Hans-Joachim Späth

Executive Summary.—Oklahoma's natural environment is characterized by diversity. Climate is the most important controlling factor in creating this diversity. In terms of precipitation, Oklahoma's climate is transitional between the aridity of the western United States and the humidity of the East. Oklahoma is also often in transition between the cold of the North in the winter and the heat of the South in the summer.

The variation in climate shapes the terrain, creating mesas and buttes in the west and rounded hills in the eastern part of the state. Intensifying the contrasts in terrain are geological structures: mountains in the southeast, hills in the northeast and southwest, and plains throughout most of the state.

Vegetation and soils are directly affected by climate. The most important variable in the biosphere is precipitation. Grasslands reflecting drier conditions characterize the state, especially the western half of the state, but significant areas are forested, particularly in the southeast. Soil variation is directly affected by precipitation. Generally, the best soils for agriculture are in the central section of the state, a transitional area between the soils derived from a humid climate in the east and soils formed from a western arid climate.

INTRODUCTION

Variety is the word to characterize Oklahoma's natural environment. With the probable exception of California, Oklahoma may have the greatest environmental variation of any state in the country. Nonetheless, for most Americans, Oklahoma's environment remains unknown. If any image is formed, it is of the plains in the central part of the state (Map 1.1). Yet Oklahoma varies in terrain from rugged mountains in the southeast to mesas in the Panhandle. The state has all kinds of terrain surprises, such as the granitic Wichita Mountains and the living Pleistocene fossil forests in the Caddo canyons. Can one imagine a greater contrast than that between the sand dunes of northwestern Oklahoma and the bayou swamps of southeastern Oklahoma? Oklahoma's natural environment presents striking images. Climate, bedrock, and vegetation have shaped these images.

CLIMATE AND THE FOUR SEASONS

Oklahoma's climate is fundamentally transitional. Oklahoma's climatic

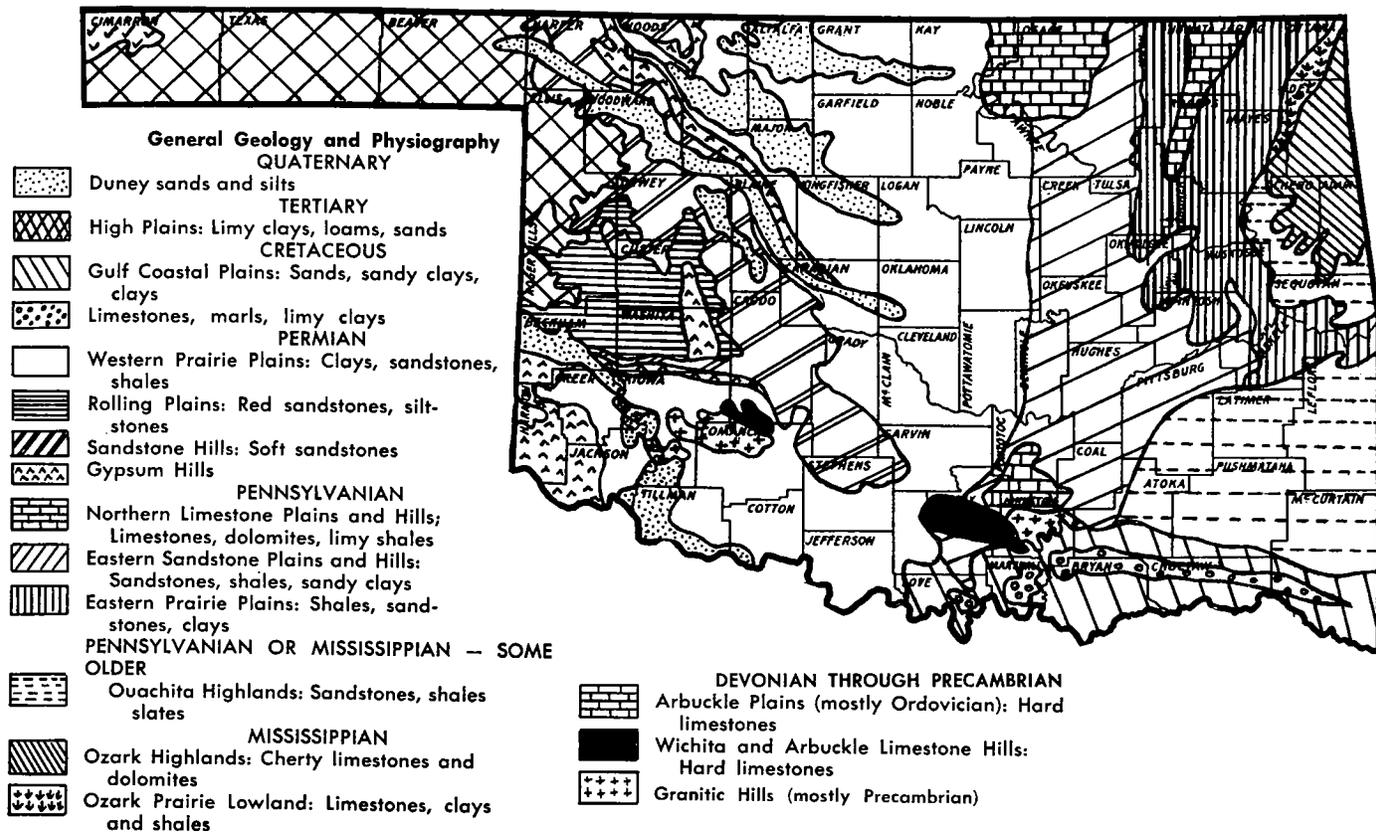
transitions are more than precipitation changes from western Oklahoma's semiaridity (a BS climate, using Koepfen's climate symbol) to eastern Oklahoma's humidity (Cfa). The state is also transitional in temperatures between northern Oklahoma's periodic continental winters (Dfa) and southern Oklahoma's subtropical summers and winters (Cfa). Oklahoma is where the regional climates of the West (BS), North (Dfa), and South (Cfa) converge and merge; one or more dominates in a climatic year. This merging of climates in Oklahoma makes for challenge as well as for variety, since the union of different air masses can produce tornadoes and dust storms.

Oklahoma's climate is created by air masses that move into the state from remote source areas. In the winter, Oklahoma is influenced by two major air masses, continental Polar (cP) and maritime Polar (mP). The continental Polar air derives from two sources, northern Canada and central Siberia. The Siberian air mass is much colder since the cold pole (i.e., the coldest temperatures recorded) for the northern hemisphere is in Siberia.

Cold Siberian air can change an Oklahoma winter from cool and dry to bitterly freezing and snowy, bringing blizzards to northern and western Oklahoma.

The maritime Polar air originating in the northern Pacific is initially more moderate in temperature and is modified as it travels over the Rockies. The effect of maritime Polar air is a cool and dry season. This air contrasts considerably to the blasts of cold continental air which plunge south from Canada, over the Great Plains, to Oklahoma.

In the spring and summer, maritime tropical air (mT) from the Gulf of Mexico and continental tropical air (cT) from the Sonoran desert of northern Mexico dominate. The maritime tropical Gulf air is warm and very humid and is the source of almost all of Oklahoma's moisture. The Pacific maritime air rarely is a source of moisture since it has lost so much humidity as it passes over the western mountains; it is important, however, as a stimulus of weather systems—fronts—that create conditions for the northward moving Gulf air to precipi-



Map 1.1 — General geology and physiographic areas of Oklahoma. Source: Gray and Galloway (1959).

tate. At times in the middle and late summer, the maritime tropical air is dominated by the Bermuda high-pressure system from the mid-Atlantic, and the result can be droughts. The effect of the Sonoran continental tropical air is that of a hot, dry furnace. It heats up Oklahoma's summers to well above 100°F and can bring severe droughts, particularly to southwestern Oklahoma.

These constant air masses create Oklahoma's characteristic seasons: cool, dry winters with periodic cold blasts; quite wet springs with numerous tornadoes and thunderstorms; hot, dry summers; and cool, humid falls.

Precipitation and Evaporation

The most significant feature about Oklahoma's annual precipitation is the decrease in levels from east to west (Map 1.2). The decrease is from an average of 50 inches per year in the southeast to 15 inches per year in the northwest. The extremes in precipitation range from more than 80 inches

per year in the Ouachitas to slightly less than 7 inches in the Panhandle.

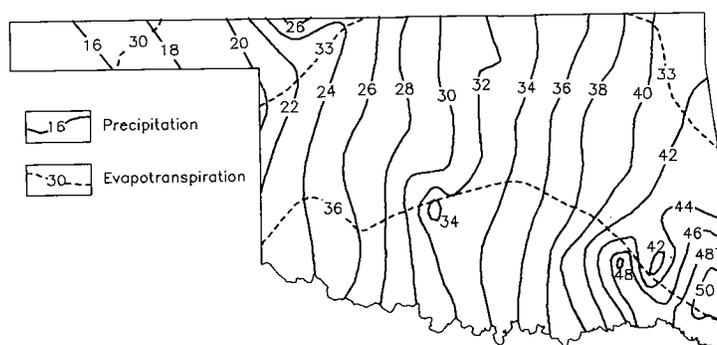
The precipitation in Oklahoma has a definite seasonality (Figure 1.1). There are two periods of heavier rainfall followed by two seasons of drier conditions. More rain falls in the spring than in the summer, and there is greater precipitation in the fall than in the winter. The main cause of this pattern is frontal activity, storm tracks that shift north and south with the upper atmosphere jet stream. In the winter, the jet stream is farther south so that southeast Oklahoma has the most winter rainfall and less of a minimum than the rest of the state. During the summer, the jet stream shifts to the north; northern Oklahoma, particularly the Panhandle, receives a greater proportion of its rain in the summer season. The greatest precipitation occurs in the spring when the jet stream is more likely to pass over Oklahoma and warm, moist Gulf air comes in contact with cool, interior air. After a summer decrease,

rainfall increases slightly in the fall as the Bermuda high pressure and Sonoran continental air leave Oklahoma.

The season of least precipitation is winter, December through February. Many Oklahomans may not perceive winter to be the driest season; they would consider the late summer months of July and August to be drier. July and August appear drier because of higher evaporation rates. Since winter temperatures are much lower, there is a lower evaporation rate; the soil remains wetter and does not dry out as in the summer.

In the winter, precipitation is in the form of light rain or snow. The snow cover typically lasts only a few days. The wettest part of the state in winter is the southeast, particularly the Ouachita Mountains.

The main season of precipitation is the spring, March through May. In this season, moist warm air from the Gulf of Mexico penetrates Oklahoma and becomes unstable due to surface



Map 1.2 — Average annual precipitation (in inches), 1970–79. Source: Pettyjohn and others (1983), Gray and Galloway (1959).

heating and frontal activity. The result often is thunderstorms and tornadoes. The intensity of the rainfall is quite different from winter showers. Several inches of rain can fall within a half-hour to an hour—the proverbial “buckets” of rain. As in the winter, the Ouachita Mountains receive the greatest rainfall.

A relative decrease in precipitation occurs in the summer, especially during the months of July and August. There is less precipitation in spite of the tropical maritime air from the Gulf of Mexico because of the dominance of the Bermuda high pressure over Oklahoma. This warm-core high pressure originates from the central Atlantic at 25°N latitude and extends over the southeastern U.S. and into Oklahoma in July and August. Most of the precipitation in these months comes from convective thunderstorms creating a specific pattern of rainfall rather than a general one. In other words, one locality could receive several inches of rain while nearby there may be an utter drought.

The pattern of summer rainfall differs considerably from patterns in winter and spring. The Ozark Mountains, not the Ouachitas, are the wettest part of the state; the driest part is the southwest, not the northwest or the Panhandle. The lack of rainfall in the southwest may be due in part to Sonoran continental tropical desert air penetrating the state from Mexico. For the northern part of the state, especially the Panhandle, summer is the wettest season because of the more northerly position of the jet stream and associated storm tracks.

In the fall, September and October, there is an increase in precipitation as the Bermuda high pressure moves out. The increase is slight because the tropical maritime air is not being heated as it is in the spring, but it is enough to break the drought of the summer.

The pattern of precipitation in the fall contrasts to that of the summer. The driest part of the state is the Panhandle; the wettest areas are in the eastern highlands.

Although snowfall is generally of minor importance for most of the state, it is significant in the Panhandle, the driest part of the state. Snowfall is often a major component in total Panhandle precipitation.

Oklahoma’s snowfall season is primarily November through April, but snow has been reported in every month of the year. The highest annual levels are in the northwest and the lowest are in the southeast: Boise City,

at a mean of 20.7 inches, receives the most snow and Idabel, the least at a mean of 2.1 inches. The annual snowfall pattern is the opposite of the annual precipitation pattern, but it corresponds to the temperature map. The southern parts of the state, which have more winter precipitation, do not have much snow because the temperatures are generally too high.

Temperature

Oklahoma has extremes in temperature as it does in precipitation, a pattern which often is typical of continental climates. The highest temperature recorded was 120°F at Altus in southwestern Oklahoma (and at other sites); the lowest temperature recorded was -27°F at Vinita in northeastern Oklahoma. In general, the southwest and southeast are the warmest parts of the state, having mean temperatures of 63°F or 64°F. The Panhandle, having a mean temperature of 55°F or 56°F, is the coolest region, a result of the combination of higher elevations in the Panhandle and cold front penetration patterns. The eastern part of the state, particularly the Ozarks, tends to be cooler than the central part of the state because of the higher elevation, greater precipitation, and resulting cloudy days. It may not feel cooler in the summer, however, because of higher humidity.

Seasonality in temperatures is common in the mid-latitudes and, of course, in Oklahoma. In January, when the continental polar air mass dominates the state, Boise City (in the

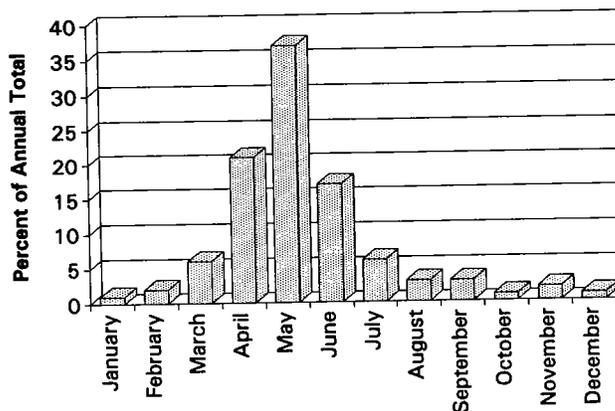


Figure 1.1 — Average monthly precipitation in Oklahoma. Source: Oklahoma Department of Agriculture (1988).

western Panhandle) has the coldest mean temperature at 34°F and Idabel (in the extreme southeast) has the warmest at 43°F. Isotherms—the lines connecting points of equal temperature—have a northeast–southwest orientation except in the southern part of the state where the trend is east–west (Map 1.3).

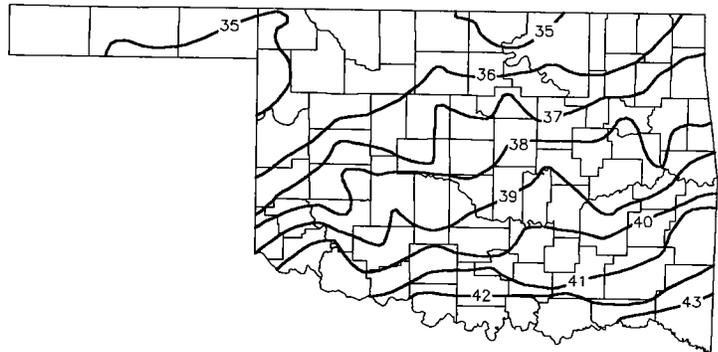
The greatest mean temperature variation occurs in April. It varies from 54°F in the northern Panhandle to 64°F along the Red River. Again, the isotherms have a northeast–southwest orientation in the north and an east–west orientation in the south. Higher elevation is the primary cause of colder temperatures in the Panhandle.

Mean temperatures vary little over the state during the summer month of July (Map 1.4). The Panhandle remains the coolest part of the state; the warmest region is the southwest where Sonoran continental tropical air often penetrates. Temperatures of 100+°F are common during the summer in Oklahoma. The southwest has an average of 20–25 days a year when the temperature reaches 100°F; many of them occur in July and August.

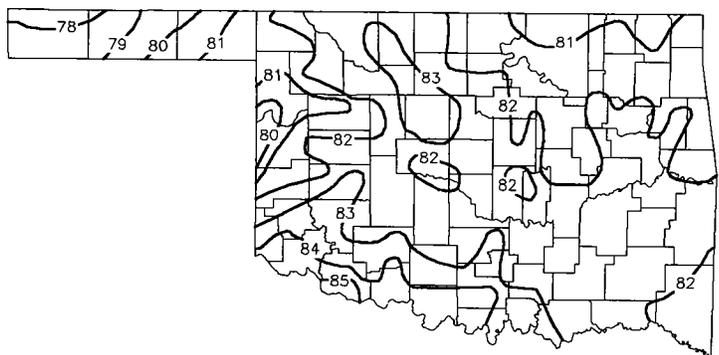
The fall season is warmer than spring. The temperature variation is much greater in the fall than in the summer; the greatest contrast is between the Panhandle and the Red River region. In October, the Ozarks in eastern Oklahoma are quite prominent for being cooler than the rest of the state. This probably is due as much to precipitation and cloudiness as to higher elevation.

Wind

Winds are a fundamental reality in central and western Oklahoma where the plains provide very little wind break. The strongest winds blow in March and April when there is shifting from the continental polar air mass of the winter to the tropical maritime air mass of the summer. Wind velocities are lowest in the summer because of the stability of the pressure systems. Eastern Oklahoma has the lowest wind velocities because of the eastern woodland forest and the relief of the Ozark and Ouachita Mountains. In June 1951, Oklahoma City recorded the highest wind velocity in Oklahoma, 87 miles an hour.



Map 1.3 — Mean January temperature (°F), 1941–70. Source: Sutherland (1977).



Map 1.4 — Mean July temperature (°F), 1941–70. Source: Sutherland (1977).

The high winds of central and western Oklahoma are a potentially significant energy source.

Thunderstorms and Tornadoes

Thunderstorms and tornadoes occur frequently in the state. Most of them (75%) appear in April through June (see Table 1.1 for monthly frequency). Very few tornadoes (only 10%) form in the winter and fall seasons. In the spring, conditions are ripe for thunderstorms and tornadoes as the warmer, maritime tropical air mass from the Gulf of Mexico comes into contact with the colder, continental or maritime Polar air masses. When the continental Polar air mass overrides the tropical maritime air, cold air overhangs warmer air. The lighter warm air rises through the cold air layer and creates instability in the process. If the cold air is very dry and the rising air can not cool fast enough, tornadoes form during this period of instability.

Oklahoma has about 60 tornadoes a year. Most of them are small and have no serious effects. (See Table 1.2

for Oklahoma's ranking among states with high annual tornado counts.) Only a small number of tornadoes are severe and, in some cases, have tracks of more than 100 miles. The number of deaths caused by tornadoes in Oklahoma has fallen considerably since 1962 because of better warning and communication through television and radio. Since about 77% of tornadoes occur between 3 p.m. and midnight, most people are at home and near warning media. The evening occurrence of tornadoes is a result of the daytime heating of the atmosphere. Most of the tornadoes (81%) travel from the southwest and west.

Dust Storms and Droughts

Droughts and dust storms are also features of Oklahoma's climate, which is transitional in the U.S. between the humid East and the arid West. In some years, the aridity of the West extends much farther to the east than in other years, causing severe droughts. The frequency of dry years, when steppe climates (B) predominate, is greatest in the Panhandle and the ex-

Table 1.1 -- Monthly Frequency of Tornadoes and Thunderstorms

Month	Percentage of Annual Total
January	1
February	2
March	6
April	21
May	37
June	17
July	6
August	3
September	3
October	1
November	2
December	1

Source: England, 1975.

Table 1.2 -- Top Ten States with High Frequencies of Tornadoes, 1953-74

States	Number of Tornadoes per 100,000 square miles
1. Oklahoma	8.2103
2. Indiana	6.1901
3. Kansas	5.957
4. Florida	5.4908
5. Illinois	4.8692
6. Iowa	4.5325
7. Mississippi	4.4289
8. Missouri	4.4030
9. Nebraska	4.1958
10. Louisiana	3.6778

Source: Kessler, Alexander, and Rarick, 1978.

spring of that year. Satellite photography showed that most of the dust came from the West Texas Llano Estacado, an extensive area of open cropland (created by irrigation from the Tertiary Ogallala Formation). Other storms originated in the marginally agricultural section of eastern Colorado.

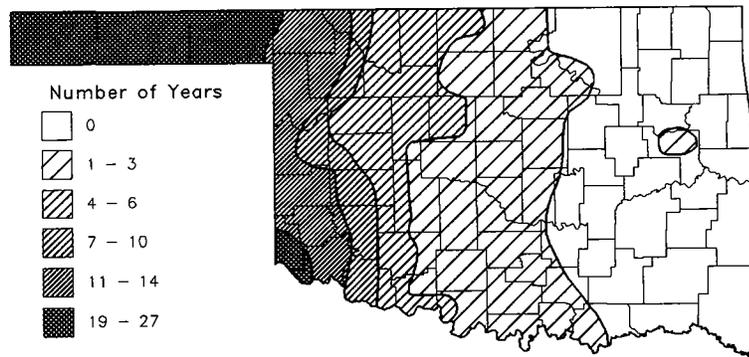
Climate and Economics

When considering the weather as a resource, it is necessary to recognize that it is very dynamic, a series of transient events. Because day-to-day weather is so variable, scientists, engineers, planners, and others interested in the weather concern themselves with climatology—the study of long-term, established patterns in the

treme southwest, but dry years are also common throughout central and western Oklahoma (Map 1.5). From 1931 to 1965, Kenton (in the Panhandle) had 27 dry years, and Hollis (in the southwest) had 20. Eastern Oklahoma's climate is classified as humid, but it, too, has droughts, particularly in July and August.

Dry years fall into cycles separated by more humid periods. During the 20th century there have been four major cycles of dry years, the 1910s, the 1930s, the 1950s, and the 1970s (Figure 1.2). These periods follow each other in 12-year intervals between peaks and troughs. The period of the 1930s, the "Dust Bowl" years, is the most famous. The drought began in 1933 and ended in 1937. The years of 1934 and 1936 were the worst drought years in the 1930s, and the Panhandle was the area affected worst. The 1940s were a time of humidity. The next sequence of aridity began in 1952 and continued through 1954; the driest year was 1954. The 1950s actually were drier than the 1930s, but dust storms and human suffering were less severe because of better adaptation by people to the environment.

Dry years recurred in the mid-1970s, and on February 23, 1977, one of the worst dust storms in 20 years occurred in central Oklahoma. Dust in the air was 20 times the state norm for suspended air particles. Other dust storms hit central Oklahoma in the winter and



Map 1.5 — Number of dry years in Oklahoma, 1931-65. Source: Taylor (1966).

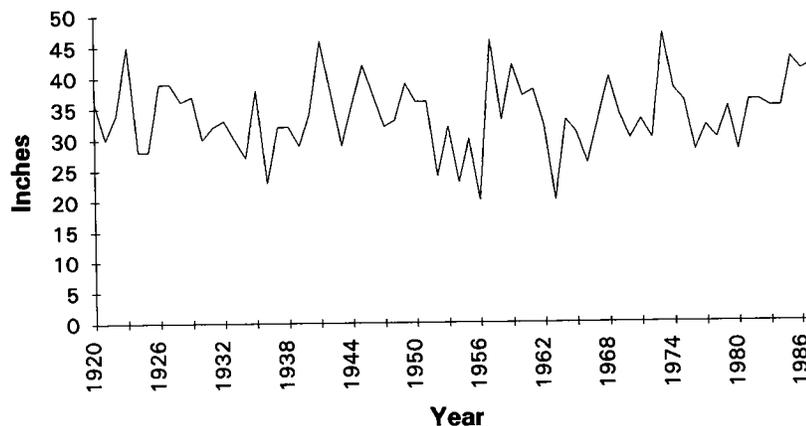


Figure 1.2 — Annual precipitation in Oklahoma, 1920-86. Source: Oklahoma Department of Agriculture (1988).

weather. When sufficient weather data is available, informative climatologies can be developed. Thanks to strong state support and local expertise, Oklahoma maintains a huge meteorological data base from which valuable climatologies have already been derived. These climatologies can assist in many decision-making processes. Information about patterns in, for example, precipitation, wind energy, solar energy, and temperature can guide people with questions vital to business ventures, such as:

- What is the likelihood of my crop getting enough precipitation during its growing stages?
- Is Oklahoma's solar energy sufficient to be a feasible alternative for our large, conventionally climate-controlled buildings?
- How many days per month will my employees be able to work outdoors without encountering freezing temperatures?

Oklahoma has a unique combination of basic and applied meteorological and climatological expertise that includes the professionals and resources of the Oklahoma Climatological Survey (OCS), the National Severe Storms Laboratory (NSSL), Bergey Wind Power, the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), the University of Oklahoma Meteorology Department, and private firms. These organizations serve as leaders and deliver specific climate-related information to enterprises in Oklahoma.

VEGETATION AND SOILS

Vegetation and soil types in Oklahoma obviously reflect the character of the state's climate, which is transitional between the humidity of the East and the aridity of the West and varies in temperature from the continental temperatures of the North to the subtropical temperatures of the South. The result is a mingling of plant and animal species from quite different communities. In Oklahoma, many plant and animal species are at the limits of their ranges. Oklahoma is the western limit for many eastern plants and animals and the eastern limit for many western flora and fauna. It is also the northern limit for southern plants and animals and the

southern limit for northern plants and animals. This gives to Oklahoma an ecologic character which almost no other state in the country has. "Diverse," "contrasting," and "unusual" are adjectives which describe the state's biosphere. It is not easy to characterize the state simply. In general, however, eastern Oklahoma is forested; central Oklahoma has both grasslands and woodland savannahs; and western Oklahoma is a grassland with fingers of woodland extending along the rivers or sandy soils (Map 1.6). In essence, Oklahoma is an ecological province between forests in the East and grasslands in the West. The transition is due to precipitation variation, not temperature extremes.

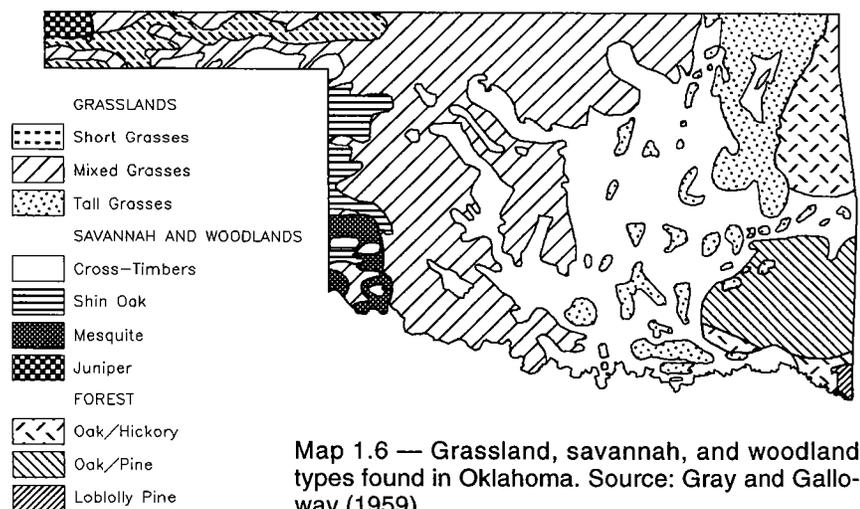
The diversity of Oklahoma's biosphere is a product of the mingling of four major communities: the Northern Hardwood Forest, composed of such trees as oak, hickory, maple, elm, ash, sycamore, walnut, beech, and dogwood; the Southern Forest, composed of pines, oak, hickories, bald cypress, gums, and magnolias; the Rocky Mountain Forest, which includes a variety of pines and junipers; and the Southwestern Forest of the Edwards Plateau of Texas, which is composed of the Texas redbud, Mexican mulberry, and Mexican juniper. From these four communities, fourteen different vegetation types have been identified.

Despite this diversity of plant species, two trees are dominant in Oklahoma's forests and woodland savannahs, the post and blackjack oaks.

Their total area (17,628 square miles) is greater than that of all other types of forests combined (12,253 square miles). Of Oklahoma's 77 counties, 65 have post and blackjack oaks. In terms of percentages and frequency, the oak is Oklahoma's true state tree. However, since forests and woodlands account for only 24% of the surface area of the state, grass is the state's true plant.

A number of factors, such as temperature, elevation, humidity, edaphic or soil conditions, and precipitation, influence the location of vegetation types in Oklahoma. Precipitation, the most crucial environmental variable, ranges from an average of 50 inches in eastern Oklahoma to 15 inches in the western Oklahoma. Soil conditions also exert a tremendous influence. In an area with the same amount of precipitation there may be a grassland or woodland, depending on the soil. Shale and limestone, which form fine-textured soils, tend to have grasses; sandstone, which forms coarser soils, normally is forested until the precipitation level reaches 18–21 inches per year. The trees themselves have a significant microenvironmental influence; by lowering soil temperatures, the shade protects the soil from the desiccating effects of the wind. The role of precipitation can be modified greatly by microclimatic influences.

Three major environmental factors that influence the formation of soil types are bedrock, climate, and topography. In the Ozarks, much of the soil is derived from limestone; it tends to



Map 1.6 — Grassland, savannah, and woodland types found in Oklahoma. Source: Gray and Gallo-way (1959).

be rich and moderately deep on the level surfaces and thin and covered with chert on the hill slopes. In the Ouachita Mountains, the soils on the mountain sides are produced from a bedrock of sandstone and are thin and rocky. The poorly drained valleys have soils derived from shale. To the west of the Ozarks in northeastern Oklahoma, fine-textured soils are created from limestone and shale. To the west of the Neosho Lowland, the bedrock changes to sandstone and the soil becomes sterile and sandy; it supports an oak/hickory savannah.

The most fertile soils in Oklahoma are found in the Great Plains west of the central section of the state. These fertile western soils differ from each other by the varying amounts of calcium or alkaline salts which accumulate in the subsoil. The more western soils have higher levels of calcium because lower precipitation does not leach the plant nutrients. The soils tend to be dark-reddish brown in color until one reaches the Panhandle. There the soil becomes lighter in color because of the higher accumulation of salts. In many areas that have western soils, hardpan is a problem. Hardpan is a zone of compaction that develops in the soil at the depth of water penetration. It stops deep root penetration and thus tends to promote grass growth rather than tree growth.

LANDFORMS

The landforms of Oklahoma are also a study in contrasts. They vary in general terrain conditions, in rock types, and in structure. Twelve landform regions are herein recognized by the authors.

Ozark Uplift

In northeastern Oklahoma, the Ozarks extend into the state from Missouri and Arkansas. The uplift has a dome structure with its center in the St. Francois Mountains of eastern Missouri. In Oklahoma, the Ozarks can be described as having two different natural landscapes or regions: the Springfield plateau and the Ozark rim (or Boston Mountains).

The Springfield plateau has the topography of a dissected plateau. The rock layers are nearly horizontal, but the landscape does not appear level

because streams have cut deep, steep-sided valleys separated by broad, flat divides. The rocks in this region are mainly limestone and chert. Chert is a white, very hard mineral that occurs within limestone beds and commonly remains as a residue after the limestone has been eroded or dissolved; the chert residue typically is several feet thick and it mantles the hills and slopes. Because limestone is soluble, it contains many caves, sinkholes, and springs. These springs most often are found along steep hillsides in deep valleys. The chert mantle rock acts like a sponge, absorbing water from November to April and discharging it during dry periods in the summer. The water flows through rock joints downward and laterally until it meets a barrier, most commonly impermeable shale, that forces the water to move laterally into the valley. The water has few impurities and quality is very high. Because of these groundwater reserves and runoff in a rocky land, the streams in this region often are crystal clear, quite in contrast to waters in many areas of Oklahoma.

The Ozark rim, also called the Boston Mountains (a term more generally applied to the southern rim of the Ozarks in Arkansas), differs from the Springfield plateau in that it has a much more rugged topography. The southern and western rims of the Ozarks are cut by several northeast-trending faults. A broken landscape of steep escarpments is formed by fault blocks consisting of hills capped by resistant sandstone. Deep stream valleys that parallel the faults have formed in the more easily eroded shale and limestone. The highest elevations are 1,550–1,621 feet, mainly to the southeast near the Arkansas border. The elevation is generally lower to the west and the north. Base relief (the difference between the top of a ridge and the base) often appears significant, because the valleys typically are 50–400 feet deep. Without doubt, this is a region of low mountains, rather than a tableland of rolling hills. This region merges into the hill and valley belt of the Arkansas Valley.

Arkansas Valley

The Arkansas Valley lies between the Ozark uplift and the Ouachita

Mountains. Most of the Valley is a low plain, about 500–600 feet high, but there are several prominent synclinal mountains and mesas, particularly south of the Arkansas River. Cavanal, Sans Bois, Sugarloaf, and Poteau Mountains rise to 1,500 feet or more above the plain. They have a strong linear character and an east–west trend. The tops of the mountains are typically broad and flat, and the sides are very steep; they have the appearance of buttes or mesas.

The process by which the Arkansas Valley hills formed is significant in understanding several other geomorphic (landform) features in the natural landscape of Oklahoma. Climates have alternated from semiarid grasslands to humid woodlands over the last 10,000 years. The alternating climatic sequences have had geomorphic influences. In such a climate sequence, hills are formed with flat summits, topped by caprock (erosion-resistant rock); slopes are steep, and very few slopes have intermediate angles. So the similarity of the Arkansas Valley hills to mesas of the western U.S.A. may not be accidental. In the Arkansas Valley, the more resistant sandstones now cap the synclinal hills; the semiarid climate that prevailed in the area during the Altithermal Interval (approximately 2,000–5,000 B.C.) helped shape the hills into mesas.

Ouachita Mountains

The Ouachita Mountains have the most rugged topography and the greatest relief in the state. They extend from Little Rock, Arkansas, to Atoka, Oklahoma, and rise to their greatest heights near the Oklahoma/Arkansas border at Rich Mountain (elevation, almost 2,700 feet). Rich Mountain is one of several long and sinuous ridges, including the Winding Stair and Kiamichi Mountains, that are topped by resistant sandstone separated by shale valleys. In this northern part of the Ouachitas there is a virtual duplication of the structure and topography of the Appalachian Ridge and Valley district.

This Ridge and Valley section of the Ouachitas has several parallel linear ridges with east–west trends. The topography has influenced the stream drainage; rivers (such as Kiamichi

River) begin near Arkansas, flow west through the valleys, and then curve to the south and flow into the Red River.

The Ouachitas change character farther to the southeast; there they can be identified separately as the novaculite uplift. The novaculite uplift, extending from Little Rock to Glover, Oklahoma, has much older rock and a more highly complex topography. The height of ridges is lower, but the elevation is more variable than in the Ridge and Valley province farther north, and knobs are prevalent. The line of the horizon is much more broken.

Between the novaculite uplift and the coastal plain, a small section of the Athens piedmont extends from Arkansas into Oklahoma to about the Mountain Fork River. The Athens piedmont is comparable to the Appalachian Piedmont. The topography is formed by relatively low east-west ridges; the highest has an elevation in excess of 1,200 feet. A very pronounced trellis drainage pattern is formed by the ridges.

Coastal Plains

South of the Ouachita and Arbuckle Mountains is the northwestern extension of the Coastal Plain of the Gulf of Mexico. The lowest elevation in the state (287 feet) is found in this area, near the Arkansas border. The relatively smooth topography has northward-facing escarpments formed by resistant limestones. Most of the sandstones, shales, and limestones in the area are soft and produce reddish-yellow soils; erosion damage has formed numerous gullies.

Prairie Plains

The Prairie Plains extend from Kansas and Missouri into northeastern Oklahoma, flanking the Ozark uplift. Two distinct subregions have been identified for the area: the Neosho Lowlands and the Claremore Cuesta Plains. The Neosho Lowlands have a smooth rolling topography with isolated, rounded knob hills. These round hills, 100–200 feet high, resemble buttes with flat tops. As in the Arkansas Valley, this landscape feature is, in part, a product of the climate alternating from semiarid to hu-

mid, and, in part, a product of a resistant cap rock.

The Claremore Cuesta Plains are the beginning of a landscape form, the *cuesta*, which characterizes much of central Oklahoma. A *cuesta* is a ridge with a gentle dip slope on one side and a steep slope or escarpment on the other. In profile, the ridge would be asymmetrical. In the Claremore Cuesta Plains, rock layers dip to the west and create a stair-step topography. The escarpments capped by limestone and sandstone face to the east, whereas the gentle slopes dip to the west. Shale forms the broad valleys that separate the *cuesta* ridges.

Rivers dominate much of the landscape; several of them converge as tributaries of the Arkansas. Several reservoirs, such as Lake O' the Cherokees (Grand Lake) and Oologah Lake, have been created in the area to utilize the large quantities of water.

Sandstone Hills

The boundaries of the eastern Sandstone Hills are not distinct from the surrounding regions; the Sandstone Hills merge into the other areas, particularly the Central Redbed Plains. The topography of the Sandstone Hills is rugged; many sandstones form steep escarpments, and the shales weather rapidly. The relief varies 300–400 feet between the hills and valleys. The shale lowlands in this region are less extensive than in the area to the east. The escarpments generally are so strewn with boulders that farming is precluded. These ridges are so densely forested with blackjack and post oaks that they were called the Cross Timbers by early settlers who had to traverse the area during their westward migration.

In the northern section, the Sandstone Hills are synonymous with the Chautauqua or Osage Hills. These sandstone escarpments have a dissected topography, with numerous narrow steep valleys that have relief of 200 feet.

To the west of the Chautauqua or Osage Hills is the Northern Limestone Cuesta Plains region, the southern extension of the Flint Hills of Kansas. The chief difference between this area and the one to the east is that the *cuestas* are formed by limestones instead

of sandstones. In the Oklahoma extension of the Flint Hills, the relief is generally much less; grassy plains dominate the landscape.

Central Redbed Plains

The largest landform region in Oklahoma is that of the Central Redbed Plains, a rolling lowland. Relief is generally no more than 50 feet. The rivers have cut broad valleys with gentle sides. This region extends from central Kansas to central Texas, with the section in Oklahoma having the widest extent. Bedrock consists of soft shales and thin sandstones that form only low escarpments. The most striking feature of the bedrock and soil is the bright red color. At times, it is almost lurid in its blood-red color and in sharp contrast with the greens of spring vegetation.

Arbuckle Upland

The Arbuckle upland, in south-central Oklahoma, is the remnant of a very old mountain-building process. The surface extent of the uplift is 65 miles long and 30 miles wide. The central core of the Arbuckles is granite, which is surrounded by steeply dipping limestones, shales, and sandstones. The dip locally is so steep that the strata are vertical or overturned. Differential erosion of these steeply dipping limestones has formed a "tombstone topography." The exposed white limestone beds are aligned in fairly straight courses and give the impression of a vast cemetery.

Topography in the Arbuckle upland is generally flat or level, even though there are a few deep valleys or canyons. The uplift is divided by the Washita River canyon into two sections; the western part is called the Arbuckle Hills and the eastern part, the Arbuckle Plains. The western Arbuckle Hills present the definite appearance of an upland; the northern escarpment has relief of 400 feet. The greatest relief, of about 450 feet, is along the bluffs of the Washita River canyon. The Washita River is unusual because it flows from the Redbed Plains and crosses an isolated upland. It is an excellent example of a superimposed stream. In an earlier geologic period, the river flowed over uniform sediments that had buried the upland;

eventually, when the Arbuckle uplift was exposed, the river cut a canyon through the mountains.

Much of the drainage in the limestone part of the region is underground, and sinkholes are frequent. Many of the surface streams have waterfalls; Turner Falls is the most widely known. The water in the region dissolves calcium carbonate as it flows underground. When the water surfaces and flows over a waterfall, the calcium is precipitated as travertine. Artesian water is found locally, caused by aquifers dipping beneath impermeable formations. Many of the springs, such as those near Sulfur, have highly mineralized waters.

Great Plains Broken Lands

In this complex region there are several physical landscapes based on different rock types and erosion processes. The region embraces most of the western quarter of Oklahoma, excluding the Wichita Mountains and the High Plains. Common to the distinct landscapes is their general "western appearance"; in this region, one feels that the West begins. The region has buttes and mesas, sand dunes, the mysterious Caddo canyons, and white-gypsum caprocks. Grasslands dominate because of the increasing aridity as one moves west, and the whole landscape opens up as low humidity gives the atmosphere greater clarity and creates the big skies of the West.

Three lines, or zones, of gypsum hills have been identified in the Great Plains Broken Lands: the Cimarron, the Weatherford, and the Mangum Gypsum Hills. The Cimarron Gypsum Hills (150–250 feet high) result from the greater resistance of gypsum to erosion. Because the rock layers are nearly horizontal, the gypsum caprock creates long detours around valleys, and extensive canyons are formed as a result. The most pronounced gypsum-capped escarpment is oriented to the northeast, overlooking the Cimarron River. In some areas, linear, narrow escarpments and badlands (highly eroded area of gullies), ravines, and ridges are present in the interbedded shales and gypsums. The most noted gypsum escarpment in northwestern Oklahoma is Glass

Mountains, so named for the selenite gypsum crystals which sparkle like glass fragments. Gypsum pieces are scattered on the slopes of the underlying shale since gypsum is more erosion resistant. The greatest relief of the buttes is about 250 feet.

Karst features (i.e., caves, sinkholes, and caverns) are associated with the gypsum formations. The best example of a gypsum cave is Alabaster Cavern, formed by the dissolution of soluble gypsum. Vertical movement of ground water through fractures and joints dissolved the gypsum and created one of the largest known gypsum caves in the world.

The other areas of gypsum hills (Weatherford and Mangum districts) have landforms and karst features very much like those in the Cimarron Gypsum Hills.

Several sand dune belts and salt plains are present in the Great Plains Broken Lands. The sand dune belts generally are found on the north side of the Salt Fork, Cimarron, North Canadian, Canadian, and North Fork Red Rivers. The sand is windblown from the modern river channels, or from the channels formed in earlier periods. Most of the sand dunes have been stabilized by grass, and the landscape has a hummocky appearance. In some areas, however, the dunes have no grass cover; there they are active and can migrate. The sand dunes are 25–75 feet high and have steep leeward slopes and gentle windward slopes; in profile they are asymmetrical. Since the prevailing winds are from the south and southwest, the steeper, leeward sides of active dunes face north, and the dunes migrate to the north. Migration of active dunes is slowed or halted by grass cover. Once stabilized, the dunes are rounded by water erosion. Little Sahara State Park, near Waynoka, is famous in Oklahoma for its sand dunes.

Salt plains are associated with several of the sandy alluvial plains along the western rivers. The major landscape features of the salt plains are their flatness and the thin crust of white salt that covers the surface after several dry days. The salt is derived from salt beds deposited during Permian time. Ground water dissolves the salt and forms a saturated brine

that flows from several springs in western Oklahoma. The greatest effect of this salt is degradation of water quality downstream from the salt plains on the Salt Fork, Cimarron, and Elm Fork Red Rivers. Some commercial use is made of the salt at Big Salt Plain on the Cimarron River.

The bedrock in the Western Sandstone Hills is soft, red sandstone which forms gentle slopes and a rolling terrain. Steep-walled canyons, called the Caddo canyons, are cut through the sandstone hills. The maple forests at the bottoms of these canyons are remnants of hardwood forests that covered the plains during Pleistocene time.

Several buttes, such as Ghost Mound, Lone Mound, and Rock Mary, rise above the generally level terrain. Rock Mary in Caddo County is the most famous; its distinctive skull shape served as a landmark for wagon trains moving west. Many of the Caddo buttes are capped by an erosion-resistant layer of dolomite.

The Western Sandstone Hills merge into the Western Redbed Plains. The gently rolling Plains are distinguished by the characteristic red color of the soil, which is derived from weathering of the underlying red shale and sandstone bedrock.

Wichita Mountains

Rising above the plains and low hills of southwestern Oklahoma are the Wichita Mountains. The Wichita Mountains, which formed in the Early Pennsylvanian Period, are the oldest mountains in the Great Plains. They can be characterized as granite mountains, but they also contain outcrops of rhyolite, gabbro, and limestone; the mountain range has an east-west trend. The highest peaks (up to 2,475 feet elevation) are in the east; Mt. Scott (elevation, 2,464 feet) has the greatest relief, 1,100 feet. The granite blocks were covered by Permian deposits, and only in more recent geologic times have they been exhumed. One consequence of this burial is that in some areas, particularly in the west, the mountain tops almost appear as islands because they are isolated from each other by the later-deposited Redbed Plains. The Wichitas Mountains are the uppermost level of an under-

ground mountainous terrain that extends into the Panhandle of Texas.

High Plains

The High Plains region of Oklahoma occupies the northwestern section of the state, particularly the Panhandle. The High Plains region, which extends from Texas to South Dakota, is a mantle of sandy alluvium and windblown sediments deposited by rivers flowing eastward from the Rocky Mountains. This Tertiary alluvial deposit is called the Ogallala Formation. Underlying much of the Ogallala is "fossil" ground water which accumulated in the Pleistocene and now is being depleted by irrigation use for crops. A noted feature of the High Plains is the region's uniform flatness. The level appearance is somewhat deceptive, however, since the land slopes generally to the east. Another feature is the caprock, a subsoil deposit of caliche. It is, however, much less noticeable in the High Plains region than farther south in the Llano Estacado.

The High Plains have few surface streams since the precipitation soaks into the Ogallala Formation, but there are depressions scattered throughout the High Plains. These shallow depressions most likely formed as blowouts, caused by wind erosion. Oklahoma's sequences of alternating climate, from humid to arid conditions, may be causal factors in forming these depressions. Leaching in wetter periods dissolves the calcium-carbonate cement of the soil, and during the arid period wind erosion forms the blowouts. In a few areas, depressions are sinkholes produced from dissolution and subsidence.

Raton Mesas

The Raton section, in the westernmost edge of the Panhandle, is an area without the Tertiary mantle of the Ogallala Formation. The prominent landscape features of the area are mesas and tablelands, which formed from erosion-resistant rock units. Black Mesa is the best known; it has the state's highest elevation (4,973 feet). Black Mesa is the easternmost extension of a larger mesa, the Mesa de Maya, which exists mainly in Colorado. The caprock for Black Mesa is

basalt formed from a lava which was extruded by a volcano whose remnant is called the Black Buttes in eastern Colorado. The lava from the volcano flowed down a valley into Oklahoma. The valley became a hill after stream erosion removed the surrounding, less resistant rocks.

CONCLUSION

Oklahoma's natural environment is composed of many contrasting features. Climate has played the key role in creating the physical variety in the state's landforms, vegetation, and soils. Oklahoma is a unique land that we need to better understand and protect.

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— Chapter 1 —
LIST OF ILLUSTRATIONS

Figures

1.1 — Average monthly precipitation in Oklahoma _____	5
1.2 — Annual precipitation in Oklahoma, 1920–86 _____	7

Maps

1.1 — General geology and physiographic areas of Oklahoma _____	4
1.2 — Average annual precipitation (in inches), 1970–79 _____	5
1.3 — Mean January temperature (°F), 1941–70 _____	6
1.4 — Mean July temperature (°F), 1941–70 _____	6
1.5 — Number of dry years in Oklahoma, 1931–65 _____	7
1.6 — Grassland, savannah, and woodland types found in Oklahoma _____	8

Tables

1.1 — Frequency of tornadoes and thunderstorms _____	7
1.2 — Top 10 states with high frequencies of tornadoes, 1953–74 _____	7

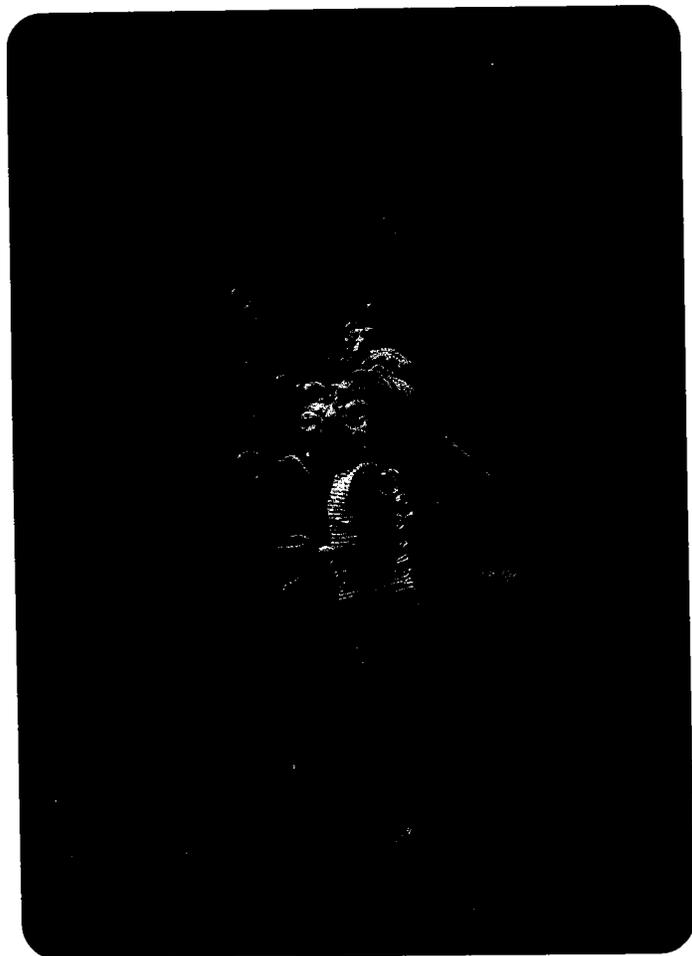
Oklahoma Resources

Chapter

2

Population and the
Labor Force

by
Karen Selland
and
John McGraw
with assistance from
Binita Sinha



Contents

Executive Summary _____	17
Introduction _____	18
Population Size, Distribution, and Racial Character _____	18
The Dynamics of Population Change _____	19
Oklahoma Migration Trends: 1950–90 _____	20
Comparison to Other States in the Region _____	20
Oklahoma Migration, Demographic and Economic Impact: 1975–80 _____	21
Origin, Destination, and Volume of Oklahoma Migrants _____	22
Demographic and Socioeconomic Characteristics of Oklahoma Migrants _____	23
Projected Future Growth _____	23
Oklahoma’s Present and Future Population Growth _____	24
Projected Regional Growth _____	24
Compositional Changes _____	24
Oklahoma’s Age Composition _____	25
Labor Force _____	25
Implications of a Changing Labor Force _____	26
Implications for School and College Enrollment _____	27
Implications of a Growing Elderly Population _____	28
Conclusion _____	29
References _____	29
List of Illustrations _____	30

Population and the Labor Force

Karen Selland* and John McGraw
with assistance from Binita Sinha

Executive Summary.—Although Oklahoma's population grew rapidly in the 1800s and early 1900s, its population density still is less than the national average. More than half of the state's population lives in the five metropolitan areas, Oklahoma City, Tulsa, Lawton, Enid, and Ft. Smith (which is shared by Arkansas). The state is predominantly white, but its Native American population is second largest in the country. The state's total minority population (including Hispanics) is 19.01% of the population as a whole. The minority population (with the exception of the Native American segment) also lives primarily in the state's metropolitan areas. Oklahoma, with a 1990 population of approximately 3,145,000, ranked fifth among its neighbors and 28th in the nation in population size.

Beginning with the Land Run in 1889, Oklahoma's population growth has fluctuated. The land runs, migration to the Sun Belt, the "baby boom," the "echo effect," and the "oil boom" all caused phenomenal increases in the state's population. However, the infamous Dust Bowl of the 1930s and the "oil bust" from late 1982 to 1986 ravaged the state's economy, and each caused a mass exodus of Oklahomans. It is estimated that more than a third of the state's population left between 1930 and 1960, due to the Dust Bowl and its aftermath. Between 1970 and 1980, Oklahoma gained more than 241,000 migrants; it gained another 204,000 between 1980 and 1983. Since 1983, due to plummeting petroleum prices, the state has consistently lost population to outmigration.

The slow population decline due to outmigration is not expected to continue. Projections show that average annual net migration over the decade 1990–2000 should be about 5,000. In addition, a healthy rate of natural increase throughout the decade is anticipated. The combination of migration and natural increase should add more than 280,000 persons to the state's population by 2000, under a medium migration assumption.

The population of Oklahoma, like that of many other states in the nation, is aging. The median age for Oklahomans, which was 33.2 in 1990, is projected to increase to 37 years by 2010. Yet, even with this substantial increase, the median age for Oklahomans will continue to be less than that of the total U.S. population. One of the most important consequences of the predicted aging of the population is the change in the composition of the labor force. In order to keep up with the employment demands of the baby-boom generation, the labor market has had to expand with each successive cohort of workers. The movement through the labor market of this generation will have important ramifications for employment and retirement, as well as effects on the Social Security system.

A second important consequence of an aging population is its impact on the education system. Despite continued population growth throughout the rest of the century, there will be an uneven distribution of children and young adults, which will force constant adaptation by schools.

Finally, revolutionary change is in store for the state as a result of the increase in the number of elderly citizens. The entire elderly population (age 65+) is projected to increase 26% by 2010. However, the segment of those aged 75+ will increase 44%, and the population aged 85+ will increase 93%. A large population of elderly people raises difficult questions about responsibility for their welfare, especially since financial and health difficulties are often associated with old age.

This chapter stresses that Oklahoma's demographic processes and social and economic life are closely interrelated. Recognition and study of present and future demographic characteristics will aid policy makers in their efforts to develop more informed and effective policies.

*Deceased.

INTRODUCTION

This chapter will trace Oklahoma's population growth and provide basic facts and figures about its population. It will examine the components of population change (natural increase and net migration) and give special emphasis to the potential changes in the age composition of the state's population. It will also compare Oklahoma's recent growth with that of other states in the region (the states surrounding Oklahoma). The chapter will present a picture of the state's current and projected growth. Finally, it will review some of the implications of projected changes for the social, economic, and political climate of the state.

POPULATION SIZE, DISTRIBUTION, AND RACIAL CHARACTER

Relatively complete documentation of Oklahoma's population growth exists back to the land runs which began 100 years ago. Almost overnight, these events brought thousands of migrants into the state. There are no state birth or death records available prior to 1920, but it is very likely that high rates of natural increase (about 30 births per 1,000 people) also contributed to the state's rapid population growth. Oklahoma's 1890 population of 259,000 tripled in only 10 years and then doubled to 1.4 million by statehood (1907). It took another 69 years, however, (from statehood to 1976) for the population to double again.

During the 1970s, the population in Oklahoma grew at rates unequaled since the 1920s and increased by more than 18%. Oklahoma's population increase reflected a nationwide movement of people to the Sun Belt. The overall population growth during 1980-90 was 4%.

Oklahoma's population density is less than the national average. In 1990, Oklahoma had 1.9% of the nation's total land area, but only 1.7% of the total U.S. population. The state's population density was 45 persons per square mile compared to 68 persons for the nation. In population size, Oklahoma is currently ranked 28th, after being surpassed by Colorado and Arizona in the 1990 census.

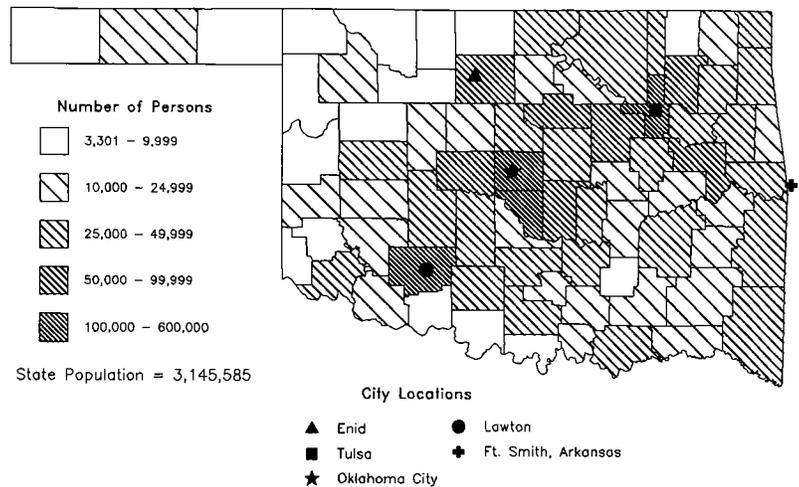
The population of the state is distributed largely among the urban ar-

reas (Map 2.1). More than half of the state's population lives in the five metropolitan areas, Oklahoma City, Tulsa, Lawton, Enid, and Ft. Smith (which is shared with Arkansas). The 14 counties comprising the metropolitan areas in the state made up 57.99% of the state's population in 1990.

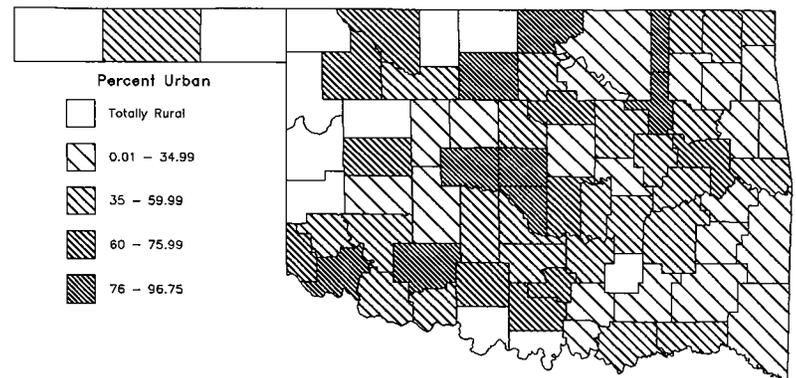
Oklahoma is primarily urban, about 68%, but less so than the nation, which is about 75% urban. In this context, urban refers to the number of persons living in urbanized areas or, outside urbanized areas, in cities and towns with populations of 2,500 or more. Still, 12 counties in the state are totally rural (they have no communities as large as 2,500) (Map 2.2). Only 9 counties have a very high proportion of urban population, 76% and above.

By race, the state is predominantly white. The nonwhite or minority races, including Hispanic, comprise 19.01% of the total state population (Figure 2.1). Native Americans are the second largest group in the state (7.84%), followed closely by blacks (7.36%). Nationally, Native Americans comprise less than 1% and Asian and Pacific Islanders, 1.6%, of the total population. The racial category of Asian and Pacific Islanders is a relatively small group in the state (1.03%).

The Hispanic population is categorized as an ethnic group rather than a race. It composes more than 6% of the nation's population and 2.74% of the state's population. Persons of "Spanish origin," the Census Bureau's designation for Hispanic heritage, can belong to any race.



Map 2.1 — Oklahoma population by county, 1990. Sources: U.S. Bureau of the Census (1990a); Center for Economic and Management Research (1992).



Map 2.2 — Percentage of urban population (living in communities of 2,500 or more) in Oklahoma by county, 1990. Sources: U.S. Bureau of the Census (1990a); Center for Economic and Management Research (1992).

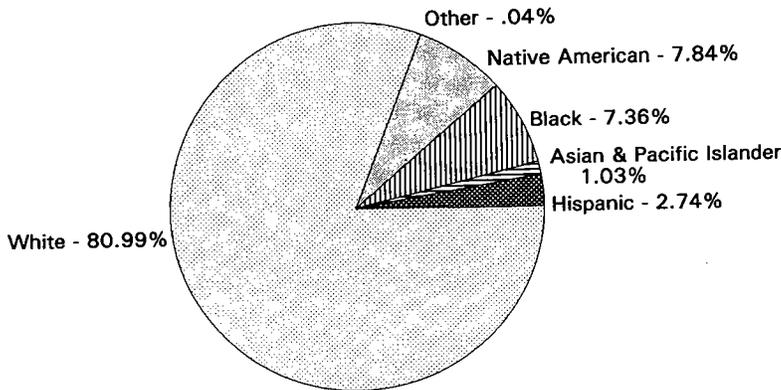


Figure 2.1 — Oklahoma population by race, 1990. Source: U.S. Bureau of the Census (1990a).

Including Hispanic with other minority groups, the state's total minority population is 19.01% of the entire population, compared to a U.S. total nonwhite population of 19.70%. Oklahoma's minority population lives mainly in metropolitan areas, with the exception of the Native American population. However, the eastern and southwestern portions of the state have higher proportions of minorities than the rest of the state (Map 2.3). Adair, Cherokee, Okfuskee, Caddo, Comanche, Harmon, and Tilman Counties have among the highest percentages of minority population (32% and above).

THE DYNAMICS OF POPULATION CHANGE

Changes in both the size and composition of a population always occur as the result of a complex interaction between the two components of population change, natural increase and net migration. Natural increase simply refers to the total number of live births in a population minus the total number of deaths. Net migration, on the other hand, refers to the number of persons moving into a particular area minus the number of persons moving out. The volume of net migration is affected both by "internal" migration (movement from state to state within the nation) and by international migration.

Substantial changes in fertility and mortality rates typically are gradual over time and, therefore, generally are slow to bring about population changes (the 1944 fertility rate was 2.5;

in 1957, 3.8). Even when accelerations in fertility occur—as during the baby boom when rates moved from average to high fertility in 12 years—the effects of an increased population on the schools and labor force are delayed. Migration, on the other hand, can change rapidly and produce immediate short-term, as well as long-term, effects on the labor force, the sale of consumer goods, housing, and the education system.

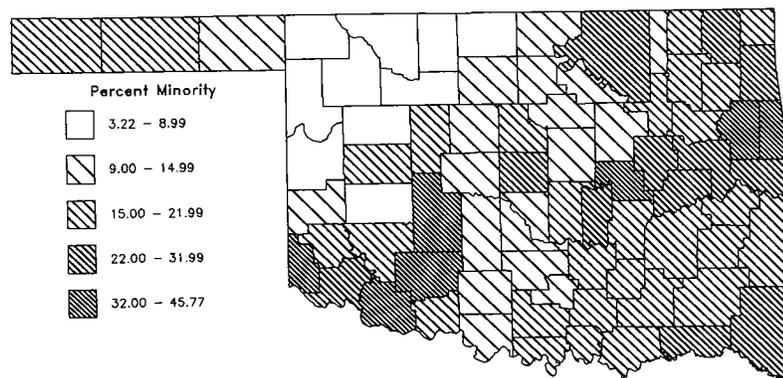
In turn, variations in all three rates—fertility, mortality, and migration—result from a complex interplay with a variety of social, economic, and demographic factors. For example, fertility rates are sensitive to female labor force participation, age at first birth, and marriage and divorce rates. Mortality rates, on the other hand, are largely determined by the level of health care, environmental quality and safety, and general health habits.

Finally, factors such as economic growth, employment opportunities, and quality of life influence migration patterns.

In order to fully understand the process by which population size changes, it is necessary to analyze each component of population change individually. Figure 2.2 shows the birth, death, and net migration rates over the period 1920–90. Because no annual migration rates are available prior to 1940, the migration component in the graph appears flat from 1920 to 1940. The shaded area between the birth rate and death rate portrays natural increase, the amount by which the population would grow were there no migration.

The graph shows that the death rate in Oklahoma has remained relatively stable, while both migration and birth rates have fluctuated. In the 1920s, for example, the high birth rate and small positive net migration produced a relatively rapid population gain. By the late 1920s, however, birth rates plummeted, reaching a low of 16.8 births per 1,000 women in 1929. Fertility rose again during the 1930s and early 1940s and accelerated rapidly after World War II. In 1947, the birth rate reached 23.3 births per 1,000 women; a record 53,000 babies were born in that year. This was the beginning of the baby boom, 1946–64.

It was the large natural increase in the decades between 1930 and 1960 that helped offset the large numbers of persons leaving the state during the same period. In those three decades, Oklahoma lost nearly 900,000 persons



Map 2.3 — Percentage of minorities in Oklahoma by county, 1990. Source: U.S. Bureau of the Census (1990a).

Table 2.1 -- Components of Population Change for Oklahoma, 1920-87

Time Period	Beginning Population (000's)	Change (000's)	Components		Change per 1,000 Population in Base Year			% Change Due to Positive Net Migration
			Natural Increase (000's)	Net Migration (000's)	Total Change	Natural Increase	Net Migration	
1920-30	2,028	368	294	74	18.1	14.5	3.6	20.1
1930-40	2,396	-60	226	-285	-2.5	9.4	-11.9	0
1940-50	2,336	-103	286	-388	94.4	12.2	-16.6	0
1950-60	2,233	95	314	-219	4.3	14.1	-9.8	0
1960-70	2,328	231	217	13	9.9	9.3	0.6	5.6
1970-80	2,559	466	173	241	18.2	6.8	9.4	51.7
1980-87	3,025	247	179	68	8.2	5.9	2.2	27.5

Sources: U.S. Bureau of the Census (n.d.); Oklahoma State Employment Security Commission (1988); and Oklahoma State Data Center (1988).

to the Dust Bowl and its aftermath. More than one-third of the state's population moved away. The total population of the state, however, declined by only 68,000 persons, a loss of less than 3% (Table 2.1). Although fertility subsequently dropped in the 1960s and 1970s and reached a new low of 15.3 births per 1,000 women in 1973, migration remained strong and accounted for half of the state's growth (52%) in the 1970s.

Fertility remained low throughout the 1970s and early 1980s, yet, in 1982, the largest number of births in state history (nearly 59,000) was recorded. The number of births jumped because of the large number of baby-boom women entering their childbearing years (the "echo effect"). The relatively large number of young adults moving into the state during the 1970s and early 1980s also increased the number of potential mothers. The number of young women in the state was so large that even the increased rates of delayed marriage, divorce, and childlessness, together with the low fertility rate, did not stop the rising number of births.

Oklahoma Migration Trends: 1950-90

Migration in Oklahoma has fluctuated over the last 40 years. From 1950 to 1960, the state lost more than 218,000 persons to migration; it then gained more than 13,000 persons between 1960 and 1970. In the 10 years between 1970 and 1980, Oklahoma gained more than 241,000 migrants; it gained another 204,000 between 1980 and 1983. Since 1983, however, the state consistently has been losing pop-

ulation to outmigration. In the mid-1980s, Oklahoma had higher outmigration because of the decline in its economy caused by losses in the mining, construction, and financial sectors.

To understand these variations in the state's migration patterns, it is helpful to examine the connection between economic conditions and large-scale population movements. Population losses in Oklahoma between 1950 and 1960 reflected a stagnant and, at times, declining state economy. Consequently, many residents of Oklahoma probably were forced to seek employment opportunities, or higher wages, outside the state. The slow but steady economic growth in the state between 1960 and 1970 turned this situation around and brought a small inflow of migrants to the state. Next came the extraordinary increase in the price of petro-

leum in the 1970s, which rapidly accelerated the state's economic growth. As a result, thousands of jobs were created, and there was a large influx of migrants to the state. A substantial downturn in the mining (including oil and natural gas) industries began in 1982, however; because of the subsequent drop in employment, the state has been losing population to outmigration again.

Comparison to Other States in the Region

During the past 60 years, Oklahoma's population has grown less than half as fast as the nation's. Moreover, state growth has been much more erratic, ranging from a low of -4.4% change in the 1940s to a high of 18.2% in the 1970s. Over the same period (1920-80), the nation's growth was lowest, 7.2%, during the Depression (1930-39) and highest, 18.5%, in

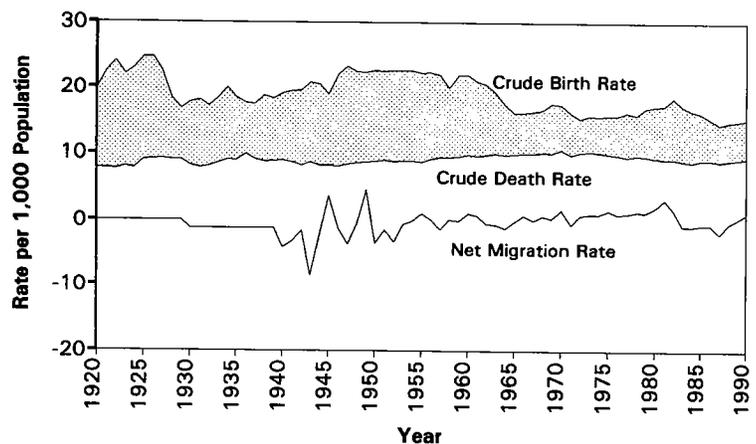


Figure 2.2 — Components of population change for Oklahoma, 1920-90. Sources: Oklahoma State Data Center (1988); U.S. Bureau of the Census (1990a).

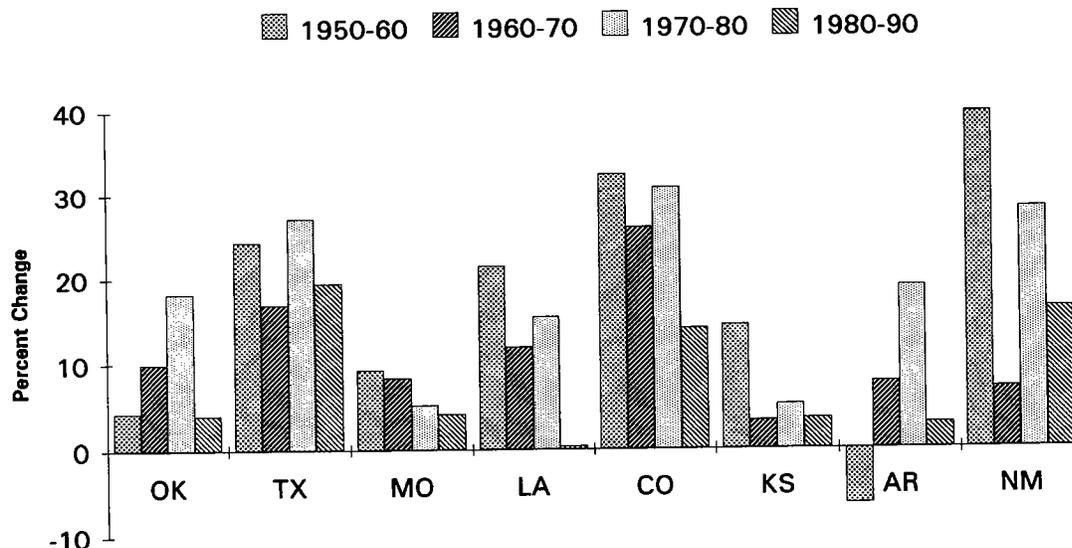


Figure 2.3 — Percentage change in population of Oklahoma and selected states, 1950–90. Sources: Oklahoma State Data Center (1988); National Center of Health Statistics (n.d.); U.S. Bureau of the Census (n.d.); Bogue (1985); Center for Economic and Management Research (1992).

the 1950s during the height of the baby boom. Prior to 1970, state growth rates were consistently lower than national rates; between 1970 and 1983, state growth rates were consistently higher than national rates. However, the overall growth rate for Oklahoma during 1980–90 was 3.97%, which was much below the national average of 9.8% during the same period.

In terms of population size, Oklahoma, with a 1990 population of about 3,145,000, was ranked fifth among its neighbors and 28th in the nation. Texas, third-largest state in the nation, continued to dominate the region with its enormous population. Its population is approximately the same as that of Oklahoma, Arkansas, Colorado, Kansas, and Louisiana combined. Oklahoma's population growth from 1950 to 1990 was fairly erratic (Figure 2.3).

Within the region, strong natural increase over the last three decades has caused state populations to grow or has moderated large population losses from outmigration. In all states in the region, natural increase declined from 1950 to 1980. This decline was due both to the high fertility of the baby boom and to the subsequent fall in fertility in the 1970s and 1980s (Figure 2.4).

Fertility, as measured by the total fertility rate (total births per 1,000 women of childbearing age), has been

more moderate in Oklahoma than in other states. It neither expanded as fully during the 1960s nor contracted as much in the 1970s and 1980s. While the state's fertility was below that of the country from 1950 to 1970, it was 10% above by 1980. All states in the region, with the exception of Colorado, had higher fertility than the nation in 1980.

Oklahoma's 1980 total fertility rate was 2,022, slightly below the replacement level of 2,100 (or, as commonly expressed, 2.1 per woman). Still, it was higher than the U.S. fertility rate, which dropped 41% from 3.1 in 1950 to 1.8 in 1980. Texas, Louisiana, and New Mexico had higher fertility rates than Oklahoma in 1980, largely because all three states have a proportionately larger nonwhite population than Oklahoma. The fertility rate for nonwhites is consistently higher than that for whites. In Oklahoma, for example, Native Americans have a crude birth rate 20% higher than the white rate, while the black rate is 45% higher. Oklahoma, Texas, Louisiana, New Mexico, and Arkansas all have similarly high numbers of births to teen-agers.

Fertility has been on decline both nationally and in the state. In 1960, the fertility rate in Oklahoma per 1,000 women aged 15–49 was 3,419; it dropped to 2,370 in 1970 and continued to decline. In 1980, the fertility

rate among the same age group was 1,191; it declined to 1,967 in 1990. Beyond 1995, fertility is calculated to decline in Oklahoma by 0.05% annually.

The pattern of migration to the region changed tremendously over the period 1950–80. Combined net migration for the eight states for the period 1950–60 was negative; approximately 546,000 more persons left than came to the region. By the 1960s, however, this large outflow had slowed; only 85,000 more persons left than entered the region. A complete turnabout was evident by the 1970s as the region gained more than 2.5 million migrants. However, even during the 1970s, Kansas and Missouri continued to lose population to outmigration.

OKLAHOMA MIGRATION, DEMOGRAPHIC AND ECONOMIC IMPACT: 1975–80

Of the three components of population change, migration has the greatest potential to change both the size and composition of a population rapidly. Migration affects the size of a population by simply adding to, or subtracting from, the total number of persons. Compositional changes, on the other hand, occur because migration tends to be a highly selective process. That is, migration typically adds to, or subtracts from, a population, very distinctive types of people. Generally, people who migrate are more likely to

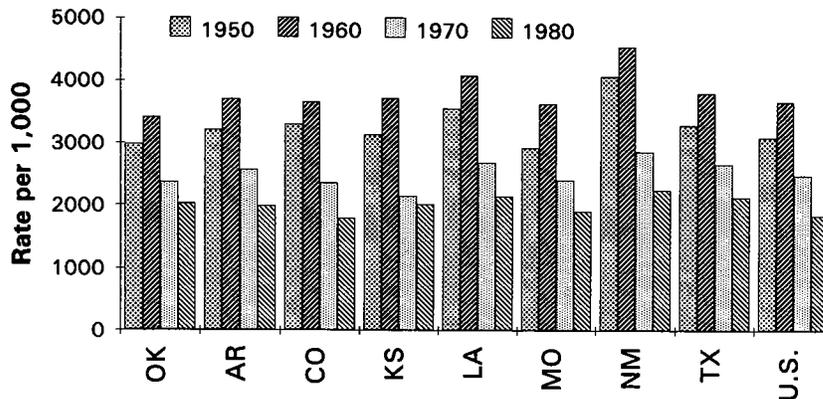


Figure 2.4 — Total fertility rates for Oklahoma and selected states, 1950–80. Source: Oklahoma State Data Center (1988).

be young, relatively well-educated, and to possess more job-related skills than people who do not migrate.

Changes in the size and composition of a population are closely related to changes in economic conditions. For example, an area experiencing substantial economic growth will naturally attract people seeking new or better employment opportunities. The resulting immigration may restructure the area's population by changing not only its size but also its composition. The immigration itself may stimulate economic growth further and, thereby, contribute to continued economic and population expansion.

In contrast, residents of an economically depressed, or declining, area may be forced to relocate in search of employment or higher wages. A large outmigration eventually may lead to further declines in the economy by depleting the labor pool of its most skilled and productive members. This in turn may reduce tax collections and lower consumer spending, which contributes to a downward spiral in the economy and additional population losses.

The search for new or better employment opportunities is one of the primary motivations underlying the decision to move. As a result, migration tends to redistribute the labor force from areas with surplus labor to those with shortages. In Oklahoma's case, the rapid expansion of the oil and gas industries during the latter part of the 1970s brought unprecedented economic growth. Thousands of new jobs were created, and there was a massive inflow of people seeking better employment.

Although it is impossible to ascertain the precise impact migration has on the economic and demographic characteristics of an area, it is possible to determine the characteristics of migrants and, thereby, estimate the changes that occur. By knowing the socioeconomic characteristics of migrants, one can gain insight into the causes and consequences of their movement.

The focus in this section is on the characteristics of Oklahoma migrants during the period 1975–80 and on analysis of the demographic and economic impact of their movement. Data used in this section were obtained from answers to the 1980 Census question about place of residence on April 1, 1975. Although these data are somewhat dated, they are the only available data that provide detailed information on the characteristics of migrants as well as their points of origin and destination. This detail makes it possible to identify and characterize immigrants and outmigrants, as well as net migrants.

Origin, Destination, and Volume of Oklahoma Migrants

It is important to remember that migration is always a two-way process. As some migrants depart a particular location, other migrants arrive. In Oklahoma's case, while nearly 266,000 residents left the state between 1975 and 1980, almost 424,000 persons from other states and countries moved to Oklahoma during the same period. Thus, the net gain from migration for the state in this period totaled more than 157,000 persons.

About 14% of the state's 1980 population entered Oklahoma between 1975 and 1980. Among neighboring states, this proportion ranked second only to Colorado's 21%. Colorado also ranked first among Oklahoma's neighbors in the proportion of the population that were outmigrants (14.6%). Oklahoma was fifth; only 8.8% of its population left the state between 1975 and 1980. In absolute numbers, Texas had the most net migrants, more than 900,000; Colorado was second, followed by Oklahoma.

Oklahoma gained population from all four regions of the nation as well as from abroad. Like most of its neighbors, about 10% of Oklahoma's immigrants were from abroad. Texas, with its large Hispanic population, attracted 19% of its immigrants from outside the country. The majority of Oklahoma's immigrants came from the South. The next largest group of immigrants came from the North-Central region, followed by the West and the Northeast. Oklahoma's neighbors provided 41% of its immigrants.

Outmigrants from Oklahoma did not move evenly throughout the nation. About half migrated to the South, one-fourth to the West, and one-fifth to the north-central states. Fewer than 10,000 people from Oklahoma moved to the Northeast. Half of Oklahoma's outmigrants moved to neighboring states. Texas, the most frequent destination for Oklahoman migrants, received more than 75,000 persons, or about 29% of all Oklahoma outmigrants. Second was Kansas, which received more than 19,000 (7.3%), followed by Arkansas, which received nearly 17,000 (6.2%). California was the only noncontiguous state to which a significant number of Oklahomans moved, 24,000 (9.2%).

Oklahoma gained more net migrants from the north-central states (42%) than from any other region. That is, Oklahoma was more attractive to migrants from the North-Central region than vice versa. Next were the western states (which contributed 28% of the total net migrants to the state), the southern states (18%), and finally, the Northeast region (13%). Among the individual states, California contributed the largest number of net migrants (24,000). Kansas contrib-

uted nearly 9,000 and Missouri, more than 7,000 net migrants. The largest flow of migrants occurred between Oklahoma and Texas (76,800 immigrants and 75,800 outmigrants), but Oklahoma gained only a total of 1,000 net migrants from Texas.

Oklahoma received 429,000 immigrants between 1980 and 1983; nearly 75% came from Missouri, Kansas, California, Arkansas, Colorado, Illinois, and Michigan. During the difficult period 1983–86, Oklahoma recorded negative migration; a majority of the outmigrants moved to Texas, California, Florida, Arkansas, and Missouri.

In 1991–92, Oklahoma had a positive net migration. In 1992, approximately 17,000 people moved into the state.

Demographic and Socioeconomic Characteristics of Oklahoma Migrants

There was a very strong relationship between age and migration. In Oklahoma, young adults 20–34 years of age were the most likely to move. The high rates of mobility within this age group reflect the many life changes and experiences which accompany early adulthood. These are the years in which large numbers of people are completing their formal education, entering the military or labor market for the first time, marrying and beginning families. These episodes often include or require a change in residence.

More than 178,000 persons aged 20–34 years moved into the state between 1975 and 1980, which accounted for 42% of all immigration. At the same time, more than 120,000 young adults (45% of the outmigration stream) left the state. Nevertheless, Oklahoma's net gain of young adults totaled more than 57,000.

Although the people who left the state during this period were somewhat better educated than those who entered, it should be noted that, compared to the state's total population, a larger portion of the net migrants had at least a high school diploma. This represents a substantial gain in human capital. In addition, Oklahoma was relatively competitive in comparison with neighboring states. Kansas and Missouri actually had net losses of persons with four or more years of

college while gaining a disproportionate number of persons with less than a high school education. Oklahoma also fared better than Arkansas in attracting persons with at least some college education and/or advanced degrees.

The state had a substantial net gain of about 65,000 economically productive individuals aged 16 years and older. Of these, 28,000 were in white-collar occupations and 37,000 held blue-collar jobs, which accounted for 43 and 57% of the net migration, respectively. Among the individual categories of occupations, the less-skilled blue collar category containing machine operators, fabricators, and laborers topped the list for net migrants with 21%. This is not surprising because many of the new jobs which spun off from the oil and gas industries required these skills. Other categories with large gains included precision production (17%) and service occupations (16%).

A comparison of the proportion of migrants employed in the different labor-force categories with the proportion employed from the total population (16 years and older) shows that a slightly lower percentage of net migrants were employed—56% of the total population versus 53% of the net migrants. Yet, only 2.2% of the 121,000 net migrants older than 16 were unemployed, which was quite similar to the 2.4% figure for the state's total population.

Given the net gain of economically productive individuals from migration, it is at first surprising that migration did not have a more positive impact upon the state's income profile. Oklahoma gained persons in all income categories, but more than one-fifth had incomes below \$3,000 per year. In 1979, the poverty level for a single person living alone was \$3,700. Since income generally increases with age and people who migrate tend to be younger, we would expect the income of migrants to be somewhat lower. Those entering the state, however, had a lower average income (\$7,500) than both the population at large (\$7,600) and those who left the state (\$8,200).

Migration between 1975 and 1980 produced no substantial changes in the racial or ethnic character of the

state's population. With a few small exceptions, the racial and ethnic composition of both immigrants and outmigrants was quite similar to that of the state's population. Overall, the state gained 129,400 whites, 10,300 blacks, 8,300 Asian and Pacific Islanders, 4,200 Native Americans, and 9,000 Hispanics (who can be of any race). The Asian and Pacific Islander gain of 5% of net migrants and the Hispanic gain of nearly 6% were greater than their respective proportions in the total population while whites and Native Americans were slightly underrepresented.

In short, the movement of thousands of individuals and families during the late 1970s not only increased Oklahoma's population, but also changed its character. While migration between 1975 and 1980 did not bring large numbers of affluent individuals to the state, it did bring individuals who were generally young, relatively well educated, and economically active. Oklahoma benefited by expanding its labor force with experienced and relatively well-trained individuals.

PROJECTED FUTURE GROWTH

By making certain assumptions about future trends in fertility, mortality and migration, we can calculate "population projections," which are predictions of the future population size. Because of uncertainties in predicting future changes in the population components, it is desirable to calculate more than one series of projections. The projections used in this chapter were calculated for the state and counties under three different sets of migration assumptions: high, medium, and low. The series of projections calculated under high migration assume atypically high rates of migration. Medium migration assumes a moderate gain from migration, and low migration assumes no population gain at all from migration. The Oklahoma Department of Commerce projections assume a high net migration of 15,000 per year, medium net migration of 5,000 per year, and a low net migration of 0 net migration. Three series of projections present a reasonable range for future population trends. One series, typically the projections calculated under the me-

dium assumption, is designed as the most probable series.

Oklahoma's Present and Future Population Growth

This section discusses future regional growth and compares Oklahoma's projected growth with that of other states in the region. It includes a brief discussion of the alternative scenarios possible under the low and high assumptions. The projections used in this section, however, are not from a single unified projection study. Rather, state-derived projections from most of Oklahoma's neighbors were used. All of these state-generated projections were completed after the recent economic recession and with full recognition of the trouble in the mining sector.

Although the recent outflow of migrants from Oklahoma has led to a slow population decline over the last several years, this trend is not expected to continue. Projections show that average annual net migration during the decade 1990–2000 should be about 5,000 persons. Although this is somewhat smaller than the 1.2% annual increases characteristic of the 1970s and the 1% annual increase for the decade of the 1980s, it nevertheless represents a relatively substantial population gain from migration. A healthy rate of natural increase (a total of more than 228,000 persons) during the 10-year period (1990–2000) is anticipated. Combined with migration, this will add more than 278,000 persons to the state's population.

The only variation in the series of projections is related to assumptions about the future course of migration in Oklahoma. Although some demographers prepare projections incorporating changes in fertility and mortality, these projections assume that these two rates will remain relatively stable through the year 2010. Under the medium assumption, the state would maintain a relatively low level of migration (approximately 5,000 per year). Since fewer young adults and young families are expected to enter the state, the rate of natural increase is expected to decline. Thus, Oklahoma's total population should reach approximately 3.6 million by the year 2010. If, on the other hand, net migra-

tion falls to a lower level than anticipated, Oklahoma's population may reach only 3.4 million. Finally, if Oklahoma has a larger net migration than expected (15,000 a year) the state's population could total 4.0 million.

The potential range of migration patterns also affects our predictions of Oklahoma's age structure. According to projections, the age group 18–64, which approximates the working age population, is most sensitive to variations in migration. Under the medium migration assumption, there would be more than 2.3 million persons in this age group by the year 2010. If Oklahoma fails to attract as many migrants as expected, however, the population 18–64 years old would total about 2.2 million. Under the high migration assumption, however, there would be approximately 2.6 million persons in this age group.

The variation in the numbers of persons aged 0–4 and 5–17 is dependent upon the migration patterns of their parents. For example, if more young families move into the state than anticipated, the number of children 0–17 years of age would naturally exceed our medium projection of nearly 852,000 by the year 2010.

Finally, the number of elderly persons (65+) in the year 2010 will also depend upon the level of migration. Although the projections for this age group appear quite similar under all three assumptions, the differences have profound implications for the state. Requirements for medical, residential, and institutional care are sensitive even to small changes in the number of elderly.

Since migration is so closely linked to the health of the state's economy as well as to the amount and type of competition among the states, it is difficult to determine the precise level of future migration to Oklahoma. At present, however, the medium migration assumption seems most reasonable.

Projected Regional Growth

Without exception, all states in the region are expected to grow. Texas, with more than 20 million persons by the year 2000, will remain the largest state in the region by far. It will have almost half the total population of the entire eight-state region. New Mex-

ico's population (<2 million) will remain the smallest. During the next decade and a half, Colorado, Texas, and New Mexico will remain the region's fastest growing states with average annual growth rates significantly higher than Oklahoma's 1.2%.

The states in the region that continue to attract more migrants than they lose will grow at a more rapid pace. Without another baby boom, states that fail to attract migrants will grow more slowly. Within the region, Colorado alone has maintained a high rate of migration since 1960; it is unlikely to be able to maintain this rate in the 1990s.

COMPOSITIONAL CHANGES

The composition of a population by age is of primary importance in many types of planning, particularly school enrollment, health care delivery, labor force, and potential voter participation. Moreover, the population's age structure is crucial to a number of social and economic variables. For example, age has a fundamental effect on subjective attitudes and beliefs as well as on objective characteristics such as income, occupation, and group membership. This section outlines how the proportion of Oklahoma's total population in each age cohort is expected to change over the next 30 years, what factors are responsible for changes, and what impact these changes are likely to have, particularly for the state's labor force, its educational system, and its elderly citizens.

To understand how a population has arrived at its present age structure and to project what changes may occur in the future requires an analysis of the three components of population change: fertility, mortality, and migration. To begin with, fertility rates change over time and produce different age group, or cohort, sizes. A sudden rise in the number of births, for example, increases the proportion of young persons in the population and, thereby, can shift its age structure downward. On the other hand, a sudden drop in the fertility rate reduces the proportion of young persons in the population and shifts the age structure upward.

Life expectancy also affects a pop-

ulation's age composition. If, on the average, individuals survive to move into older age groups, they increase the proportion of older persons in the population. On the other hand, if a population's life expectancy is low (such as in developing nations), fewer individuals survive to move into older age groups and the proportion of elderly is small.

Finally, someone who migrates subtracts one individual from his age group in one location and adds one to his age group in another location. Since people who migrate are typically young, a large immigration can rapidly increase a population's proportion of young people. In short, both immediate and long-term fluctuations in fertility, mortality, and migration rates are reflected in the age composition of a population.

Oklahoma's Age Composition

As measured by the median age, the population of Oklahoma, like that of many other states in the nation, is aging. Median age is a statistical measure which refers to the age at which half of the population is younger and half is older. The median age for Oklahomans, which was 30.1 in 1980 and 33.2 in 1990, is projected to increase to 37 years by 2010 (Table 2.2). Yet, even with this substantial increase, the median age for Oklahomans will continue to be less than that of the total U.S. population, which is projected to increase from 30 to 39 years.

The state's population is aging as a result of a combination of two factors. First, the fertility rate in Oklahoma has been declining since the late 1960s. In other words, the average woman is having fewer babies than she used to. As the number of children being born decreases, the proportion of older persons in the population increases. Second, the eldest of the individuals born during the baby boom are now entering their forties, and the sheer number of people in this age group results in a higher median age.

One way to represent the age structure of a population graphically is by a population pyramid, like the one shown in Figure 2.5, which displays the distribution of the 1990 state population and the projected distribution of the 2020 state population (under a

medium migration assumption). The pyramid consists of stacked bars with each bar representing the number of males and females born within a particular period. The scale at the bottom of the period shows the proportion of males and females in each age group. Typically, the youngest age groups have the largest bars while the bars become smaller as age increases.

Any significant change in the age structure of a population can be expected to produce a variety of social and economic changes. These changes can range from shifts in consumer behavior patterns to alterations in the labor force. Following a discussion of the labor force in Oklahoma, this section will point out some of the social and economic implications of probable changes in Oklahoma's age structure.

Labor Force

The labor force in Oklahoma has grown rapidly and has become proportionately younger and more female in the past two decades. Table 2.3 provides a summary of the state labor force for 1960-90. While popula-

Table 2.2 -- Median Age for Oklahoma and the U.S., 1980-2010

	Census		Projections	
	1980	1990	2000	2010
United States	30.0	32.9	36.5	39.0
Oklahoma	30.1	33.2	35.4	37.0

Projections are based on 1980 data.

Sources: U.S. Bureau of the Census (1990a,b) and Oklahoma State Data Center (1988).

tion grew 26% from 1960 to 1990, the size of the labor force increased by 78.8%. The civilian labor force grew most rapidly during the 1970s as the baby-boom generation entered the employment market.

The proportion of the population in the labor force climbed steadily over the period, from 50.2% in 1960 to 65.1% in 1987, largely due to the increased participation of females in the labor force. Female participation rose very rapidly from 30.4% in 1960 to

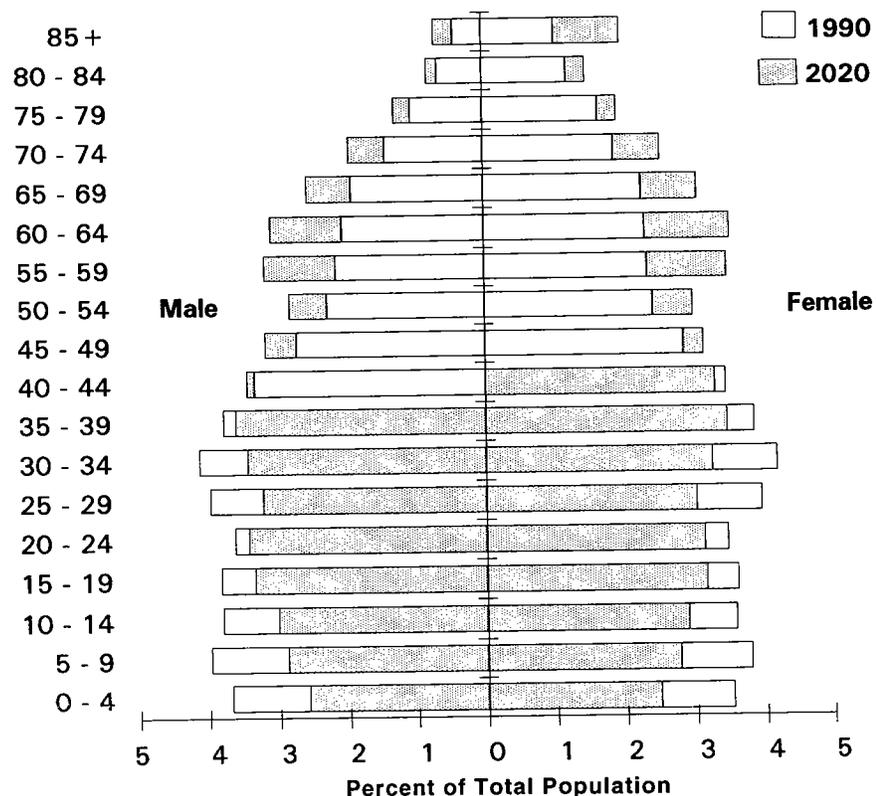


Figure 2.5 — Age and gender composition of Oklahoma population, 1990 and 2020. Source: Oklahoma Department of Commerce (1993).

Table 2.3 -- Employment Status of Oklahoma's Noninstitutionalized Population by Sex, 1960-90

Year	Civilian Labor Force (000's)	% Growth in Labor Force	Labor Force Participation Rates (%)		
			Both Sexes	Male	Female
1990	1,470	8.6	62.5	71.5	53.5
1980	1,343	38.7	59.7	73.5	47.2
1970	968	17.8	55.4	73.8	39.3
1960*	822	5.0	50.2	73.7	30.4

* Date for Total Civilian Labor Force Participation based on persons between the ages of 14 and 64 (all others 16-64).

Sources: Oklahoma State Data Center (1988) and U.S. Bureau of the Census (1990a).

55.8% in 1987. However, it remained considerably lower than male labor-force participation, which was remarkably stable over the time period, at approximately 75% of the male, noninstitutional, civilian population.

Labor-force participation fluctuated with age. Only about half of the adolescents (ages 16-19), who usually are still dependent and attending school, were in the labor force. The female participation rate flattened from age 20 to age 40, and then declined. Male participation, on the other hand, continued to rise after age 20, remained high from ages 25 through 49, then declined rapidly to levels more similar to those of females. At age 60, however, males still had as high a participation rate as the highest female levels.

Whites in Oklahoma comprised the largest portion of Oklahoma's civilian labor force in 1990 (86.8%). Other races' proportion of the labor force was commensurate with the size of their populations. Labor force participation rates varied somewhat by race, but the differential by race was not as large as that by age and gender (Table 2.4). In 1990, whites and Hispanics had a higher rate (95.2% and 91.6%, respectively) than other races, while Native Americans in the state had the lowest rate (87.6%). In the previous decade (i.e., 1980), white males and females had the largest differential in labor-force participation rates, 28.2%. The smallest differential, 12.4%, was between black males and females. (In general, black women are more likely to be in the labor force than females of any other race, and black males have lower participation rates than males of all other races.) The services-pro-

ducing sector is the largest employing sector in Oklahoma; it employs more than 20% of the state's workers (Figure 2.6). The services and trade sectors, together, employed about 46.7% of the total workers in 1990. Employment in the manufacturing sector was relatively low, at 14.1%, while the mining and construction sectors employed 3.6% and 3.3% of the workers, respectively.

From 1960 to 1980, there was not only an expansion in the size of the labor force, but also a change in the relative size of each industrial sector. The services sector expanded, largely due to increases in educational and health services. The services sector grew from 22% of all employment to 27%. Nationally, manufacturing declined in importance, from 31% of employment to 22%, but in Oklahoma this sector increased from 13 to nearly 17%. In addition, the national mining sector fell slightly, from 1.3 to 1.1%, but it increased in Oklahoma from 4.5 to 5.0%. In Oklahoma, as well as in the nation, retail and wholesale trade, construction, and public services remained stable over the period. In both Oklahoma and the nation, agriculture declined sharply. In Oklahoma, it fell from 9.4% to 3.8% of total employment.

Implications of a Changing Labor Force

Perhaps one of the most important consequences of the coming shift in Oklahoma's age structure will be changes in the labor market. Changes in the size of the labor force can be estimated through projections of the population within the working-age range (18-64). Of course, not everyone within this range is actually working.

Therefore, projections of labor-force participation based on projections of the working-age population are likely to be overestimated.

As the baby-boom cohort aged, each successive wave of workers entering the labor force increased the pressure on the labor market to expand. Table 2.5 provides data that show that the working age population is projected to expand to more than 2.3 million by 2010, an increase of 30.4% from 1980. The increase, however, will not be distributed equally across the age cohorts. The most dramatic increase will occur in the 45-54 age group, which is expected to increase by almost 84%. The proportions of the population aged 35-44, and 55-64 are expected to grow by 41% and 53%, respectively. By contrast, the population of younger workers (ages 18-34) is expected to grow by only 0.9%.

These shifts have important ramifications for employment and retirement prospects. Because of their years of work experience, larger numbers of those in the prime age groups (45-54) should both improve the quality of the state's labor force and heighten productivity. However, also because of their large numbers, this age group may find that there will not be enough management and higher level jobs. Turnover in the higher positions will decrease, and advancement will become a longer and more difficult process. However, if the incentives for early retirement of current retirement policies are maintained, the labor force may not be large enough to meet demand.

Of equal importance is the impact of an aging population on the Social Security system. At present, the number of people in the labor force exceeds the number of those receiving Social Security benefits. However, when people born during the baby boom reach retirement age (beginning in 2010), the demands on the Social Security system may produce severe strains between this large group and the smaller number of younger workers who will have to finance the system. In other words, the retired baby boomers will be dependent upon a much smaller group of workers to keep the Social Security system sol-

Table 2.4 -- Employment Status of Oklahoma's Noninstitutionalized Population by Race and Sex, 1960-1990

Race	Date	Labor Force Participation Rates (%)				
		Civilian Labor Force (000's)	% Growth in Labor Force	Both Sexes	Male	Female
White	1990	1,357	17.6	95.2	—	—
	1980	1,154	30.3	59.4	74.2	46.0
	1970	886	16.3	55.8	76.9	37.3
	1960**	762	5.5	51.5	73.5	30.4
Black	1990	89	15.6	88.7	—	—
	1980	77	47.9	58.9	65.8	53.4
	1970	52	13.3	51.8	62.1	44.1
	1960**	46	-5.6	48.6	64.0	36.3
Native American	1990	73	15.9	87.6	—	—
	1980	63	123.8	56.6	69.0	45.4
	1970	28	97.4	48.1	60.4	33.7
	1960**	14	43.3	37.4	54.7	21.0
Hispanic	1990	24	14.3	91.6	—	—
	1980	21	85.6	62.7	76.4	49.0
	1970	11	—	57.8	78.7	38.7
	1960**	—*	—	—	—	—
Asian & Pacific Islander	1990	21	200	95.0	—	—
	1980	8	—	57.2	67.8	49.6
	1970	—	—	—	—	—
	1960**	—	—	—	—	—

* — Indicates that the information for the cell is not available.

** Data for Total Civilian Labor Force Participation based on persons between the ages of 14 and 64 (all others 16-64).

Sources: Oklahoma State Data Center (1988) and Center for Economic and Management Research (1992).

vent. As Social Security taxes may have to increase dramatically, the younger workers may reject the obligation.

Although the aging of the state's labor force may create employment difficulties for the baby boomers, the situation should benefit younger workers. The proportion of younger workers (born during the "baby bust") will comprise a steadily declining share of the total working-age population. The number of those in the entry-level working group, 18-24 years old, is projected to decrease by about 6% from 1980 to 2010. In 1980, this group comprised 22% of all 18-64 year olds but will account for only 16% in 2010. The population aged 25-34 will also grow at a declining rate.

There is considerable controversy about the ultimate impact that the decline of young workers will have on the labor force. On the one hand, many experts believe there will be a severe shortage of entry-level workers, particularly in the near future. The decline in growth rates for these cohorts no doubt will mean fewer people competing for the available jobs. In fact, employers, now accus-

tomed to an abundance of workers eager for any kind of work, may have to offer improved benefits and increased salaries or wages in order to compete successfully for employees from the smaller pool of available workers. If, indeed, there is a shortage, the businesses most likely to be hurt will be those, such as the service industries, that traditionally have relied on young, low-wage workers.

Other experts, however, believe that a number of intervening factors will offset the decline in the entry-level population. For example, advances in technology and automation may reduce the number of workers necessary to perform some tasks. Moreover, the entry of women into the labor force may accelerate and, thus, help to avert any labor shortage. Finally, increases in the typical retirement age, along with immigration, may also contribute workers to the labor force.

Implications for School and College Enrollment

Usually the education system is first to feel the impact of a changing age structure in the population. As

members of the baby-boom cohort reached school age, educational facilities were strained to provide adequate space for the huge number of new students. Between 1950 and 1970 alone, the number of school-aged children in the state increased by 26% and crowded classrooms, created a shortage of teachers, and outdated existing facilities. As a result, secondary, and later some upper-level, schools were forced to expand both in physical size and in the number of faculty. But as the baby boomers moved out of the system and fertility rates declined, the demand on the education system lessened. School enrollments dropped; the number of teachers was cut and some programs were curtailed.

Projections show that the elementary school population, aged 5-13, will have grown from about 413,000 in 1980 to about 422,000 by 2010, a growth of 2%. This overall growth rate, however, will have fluctuated substantially over the three decades. There will be a small increase between 1990 and 2000 (only about 2%) because of the movement of the youngest of the baby-boom females out of the most productive child-bearing

ages, 20–24. Between 2000 and 2010, the 5- to 13-year-old group will actually decline by 8%.

The impact of this overall increase on Oklahoma’s elementary school system will vary. The 11% increase of the elementary population between 1980 and 2000 will require a substantial increase in the number of elementary teachers and may require an expansion of school facilities. The decline in the size of this population between 2000 and 2010, however, will have just the opposite effect. Once again, the demand for teachers will decrease. On the positive side, however, we could expect an improvement in the student-teacher ratio if teachers are not laid off. Moreover, the total dollar amount spent by the state on education may decrease without any corresponding decrease in the quality of education.

The high school population (aged 14–17), on the other hand, is expected to decrease only slightly by 2010. The 1980 figure of 208,000 is expected to decline to a 2010 total of about 199,000. Again, the rate of growth will fluctuate.

Although many factors, such as tuition costs, family income, and employment prospects, are involved in the decision to attend college, the size of the traditional college-age popula-

Table 2.5 -- Number and Percentage of Working Population (Ages 18-64) for Oklahoma and the U.S., 1980-2010

	Census				Projections			
	1980		1990		2000		2010	
	Number	%	Number	%	Number	%	Number	%
Oklahoma	1,794,300	59.3	1,884,365	60.0	2,163,356	61.6	2,339,695	63.8
U.S.	137,241,000	60.6	153,853,610	61.8	167,154,000	62.4	180,047,000	63.9

Sources: U.S. Bureau of the Census (1990a) and Oklahoma State Data Center (1988).

tion (18–24) can provide an indication of likely higher education enrollment. The college-aged population is projected to decrease from about 402,000 persons in 1980 to about 372,000 in 2010, a decline of 7%. It is unclear what effect this will have on higher education enrollment in the state. Colleges have been fairly successful in attracting older students to supplement their enrollments.

Implications of a Growing Elderly Population

One truly revolutionary change in store for the age structure of Oklahoma’s population is the dramatic increase projected for the number of elderly. It has profound implications. Increases in longevity, in conjunction with declines in fertility, may shift priorities further towards the welfare of

the elderly. Governmental leaders and policy makers will be forced to pay increasing attention to the need for hospital and nursing home care, retirement housing, recreation, rehabilitation, and adequate in-home support services for the elderly. Both state and federal governments probably can expect increases in the amount of money needed for transfer payments and various services to the elderly.

Oklahoma’s elderly population (age 65+) has grown consistently since 1950. In 1970, this age group formed 11.7% of the total population, while in 1980 and 1990, it constituted 12.4% and 13.5% of the total population, respectively. The elderly population is expected to grow faster than the rest of Oklahoma’s population. By 2010, it will have increased to a little more than 473,000 (Table 2.6). The population aged 75 and older, however, will increase by 44%, and the population aged 85 and older will increase by 93%. The corresponding increases nationwide will be even greater.

As the elderly population continues to grow, more and more pressure will be placed on health care facilities. Persons living past age 75 are likely to face a succession of illnesses that require medical attention and often hospitalization. This could become a critical factor in health care planning, especially in the next century when large numbers of baby boomers move into the over-75 age bracket. In fact, if the elderly continue health-care use at the present rate, it could place strains on the state’s economy. In order to control costs of health-care services provided to the elderly, the system by which the health care is financed and delivered will have to be reevaluated.

A related, and potentially more serious problem, is the probable in-

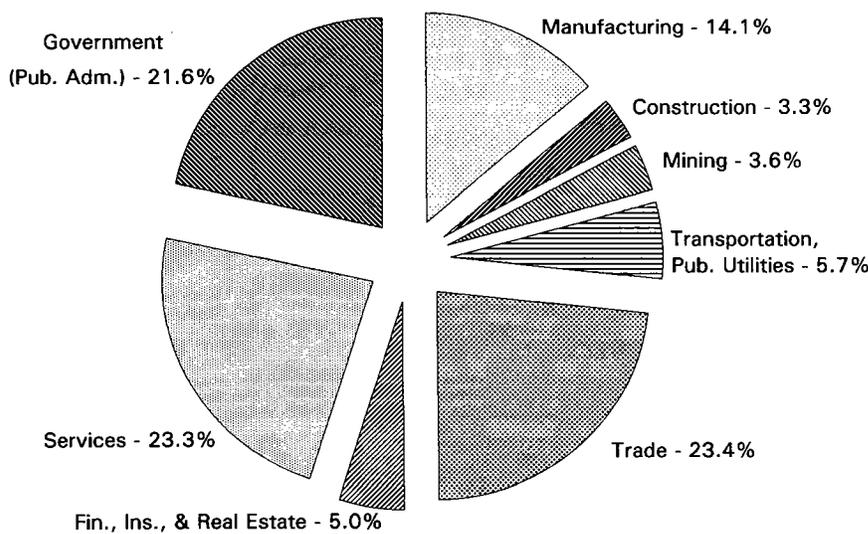


Figure 2.6 — Oklahoma’s distribution of employment by industry, 1990. Source: Oklahoma State Employment Security Commission (1992).

Table 2.6 -- Number and Percentage of Elderly in Oklahoma and the U.S., 1980-2010

	Census				Projections			
	1980		1990		2000		2010	
	Number	%	Number	%	Number	%	Number	%
Oklahoma								
65+	376,100	12.4	424,213	13.5	443,104	12.6	473,032	12.9
85+	33,981	1.1	45,848	1.5	59,109	1.7	65,566	1.8
U.S.								
65+	25,549,000	11.3	31,241,831	12.6	34,882,000	13.0	362,000	14.0
85+	2,240,000	1.0	3,080,165	1.2	4,622,000	1.7	6,115,000	2.2

Sources: U.S. Bureau of the Census (1990a) and Oklahoma State Data Center (1988).

crease in the number of elderly who are disabled and, therefore, require residential or institutional care. Of course, the number that will require institutional care depends on a number of factors. If, however, current living-arrangement patterns and income levels for this group persist to the year 2010, then increased stress on health care facilities can be expected. Finally, since women tend to live about seven years longer than men, many women can expect to spend a number of years at the end of their lives without a companion and, possibly, without adequate resources. In 1980, for example, nearly 85% of women aged 85 or older lived alone; only 34% of men in the same age group lived alone. In 1980, elderly women (age 65+) living alone had the lowest median income of all elderly, only \$3,937.

As mentioned earlier, considerable strain will be placed on the Social Security system early in the next century. In 1985, there were about 366,000 elderly drawing Social Security benefits in Oklahoma. If we assume similar proportions in 2010, there will be more than 460,000 elderly receiving Social Security.

CONCLUSION

This chapter has detailed some of the projected changes in the size and composition of Oklahoma's population from 1980 to 2010. Some of the implications for the social, political, and economic climate of the state have been examined for their potential in aiding governments, businesses, private agencies, and commu-

nity organizations in the process of policy formation. Throughout the chapter, emphasis has been placed on the close relationship between demographic processes and the social and economic life of the state. It follows, then, that social or economic policies formulated without taking demographic factors into account will be incomplete and ill-formed policies.

Even in the absence of specifically formulated population policies, the state may have a myriad of de facto policies that unintentionally affect demographic processes and population growth. For example, the recruitment of industries and new business, while not directly controlled by the state, does affect future population growth and migration to an area, as do local zoning and building codes, the location of highways, and the development of recreation areas. Fertility and mortality may be affected indirectly by policies such as support of family planning, allocation of transfer payments, maternity leave policies, support of medical research, and the availability of affordable child care facilities. Such policies may increase fertility and decrease mortality and, thus, enlarge population because they make raising a family and saving a life easier.

Changes in the size and composition of Oklahoma's populations have important consequences for the state's labor force. In order for the Oklahoma economy to prosper, it must have an available labor force that is both adequate in size and properly trained. This chapter identifies two possible scenarios. On one hand, there is a pos-

sibility, sometime late in this century, of a labor shortage, particularly for businesses that rely heavily on younger workers. Such a shortage would occur if fertility and migration gains remain low. However, unexpected population gains from migration, increased labor-force participation among women, and delayed retirement may offset this shortage.

Changes in the composition of the population also affect the education system. Despite continued growth in the population throughout the rest of the century, there will be an uneven distribution of children and young adults. Education leaders should prepare for these future compositional changes, which will force constant adaptation by our schools.

The dramatic increase projected for the number of elderly citizens has profound implications for the state. A large population of elderly people raises the difficult question of responsibility for their welfare, especially since financial and health difficulties are often associated with old age. If state and local governments assume wider responsibility, there could be substantial strains on their respective economies. In order to control the ever-increasing costs of health care and to maintain high-quality care, a substantial restructuring of the system by which health care is financed and delivered is needed.

The demographic and economic forces that are shaping Oklahoma currently will affect social and economic institutions for years to come. Identifying and studying demographic characteristics will help policy makers to develop more informed and effective policies.

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— Chapter 2 —

LIST OF ILLUSTRATIONS

Figures

2.1 — Oklahoma population by race, 1990	19
2.2 — Components of population change for Oklahoma, 1920–90	20
2.3 — Percentage change in population, 1950–90	21
2.4 — Total fertility rates for Oklahoma and selected states, 1950–80	22
2.5 — Age and gender composition of Oklahoma population, 1990 and 2020	25
2.6 — Oklahoma's distribution of employment by industry, 1990	28

Maps

2.1 — Oklahoma's population by county, 1990	18
2.2 — Percentage of urban population in Oklahoma by county, 1990	18
2.3 — Percentage of minorities in Oklahoma by county, 1990	19

Tables

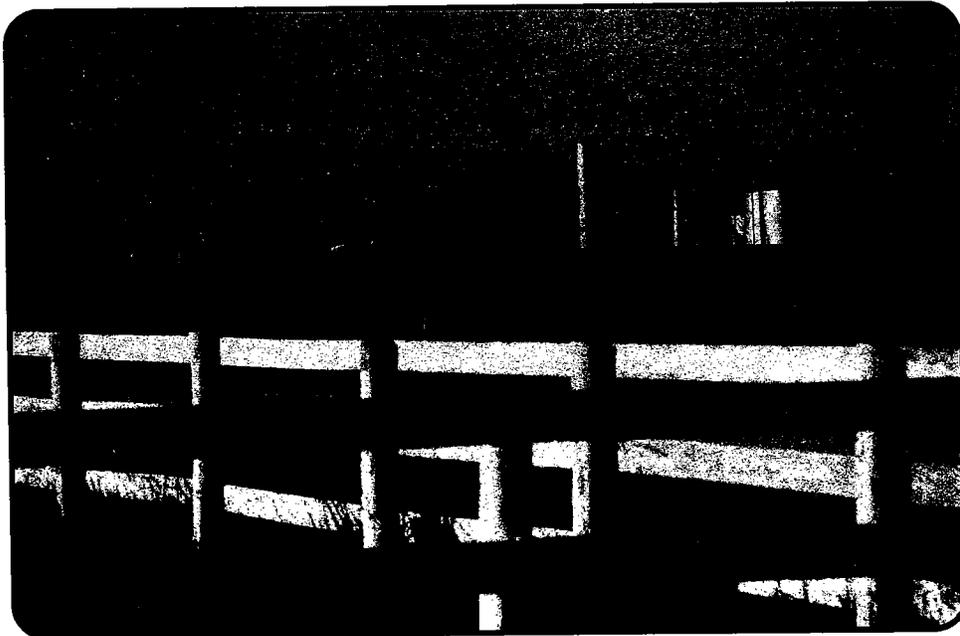
2.1 — Components of population change for Oklahoma, 1920–87	20
2.2 — Median age for Oklahoma and the U.S., 1980–2010	25
2.3 — Employment status of Oklahoma's noninstitutionalized population by sex, 1960–90	26
2.4 — Employment status of Oklahoma's noninstitutionalized population by race and sex, 1960–90	27
2.5 — Number and percentage of working population in Oklahoma and the U.S., 1980–2010	28
2.6 — Number and percentage of elderly in Oklahoma and the U.S., 1980–2010	29

Oklahoma Resources

Chapter
3

The Outlook for Energy

by
Edward J. Pugh



Contents

Executive Summary	33
Introduction	34
Historical Overview and the Energy Outlook for Oklahoma	34
Oil and Gas	34
Coal	36
Energy Conservation and Alternative Energy Sources	37
Oklahoma Energy Demand and Consumption	37
Oklahoma's Crude Oil and Natural Gas Resources	39
Oil Production	39
Oil Reserves	40
Natural Gas Production	41
Natural Gas Reserves	42
Drilling Activity and Well Completions	42
Drilling Costs	43
Price, Value, and Revenues	44
Refining, Processing, Delivery, and Storage	45
Employment in the Oil and Gas Industry	46
Coal Resources and the Coal Industry	46
Energy Conservation and Alternatives to Conventional Fossil Fuels	48
Synthetic Fuels	48
Renewable Resources	48
Energy Conservation	49
Energy Research	49
Energy Policy and Regulation	50
Energy in the 1990s	51
References	51
List of Illustrations	54

The Outlook for Energy

Edward J. Pugh

Executive Summary.—Historically, Oklahoma has been one of the nation's major producers of oil and gas, not only fueling the state's economy, but also substantially contributing to the economic welfare of the country. Under favorable economic conditions and with positive, progressive policy initiatives by federal and state government, Oklahoma has the oil and gas resources to continue its strategic contribution to national economic health.

As an oil producing region, Oklahoma is in an advanced stage of maturity, but there are decades of substantial production life remaining. Exploration will continue to add to Oklahoma's energy resource base, and advanced technology may contribute to greater levels of recovery. More than two-thirds of Oklahoma's oil production is from stripper wells. The viability of these wells, and their protection from early abandonment, is important not only for current production but also for ultimate oil recovery in the future through application of more advanced technology.

Oklahoma's energy future may well rest with its vast natural gas resources. It is estimated that about 20% of the nation's yet-to-be-discovered, onshore natural gas is in Oklahoma. Oklahoma currently ranks third in gas production and fifth in the number of natural gas wells in the nation; it produces more than 12% of the country's gas.

Along with oil and gas extraction, petroleum refining and natural gas processing have been important energy sector activities in Oklahoma. Oklahoma also has an extensive pipeline network, spanning more than 40,000 miles, for delivery of in-state and out-of-state crude oil, petroleum products, and natural gas.

In addition to vast oil and gas resources, Oklahoma has substantial coal resources—an estimated 2.3 billion tons of net recoverable coal reserves minable under current conditions. Of this, some 500 million tons may be produced from surface mining, more than 275 million tons of which are of low-sulfur quality. Historically, coal production in Oklahoma has been small in comparison to that of many other producing states, but there is the potential for substantially increased activity.

In addition to its substantial conventional fossil fuels base, Oklahoma has the resources to become a substantial producer of alternative energy based on coal, heavy oil, tar sands, the sun, solid waste-to-energy, biomass, and cogeneration. Energy conservation and management will continue to play a significant role in extending the life of Oklahoma's conventional fossil fuels base.

Energy research is also important to Oklahoma's future. Oklahoma is moving toward establishing itself as a major world center for energy research. The National Institute of Petroleum and Energy Research and other private research facilities already are operating throughout the state. The Oklahoma Geological Survey is the state's official energy and minerals research agency. The state's public and private institutions of higher education, particularly the University of Oklahoma, Oklahoma State University, and the University of Tulsa, also are centers for energy research. Of special significance are two new facilities, the \$50 million Sarkeys Energy Center at the University of Oklahoma and the \$46-million Noble Center for Agriculture and Renewable Resources at Oklahoma State University.

An evaluation of Oklahoma's assets reveals a potentially promising future for energy in Oklahoma. The most positive indicators for a healthy energy sector are Oklahoma's resources—fossil fuels reserves, the expertise and dedication of Oklahoma's energy industries and productive work force, the massive transportation infrastructure, the capability for alternative fuel development, and progressive state energy and economic policies. Still, under current world circumstances, Oklahoma and other producing states are vulnerable. Responsible national policy is essential to providing stability.

INTRODUCTION

The United States has entered a new period of economic transition. By the year 2010, energy technology and consumption may change significantly due to increased scarcity of conventional energy resources and the higher costs for energy supplies needed to fuel the national economy. These developments may well place hardships on certain sectors of the economy and geographic regions of the country. A vigorous federal effort will be needed to provide an impetus for the recovery of the oil and gas industry and to nurture the expansion of coal production. Also necessary will be the development of new technologies for the recovery of fossil fuel resources, research and development focused on alternative energy sources, and continued conservation. A positive, comprehensive national energy policy is necessary to achieve economic stability and national security in the 1990s and beyond. Only through efficient planning and management will state government and the energy industries be able to adequately meet the energy demands of the future.

This chapter focuses on the energy resources of Oklahoma, historical trends, inherent capabilities, and prospects for the future. Oklahoma has been, and will continue to be, a major producer of oil and gas as well as a small, but potentially important, producer of coal. Due to a cluster of interrelated factors, Oklahoma is in an advantageous position to contribute significantly to unconventional oil and gas production, synthetic fuels, renewable energy resource development, cogeneration, energy conservation, and energy-related research. The following sections discuss specific energy resources, energy demand and consumption, specific components of the energy industries, research capabilities, national and state energy policies and regulations, plus prospects for Oklahoma's energy future. First, an overview of historical trends in energy resource production, the potential for further energy development, and the impacts of governmental policies and regulations on Oklahoma's energy sector will be outlined.

HISTORICAL OVERVIEW AND THE ENERGY OUTLOOK FOR OKLAHOMA

Oklahoma's energy and agricultural resources historically have been the foundation of the state's economy. Since the 1960s, the nonenergy/non-agricultural sectors of the economy have grown rapidly, substantially diversifying the economy. Still, Oklahoma's energy resources will continue to be a primary economic factor in the development and well-being of the state far into the next century.

Energy resources are the most volatile factor in Oklahoma's economic equation. In its variety of sources and forms of use, energy is a critical and strategic resource subject to manipulations of supply, demand, and price, often with painful consequences for producers, suppliers, and consumers. Without international agreements to provide energy supplies and price stability, long-term predictions are difficult. Since the late 19th century, booms, fevers, panics, and depressions, interspersed among variable periods of stability, have been the rule rather than the exception for the world's fossil fuel industries.

Numerous scenarios for Oklahoma's energy and energy-related economic future have been formulated. Top energy experts give differing predictions about the state's energy future, but there is a common thread of agreement—Oklahoma's energy future may be assured by a combination of the following factors: (1) the state's remaining vast energy resources, (2) private and public commitments to a healthy energy industry, (3) the vast production and transportation infrastructure, (4) the expertise and dedication of the state's energy industry and businesses, (5) a favorable regulatory environment, and (6) emergent energy research capabilities.

Still, these positive indicators for a potentially bright energy future are dependent upon many factors beyond control. Oklahoma is more than ever a part of the international economy and is strongly affected by events that alter the world's energy sources, such as the Arab oil embargo in 1973, OPEC price and supply manipulations, levels of foreign oil imports in the 1970s, the Iranian Revolution, the Persian

Gulf War, and new worldwide exploration and production. Although all of these events directly involved oil, crude oil and refined petroleum products, there were implications for all energy sources: crude oil, natural gas, coal, synthetic fuels, renewable resources, and energy conservation. These events influenced energy policy on the national level and state government and energy industry responses. Future events also will have an impact on Oklahoma's energy industries and economy.

Oil and Gas

Although the situation is stabilizing and improving to some degree, Oklahoma is currently on the down side of the most recent boom/bust cycle which began after the 1973 Arab embargo. Crude oil and gas prices gradually rose from 1973 to 1979, followed by substantial price increases through 1982 and a subsequent gradual decline of prices to 1986, when prices fell drastically. Although still variable, prices rebounded, stabilized, and improved somewhat in the 1987-90 period. Coal prices also increased during the 1970s, but there has been a weakening in recent years due to domestic oversupply and slightly reduced demand. Due to the common capability to switch fuels, supply and price (aside from federally mandated energy policies) were the primary determinants of industrial and utility energy use over this period.

Assuming that technology and policy will not substantially shift the U.S. economy's dependence on fossil fuels to alternate sources, Oklahoma's energy resources hold considerable potential for development well into the next century. The most promising energy resource for both the short and long term is natural gas. Of the nation's "to-be-discovered," onshore natural gas, 20% is estimated to be in Oklahoma, primarily in the Anadarko and Arkoma basins. Due to aggressive production and transportation sectors, Oklahoma has gradually increased its domestic share of the nation's energy market to 12%. Currently, about 60% of Oklahoma's natural gas production is exported by extensive interstate pipeline networks. The existing infrastructure could handle

substantially increased production and shipments in response to greater demand. The ratio of the state's natural gas reserves to production is increasing but will come into balance in a few years due to reductions in exploration and drilling since 1985.

Oklahoma has an estimated 127 trillion cubic feet (Tcf) of gas yet to be discovered. Allowing for modest increases in current demand and production, this represents more than 60 years of potential production. The nation's present "gas bubble," or surplus, may be absorbed by the market in the near future. A national trend toward increased exploration and production to meet increasing demand and improve reserves suggests that natural gas supply and demand may be in relative balance by the mid-1990s. Natural gas prices should gradually increase during the next few years and, in the face of shortage, should encourage increased drilling activity in the mid-1990s. The decade of the 1990s should be a rebounding period for natural gas producers and the gas industry overall. Efforts should be made to seek new gas markets and to extend distribution networks.

An important new initiative—to encourage energy-intensive industry to locate in Oklahoma in order to take advantage of existing resources and cogeneration facilities—could assure a surge of industrial development. Such a measure would add substantial "value" to Oklahoma's raw energy resources by providing increased employment, payroll, and tax-generated revenue. At the same time, new industry would be assured (1) relatively low-priced and abundant energy, (2) a highly productive labor force (for which Oklahoma is known), and (3) access to the nation and the world by well-developed water, land, and air transportation systems. The economic multiplier effect of this value-added concept would be a substantial added benefit to the state's economy.

Natural gas has become Oklahoma's premier energy resource; both its produced value and reserve value far exceed that of crude oil. From 1973 to 1983, gas gross production taxes were the fastest growing source of state revenue. Declines have occurred during the past few years, but increased

prices and demand may rejuvenate this source of revenue.

Natural gas demand and supplies are moving gradually toward a critical balance due to a greatly reduced level of drilling activity, low spot-market prices, a lack of long-term contracts, rapid gas depletion in some fields, the adverse effects of the Federal Tax Reform Act of 1987, substantially reduced outside investment capital, continuing corporate bankruptcies and reorganizations, and mixed Federal policy and regulation. Once shortages occur, consumers may switch fuels or seek Canadian gas, while domestic gas producers will be gearing up for a relatively rapid increase in activity.

At prices above \$8/Mcf, liquified natural gas becomes competitive, and foreign imports increase. Whether there will be a natural gas shortage during this decade is yet to be seen. There are adequate domestic resources, but they must be developed to be available. Only improved prices will stimulate the exploration and production needed to maintain a stable balance between supply and demand. For adequate activity in the natural gas industry to occur, gas prices need to equal replacement costs plus a reasonable rate of return. A price increase or decrease of \$1/Mcf of gas means billions of dollars of increased or decreased value and the gain or loss of hundreds of millions of dollars in local and state tax revenues. The state could assist in improving its own economy by establishing a cooperative venture with the private sector to create gas and coal marketing programs. Considerable potential for new markets exists, especially for gas, both out-of-state and in-state.

A promising indicator in 1990 was the increase in Oklahoma's natural gas production. The value of gas increased, although prices were down. The Petroleum Information Corporation's prediction of a gas price increase in 1988–89, up from \$1.46 per million cubic feet (MMcf) in 1987, was premature. A major joint venture by two private companies to further expand eastern Oklahoma's gas export capability is another promising sign for the natural gas industry.

The future is not quite as clear for

Oklahoma's petroleum liquid resources—crude oil, and condensate. Oklahoma, as an oil-producing region, is in a stage of advanced maturity and has a large number of oil wells producing at very marginally economic levels. The average Oklahoma oil well produces only about 4 barrels of oil per day. More than 70% of Oklahoma's crude oil production comes from these stripper wells (production of less than 10 barrels of oil per day), which number more than 73,300 or 89% of all Oklahoma oil wells. This places Oklahoma in a very sensitive position with regard to market circumstances and to national and international policies. The stripper well economy is extremely vulnerable to adversities which, if severe and prolonged, may cause temporary "shut-ins," premature abandonment, or plugging, and, thus, the permanent loss of a substantial resource.

No one drills for a stripper well. Stripper wells usually result from the aging of more productive wells. The number and aggregate production volume of Oklahoma stripper wells make them a major resource from the standpoint of value and governmental revenues. In 1990, thousands of stripper wells were shut-in (to wait for improvement in oil prices), and more than 2,000 wells were permanently abandoned and plugged. Stripper well production currently represents about 70% of the produced value of oil in Oklahoma. Their critical importance to the state's economy is clear. Oklahoma's oil production future, from enhanced oil recovery, lies in its large producing oil fields, which are dominated by stripper wells. Every incentive and initiative to preserve stripper well production should be pursued.

The Interstate Oil and Gas Compact Commission's study of enhanced oil recovery (EOR) potential in Oklahoma indicates that 880 million to 1.5 billion additional barrels of oil may be recoverable from Oklahoma's known reservoirs. At current production levels, this could add 7–14 years of productive life to the state's oil resource base. Increased prices and incentives are essential to EOR, which requires long lead times and substantial investments.

Oklahoma's oil future lies primarily with technology for improved conventional and enhanced oil recovery production. Continued developmental drilling will add production and reserves, but both reserves and production will decline rapidly without the discovery of new fields and production zones through extensive exploratory drilling. Additions to petroleum reserves from new fields have been limited in recent years. Even in 1985 reserve additions from new fields contributed only 2%, or 3 million barrels, to reserves.

Record drilling activity during the boom period, 1980-83, was required to maintain a relatively balanced production-to-reserve ratio for oil. In 1990 only 870 oil wells were completed, a very low level of activity. A substantial improvement in the drilling activity picture is not expected to occur unless prices increase. It takes a price of at least \$25 per barrel to stimulate a drilling activity of 4,000-5,000 new wells per year.

By 1995, oil production is estimated to be in the 85-100 million barrels per year range; a fall to slightly lower levels by the year 2000 is anticipated. Since a difference of \$1 in the price of oil may equate to a \$134 million value and \$9 million in state gross production tax collections, the importance of price to the state's economy is quite apparent.

Many circumstances can affect price. As world oil demand increases and OPEC continues to capture a larger market share, a high level of production capacity centered in OPEC could result in rising prices. A myriad of possible events could cause temporary disruptions in oil supply and, thus, increased prices. Lower prices may result if certain members of OPEC decide not to limit production to their quotas or if certain non-OPEC producers substantially increase production. It should be remembered from the 1973 Arab embargo, the Iranian Revolution oil cutoff of 1979, the 1986 OPEC-manipulated "oil glut," and the Iraq-Kuwait conflict that it takes only a small oil shortage or surplus to create market responses that result in substantial price increases or reductions.

The fossil fuels industries of Oklahoma are gradually easing out of a

severe depression that began with a steady decline in oil and gas prices in the 1982-85 period. The economic recession was well-entrenched in Oklahoma before the abrupt decline in prices in late 1985. Overextension and high positive speculation based on high oil and gas prices resulted in a substantial degree of leveraging by many exploration and production firms. To meet the demand of a record level of investment in exploration and production, the oil field service industry expanded between 1980 and 1983.

Between 1979 and 1983 the state's economy flourished. Oklahoma had never experienced better economic times. Declining oil prices in 1982, followed by declining gas prices in 1984, were foreboding signs to investors, creditors, and the industry. The unprecedented collapse of Oklahoma City's Penn Square Bank, which had extended credit to independents in the oil and gas business and sold the loans to upstream banks in other states, created a shock wave and signaled a financial crisis for the state. Huge assets disappeared and severely disrupted business. The effect of the collapse on Oklahoma's economy was as much psychologically as economically real. Out-of-state financial institutions were affected. Investors and financial institutions became apprehensive about the stability of oil and gas investments. Yet, in spite of gradually declining prices, the level of drilling activity remained high until the abrupt oil price collapse in late 1986.

Following the 49% drop in the price of oil, the industry contracted. Earnings were down \$451 million, a 19% drop. Business starts declined 29% and business failures rose 67%. This decline in activity substantially reduced revenues from the gross production tax, and from personal and corporate income taxes; it also had adverse effects on the ad valorem tax base. For the oil and gas industry, 1986 was a year for readjusting priorities and strategies for the future; 1989-90 witnessed the lowest level of drilling activity since 1973.

That period of severe economic instability now lies in Oklahoma's past. For several years, a high percentage of the oil and gas industry's cash flow was diverted to service debt. Outside

investment capital has been extremely limited recently. Oil and gas prices have stabilized somewhat and show signs of improvement. Drilling costs are at a near low and efficiency is improved. With more stability, return on investment can be more credibly determined. Innovative marketing of gas is taking place in an increasing gas-to-gas competitiveness. Emphasis is on proved undeveloped reserves resulting in a high well/success ratio. Cash flow appears on the increase and adds to internal resources for gradual increases in activity. Bankruptcies have leveled off, and for many companies debts and liabilities are structured for more progressive programs. Survivors of the shake-up are regrouping and reformulating strategies for a more productive future. Drilling economies in Oklahoma appear very favorable. Drilling activity will remain relatively depressed, however, until the confidence of external investors, especially institutional investors, is regained. The 1990s will provide new opportunities for Oklahoma's oil and gas industry and associated businesses, especially for natural gas exploration, production, and marketing. If crude oil prices rise toward the \$25 per barrel mark, oil well drilling will accelerate and the proportion of wildcat and exploratory activity will increase. New enhanced oil recovery projects also may be developed.

Coal

Oklahoma has large recoverable coal reserves, strippable and underground, of both steam and metallurgical quality. Currently, steam coal is the primary marketable commodity; there is limited domestic demand for metallurgical coal. An estimated 7.2 billion tons of coal underlie 24 counties in eastern Oklahoma. Under present conditions about 2.3 billion tons of net recoverable coal reserves are minable; about 500 million tons are extractable by surface mining. Of the total minable reserves, 687 million tons are of the low-sulfur type (less than 1%), 120 million tons of which can be surface-mined.

The future for the coal industry in Oklahoma is complicated by uncertainties related to the larger outlook for energy. Still, the potential for a

prosperous future exists. Coal production has increased substantially in the U.S. since 1973 due to federal policies encouraging its use as a substitute for oil and natural gas in electric power plants and in large industrial boilers. This pattern of increased production has been reflected in Oklahoma. Historically, Oklahoma coal production remained at high levels between 1977 and 1982, the period of highest sustained production for the state. Production peaked in 1978 and 1981 at more than 5.7 million tons; more than 99% of production was from surface mining operations.

After 1982 the gradual reduction in coal usage to about 3 million tons in 1986 and only 1.6 million tons in 1990 was due to several conditions: a national oversupply of coal; lower prices at home and internationally; an abundance of cheap, low-sulfur western coal; the effects of the federal Surface Mining Control and Reclamation Act; and internal production problems.

Moderate lead times and large capital investments are needed to develop the coal industry, which historically has been dominated by small independent producers, noted for being both effective and responsible operators. Oklahoma coal mining has faced adversities associated with thin seams and large overburdens. Production of high-sulfur coal has added to the market limitations, but Oklahoma coal has a very high BTU value. A substantial portion of the reserve is of low-sulfur quality.

During the past 15 years, electric utilities have been major consumers of Oklahoma coal. In 1986, in the face of production declines and economic problems, the State Legislature enacted legislation requiring Oklahoma electric power generating utilities to use at least 10% Oklahoma coal by BTU value. This state law was struck down recently by federal court. While in force, it provided a substantial market for Oklahoma coal. Oklahoma coal is also marketed out-of-state for blending coal and for use in industrial boilers; and it is exported internationally. Oklahoma coal is excellent for steam or coking and is competitively priced, but the Oklahoma coal industry seems to need a better strategy for marketing. The formation of a market-

ing consortium or cooperative of small operators is being considered.

Oklahoma coal has a major impact on local economies in eastern Oklahoma. At the high production level of 5 million tons per year, the industry could employ about 1,700 workers directly at a payroll of about \$49 million. It also would support indirectly the employment of another 3,000 with a resource value of about \$140 million (\$28 per ton), and it would generate about \$1 million in state severance taxes. In 1986, when about 3 million tons were produced, about \$6.4 million was paid in royalty to mineral owners.

A positive factor in the future of Oklahoma coal production is Oklahoma's excellent transportation infrastructure—rail transport, trucking, and particularly the McClellan-Kerr Navigation System which opens the coal region to the Mississippi waterway. For the long term, Oklahoma coal may have great potential for gasification and liquefaction, cogeneration, and synthetic fuels production. The realization of that potential is some years into the future and is very dependent upon the future circumstances surrounding conventional fossil fuels. Oklahoma has a substantial coal, heavy oils, and tar sands resource base which can provide the basis for a prosperous synthetic fuels industry. Significant substitute fuels can also be derived from the state's biomass and solid waste. Several waste-to-energy projects are in the development stage, and the state and industry have several biomass-to-energy projects.

There is tremendous potential for Oklahoma's coal resources to provide the basis for economic growth; only the apex of coal resources has been exploited. Huge bituminous and metallurgical deposits remain to be produced, but require large capital investments by sophisticated mining companies. A myriad of issues are of concern, including the development of adequate markets and the strict state and federal environmental, health, and safety regulations that add to the costs of mining. Companies must have adequate financial resources and trained personnel to pursue a successful venture in the coal industry.

Energy Conservation and Alternative Energy Sources

Since the late 1970s, energy conservation has become an accepted way of life, not only in Oklahoma but throughout the nation. Oklahoma supports a strong energy management program for state government as well as an awareness program for industry, business, and the household.

During the on-going "oil glut" and "gas bubble," investment in synthetic fuels and substitutes for conventional fossil fuels have been discouraged. As these oversupply situations moderate and shortages and interruptions occur, greater emphasis will turn to synthetic fuels, nonconventional substitutes, and renewable resources. Further research and development and commercialization will be prerequisites before these new energy resources can contribute substantially to the nation's energy source mix.

Oklahoma, because of its geographical situation, has considerable potential to develop the use of solar energy. The potential for wind power development is very high in western regions of the state.

An overview of the issues facing the energy industries of Oklahoma reveals a potentially promising future. Oklahoma is blessed with vast energy resources and a commitment by state government and private industry to pursue the ultimate recovery of those resources. The potential for developing a well-balanced economy based in part on Oklahoma's energy resources is clear. The state has not only the resources and the commitment but the valuable experience and infrastructure necessary to build a solid, stable energy sector, and to extend present productivity and innovative change well into the next century.

Oklahoma Energy Demand and Consumption

Oklahoma is a major energy exporter and supplier of crude oil, natural gas, petroleum products, and processed natural gas and coal. In 1989, Oklahoma ranked 23rd in total energy consumption in the U.S. and 10th in consumption per capita. Oklahoma consumed a little over 1.6% of the total energy used in the country.

Table 3.1 -- Oklahoma Energy Consumption by Source, 1960-89

Year	-----Petroleum Products-----												Hydro- electric Power	Net Interstate Sales of Elect.	
	Coal Thousand Short Tons	Natural Gas Billion Cubic Feet	Asphalt & Road Oil	Aviation Gas	Distillate Fuel	Jet Fuel	Kero- sene	LPG	Lubri- cants	Motor Gas	Residual Fuel	Other			Total
	Thousand Barrels														
1960	77	308	2,034	559	2,618	2,853	431	6,433	661	22,707	1,454	7,880	47,630	705	-3,602
1965	30	468	3,586	713	2,877	3,389	945	7,654	679	25,815	851	8,548	55,057	825	-4,992
1970	7	597	4,598	409	5,584	4,318	1,103	9,618	622	32,521	807	9,123	68,703	1,406	-18,720
1971	7	612	5,227	381	5,477	4,316	886	9,167	752	33,714	617	8,531	69,068	1,383	-16,497
1972	7	630	4,842	360	7,944	4,085	678	9,706	805	35,754	1,418	8,833	74,425	1,447	-15,283
1973	175	612	5,049	353	8,951	3,965	656	9,677	1,075	37,437	1,499	9,369	78,031	3,761	-20,440
1974	181	660	5,506	336	8,849	3,948	494	9,087	1,029	36,997	1,216	8,971	76,433	3,590	-22,527
1975	23	669	5,675	284	9,449	3,867	328	9,342	810	38,470	641	9,074	77,940	2,945	-21,278
1976	73	760	4,728	300	11,856	3,967	263	9,490	900	49,477	672	9,855	91,508	1,541	-22,589
1977	675	767	4,646	331	12,965	4,183	241	9,508	1,355	41,903	781	9,847	85,760	1,749	-18,667
1978	2,463	770	4,385	351	14,513	4,750	256	10,179	1,456	43,763	1,028	9,666	90,347	1,763	-24,551
1979	3,382	825	4,662	307	14,560	4,564	645	8,437	1,523	41,279	888	9,696	86,561	2,323	-27,074
1980	6,046	722	4,826	328	12,125	4,900	342	8,967	1,356	39,633	732	9,296	82,505	1,315	-28,040
1981	9,048	671	3,353	268	15,488	5,009	302	7,145	1,301	41,673	741	5,733	81,013	1,122	-16,937
1982	11,781	677	3,436	155	14,512	5,911	461	8,073	1,186	43,409	676	5,193	83,012	2,090	-15,902
1983	12,629	629	4,332	121	16,589	5,974	120	8,122	1,242	42,921	516	6,151	86,088	2,500	-15,915
1984	13,254	653	3,093	188	17,992	7,017	117	8,619	1,324	41,908	489	5,359	86,106	2,339	-10,634
1985	13,602	587	4,003	217	18,377	5,870	174	10,513	1,234	42,160	262	4,955	87,765	3,980	-5,137
1986	12,395	554	3,281	250	13,948	5,942	77	7,497	1,207	40,569	472	5,212	78,455	2,951	-10,680
1987	13,476	596	2,729	179	13,960	7,440	56	6,422	1,364	38,642	346	5,946	77,084	2,948	-14,994
1988	15,006	589	3,564	172	14,916	7,224	80	6,103	1,316	38,857	710	7,077	80,019	2,045	-13,986
1989	15,006	595	2,750	165	14,762	9,239	129	6,770	1,349	38,870	499	7,367	81,900	2,392	-16,358

Source: U.S. Department of Energy (1990).

For 1989, Oklahoma's consumption per capita was more than 22% above the national average. From 1973 through 1989, the average annual energy consumption growth rate for the United States was 0.6% while, at 1.5% annually, Oklahoma had one of the highest growth rates among the lower 48 states. (Alaska had the highest, at 7.2%.) Oklahoma also had one of the highest growth rates in energy use per capita. Oklahoma's demand for energy has continued to grow in recent years in contrast to a trend in most states toward a leveling off or declining demand. The state's current mix of energy sources is dominated by natural gas and petroleum products; however, there is a substantial growth in the demand for coal.

Since 1960, there has been a continuing reduction in demand for natural gas and petroleum products and a sharp increase in the use of coal. Hydroelectric power is an important supplemental source, and Oklahoma continues to be a net ex-

porter of electricity.

Petroleum products in greatest demand are motor gasoline, diesel fuel, and other distillate fuels. Liquefied petroleum gas consumption has been substantial, about 6% of total petroleum product consumption. Demand for jet fuel, lubricants, asphalt, and road oils has also increased substantially. Consumption of aviation gasoline, kerosene, and residual fuel has decreased.

In Oklahoma, the industrial sector is the largest consumer, followed by transportation. The residential and commercial sectors also have large demands. These demand patterns by sector are similar to national trends in consumption. The electrical power generation sector depends most on coal, followed very closely by natural gas. More than 90% of Oklahoma's coal use is by electrical generation facilities; only about a third of the state's natural gas demand is from that sector. Table 3.1 indicates the trends in energy consumption by source.

The residential sector depends primarily on natural gas and electricity for energy, but about 6% of residential energy comes from propane. The commercial sector chiefly consumes electricity, natural gas, and propane; the industrial sector's major demand is for natural gas and a variety of petroleum products. The electric utilities consume primarily coal and natural gas but use about 5% hydropower. The transportation sector demands a wide variety of petroleum and natural gas products, dominated by motor gasoline and diesel fuel.

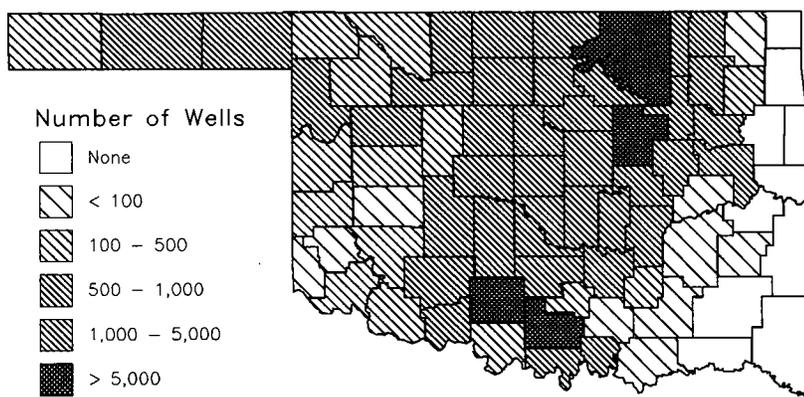
Consumption of natural gas and petroleum products has declined in recent years. There have been major declines in demand for natural gas in the electric utility and industrial sectors; the biggest declines in demand for petroleum products have been in the industrial and residential sectors. Electricity use is up considerably, as is the demand for coal, which is used primarily by the electrical generating sector.

OKLAHOMA'S CRUDE OIL AND NATURAL GAS RESOURCES

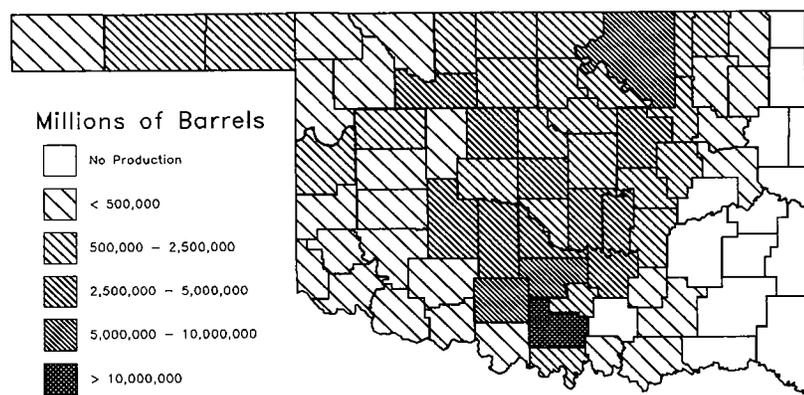
Oil Production

Cumulative crude oil production in Oklahoma through 1990 was 12.7 billion barrels. The highest crude oil production, more than 277 million barrels, occurred in 1927 early in the history of the state's oil industry. Since then, there have been four peak periods of production centered around 1937, 1956, 1967, and most recently, 1984, when 168 million barrels were produced. The production of 112 million barrels in 1990 indicates a gradual decline from the peak in 1984. Of the total production in 1990, about 8% (9 million barrels) was condensate/gas liquids. In 1966, 19% of total production (about 42 million barrels) was condensate. Over the past 25 years, condensate's share of overall petroleum liquid production has declined gradually, leveling off since 1982. Figure 3.1 shows the trend in liquid petroleum production since 1918. The condensate/gas liquids will continue to be a substantial portion of overall petroleum liquids production from currently producing reserves.

In 1990 Oklahoma had 81,667 producing oil wells and an average production of about 3.8 barrels/day per well, down from 7.9 barrels in 1971. In 1990 Oklahoma crude oil and condensate production was 4.1% of the total U.S. production, down from 7.9% in 1966. Oklahoma ranks sixth nationally both in crude oil production and in condensate production. The number of producing oil wells by county and



Map 3.1 — Producing oil wells by county, 1990. Source: Oklahoma Corporation Commission (1991f).



Map 3.2 — Crude oil production by county, 1990. Source: Oklahoma Corporation Commission (1991d).

the distribution of crude oil production by county is shown in Maps 3.1 and 3.2, respectively.

The actual number of producing oil wells in Oklahoma has fluctuated over the past 25 years. There were

81,477 in 1966; 71,657 in 1975; 102,935 in 1985; and 81,667 in 1990. The 1990 total was 14.5% of all producing oil wells in the U.S. and the second-largest state total (behind Texas); Oklahoma had many more producing oil wells than any foreign country. Oklahoma ranks 19th in the nation in crude oil production per well per day. Figure 3.2 shows Oklahoma production per well per day from 1966 to 1990.

More than 70% of Oklahoma's crude oil production in 1990 was from stripper wells. According to the National Stripper Well Survey by the Interstate Oil and Gas Compact Commission in January 1991, 73,345 of Oklahoma's 81,667 producing oil wells (about 89%) were classified as stripper wells and had an average daily production per well of 2.94 barrels of crude oil. Yet, stripper well acreage under lease in 1990 accounted

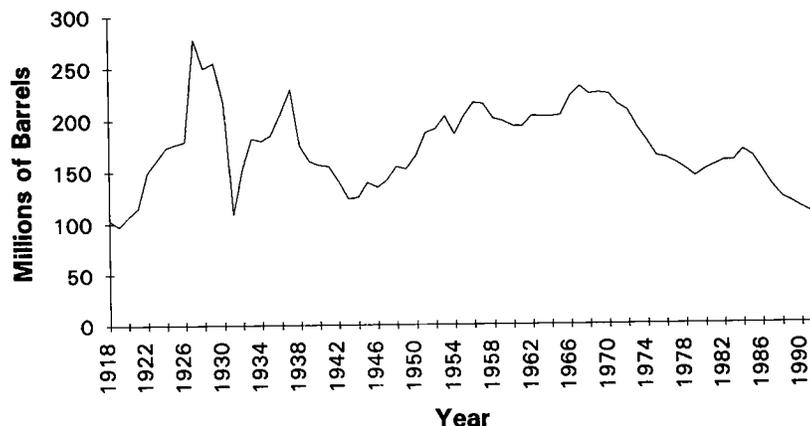


Figure 3.1 — Oklahoma liquid petroleum production, 1918–91. Source: Oklahoma Corporation Commission (1992).

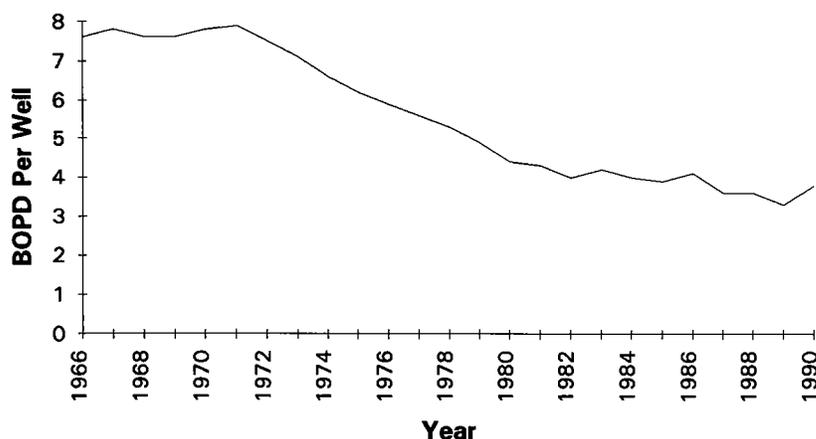


Figure 3.2 — Oklahoma oil production, barrels of oil per well per day, 1966–90. Source: Oklahoma Corporation Commission (1991a).

for only about 17% of producing acres (about 1.33 of 7.65 million) and only 7% of all leased acreage, productive or nonproductive. Its stripper well production makes Oklahoma the leader in secondary recovery production.

Oklahoma has numerous small oil fields and 11 giant fields. Historically, the giant oil fields have been the heart of the state's oil activity, and they continue to provide a substantial portion of the state's total production. In recent years these giant fields have produced about a third of the state's overall crude oil, and they will continue to be major contributors to future production, particularly secondary and enhanced recovery production.

Of Oklahoma's 77 counties, 66 were producing crude oil in 1990. The top six producing counties were Carter, Stephens, Osage, Garvin, Grady, and Creek Counties, all producing more than 4 million barrels annually and accounting for about 69% of the state's total production for 1990. Most regions of the state have at least one major oil-producing county. Major oil production is focused around Carter, Garvin, and Stephens Counties in the far south-central sector of Oklahoma; Pontotoc County in the southeast; Seminole and Pottawatomie Counties in the east-central section of the state; Creek, Pawnee, Noble, and Osage Counties in the northeast; Kingfisher and Major Counties in the north-central sector; Texas County in the Panhandle; and Caddo and Grady Counties in the west-central and southwest parts of the state.

The average oil production per well in Oklahoma in 1990 was about 3.9 barrels/day or about 1,500 barrels/year. Relatively new wells in all producing counties have much higher production rates, and wells in several newly explored and developed counties also have considerably higher production rates. The average production rate in Grady County is 18.9 barrels/day per well and in Texas County, 11 barrels. Production averages in Oklahoma and McClain Counties are 10.8 and 10 barrels/day per well, respectively. In relatively newly developed counties, production averages soared: Custer, 56 barrels/day per well; Washita, 55; Murray, 33; Beckham, 24; Roger Mills, 20; and Harmon, 16. Four of these counties are in west-central Oklahoma, not previously considered a major oil-producing region. These and other western counties are prime for future development and exploratory activity, which may establish the west as a major oil producing region in the state.

Oil Reserves

Oklahoma's reserves of crude oil and total liquid hydrocarbon peaked in the mid-1950s. Oklahoma's oil reserves declined 51% between 1966 and 1990, down from more than 1.5 billion barrels to 734 million barrels. Reserves also declined in the neighboring states of Texas, Louisiana, New Mexico, and Kansas.

A very important measure of future promise is the amount of annual production of a resource in relation-

ship to its reserve. The percent of crude oil production-to-reserves has remained relatively constant over the past 24 years. It has fluctuated from 15.2% production-to-reserves in 1966 to a low of 13.2% in 1975 and 1976 and back up to 14% in 1990. The 1990 figure indicates a total reserve production life for crude oil of 7 years, about the same as in 1966. This comparison, however, is misleading: although the production-to-reserves ratio was about the same in 1966 as in 1990, actual crude oil production dropped substantially. Almost twice as much crude oil was produced in 1966 as in 1990.

Gas liquid production-to-reserves in 1990 also was similar to what it was in 1966, but the recent pattern of production of gas liquids differs from that of crude oil. The percent of gas liquids production-to-reserves almost doubled in the 1970s but declined drastically throughout the 1980s. The increase through the 1970s reflected not higher production but a decrease in reserves. There was a sharp increase in reserves during the early 1980s. Actual production of gas liquids declined from about 41 million barrels in 1966 to 12 million barrels in 1983. In 1990, production was at about 9 million barrels.

In 1990, stripper well reserves were 53% of Oklahoma's crude oil reserves and were the second largest stripper oil reserve in the nation. Oklahoma's stripper well reserves were 627 million barrels in 1975. They increased to more than 648 million barrels in 1979 and remained relatively level until a sharp decline of 522 million barrels in 1985. They declined even further, to 391 million barrels, in 1990. For 1990 primary production reserves for stripper wells was about 193 million barrels of crude oil and 198 million barrels of secondary reserves, representing 49% and 51% of total stripper well reserves, respectively.

The percentage of stripper oil production-to-reserves was 20% in 1990, which indicates a production life of less than 5 years. Still, new reserves will be added continuously as more productive crude oil wells decline in production and become stripper wells. On the average, 3,700–5,000 oil wells are reclassified as stripper wells

each year; 1,100–1,500 stripper wells are taken out of production permanently by abandonment or plugging. Some 2,008 oil wells were taken out of production in 1990. Figure 3.3 shows the importance of stripper wells to the oil reserves of the state.

Natural Gas Production

Oklahoma is the third-largest natural gas producing state in the U.S. and produced 12.3% of the nation's natural gas in 1990. Between 1966 and 1990, Oklahoma's share of national production increased from 8.2%.

The highest level of annual natural gas production in Oklahoma occurred in 1990 when more than 2.2 trillion cubic feet (Tcf) were produced. Oklahoma's natural gas production has increased more than 300% since 1950 (22% just since 1975). The increase has been gradual: from 482.6 billion cubic feet (Bcf) in 1950, to 1.1 Tcf in 1962, to 1.7–2.1 Tcf annually since 1970. Future production may be higher.

Natural gas production is both from oil wells (associated gas) and from gas wells. In 1990 oil wells contributed about 16% of the total natural gas produced, and gas wells contributed more than five times as much. Historically, oil wells contributed a larger share; for example, in 1966, oil wells accounted for 29% of the state's natural gas production. Figure 3.4 indicates the trend in Oklahoma's natural gas production since 1950.

By the end of 1990, Oklahoma had 24,110 producing natural gas wells, with an average production of about 211 Mcf of gas/day per well. This production figure was down from 1971, when production per day per well was 480 Mcf. The number of producing natural gas wells increased gradually from 1966 to 1981, from 7,841 to 16,994. In 1982, there was an abrupt increase to 20,742. The number reached 23,647 in 1984 and dropped to 19,174 by 1987. Oklahoma has witnessed a surge in natural gas activity over the past 20 years; the number of gas wells in the state has almost tripled while, at the same time, associated (oil well) gas production has been maintained. Among the major gas producing states, Oklahoma ranks second in the number of producing

gas wells and third in production per well per day.

Of the 77 counties in Oklahoma, 66 were natural gas producers in 1990. Ten counties had more than half of the producing wells and produced more than 50% of the natural gas (both casinghead gas from oil wells and natural gas from classified gas wells). Counties, by region, with the most gas producing wells were: Texas and Beaver (Panhandle), Canadian (central), Major and Harper (northwest), Okmulgee (northeast), and Pittsburg (southeast). Gas production was not

necessarily greatest where the number of producing wells was highest.

The top 14 gas-producing counties, led by Latimer, Roger Mills, Custer, Grady, Texas, Pittsburg, Canadian, Le Flore, and Beckham, accounted for 69% of Oklahoma's gas production, and showed the dominance of western Oklahoma in gas production. Latimer, Pittsburg, and Le Flore were the only eastern counties in the top 14 gas producers, although there is substantial gas production in the eastern half of the state from both oil wells and gas wells. There is also considerable

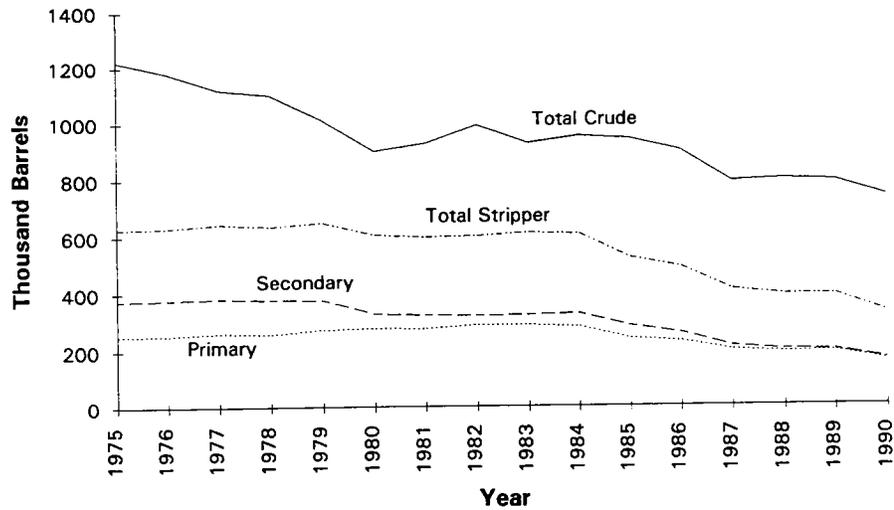


Figure 3.3 — Crude oil and stripper oil well reserves in Oklahoma, 1975–90. Source: Interstate Oil and Gas Compact Commission, National Stripper Well Survey (1991a).

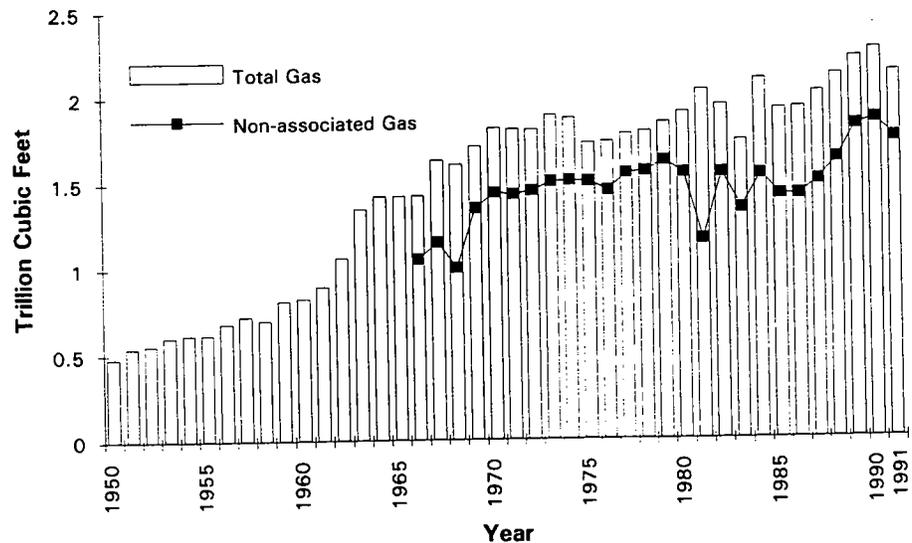


Figure 3.4 — Oklahoma gas production, 1950–91. Source: Oklahoma Corporation Commission (1992c).

new gas production in the Arkoma basin of southeastern and east-central Oklahoma.

The average natural gas production per gas well in Oklahoma was about 211 Mcf/day, or 77 MMcf/year. Counties with the highest annual production of gas per natural gas well were Latimer, Roger Mills, Atoka, Beckham, Washita, Alfalfa, Le Flore, Custer, Blaine, Grady, Caddo, Sequoyah, and Pittsburg. Latimer County had an annual production per gas well of 376 Mcf. Pittsburg County, ranking 13th in the state, produced 103 Mcf per gas well per year. Roger Mills in the Anadarko basin of western Oklahoma had an annual production per gas well of 622 Mcf.

Maps 3.2, 3.3, and 3.4 show Oklahoma's producing oil wells, gas wells, and total gas production by county for 1990, respectively.

Natural Gas Reserves

Oklahoma ranks third among the states in natural gas production and reserves. At the end of 1990, the state held 10% of the nation's natural gas reserves. While reserves in other major gas-producing states (and in the nation as a whole) have been declining, Oklahoma reserves have increased: U.S. natural gas reserves have decreased 18% since 1977; Oklahoma reserves have increased 45%.

Oklahoma's natural gas reserves peaked in 1965 at almost 21 Tcf. By 1979, they had declined to about 11 Tcf, a reduction of almost 48%. Since 1979, however, Oklahoma reserves have increased. New field discoveries have added about 2.2 Tcf to Oklahoma's natural gas reserves. New reservoirs in old fields and extensions to existing fields have added about 3.4 Tcf, and more than 7 Tcf, respectively.

Additions to the gas reserve from new field discoveries were highest in 1980-81; less has been added since 1982. Additions from new reservoirs in old fields increased from 1981 to 1990, while reserve additions from extensions to existing fields generally declined.

From 1980 to 1990, dry natural gas reserves in Oklahoma steadily increased from about 13 to about 17 Tcf. (In comparison, gas reserves in Texas and Louisiana decreased considerably after 1979, and Kansas reserves dropped 20%.) Additions to the Oklahoma natural gas reserves have been nonassociated gas.

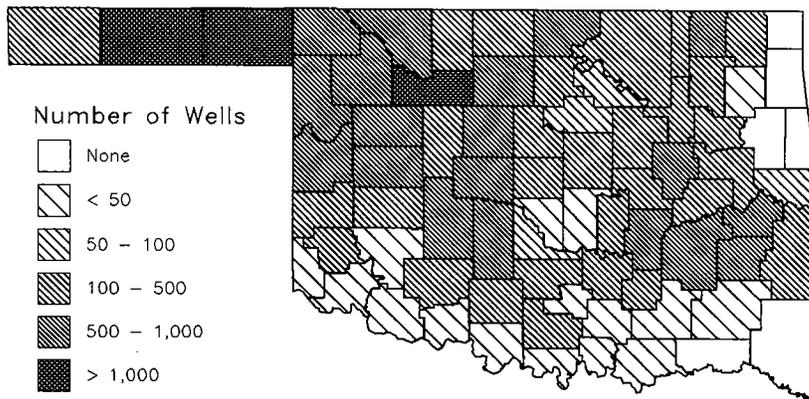
The production-to-reserve percentage for natural gas steadily increased from 1966 to 1979, when it reached 17.4%, then gradually declined to 10.8% in 1990. Although the production-to-reserve ratio has changed considerably since 1966, the actual production has changed only slightly. Natural gas reserves have increased since 1969, but nonassociated gas reserves per producing well have declined about 56%.

Figure 3.5 illustrates the natural gas reserve situation in Oklahoma and the U.S. from 1966-90.

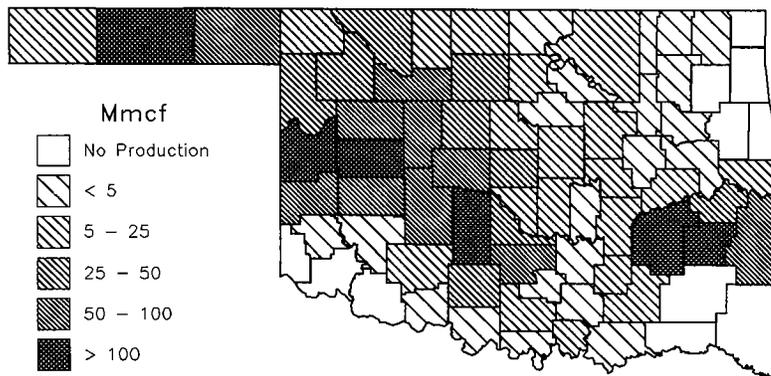
Drilling Activity and Well Completions

Since 1957, more than 172,000 oil and gas wells have been completed in Oklahoma; a little more than half were oil wells and about 18% were natural gas wells. From a drilling-activity peak of about 6,000 well completions annually in 1957-58, activity dropped to about 2,300 completions in 1973. Drilling activity gradually increased to 6,500 well completions in 1979 followed by a rapid increase in drilling activity during 1980-85. Well completions peaked in 1981-82 at about 12,000 completions annually, almost twice the activity of any year since the 1950s. With declining oil prices, drilling activity dropped abruptly from more than 9,000 completions in 1985 to fewer than 6,000 in 1986. The decline continued and in 1990 only 2,340 wells were completed.

The general trend in well completions between 1957 and 1974 was an increase in the proportion of natural gas wells to oil wells drilled. Histori-



Map 3.3 — Producing natural gas wells by county, 1990. Source: Oklahoma Corporation Commission (1991e).



Map 3.4 — Total gas production by county, 1990. Source: Oklahoma Corporation Commission (1991a).

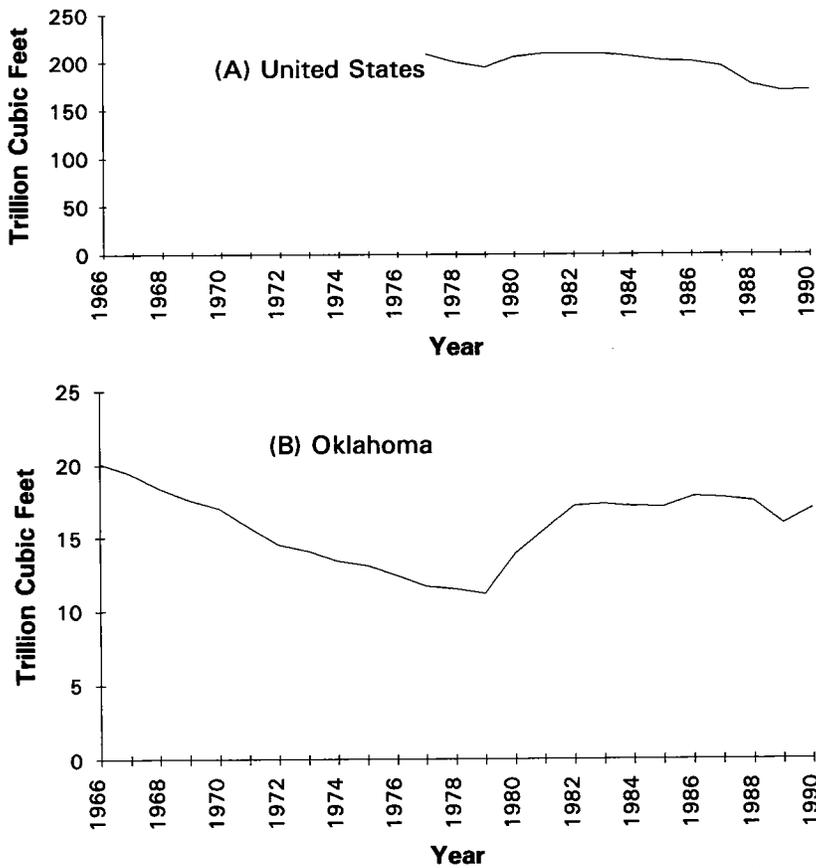


Figure 3.5 — Estimated proven reserves of natural gas for (A) the United States and (B) Oklahoma, 1966–90. Sources: Interstate Oil and Gas Compact Commission (1991b); Mankin (1987).

cally, since 1974, oil well completions have been 62–74% of total completions. Over the past few years the percentage has dropped to about 55%. Figure 3.6 shows the historical trends in Oklahoma drilling activity.

Since 1977, the success rate in drilling has averaged more than 70%, a higher success rate than in previous years. Wells are categorized as wildcat, exploratory, or development—wildcat wells involve the most risk and development wells, the least. More than 2,700 wildcat wells have been drilled in Oklahoma since 1980 with about 26% success. These are the wells that discover new producing fields. About 60% of these were oil wells. Wildcat drilling activity peaked in 1982 then declined abruptly. Although exploratory wells have shown a greater success rate, fewer have been drilled. Development wells, drilled in proven fields, represent about 95% of all completions in recent years.

Rotary rig activity had a high weekly count of 881 in late 1981. The count dropped to 285 in 1983 and was down to 125 in 1990. More than 63 million feet were drilled in 1982, followed by a gradual decline until 1985.

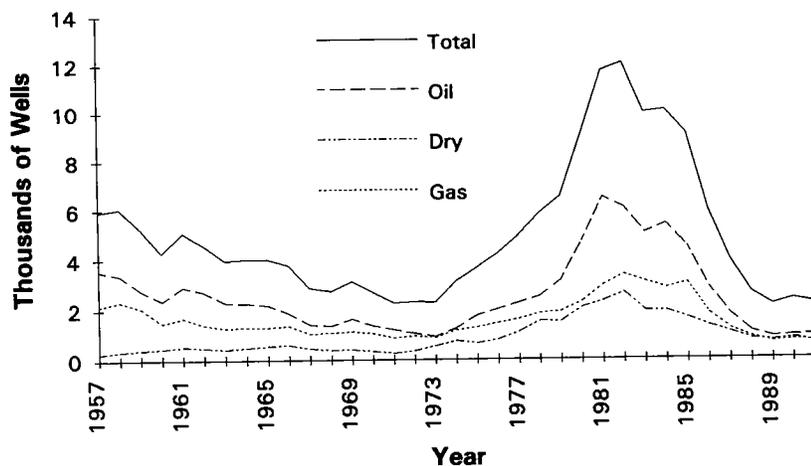


Figure 3.6 — Oklahoma well completions, 1957–91. Source: Oklahoma Corporation Commission (1992f).

There was an abrupt decrease in 1986, when only 19 million feet were drilled. Since 1979, more than 90% of footage drilled has been for development wells. Figure 3.7 reviews trends in plugging and abandonment.

In recent years, the average depth of a well has been 4,800–5,300 feet. Exploratory wells average 2,000–3,000 feet deeper. Counties which had the greatest footage drilled in 1990 were Grady, Roger Mills, and Garvin. Seventeen counties had a million or more feet drilled in 1985. In 1990 no county drilled more than 800,000 feet. Footage drilled for gas wells represented an increasing proportion of drilling activity over the past few years.

Seismic crew activity peaked in the 1981–83 period and then declined through the rest of the decade. Acreage under lease in Oklahoma continued to increase until 1985, then leveled off. During the same period, acreage under lease in most major producing states declined substantially. Currently, more than 38% of Oklahoma's leased lands are producing oil and gas.

Drilling Costs

Drilling costs generally reflect the demand and supply related to rotary rigs, equipment, labor, and services. Drilling costs increase during periods of increased drilling, particularly when demand rises rapidly; costs have dropped substantially during the recent decline in drilling activity. An additional factor, often overlooked, is the influence of improved drilling

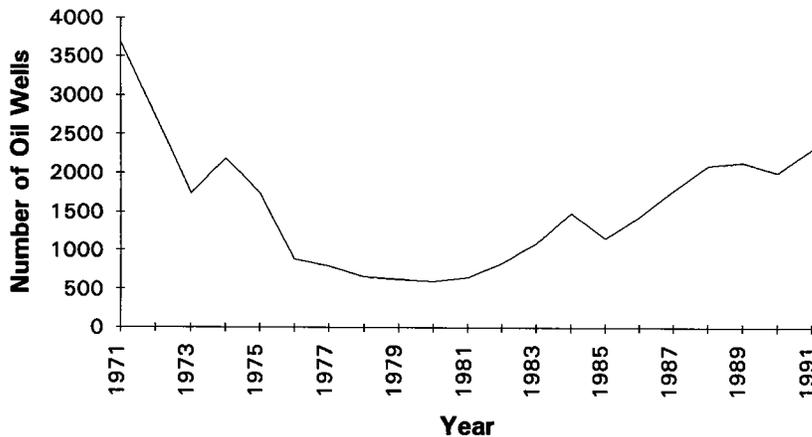


Figure 3.7 — Oil wells plugged and abandoned, 1971–91. Source: Oklahoma Corporation Commission (1992e).

technology on cost. A more efficient drilling operation moderates cost even during periods of peak activities.

In Oklahoma, average drilling costs gradually increased from about \$19 per foot in 1970 to \$68 in 1979. They peaked at \$109 in 1982, and then declined to \$72 in 1984 and to \$67 in 1989. Of course, drilling costs vary considerably by specific well. Generally in Oklahoma, the cost of drilling the average gas well in 1989 was \$663,000 or \$91 a foot, while the cost for the average oil well was about \$245,000 or \$55 a foot.

Price, Value, and Revenues

Price is the primary factor influencing the level of oil and gas activity, particularly exploration and production; it determines the resource value and revenues. Wellhead prices of crude oil gradually increased from less than \$3/barrel in 1961 to \$3.78 in 1974 and continued to rise gradually until 1978. By 1980, prices had increased to more than \$28/barrel; they peaked at nearly \$36/barrel in 1981. Prices then declined gradually from 1981 to 1985 and dropped sharply in late 1986 to less than \$10/barrel. Since that low, price has increased but has been variable, reaching about \$23 in 1990. Condensate wellhead price followed similar trends.

In 1961 natural gas prices were only 12¢/Mcf. They had tripled by 1976 and then more than doubled again in 1977. By 1981, natural gas was \$1.88/Mcf. Prices peaked in 1983 at \$2.83/Mcf, then declined gradually

until 1985. By 1987 they had fallen to \$1.47/Mcf; in 1990 they averaged \$1.57/Mcf. The prices for casinghead wellhead gas followed similar trends. Using constant dollars, neither increase has been as dramatic as it seems from actual price; nevertheless

prices have increased significantly over the past 27 years. Figure 3.8 shows trends in wellhead prices and value for oil and gas.

The value of Oklahoma's crude oil, condensate, and natural gas increased from \$827 million in 1965 to more than \$4.2 billion in 1979; it was up to more than \$10 billion during the early 1980s. Recent price declines and reduced production levels brought annual value down to \$6 billion in 1990. More specifically, total petroleum liquids increased in value from \$623 million in 1965 to a peak of \$5.3 billion in 1981; value dropped to \$2.2 billion in 1986, and to \$2.4 billion in 1990. Wellhead value of natural gas increased from \$182 million in 1965 to more than \$5 billion in 1981, and then declined to \$3.2 billion in 1986. It was \$3.4 billion in 1990.

Due to increased prices, state gross production tax (GPT) revenues from oil and gas greatly increased from \$42

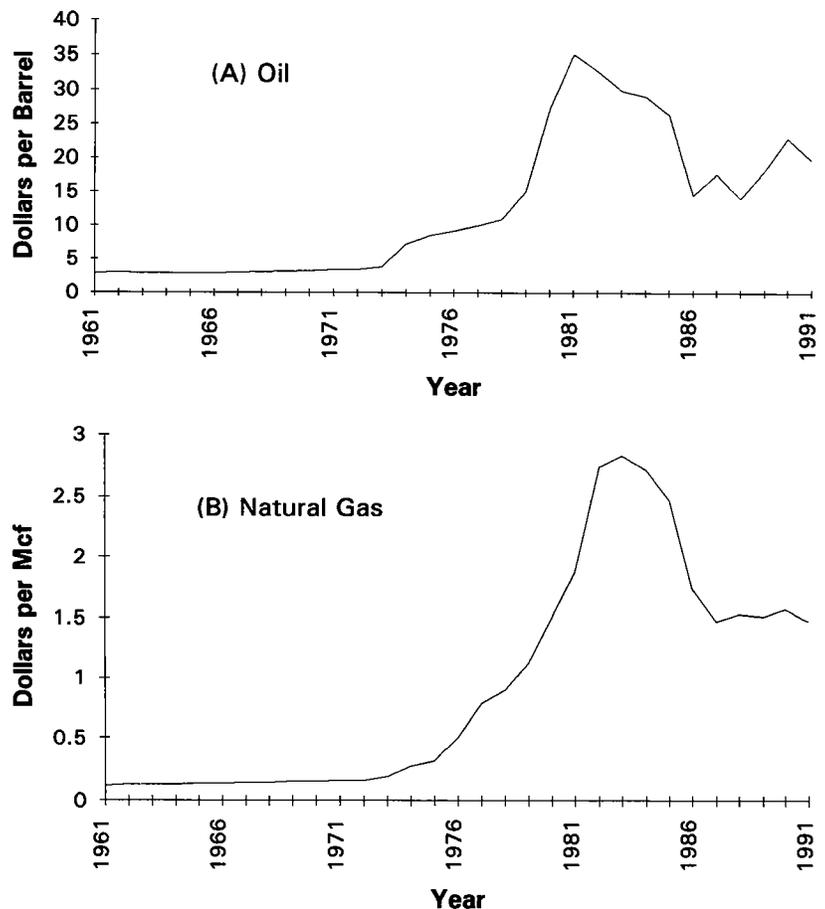


Figure 3.8 — Crude oil (A) and natural gas (B) wellhead prices, 1961–91. Source: Oklahoma Corporation Commission (1992b).

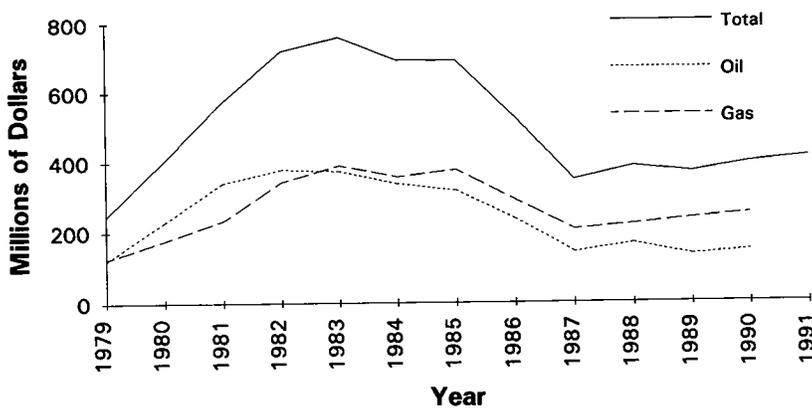


Figure 3.9 — Oklahoma gross production tax (GPT) revenues, 1979–91. Source: Oklahoma Tax Commission Annual Reports (1991, 1992).

million in 1965 to \$740 million in the early 1980s. A considerable decline in price and a continued reduction in production lowered state GPT revenues to \$376 million in 1986. In 1990–91, GPT revenues were \$412 million. Natural gas production has been the major contributor to GPT revenues since 1983. About 20% of these revenues return to the counties of production for schools and roads. In the 1990–91 tax fiscal year, county governments received about \$29 million in revenue, down from \$50 million in 1984–85. Figure 3.9 indicates recent trends in state GPT revenues.

Refining, Processing, Delivery, and Storage

Refining

In 1973, with 12 petroleum refineries and a crude oil capacity exceeding 474,000 barrels/day, Oklahoma ranked ninth in the production of refined petroleum products. Inadequate crude oil supplies dedicated to state refineries, infrastructural obsolescence of some facilities, and new refining and marketing strategies brought about the closing of several refineries. The trend to move refineries to coastal sites easily supplied by crude oil imports also affected other inland oil-producing states.

As of January 1, 1991, Oklahoma had six operating refineries with a capacity of 395,500 barrels per calendar day. Since 1981, 121 refineries have closed throughout the U.S. Eight of these were in Oklahoma. Even with a reduction in Oklahoma's refining capacity, in 1990 the state ranked 10th in

the country as a producer of refined petroleum products. Historically, Oklahoma has depended on crude oil feed stocks from other producing states to supplement local oil supplies. Petroleum produced from Oklahoma's crude oil refineries includes gasoline, propane, butane, kerosene, diesel fuel, lube oils, special naphthas, coke, and a variety of other fuel oils.

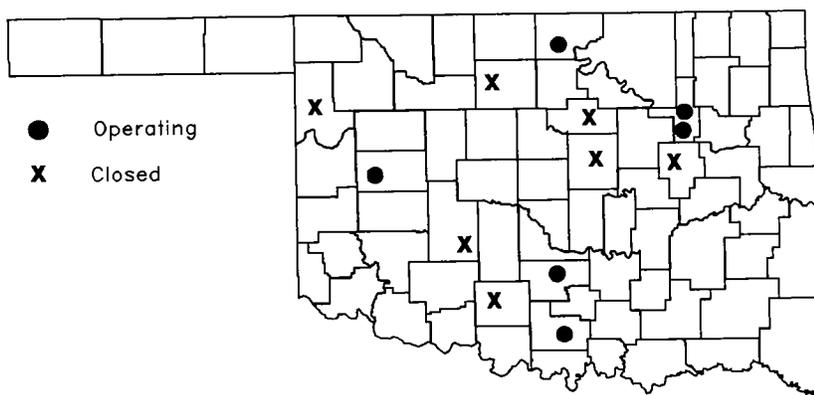
Gas products separated in processing are methane, ethane, propane, and butane. Methane and ethane act as refinery fuel gas. Butane and propane are liquefied under compression and marketed as liquefied petroleum gas. Butane may also be used in motor gasoline products. Light and medium distillates derived from the refining process provide naphthas and kerosene. Certain grades of both are used in the production of jet fuels. Kerosene, is also produced, of course, as a heating oil.

Other middle distillates, including diesel fuels, are used as cracking stock in the refining process during the production of gasoline. Residue not removed as a distillate may be used as fuel, residual fuel oil, or in the production of asphalt. Various fuel oils are produced primarily for space heating. Each fuel oil meets a specific grade based on "burner" suitability. For diesel fuels, kerosene, and jet fuels, a variety of grades are produced, suitable for a variety of combustion engines. Historically, well over half of Oklahoma's refined product has been gasoline, and about a quarter has been distillates and fuel oils.

Petroleum refineries have been important to Oklahoma not only for employment, but also for their major use of natural gas. The shutdown of some refineries has substantially reduced the intrastate demand for natural gas. The location of Oklahoma refineries in operation since 1981 is shown in Map 3.5.

Processing

Natural gas processing facilities in Oklahoma are chiefly associated with crude oil producing fields where casinghead gas is gathered from the oil field by a pipeline system and transported to a processing plant. Products from natural gas processing include propane, butane, and natural gasoline, with residual gas forwarded to gas distribution pipelines. In 1973 there were 86 gas processing plants operating in Oklahoma with a total processing capacity of about 4.5 Bcf/day. Actual gas throughput (gas moved through the system) was 3.4



Map 3.5 — Oklahoma refineries in operation and closed, January 1, 1991. Sources: Oil and Gas Journal (1991); American Petroleum Institute (1992).

Bcf/day, 74% of capacity. By 1990, there were 101 plants, and processing capacity increased to 4.68 Bcf/day; gas throughput was only 2.8 Bcf, primarily because the reduction in crude oil production reduced the volume of casinghead gas available for processing (Map 3.6). New oil discoveries and increased in-fill drilling will be necessary to maintain or increase the throughput of gas. Secondary recovery through gas injection can further increase the availability of casinghead gas.

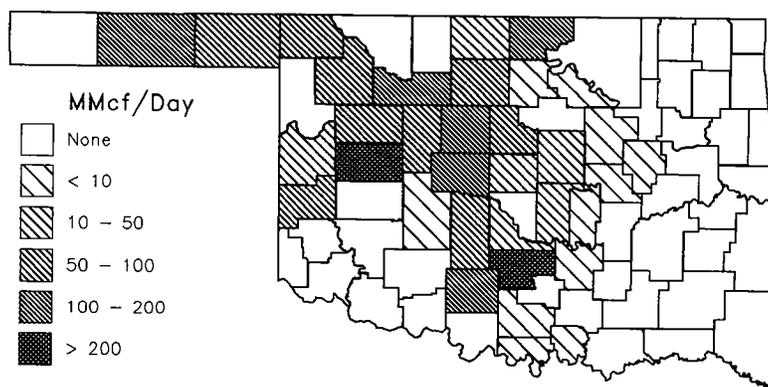
In 1990, the 101 natural gas processing plants produced per day about 813,000 gallons of propane, 286,000 gallons of normal butane, 109,600 gallons of isobutanes, 119,300 gallons of liquid petroleum gas mix, 326,200 gallons of natural gasoline, and more than 5 million gallons of raw natural gas liquids mix.

The decline in Oklahoma's crude oil production reflects a reduction in the production of liquified petroleum gas produced from casinghead gas. Continuing exploration and development of the deep Anadarko basin has added oil reserves, a positive indicator to natural gas processing and products derived from casinghead gas and natural gas. The discovery of new oil reservoirs and continued development of existing reservoirs is important to the natural gas processing industry.

Delivery and Storage

Adequate gathering, storage, and distribution networks are essential to getting a produced raw energy resource or processed product to the consumer or purchaser. Oklahoma has well-developed land, air, and water transportation systems, and an extensive pipeline network for the distribution of crude oil, natural gas, and refined petroleum products. This pipeline system is interconnected to substantial storage facilities.

In 1990, the intrastate pipeline system included more than 43,600 miles of gas utility industry pipeline. Almost 12,000 miles were for field and gathering purposes and about 14,000 miles were used for transmission by 179 operators, which included public utilities, municipalities, and pipeline transportation companies. The pipe-



Map 3.6 — Oklahoma natural gas processing, 1990. Source: Oil and Gas Journal (1991d).

line is connected to most of the U.S., with an emphasis on the Midwest, Texas, and Pacific Coast. In 1990, of 2.26 Tcf of marketed gas production, more than 1 Tcf were purchased by the interstate pipeline companies. Interstate purchases peaked in 1982, and again in 1990, at over 1.1 Tcf. Marketed production grew by more than 20% between 1975 and 1985, peaking in 1984, and grew another 19% by the end of 1990. Oklahoma also has a very extensive liquids pipeline network of more than 4,000 miles; 12 operators provide a transportation capability for petroleum products.

Employment in the Oil and Gas Industry

Employment in the oil and gas extraction industry jumped from about 34,000 employees in 1972 to more than 102,000 in 1982. Following the decline in oil and gas prices, employment fell to about 49,100 in 1986 and to 41,600 in 1990. Employment in the oil field machinery sector had the same trends except that there has been an upswing in employment in this sector since 1987. The price decline severely affected the oil and gas services industries. Oil refinery employment patterns were sustained between 1972 and 1982, but declined about 14% between 1982 and 1986; they continue to decline in part due to factors unrelated to the oil price fall.

In 1981–82, more than 136,000 Oklahomans, representing more than 11% of the state's labor force, were employed in the oil and gas industry, a 139% increase from 1973. In 1990,

workers in the oil and gas sector made up 5% of the nonagricultural labor force. An additional 73,000 jobs outside of the oil and gas industry were lost as well. In spite of losses, Oklahoma's oil and gas industry base and work force remain a strong foundation for the state's economy.

COAL RESOURCES AND THE COAL INDUSTRY

Coal is a major energy resource in eastern Oklahoma. Commercial coal mining began with the completion of the Missouri–Kansas–Texas Railroad to McAlester in 1872. Other early railroad lines expanded the production of the area. In 1897, 18 companies were mining coal in eastern Oklahoma, and by 1903, 117 mines produced more than 3.5 million tons. This production level was maintained through 1920 when World War I stimulated production to more than 4.85 million tons. The 1920s saw production decline to about 3 million tons annually. During the Depression of the 1930s, production sank to about 1.1 million tons. Not until World War II did production increase to 2.8 million tons (in 1943). Coal production reached its highest level in 1981, when more than 5.7 million tons were mined (Figure 3.10).

In 1930, about 89% of coal production came from underground mining, but by 1959, surface mining or strip mining accounted for 80% of production. It made up 99% by 1964. Renewed underground mining between 1969 and 1971 accounted for 6–9% of total production. Since 1972, surface

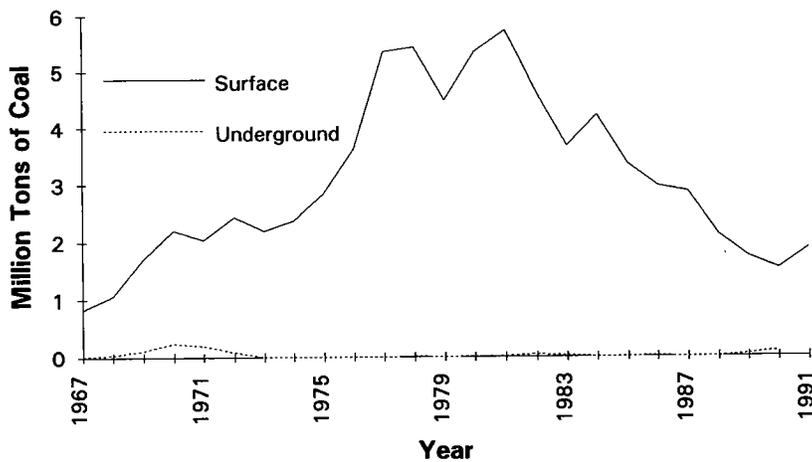


Figure 3.10 — Oklahoma coal production, 1930–91. Source: Oklahoma Mining Commission–Oklahoma Department of Mines (1992).

mining has accounted for 99–100% of production, except in 1989–90 when some new underground mining was initiated.

In 1985–86, 12 eastern Oklahoma counties produced more than 6.3 million tons. In 1989–90, production was limited to 3.4 million tons in only nine eastern Oklahoma counties. Production was down more than 70% from the peak in 1981. In 1990, major producing counties were Craig and Rogers in the northeast, accounting for more than 50% of production, followed by Latimer, Haskell, and Le Flore Counties (Figure 3.11). Since 1969, Craig County has been the major coal producer, followed by Rogers and Haskell Counties. Other substantial production has come from the counties of Latimer, Le Flore, Muskogee, Okmulgee, McIntosh, Nowata, Wagoner, and Pittsburg, and limited production has come from Coal, Mayes, and Atoka Counties. In 1990, 34 companies, with a total of 330 employees, were actively operating. About 10,400 acres were under permit for coal mining.

Oklahoma has an estimated 7.2 billion tons of coal resources underlying 24 counties in eastern Oklahoma and covering some 1.5 million acres. Net recoverable coal reserves which are minable under current conditions are estimated at 2.3 billion tons, of which about 500 million tons are extractable by surface mining methods. Of these, about 275 million tons are of relatively low sulfur content, below the U.S. Environmental Protection Agency's

maximum allowable sulfur dioxide emission limits. These low sulfur coals are located primarily in the Lower Hartshorne coalbeds of Haskell and Le Flore Counties. Most of Oklahoma's recoverable coal is characterized by high sulfur content, thin coal seams, high BTU value, considerable overburden, and high volatility. Local conditions vary considerably; a very significant reserve of recoverable coal is characterized by low sulfur content.

Although Oklahoma possesses abundant supplies of steam and metallurgical coal, the state has never ranked as a major producer. Historically, Oklahoma has produced only about 0.5% of the nation's annual pro-

duction. Generally, Oklahoma's coal has been mined by relatively small, independent companies. Modern-day coal mining requires large capital investments and modern, sophisticated operations with highly trained employees. Large-scale strip mining is often met with public opposition and concern. More than 27,000 acres of previous strip mining operations lie unreclaimed.

The construction of the McClellan–Kerr Arkansas River Navigation System, which began operation in 1972, has been an incentive to coal production by providing low-cost accessibility to world markets. Barge shipments of coal peaked in 1981 at about 1.3 million short tons. In 1986 fewer than 680,000 tons were shipped by barge; the remainder was carried by rail and truck.

The lack of a high state severance tax on coal production is an incentive to production. In-state, coal-fired electrical generating plants provide a market for Oklahoma coal, even for coal higher in sulfur (which can be blended with other coal to meet environmental standards). In recent years, out-of-state utilities have been the major consumers of Oklahoma coal. Major in-state use has been by the cement and lime industry, paper industry, and utilities, and by industries as process heat. The coal industry has experienced production cycles; it has had as few as 12 active mines and as

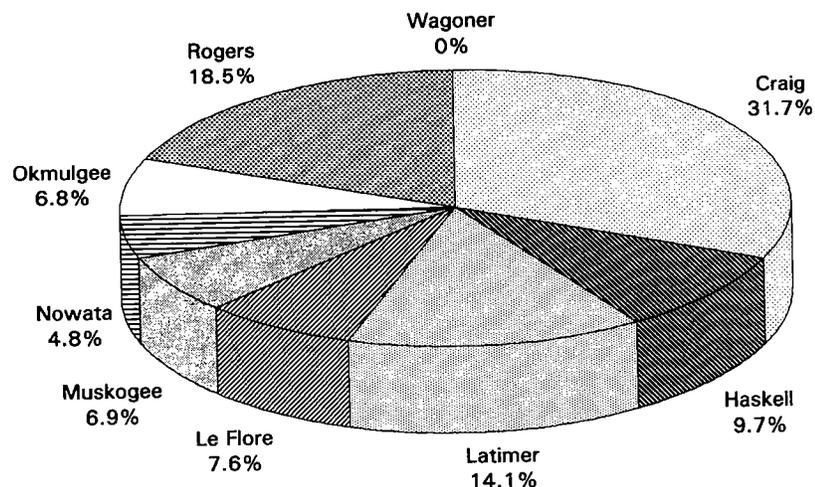


Figure 3.11 — Percentage of coal production by county, 1990–91. Source: Oklahoma Mining Commission–Oklahoma Department of Mines (1992).

many as 60 since 1969. A 1987 survey conducted by the Oklahoma Association of General Contractors revealed that, in 1986, 10 companies producing 2.9 million tons of coal accounted for 95% of Oklahoma's production. They employed 721 workers, with a combined average annual payroll of \$20.8 million. Payrolls, payments to subcontractors, and royalties amounted to \$98.6 million. A healthy coal industry is important to Oklahoma, particularly to the coal-producing counties.

ENERGY CONSERVATION AND ALTERNATIVES TO CONVENTIONAL FOSSIL FUELS

Crude oil and refined petroleum products imports began to accelerate in the late 1980s. By 1990, imports met more than 50% of domestic U.S. demand. By 1995, as domestic production and drilling decline, imports are projected to fill 65% of demand. Based on reduced drilling for natural gas and high gas production-to-reserve ratios, there is the prediction of possible gas shortages later in the decade; there could be severe gas curtailments to consumers throughout the country. Turning to the nation's vast coal resources could provide only a partial solution. In view of such adverse forecasts for domestic production of conventional fossil fuels, alternatives to these traditional resources become most important. Despite the presence of basic resources to develop a significant alternative energy industry, there has been little research and development so far, and the nation has minimal ability to provide such energy alternatives. Policy to restrict energy use is the only substantive measure the nation could implement rapidly.

Oklahoma has vast potential resources for the production of synthetic fuels; it also possesses abundant renewable energy resources. During the energy crisis of the 1970s, Oklahoma implemented energy conservation, efficiency, and management initiatives which substantially reduced energy demand. Oklahoma, like the nation, could only respond to an energy shortage crisis by implementing policies to restrict energy consumption. Advancements in synthetic fuels and renewable resources will require substantial, government-supported

research and development, incentives for the private sector, and plenty of lead time.

Synthetic Fuels

Oklahoma has considerable reserves of coal, heavy oils, and tar sands, which can provide the basis for a substantial synthetic fuels industry. Biomass and solid waste can also provide significant substitute fuels.

Oklahoma coal can be converted into a liquid fuel like gasoline; compared to current oil prices, however, the product cost would be prohibitive. A large percentage of the initial energy source potential is lost in the process; only about two to three barrels of liquid synfuels are derived from each ton of coal. The production of a million barrels of synfuel would require 350,000–500,000 tons of coal and capital investment requirements would be large. Still, Oklahoma has the surplus coal resources to provide the feed stock for such a synfuels project. The production of clean liquids from coal is achieved by several proven but expensive processes.

Oklahoma's coal resources can also be converted to a variety of gaseous fuels by a number of proven technologies. The gases from the conversion processes are mixtures of carbon monoxide and hydrogen with methane. They generally have less heating value than natural gas, although some medium-BTU gas can be converted to high-BTU gas, equivalent to natural gas.

A potential development for Oklahoma coal is underground coal gasification. Production of gas from coal in situ is accomplished by injecting air or oxygen into the coal seams. This method is particularly attractive in areas where the coal is relatively inaccessible for conventional mining. Oklahoma's steeply dipping coal beds would be quite suitable for this process; they may be easy to gasify in place. Underground coal gasification also has some environmental advantages. The gas produced could be utilized for local process heat, as a feed stock, for the generation of electricity, and for conversion to high-BTU gas.

Oklahoma tar sands are also suitable for synfuels production. Tar sands (asphaltic rock) contain hydro-

carbon resources which are recoverable conventionally. Tar sands are usually found as outcrops and contain a mixture of bitumens and sand. Tar sands are deposits of porous rock or sediments containing thick oils. Oklahoma has a large number of outcrops found primarily in south-central and northeastern Oklahoma. Hydrocarbons in tar sands may be extracted by mining and transporting the tar sands to the surface for processing, or by underground techniques. The refining process is the same as for crude oil. To be economically feasible, the recovery of oil from tar sands normally requires a large-scale operation.

Heavy oils also are suitable for the production of synthetic fuels. Large deposits of heavy oil not conventionally producible may represent a large reserve. The largest reserve is found in the northeastern part of the state. Hydrogen produced from fossil fuels, most likely coal and more unconventional hydrocarbon sources, is also a possibility.

Renewable Resources

Oklahoma's "renewable" resources deserve careful attention. Over the past decade, research and development have brought renewable energy sources into commercial use, but continued work is needed to improve these solar, wind, and geothermal technologies. Although generally effective and efficient, these renewable resources currently provide less than 1% of total energy consumption in Oklahoma.

Oklahoma possesses abundant renewable energy resources. Geothermal energy, derived from the interior of the earth, may be used to operate steam driven turbines or may supply heat directly for space or process needs. Chief potential sources for geothermal heat are found in the hot waters of deep sedimentary beds, particularly in the Anadarko, Arkoma, and Ardmore basins.

Moreover, Oklahoma is situated in a location very favorable to the application of solar energy technology. Future developments in solar energy technology will allow greater applications; conventional development is presently limited to heating. Wind energy is a form of solar-created energy that is used to turn turbines to

generate electricity. Oklahoma is in a very favorable geographic location with climatic characteristics that make wind energy projects practical and economical. Wind energy projects, small-to-moderate in size, have appeared across the state, but generate an almost insignificant amount of electrical energy. Western Oklahoma lies in the area of highest potential for wind energy development.

The degree and timing of the development of alternative energy applications is highly dependent upon the price of conventional energy, particularly that of electricity, natural gas, and propane. When the time and technology are right, Oklahoma has the potential to benefit greatly from solar and wind energy.

Energy Conservation

The Arab oil embargo of 1973 caught the country and its energy industry by surprise. After many decades of near energy independence, a false attitude of security had become the mind-set of the public and officials of the U.S. Reduced domestic production and increasing reliance on imported oil, however, had made the country vulnerable to disruptions in supply; the domestic industry could not maintain the energy supplies necessary for the economy to operate smoothly. Conservation of energy became essential. Oklahoma responded to the embargo with policies and programs to minimize the impact on the state's economy. Shortages of natural gas in the mid-1970s further stimulated federal regulation.

Federally mandated state energy conservation programs were directed primarily at transportation and at space heating and cooling but also touched almost all energy-consuming sectors of the economy. Oklahoma planned, implemented, and enforced an extensive energy conservation plan which extended to energy-efficient procurement practices and building standards, and involved a high-profile public awareness program. The energy conservation and management programs were monitored for results. The goal of the plan and its many programs was to reduce overall consumption by 5% by 1980. In the first report to Congress, the U.S. Depart-

ment of Energy reported that Oklahoma ranked first in energy savings per capita. Oklahoma, its industries and its citizens, understood the importance of conservation to the economy of the state and the nation in times of oil and gas shortages.

Outside state government initiatives, the private sector implemented numerous conservation projects and energy management schemes which considerably reduced consumption of various energy resources. The state's electricity and natural gas utilities have been outspoken proponents of energy conservation and continue to provide economic incentives for measures that reduce consumption. Numerous public and private agencies provide information about energy and cost-savings to the public.

Energy conservation and the efficient use of energy continue to be priorities with Oklahomans if for no other reasons than cost-savings and cost-efficiency. This conservation awareness in both the public and private sectors will help soften the blow of any future energy-shortage crisis.

ENERGY RESEARCH

Oklahoma's public and private institutions of energy research are known nationally and worldwide for their scientific, technical, and policy research. The Oklahoma Geological Survey (OGS), located in the Sarkeys Energy Center on the campus of the University of Oklahoma in Norman, is the official state energy and minerals research and public-service agency. The OGS was authorized by the State Constitution and implemented by the first State Legislature. The Survey's mandate is "to investigate the land, water, mineral, and energy resources of Oklahoma, and to disseminate the results of their investigations to encourage the wise use of our natural resources."

The Survey engages in a wide variety of field investigations and performs a broad range of laboratory analyses. It has performed extensive research regarding Oklahoma's conventional fossil fuels and other energy sources such as tar sands, heavy oils, and geothermal resources. The Survey maintains a microfilm well-log collection and has developed a computer-

ized data base of the state's oil and gas fields.

Associated with the Survey are the OGS Core and Sample Library, the Laurence S. Youngblood Energy Library, and the OGS Observatory (located near the town of Leonard). Also affiliated with the Survey is Geo Information Systems (GeoSystems), an organization skilled in the development and management of large data bases. GeoSystems is presently developing a Natural Resources Information System for Oklahoma to include petroleum, coal, and production data bases. Included in the Survey's extensive involvement in petroleum research and information management is the development of an Oil and Gas Field Production File, a Petroleum Well History File, and a Petroleum Well-Log Library. The Survey, in cooperation with the U.S. Geological Survey, is developing a coal data base.

The Sarkeys Energy Center at the University of Oklahoma in Norman is a rapidly developing center for energy and environmental research. The Energy Center, completed in late 1990, includes a 250,000 square-foot main structure and a 90,000 square-foot high-rise tower. Programs at the Energy Center focus on the extraordinary changes and new technologies that have occurred in the energy sector over the past decade. There is close interaction with the energy industry. The approach in research is interdisciplinary and recognizes the importance of interfacing technology with economics, politics, and land use. A key objective is to stimulate research relevant to the volatile climate foreseen for the energy world. Research initiatives should lead also to educational programs that better prepare students to be productive in the wide range of energy fields.

The Energy Center emphasizes the interactions among geology, geophysics, geochemistry, remote sensing, geography, chemistry, petroleum engineering, applied mathematics, computer science, chemical engineering, meteorology, economics, business, political science, economics, and communications. All of these disciplines are expected to affect energy development in the years ahead. The Energy Center houses the College of Geo-

sciences, composed of the School of Geology and Geophysics, the School of Meteorology, and the Department of Geography.

The University Center for Energy Research (UCER) at Oklahoma State University was created in 1979 with the general objective of applying a multidisciplinary approach to the complex problems in energy. Recent emphasis has been on policy, fossil fuels, and other energy sources. Policy research has focused on the impact of changes in oil industry tax preferences on Oklahoma's economy. The UCER also promotes energy awareness through sponsored symposia and the dissemination of information. The College of Engineering, Architecture, and Technology has been intimately involved in much of the University's energy research.

The Noble Center for Agriculture and Renewable Resources, also at Oklahoma State University, houses the biological sciences departments, the Center for Applications of Remote Sensing, and the School of Geology. This facility is another significant center for research and education focused on future needs of agriculture and energy.

The College of Petroleum Engineering and Applied Science, the College of Geosciences, the College of Law, and the National Energy Law and Policy Institute at the University of Tulsa help make this private institution well known for its energy programs and research. Recent research has focused on fossil fuels, renewable resources, and energy law.

Total expenditures in energy research by Oklahoma's public higher education system increased from about \$34 million in 1975 to \$66 million in 1986, and to more than \$91 million in 1989-90. Funding sources were both public and private. For 1989-90, more than 78% was spent by the University of Oklahoma and Oklahoma State University. The state's 10 senior regional universities spent about 15% of the research funding. The 13 junior colleges spent about 7%. For fiscal year 1989-90, most research funds for constituent public agencies targeted research in the health sciences and agriculture.

There is considerable energy research in the private sector. One out-

standing research facility is the National Institute for Petroleum and Energy Research (NIPER), an operation of the IIT Research Institute (IITRI) in Chicago. NIPER is the former U.S. Department of Energy (DOE)-Bartlesville Energy Research Center, later known as the Bartlesville Energy Technology Center. In 1983, NIPER was founded under a cooperative agreement between the Research Institute in Chicago and the DOE. NIPER works closely with the petroleum industry and government to find new and improved ways of producing, processing, and utilizing petroleum and alternative liquid fuels. Now administered by private industry and the University of Tulsa, NIPER emphasizes the development and modernization of petroleum technology. More than 200 scientists, engineers, and support staff work in 17 buildings on a 17-acre campus. On the leading edge of enhanced oil recovery (EOR), NIPER continues to research surfactant-polymer flooding, gas flooding, microbial EOR, and thermal recovery.

Other internationally renowned research centers in Oklahoma are Phillips Petroleum in Bartlesville, Conoco in Ponca City, and Kerr-McGee in Oklahoma City, along with Keplinger Laboratories, Dowell Schlumberger, Amerada Hess Cities Service, John Zink Company, C-E Nots, Amoco, and Williams Brothers in Tulsa. Important energy-related research is also conducted by Halliburton in Duncan, Chem-Link in Sand Springs, and Vista Chemical in Ponca City. There are many other Oklahoma companies involved in energy research.

Numerous energy businesses and professional organizations are headquartered in Oklahoma. Among these are the American Association of Petroleum Geologists, the National Stripper Well Association, the Interstate Oil and Gas Compact Commission, and the National Association of Royalty Owners.

ENERGY POLICY AND REGULATION

Another important factor in the "energy equation" is national and state energy policy. Policy can be the major factor that establishes balance,

or imbalance, in the capacity to meet energy demands and to provide for a stable, viable economy. Both national and state policy, together and separately, significantly influence the energy picture. Because of the paramount importance of energy to the economy and to the security of the nation, policy is a critical factor.

National policy in the 1970s was based on a belief that energy stability, if not energy independence, was desirable and could be attained. In contrast, national policy during most of the 1980s practically ignored the need to promote energy self-sufficiency, not only in fossil fuels, but also in alternate and substitute fuels. Energy as a national policy issue deteriorated from a major priority in the 1970s to a commodity issue in the 1980s, although windfall profit taxes and some natural gas issues were addressed late in the decade. The nation has been, and is currently, in a very vulnerable position.

Energy policy generally has been directed toward particular energy sources; there has been little consideration for the overall production/demand/consumption mix. Policy in energy has been, most often, a response to crises rather than sound initiatives for long-term management and security.

Historically, national oil policy has been focused on influencing prices, limiting imports, and reacting to temporary domestic and international oil surpluses or shortages. Until oil was decontrolled in 1981, federal policy was to hold oil prices artificially low, which adversely affected the potential for ultimate resource recovery and the development of new energy sources.

Except in the early 1980s, national energy policy in 1980-90 resulted in growing foreign crude and refined oil imports, decreasing investment and activity domestically, and increasing movement of investments and major energy company activity to producing regions in other parts of the world. Drilling activity for 1990 in the entire U.S. was less than it was just in Oklahoma earlier in the decade.

Historically, the national policy for natural gas also has been aimed at influencing price, directly or indirectly, particularly in interstate sales of gas

and federal regulation of interstate pipelines. The effect of controls on gas was to lower consumer prices. National policy also has resulted in gas market discrimination and distortions; energy source to end-user prohibitions were set and selective pipeline regulation were mandated.

Current national policies continue to support the status quo, which overly or unfairly regulates the natural gas industry and impedes the efficient and fair operation of interstate and intrastate distribution systems, and the creation of new markets. Studies are to address this situation.

National coal policy in modern times has encouraged the use and export of coal through prohibitions on certain oil and gas usage, yet raised obstacles to production and usage in the form of environmental use regulations and stringent environmental regulations for mining and for miner health and safety. Over the past decade and a half, due to national policies primarily, the domestic demand for coal has replaced substantially the demand for oil and natural gas.

National energy policy has been very influential in the research, development, and commercialization of renewable resources, synfuels, and energy conservation. Certainly, conservation has achieved the most success to date. Funding initiatives for the improved recovery and more efficient use of conventional fossil fuels have declined at the national level. Oklahoma has taken the lead, nationally, in promoting compressed natural gas in the transportation sector.

A review of national policy since 1970 clearly indicates contradictory objectives that have affected adversely the development of an integrated national energy policy. Energy is so critical to the economy, and to the security of the U.S., that a responsible, comprehensive policy is essential to survival.

Historically, Oklahoma has led producing states in establishing progressive energy policy and regulation. Policy formulation extends back to the early years of production. Authority for regulating industry and protecting the state's energy resources is primarily with the Oklahoma Corporation Commission for oil and gas matters and with the Oklahoma Department

of Mines for coal. Oklahoma's executive and legislative branches, as well as its regulatory agencies, continue to initiate progressive actions in the interests of the citizens of the state and the energy sector of the state's economy.

ENERGY IN THE 1990s

With few exceptions, oil and gas activity in Oklahoma continued to be depressed through 1991 and 1992. The average price for oil was down from \$22.95 to \$19.72/barrel. Production was down about 4%, from 112 million barrels to 108 million barrels. A mild positive sign was that oil-well drilling was up to 917 from 870 in 1990. The price for natural gas declined to \$1.47 per Mcf before prices began to recover. Gas production was down to 2.13 Tcf from 2.26, and gas well drilling was down to 631 from 780. Drilling for new field wildcats and exploratory wells was about the same while total drilling was down to 2,206 from 2,340, and the rig count was down substantially. Total footage drilled was down to 12.4 million feet from 14.6 million feet, and the average depth drilled declined to 5,608 feet from 6,257 feet. The number of wells plugged and abandoned was up by 15% in 1990. Consistent with reduced production and price, resource value and generated gross production tax revenue declined.

An evaluation of Oklahoma's assets reveals a potentially promising future for energy. The best indicator for success is Oklahoma's resource base—fossil fuels reserves, the expertise and dedication of Oklahoma's energy industries and productive work force, the massive transportation infrastructure, the capability for alternative fuel development, and progressive state energy and economic policy. Still, under current world circumstances, Oklahoma and other producing states are vulnerable. Responsible state and national policy is essential to providing stability in the face of the potential for global overproduction. Natural gas offers particular promise for future development.

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— Chapter 3 —
LIST OF ILLUSTRATIONS

Figures

3.1 — Oklahoma liquid petroleum production, 1918–91 _____	39
3.2 — Oklahoma oil production, 1966–90 _____	40
3.3 — Crude oil and stripper oil well reserves in Oklahoma, 1975–90 _____	41
3.4 — Oklahoma gas production, 1950–91 _____	41
3.5 — Estimated proven reserves of natural gas for the U.S. and Oklahoma, 1966–90 _____	43
3.6 — Oklahoma well completions, 1957–91 _____	43
3.7 — Oil wells plugged and abandoned, 1971–91 _____	44
3.8 — Crude oil and natural gas wellhead prices, 1961–91 _____	44
3.9 — Oklahoma gross production tax revenues, 1979–91 _____	45
3.10 — Oklahoma coal production, 1930–91 _____	47
3.11 — Percentage of coal production by county, 1990–91 _____	47

Maps

3.1 — Producing oil wells by county, 1990 _____	39
3.2 — Crude oil production by county, 1990 _____	39
3.3 — Producing natural gas wells by county, 1990 _____	42
3.4 — Total gas production by county, 1990 _____	42
3.5 — Oklahoma refineries in operation and closed, January 1, 1991 _____	45
3.6 — Oklahoma natural gas processing, 1990 _____	46

Table

3.1 — Oklahoma energy consumption by source, 1960–89 _____	38
--	----

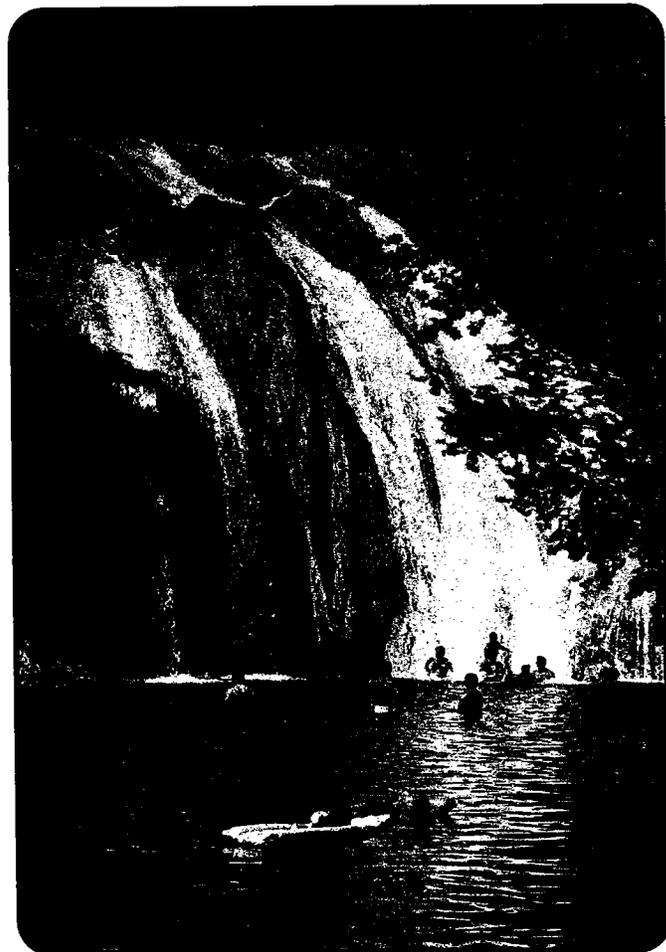
Oklahoma Resources

Chapter

4

Water—Oklahoma's
Vital Resource

by
Chand Wije
and
Mark Meo



Contents

Executive Summary _____	57
Introduction _____	58
Development of Water Resources in Oklahoma _____	59
Development of Water Supply _____	59
Development of Water-Resources Use _____	60
Changes in Water Use _____	60
Spatial Distribution of Water Use _____	61
Current Patterns and Trends in Water Use _____	62
Agricultural Water Use _____	62
Municipal Water Use _____	62
Industrial Water Use _____	63
Water Use for Oil and Gas Production _____	63
Water Use for Power Generation _____	63
Commercial Water Use _____	63
Recreational Water Use _____	64
Water Resources Planning and Administration _____	64
Oklahoma Comprehensive Water Plan _____	64
Water Supply Management _____	65
Floodplain Management _____	66
Water Demand Management _____	66
Water Management Trends in Oklahoma _____	69
Navigation Canals _____	69
Water Recreation _____	69
Financial Assistance Program _____	69
Interstate Cooperation _____	69
Market Sale of Water _____	69
Conclusion _____	69
References _____	70
List of Illustrations _____	72

Water—Oklahoma's Vital Resource

Chand Wijé and Mark Meo

Executive Summary.—Oklahoma ranks 14th in total surface water area among the 50 states and has 6,500 miles of shoreline along its lakes that hold at least 1,000 acre-feet of water. Water covers approximately 991,000 acres and comprises 2.2% of the state's total land area. Within a period of 22 years from 1962 to 1984, Oklahoma's water storage capacity has doubled from 6 to 12 million acre-feet. Since 1905, 43 major reservoirs have been constructed in Oklahoma; four more are under construction and five others have been authorized for federal funding in the near future.

Oklahoma's annual rainfall varies from 50 inches in the southeastern corner to 15 inches in the western Panhandle. The incidence of high-intensity rainfall upon the state's open rolling landscape bears witness to a climatic regime renowned for periodic cycles of flood and drought. Spatial variability in water availability has been further accentuated by the fact that the major rivers in Oklahoma run on a northwest to southeast direction, draining water from the drier west to the humid east.

Fortunately for the state, the western region is well-endowed with a generous supply of ground water. The state has 12 major and 150 smaller ground-water basins; together they store 320 million acre-feet of fresh water, half of which is recoverable for socially beneficial uses. As a cheap and reliable source of water for irrigation, ground water has been developed rapidly by farmers and overdrafting of aquifers has become a matter of grave regional and national concern.

In response to changes in both the economic viability of irrigated farming and in ground-water law and policy, the heavy use of ground water for irrigated agriculture in Oklahoma has declined in recent years. While ground-water usage has decreased, stream-water use has risen, making it the principal source of water supply. With 5,520 miles of streams, Oklahoma is well-endowed with stream water. Water runoff in the arid Panhandle region is only about 0.2 inches, but it increases to 20 inches in the humid southeastern corner. Yet much of this water is fugitive. The average amount of water leaving the state is about 22 million acre-feet for the Arkansas River and 3 million and 9 million acre-feet for the Little and Red Rivers, respectively. Increased stream-water use could help with the dispersion of economic activities in a manner consistent with the goal of diversifying the state's economy.

A surplus of stream water has been problematic in the humid east as well as in the semi-arid west. The nation's first upstream flood prevention project was constructed in western Oklahoma in 1953 with the voluntary cooperation of the area farmers and ranchers. Approximately 1,800 small lakes greater than 10 acre-feet in size and hundreds of thousands of farm ponds reinforce the principle of self-reliance practiced by these local citizens. In the east, where water supplies are adequate, public and federal funds have been used to construct several large reservoirs in the area. These dams, combined with the region's hilly terrain and unspoiled natural landscape, have created an area with untapped development potential for water recreation. Federal and state efforts to protect area scenic rivers along with a program of floodplain management have given this potential a further boost.

Oklahoma's decision to privatize its ground-water basins among the overlying land owners is the first such initiative in the nation. Ground-water rights can now be sold in the open market in Oklahoma. This and other laws and policies have been operationalized in the Oklahoma Comprehensive Water Plan, completed in 1980. The plan's recommendations regarding weather modification, floodplain management, and ground-water recharge have been progressing well for years with emphasis placed on private and community participation. Further, the blueprints prepared for a chlorine control program will likely benefit from recent water legislation passed by the U.S. Congress.

The new concept of water-resources financing, which began in the 1980s, is another innovative step. This strategy encourages a local, community-based approach to solving the water-resource problems of cities, towns, rural water and sewer districts, and other special service districts. Within the state, emphasis is placed on the regional and local components of the major water-conveyance schemes proposed under the comprehensive water plan.

INTRODUCTION

Water has never been an insurmountable obstacle to development in Oklahoma. When the U.S. Congress enacted the Desert Lands Act in 1877, the land area that later became the State of Oklahoma was not included within the nation's "arid belt." However, its central location in the zone of transition between the arid and humid portions of the country made Oklahoma geographically relevant for the Bureau of Reclamation's water supply projects in the western U.S. and the Army Corps of Engineers' water-taming projects in the eastern United States. Like most other states, Oklahoma experiences an uneven distribution of both annual precipitation and ground-water availability. Its rainfall is seasonal, variable, and exhibits high intensity. The eastern half of the state has a humid climate, while the western part is relatively dry to semi-arid. Major rivers in Oklahoma run on a northwest to southeast directional gradient that leaves ground water as the main source of water supply in the western part of the state. Yet the availability of plentiful stream water in the east has created the potential for water supply and recreation in the hilly eastern border regions of the state (Map 4.1).

Oklahoma's central location in the country endows it with many features common to a transitional region. At least five zones of rainfall are observable, ranging from the humid, heavy precipitation experienced in the southeast to the semi-arid condition in the northwest Panhandle. Oklahoma's average precipitation is about 34 inches with a high yearly variation (Figure 4.1). While summers can be very hot with extremely high evaporation rates, the flat, rolling landscape allows for rapid runoff from torrential rains. These climatic and geomorphic factors have created periodic cycles of flash floods followed by dry spells and droughts in Oklahoma. Consequently, while settling the land and developing the state's economy, Oklahomans have written a remarkable history regarding the management of their water resources.

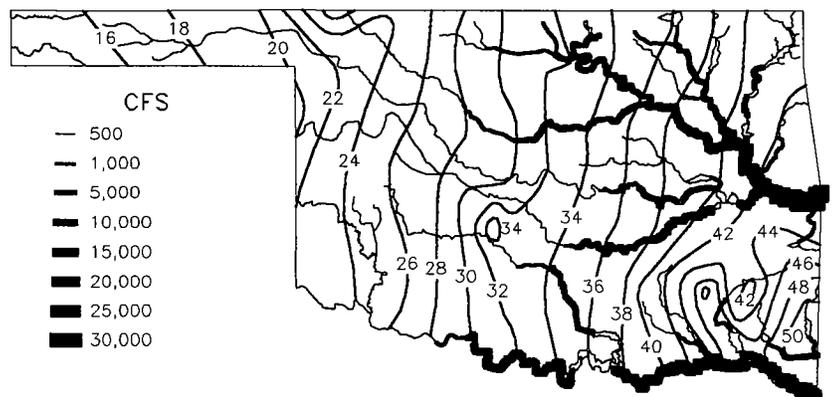
Flash floods are not limited to the eastern humid portion of the state. In fact, the nation's and the world's first

upstream flood prevention project was built on the Washita River in western Oklahoma. At present, approximately 20 million acres of land in Oklahoma are under the Upstream Watershed Program supported by the U.S. Soil Conservation Service. Climatic distinctions between the east and the west, however, have created a "duality" in the irrigation economy of the state. In the eastern region, irrigation is a minor activity that uses mainly surface water. In the western region, on the other hand, irrigated agriculture is an important economic enterprise that takes the major share of the ground-water supply in the area. If this water used for irrigation is reduced, ample water will become available to meet the growing water needs of other sectors of the state's economy.

The humid east with its hilly natural landscape is quickly emerging as a region valued for recreation. With the development of Oklahoma's surface-water resources, the potential for a recreation industry appears rewarding. Federal and state efforts to protect scenic rivers in the area have increased the potential for economic investment. Riparian landscapes also receive protection indirectly through federal- and state-sponsored flood-plain management programs. By improving regional access through water transportation, the movement of goods and people in this part of the continental United States could be increased. A navigation canal now connects Tulsa, once known as the world's oil capital, with Mississippi

River ports on the Gulf of Mexico. A proposal to extend this canal so that Oklahoma City, the state's capital, would gain access to an oceanic transportation network received serious consideration in the early 1960s. Depending on forecasts for increased waterborne transportation, it may be timely to resurrect this "Central Oklahoma Project" because of the integral role it could play in strategies to diversify Oklahoma's economy.

In most situations, water is not available at the place where it is needed most. More often than not, competition for water occurs at sites where it is naturally available. Oklahoma is, however, managing demands for water and associated conflicts in water needs remarkably well. It has a unique record of constructing the physical infrastructure of dams and distribution systems necessary for the development of its water resources. Similarly, the institutional structure of governance developed by Oklahomans to meet present and future water problems is possibly one of the best examples of its kind in the nation. The Oklahoma Comprehensive Water Plan adopted in 1980 has become a guide for implementing the state's water-management strategies. In the case of ground water, it has introduced private property rights and the sale of water in the open market. With regard to municipal and rural water-supply and water-quality management issues, it has adopted a policy of providing state financial support for community-based solutions. This local approach allows for



Map 4.1—Mean annual rainfall in Oklahoma and average annual discharge of its principal rivers. Source: Oklahoma Water Resources Board (1980a).

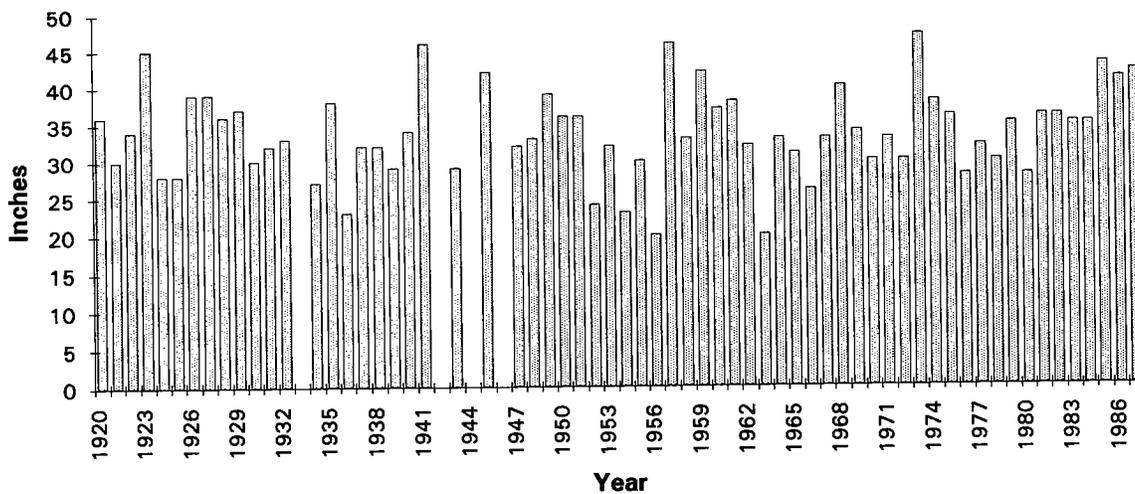


Figure 4.1—Annual precipitation, Oklahoma, 1920–87. Source: Oklahoma Department of Commerce (1988).

the integrated management of water resources. Oklahoma's community and market-oriented approaches are consistent with the recent federal policy promulgated by the federal Water Resources Development Act of 1986 for local governments and private businesses to undertake smaller projects on a cost-sharing basis.

The boom and bust cycles of oil and gas production experienced in Oklahoma have sometimes eclipsed the vital role water has played in the economic and social progress of the state. At a time when another recent oil bust has compelled Oklahomans to think seriously about the need to diversify their economy, water resources have become a key component in long-range planning. Fortunately, Oklahoma has an abundant supply of water to meet all demands for water from the other sectors of its economy. How Oklahoma has developed this water-resource capability and institutional resilience is an important issue in the legacy of Oklahoma's water usage.

More specifically, the following discussion addresses the development of water resources in Oklahoma from the perspectives of water supply improvements, growth of water use, and the temporal and spatial changes and concomitant distribution patterns of water use. These developments explain, at least in part, the current patterns and trends in water-resource use. Past developments and the present patterns and trends are a

product of water-resources planning and administration at both federal and state levels. Until the management of demand became a national concern in water-resources planning and administration in the 1970s, the emphasis had always been on the enhancement of the supply of water. The future structure of water-resources management in Oklahoma will likely be comprised of a mixture of the state's traditional supply augmentation role, growing interest in managing demand through conservation measures and more efficient use of water, improved control of negative externalities such as pollution associated with improper water use, and, finally, the strategic use of water as a catalyst for the diversification of Oklahoma's once oil-dependent economy.

DEVELOPMENT OF WATER RESOURCES IN OKLAHOMA

Development of Water Supply

Oklahoma has an impressive water-works construction record. Within a period of 25 years from 1962 to 1987, the water-storage capacity in the state doubled from 6 million acre-feet to 14.5 million acre-feet. Figure 4.2 illustrates the actual conservation storage capacity of major Oklahoma lakes. A typical pattern of storage in these multipurpose reservoirs can be divided into a flood-control pool and a conservation pool. The latter consists of storage pools for navigation, hy-

dropower, water quality, irrigation, and municipal and industrial uses. In 1905, there was only one water-development project in all of Oklahoma. This number increased to 46 projects by 1987. During the past 85 years, 11 major municipal lakes were built with nearly 2,400 industrial, recreational, private and other municipal lakes. During the past 55-year period, Oklahoma has constructed 30 major lakes and more than 2,000 smaller Soil Conservation Service lakes.

Oklahoma's achievements through private initiative must be added to this impressive construction record for public water projects. Map 4.2 shows the number of lakes in each county in Oklahoma that are more than 10 acres in size. It also shows the surface acreage and the conservation storage capacity for each county provided by these lakes. There are 1,777 such lakes in the state; their combined surface lake area is 111,170 acres. The conservation storage capacity is 1.6 million acre-feet. These lakes have a high recreational and climatic significance, especially in the western part of the state. The absence of such lakes in the Oklahoma Panhandle area is clearly noticeable, whereas south and southwestern counties endowed with streams have a larger number of lakes. In fact, Roger Mills, Custer, and Washita Counties in western Oklahoma have the greatest number of lakes. In addition to these lakes, farm ponds of less than 10 acres in size cover an area of 189,579 acres in Okla-

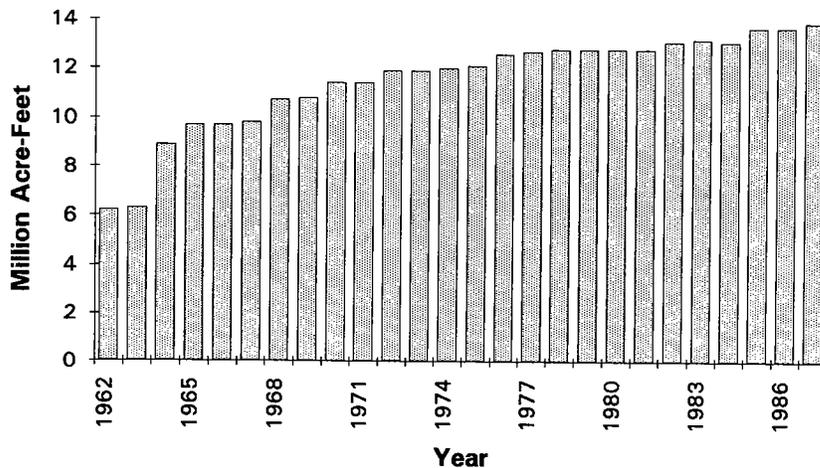


Figure 4.2—Growth of conservation storage capacity in Oklahoma, 1962–87. Source: Oklahoma Water Resources Board (1990).

homa. More farm ponds can be found in the eastern region of the state than in the western region. Kiowa, Caddo, and Comanche Counties have the greatest number of farm ponds.

Past growth in public water-works projects and private water-conservation and storage-capacity improvements has been a noteworthy response to climatic conditions of the state. These activities have been undertaken largely by private initiative. In Oklahoma the rainfall is highly seasonal, and the subtropical cyclonic depressions that bring rain produce the moisture along narrow paths with high intensity, making rainfall distribution highly variable and often giving rise to flash floods. A landscape of rolling plains without excessive vegetative growth enhances runoff. The eastern part of Oklahoma has a more humid climate with abundant precipitation. Because the major rivers in Oklahoma run in a west-to-east direction, the eastern part of the state has an abundant supply of water. During the hot summer months most rivers in the western region are dry. In the western region, ground water has supplied a partial solution to such droughts. Upstream flood-prevention projects, Soil Conservation Service watershed protection projects, and hundreds of thousands of farm ponds scattered all over the region are other measures used for water retention. In the east, a host of multipurpose reservoirs have been built to act as flood control and conservation pools. As a

result, Oklahoma today has 6,500 miles of shoreline along lakes of 1000 acre-feet or more. Water covers approximately 991,000 acres and is 2.2% of the state's total land area. Thus, Oklahoma ranks 14th among the 50 states in total water area within a state.

Development of Water Resources Use

An important characteristic of the development of water use in Oklahoma is the influence of ground-water use changes on the pattern of total water use. The decline in the use of ground water for irrigated agriculture in the western portion of the state is an important recent change in Oklahoma's water use (Table 4.1). Any release of ground water from irrigation will help reduce the overdrafting and rapid depletion of ground-water resources and provide a stable source of water for other sectors of the economy. According to Oklahoma Water Resources Board statistics, the state's total reported water consumption has been about 1.4 million acre-feet (Figure 4.3). The total water consumption for 1986–87, which includes both reported and unreported water use, is estimated to be about 2 million acre-feet of water.

From 1970 to 1974, total water use declined, then increased sharply until 1977. This increase was due mainly to growth in the use of ground water for irrigated agriculture. Total ground-water use, however, declined from

about 120 thousand acre-feet in 1977 to almost half that amount in 1983, reducing the total state water consumption figure drastically to its average level of 1.4 million acre-feet.

The declining trend in ground-water use was paralleled by an increase in the share of stream-water use, which did not fluctuate as much as ground-water use and has remained constant (Table 4.2). Since 1980, the contribution of stream water to the state's total water use has become higher than that of ground water, and is likely to continue to grow with further reductions in the ground-water share. For a period of time in the late 1960s and early 1970s, stream water took an equal or sometimes greater share along with ground water in contributing to total water consumption, but for the next decade or so, stream water's share lagged far behind that of ground water. In 1980, this situation changed for the first time with stream water taking a big lead. Increased reliance on stream water is a positive sign for the state because Oklahoma is not deficient in it.

Changes in Water Use

Adjustments that took place in water-use patterns during the recent past suggest that different economic growth sectors in Oklahoma can be assured of an adequate supply of water for years to come. Major consumptive and nonconsumptive water usages in Oklahoma are irrigation, municipal, industrial, recreation, secondary oil recovery, commercial, and power generation. Ground water used for irrigated agriculture takes the largest quantity of water. During the period from 1968 to 1978 the quantity of ground water consumed for irrigation increased from 550,000 to 1,000,000 acre-feet. But the peak reported in 1978 dropped precipitously to 500,000 acre-feet in 1981 and has continued to drop further. The reduction in ground-water use for agriculture is beneficial to the state because it prevents further depletion of ground-water aquifers. The use of stream water for irrigation did not show any dramatic increases as ground water has shown.

The water needs of other sectors of the state's economy are only a fraction

Table 4.1 Change in Groundwater Use for Irrigation, 1970-85, 10 Counties with the Largest Change

County	Water Use (in acre-feet)			Change 1975-85
	1970	1975	1985	
Texas	262,896	266,077	184,033	-82,044
Beaver	41,570	66,576	34,260	-32,316
Cimarron	94,657	75,410	43,366	-32,044
Ellis	5,532	42,042	19,699	-22,343
Woodward	8,828	22,030	3,720	-18,310
Harper	5,590	20,132	8,454	-11,678
Major	13,927	13,234	5,323	-7,911
Roger Mills	13,207	9,963	4,678	-5,285
Kingfisher	4,940	10,717	5,696	-5,021
Custer	5,641	5,387	3,044	-2,343

Source: Oklahoma Water Resources Board (1985).

of the water used in the production of agricultural crops. On the other hand, the total quantity of stream water used for irrigation was only a fraction of that of ground water. The highest quantity of stream-water usage reported was about 150,000 acre-feet in 1969. Similar to the trend in ground-water use, stream-water use is also decreasing, with only 90,000 acre-feet of use reported in 1983. The contribution from stream water has been about one-third that of ground water and the future use of stream water is either increasing or stable at a present rate of about 100,000 acre-feet.

Ground water has contributed substantially to municipal water needs. Unlike irrigation-water-use trends, high yearly variations in the quantity of ground water used for municipal purposes have not occurred. Public water supplies account for the highest share of stream-water use and continue to increase. Although stream water plays a significant role and is a major contributor toward industrial water usage, there was a drastic reduction in industrial-water use in the years 1980-82, perhaps a result of the oil crisis in Oklahoma. Stream-water use for power also shows an upward trend. On the other hand, the contribution of ground water to industrial and power production is minimal. Recreational and wildlife water uses are not very high and indicate high annual variation. As expected, these are mainly stream-water uses. The process of secondary oil recovery

uses more ground water than stream water, because enhanced oil and gas recovery work often is carried out in areas of the state where stream water is not available.

Although the competition for water between oil and gas producers and irrigators has diminished, drastic reduction in the use of ground water for irrigation has released ample water for use in other economic activities that require it. In addition, recently passed ground-water laws have enabled farmers to sell their ground-water to prospective buyers, thus relieving water as a constraint to economic development planning in the western part of Oklahoma. The ability to sell ground-water rights in water markets to the highest bidder would tend to prevent any farmer or irrigator from engaging in uneconomic and inefficient uses of ground water

such as growing low-value-high-water consumptive crops. What is taking place in western Oklahoma today is what water-resource economists have long recommended as a remedy to chronic water shortages in the American West.

Spatial Distribution of Water Use

An examination of the spatial distribution patterns of water use indicates that if a problem of water availability exists in Oklahoma, it is limited to only a few geographical areas. Although water use in the state is highly concentrated in specific areas, the rest of the state has ample water available. Map 4.3 illustrates the relative position of counties with regard to ground-water and stream-water use. The three Panhandle counties alone account for 45% of the state's total ground-water consumption. If Caddo and Oklahoma counties are added to this list, the total rises to 56%. Thirteen counties in Oklahoma account for 77% of the total ground-water consumption.

Stream-water use is even more concentrated than ground-water use. Oklahoma, Tulsa, Rogers, and Muskogee Counties accounted for 47% of the total stream water used in the state. Thirteen counties used 76% of the total. This concentration of water use in a relatively small area of the state means that potential water users have a wider choice in selecting locations for development activities. While the western part of the state

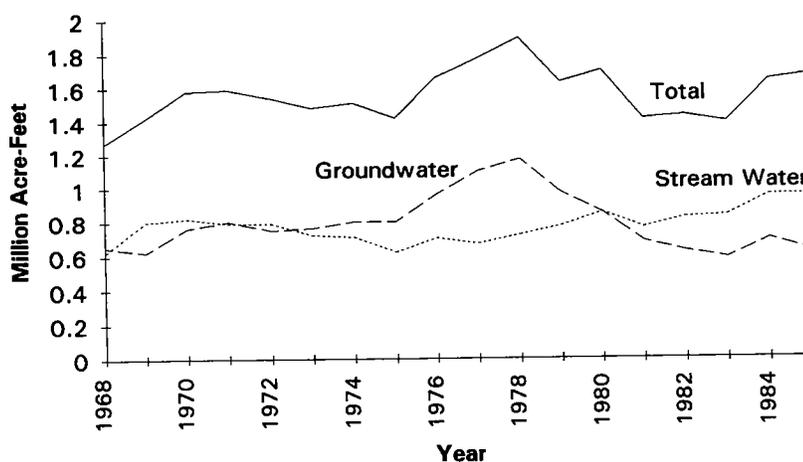


Figure 4.3 — Reported stream- and ground-water use in Oklahoma, 1968-85. Source: Oklahoma Water Resources Board (1985).

Table 4.2 Change in Stream Water Use for Economic Sectors Excluding Irrigation, 10 Counties with the Largest Change

County	Water Use (in acre-feet)			Change 1975-85
	1970	1975	1985	
Oklahoma	132,672	68,752	130,000	+61,248
Pawnee	594	786	50,120	+49,334
Muskogee	133,885	94,589	131,310	+36,721
Tulsa	5,848	94,251	130,000	+35,749
Kay	38,877	27,903	4,400	-23,503
Murray	11,324	2,758	18,615	+15,857
McCurtain	5,740	26,509	40,267	+13,758
Carter	24,088	28,300	15,836	-12,464
Caddo	16,036	1,992	12,111	+10,119
Rogers	18,245	8,887	18,694	+9,807

Source: Oklahoma Water Resources Board (1985).

depends heavily on ground-water supply, Canadian, Oklahoma, Cleveland, and Kay are the only counties in central and eastern Oklahoma that have noticeable levels of ground-water use. Conversely, eastern counties use surface water extensively. A few western counties with major streams running through them, including Jackson, Comanche, Custer, and Washita, record higher stream-water use.

There have been significant changes in the use of stream water and ground water over the past 10 years. The most important changes have occurred in the Panhandle area where substantial reductions in water use have been recorded. Very high increases in ground-water use in several eastern counties have taken place, but absolute increases are not as large because the original water use had been comparatively low in these counties. In the case of stream-water use, increases have occurred over most of the state.

Ground-water-use data for 1975 and 1985 reflect what happened over the course of the decade. Out of 20 counties that were leaders in ground-water irrigation, only one—Kiowa County—had an increase in water use. In the three Panhandle counties the drop in water use is substantial, amounting to reductions of 42%, 31%, and 49%. Desirable changes in ground-water use and consumption were brought about by rising costs of energy, declining ground-water levels, lower prices for agricultural products, general economic problems in the state as a result of the oil bust, and the effect of institutional changes in water

laws and regulations that allow for marketing of ground-water rights. Gains in ground-water use can be found only in the east-central counties. This new trend is of interest because vast ground-water resources available in the eastern part of the state could be tapped for development as a supplementary source of water. Ground water could be a solution to temporary water shortages faced by eastern communities when a dry spell occurs during a long hot summer.

CURRENT PATTERNS AND TRENDS IN WATER USE

Agricultural Water Use

Agriculture is the primary consumptive use of Oklahoma's water. Two important issues should be considered in a discussion of water use distribution. One is the predominant role ground-water irrigation plays in water consumption. The second is the heavy concentration of ground-water irrigation in the western border counties of the state (Map 4.4). In 1985, eight of the 10 highest ground-water-irrigating counties in the state were in western Oklahoma. The other two were Caddo and Canadian counties in west-central Oklahoma. Very little ground-water irrigation occurs in the remainder of the state.

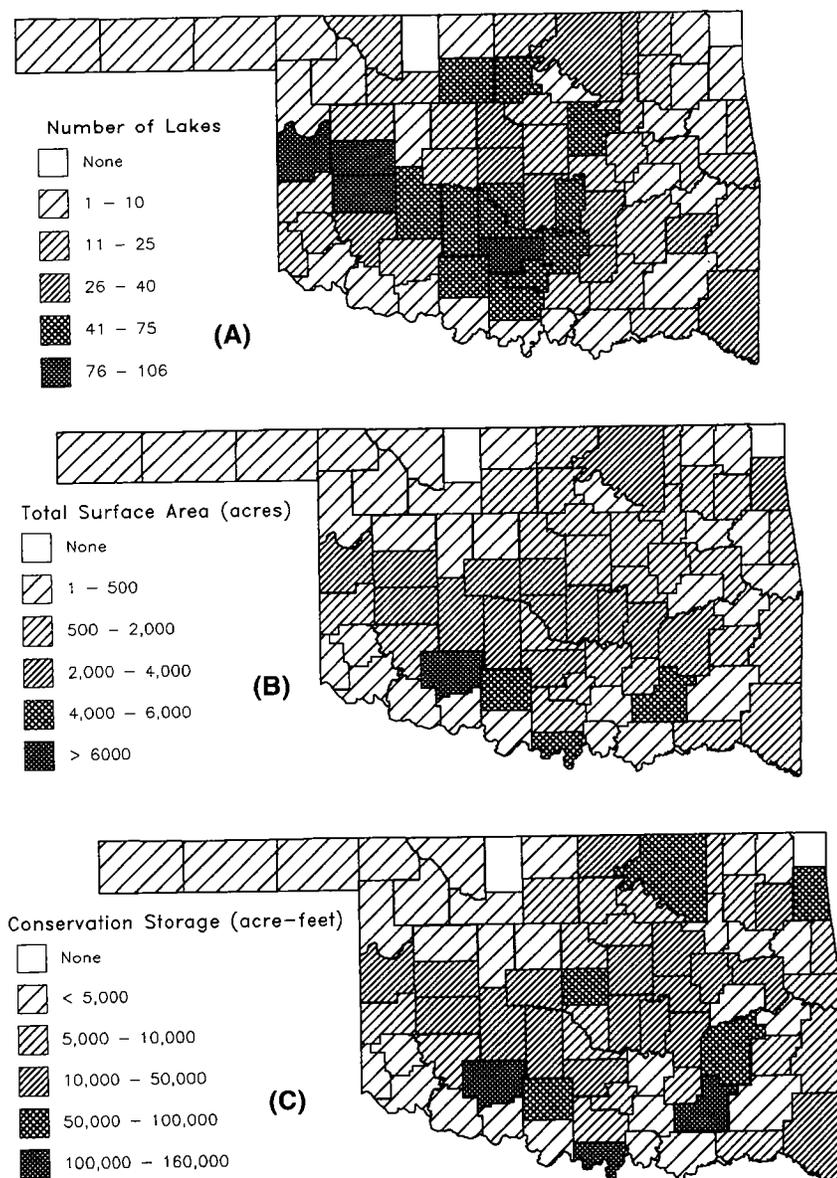
Stream-water irrigation activities are more widespread than ground-water irrigation throughout Oklahoma (Map 4.4). Smaller concentrations of stream-water irrigation can be found in Washita, Caddo, and Grady

Counties and in several southeastern counties. Significant stream-water use for irrigation can be found along the Red River in southeastern Oklahoma in Marshall, Bryan, and McCurtain Counties. Jackson County (located in the west) has the highest stream water acreage in the state because it is the location of Oklahoma's largest surface irrigation project, the Lugert-Altus Irrigation Project, completed in 1946. By comparison, stream-water irrigation represents only a fraction of the total agricultural water use in the state. In 1985, total ground-water irrigation water use was about 450,000 acre-feet, whereas surface irrigation was only about 100,000 acre-feet.

Municipal Water Use

Municipalities are the primary users of stream water. The distribution of public water use follows the north-east-to southwest-oriented urbanized corridor within the state (Map 4.5). Since the Oklahoma City and Tulsa Standard Metropolitan Statistical Areas that lie within this corridor represent about one-half of the state's 3.3 million residents, municipal water use is dominated by these two urban areas. Both cities, however, depend upon a large source area for their water supply. Oklahoma City receives its water from the North Canadian River through Lake Hefner and Lake Overholser and from Lake Atoka in southeastern Oklahoma. Water from Lake Atoka is transported via a 90-mile pipeline to Lake Stanley Draper. In the 1960s, Oklahoma City began leasing storage in Canton Reservoir, upstream of Lake Overholser, to supplement its North Canadian system. A new reservoir, McGee Creek, boosts Lake Atoka's supply.

Since 1924, Tulsa's major source of water has been Spavinaw Creek. The two city owned lakes, Spavinaw and Eucha, are located about 5 miles east of Tulsa in northeastern Oklahoma. In the mid-1950s a connection was made to Lake Hudson for use as an emergency supply source. The city has additional pipeline connections to Lake Oologah. Completed in 1977, this supply line pumps water to the A. B. Jewell Reservoir for treatment and for distribution as an additional supply source.



Map 4.2—Number (A), surface area (B), and water conservation storage area (C) of lakes 10 acres or more in size in each county in Oklahoma. Source: Oklahoma Water Resources Board (1970).

During the 10-year period from 1973 to 1983, public water supply projects have been improved in the western half of the state. Local water problems during dry spells or drought periods did not become a serious issue until a long drought in the summer of 1980 created 275 problem locations in urban and rural water supplies. Approximately 185 of these cases were so critical that mandatory rationing of water was required. Steps taken by state agencies to remedy these supply problems reduced the number of water-

rationing cases to a smaller and more manageable amount. For example, the Oklahoma Water Resources Financial Assistance Program now provides grants and loans to local communities for water development projects which address water shortages and supply-process situations.

Industrial Water Use

Industrial water use depends very little on ground water. Water used by industry is predominantly stream water, and most of it is consumed in a

tier of counties located along the Arkansas River. The McClellan-Kerr Arkansas River Navigation System created new industrial and commercial development opportunities along the navigation canal. Other high-volume industrial water consumers include Oklahoma County; the two southernmost counties along Interstate Highway 35 in Oklahoma, Murray and Carter Counties; Seminole County; and McCurtain County with its lumber industry.

Water Use for Oil and Gas Production

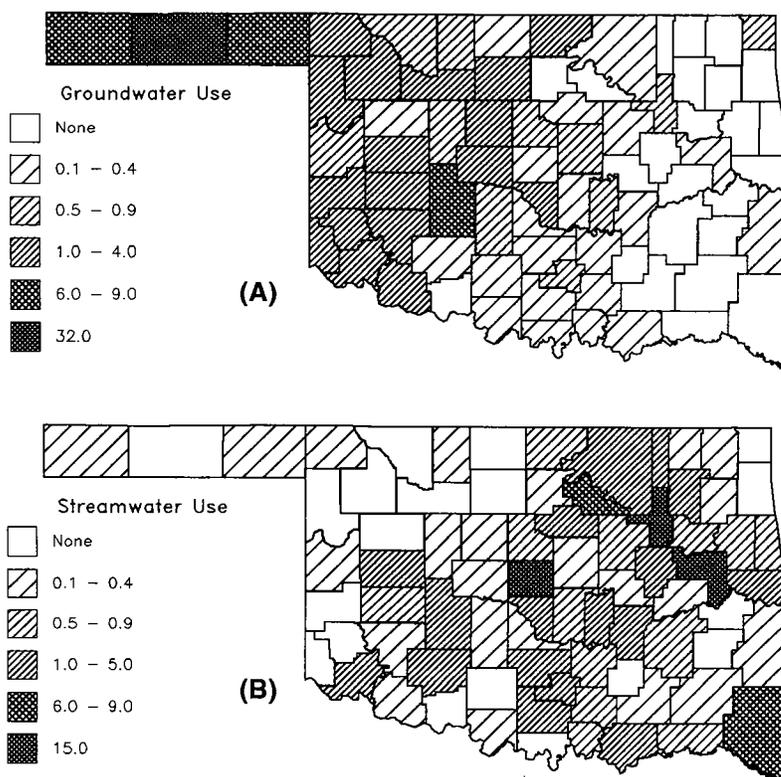
Water use for mining is limited to counties that have secondary recovery operations in oil and gas, or where water is needed for other mineral extraction industries. Competition for ground-water between agricultural-use irrigators and the oil and gas industry has occurred in Texas County in the Oklahoma Panhandle. With the expansion of enhanced oil recovery activities, conflicts of this nature have arisen in other areas of the state. Unlike other industrial activities which are sufficiently flexible to be moved closer to stream water, oil and gas drilling or enhanced recovery processes need water on-site. The recent trend toward reduction in the use of ground water for irrigation, coupled with new ground-water legislation that allows for the market sale of water, have facilitated solutions to the problem of uncertainty in water sources.

Water Use for Power Generation

Water use for power production is highly concentrated in several counties along the state's urbanized corridor. Water is used for hydroelectric power production as well as in thermal- and nuclear-power generation plants. These generation plants are as heavily dependent on the availability of water for their location as hydroelectric power plants. In Oklahoma there are 11 existing hydroelectric projects with a total power storage of 5.1 million acre-feet of water and a water use of 37.7 million acre-feet annually.

Commercial Water Use

Commercial water use is limited to a few counties in the northeastern region of the state with Tulsa County in



Map 4.3 — Reported ground-water use (A) and stream-water use (B) in Oklahoma as a percentage of total ground- and stream-water use. Source: Oklahoma Water Resources Board (1985).

the lead. The Arkansas navigation canal has created ample commercial development opportunities along the waterway. Comanche County in the southwest is an exception to this concentration.

Recreational Water Use

Recreational water use is concentrated in the south-central part of the state. Since most recreation activities take place without adequate water use reporting, it is not feasible to estimate the distribution of recreational activities in the state from the reported water use data on recreation. One of the goals of the Oklahoma Comprehensive Water Plan is to develop the state's recreational potential. The Arkansas River Navigation Canal created favorite opportunities for recreational development in the northeastern portion of the state. New industrial and commercial enterprises have created a need and a market for recreational facilities. Oklahoma possesses 35 state parks, 25 recreation areas, and 12 historical monuments. Fur-

ther, the four-lake area of Fort Gibson, Robert S. Kerr, Tenkiller Ferry, and Webbers Falls may become a unit of the National Recreational Area System in Oklahoma.

WATER RESOURCES PLANNING AND ADMINISTRATION

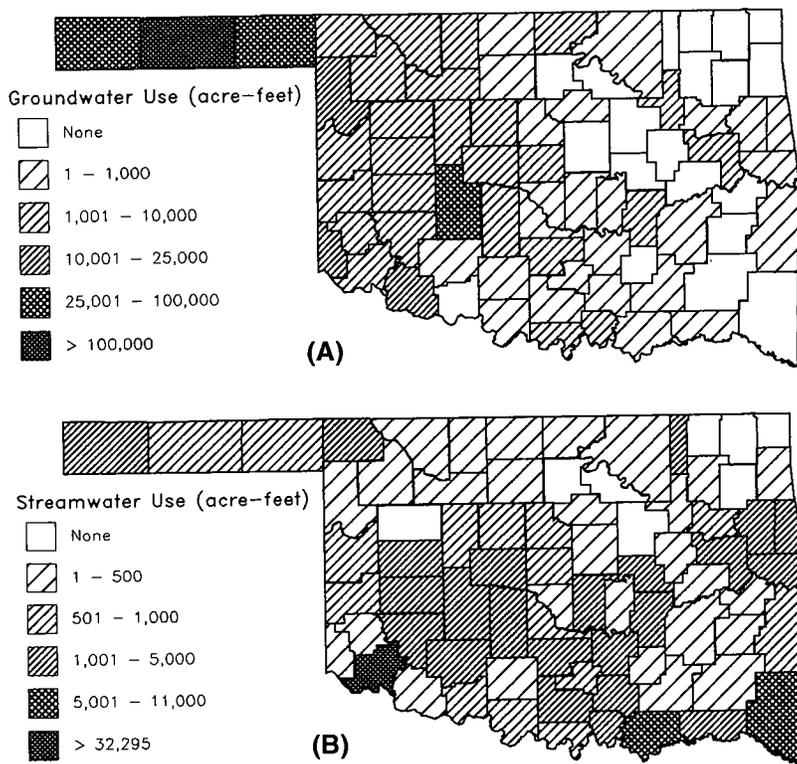
Oklahoma Comprehensive Water Plan

The water available in Oklahoma is sufficient for both present and future use. There was a time, however, when the perception prevailed that "Water is the No. 1 problem in Oklahoma." Water transfer plans developed in California and Texas encouraged local administrators to develop a similar plan. In 1980, after more than a decade of research, data collection, and study, a comprehensive water plan was prepared for Oklahoma. After an assessment of future water requirements and availability of existing resources, it was evident that the possibility of variable water shortages existed in the western and central parts

of the state, while an abundant supply of water existed in the state's eastern regions. Thus, administrators proposed to transport water from the eastern half of the state to the western half via two canals—one running from southeastern Oklahoma to southwestern Oklahoma, and the other from the east-central region of the state to the Panhandle region. To date, no attempt has been made to carry out this transfer plan, thus each region must follow local options to meet water needs.

Large reductions in ground-water irrigation use in the 1980s have changed the basis on which the water shortage forecast for the western part of the state was made. Yet the Oklahoma Comprehensive Water Plan was a positive step because it brought forth proposals and stimulated discussion for dealing with water shortages and possible transfer systems. The imminence of future water shortages facilitated planning for water management and conservation strategies, which generated many positive benefits. In fact, today all but two of the recommendations of the plan are being implemented. The Oklahoma Comprehensive Water Plan has been accepted as a general guideline for assuring the orderly control, protection, and management of Oklahoma's water and land resources. Currently the plan's recommendations that relate to the state water development assistance program, Arkansas-Red River Basin chloride control projects, floodplain management, weather modification program, and institutional approaches to water conservation are all functioning smoothly.

The projects under the Oklahoma Comprehensive Water Plan have opened the door for private enterprise in water-related development activities. Except for the two water conveyance canals, the philosophy behind the plan was to promote private voluntary cooperation at the local community level. The plan's many programs, such as cloud-seeding and ground-water recharge, have been carried out to provide initial public assistance until the private sector has gathered sufficient interest to bring about functional solutions. Some progress has already been made with regard to the regional and local com-



Map 4.4 — Reported use of (A) ground water and (B) stream water for irrigation on county basis, Oklahoma, 1985. Source: Oklahoma Water Resources Board (1985).

ponents of the two water-transfer canals. The Water Plan's recommendation to resurround the feasibility studies on the water-conveyance portion of the Central Oklahoma Project could act as a catalyst in the attempts to diversify the state's economy.

Table 4.3 summarizes major components of the Oklahoma water management program—supply management, demand management, and research and administration. Some of the listed activities fall within both supply and demand management aspects of water-resources planning. In some cases, voluntary efforts of water conservation began before official actions. Some major activities of the state water-administering agency, the Oklahoma Water Resources Board, are indicated under the Research and Administration heading.

Water Supply Management

Ground-Water Recharge Program

The development of ground-water irrigation has resulted from private-

sector responses to water-shortage contingencies during the crop growing season. It was a method of crop insurance based on the principle of self-help. For example, when local farmers and ranchers were confronted with the possible end of irrigation as a result of rapid depletion of ground-water resources in 1965, they pooled their resources to create an independent conservation district. Known as the Southwest Water and Soil Conservation District, it was organized to raise the water table of the Dog Creek Shale and Blaine Gypsum Formations in Harmon County, Oklahoma. From 1967 to 1970, using its own funds, the conservation district drilled 37 recharge wells. The Water Resources Board provided the geohydrologic data. In 1986, the Oklahoma Water Resources Board selected this area to be used as a demonstration project under a grant from the U.S. Bureau of Reclamation pursuant to 43 U. S. Code section 390g et seq. A similar proposal was submitted for Ogallala ground water in Woodward County.

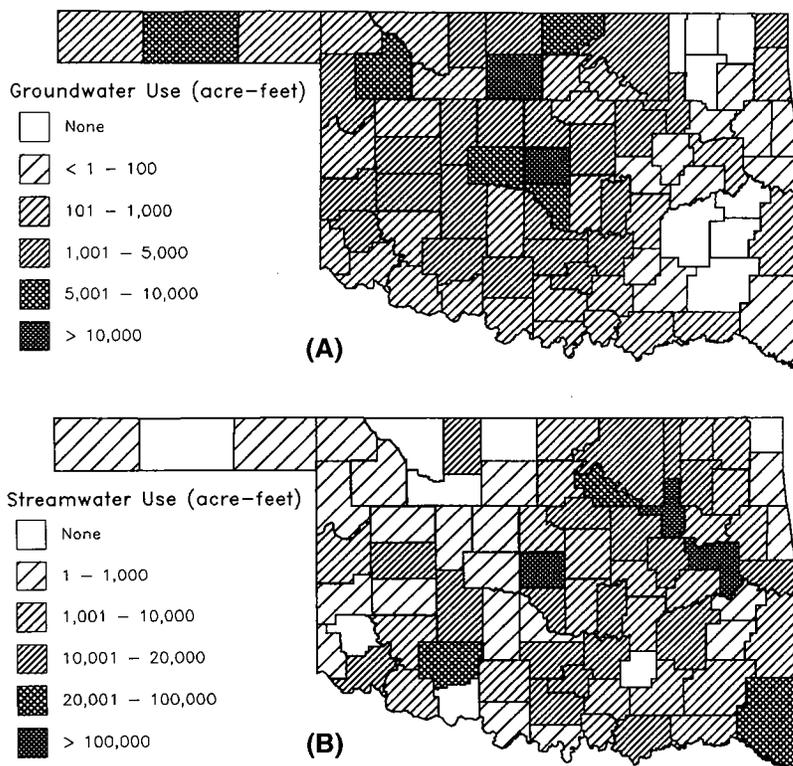
In 1981, the Water Resources Board prepared a report on the potential for artificial recharge. Experiments are also underway to test the secondary recovery of ground water by pumping air into aquifers in order to squeeze water from the water-bearing strata. These initiatives by state and federal agencies are helping to create a desirable environment for future investments in artificial recharge projects. The Water Resources Board has sponsored studies that provide data for private enterprises interested in ground-water recharge programs; estimating effective recharge rates in central Oklahoma is an example.

Weather Modification Program

One of the supply management programs receiving renewed interest is the Oklahoma Weather Modification Program. In 1972, the Oklahoma Legislature enacted a law to enable private sector participation and development of this activity on a local community basis. The Oklahoma Water Resources Board administers this act and is developing a sound cloud-seeding program for Oklahoma with the support of other state agencies. For the benefit of those wishing to invest in weather modification activities, in 1985 it prepared a report titled "The Oklahoma Rainfall Enhancement Program." In July 1986, under the Oklahoma Southwest Drought Research Program, the Board joined with a private company, Comanche County Weather Modification Inc., to conduct a countywide weather modification experiment. Since 1952, more than 30 such weather modification experiments have been undertaken by private parties in the state of Oklahoma. At present, Oklahoma is experimenting with more economical ground-based cloud-seeding methods in contrast to states such as Texas where aerial spraying is being attempted.

Chlorine Control Projects—Desalinization

Issues relating to water quality have received greater interest in recent years in view of the availability of federal funds to solve contemporary environmental problems. Water quality is an important issue in western



Map 4.5 — Reported use of (A) ground water and (B) stream water for non-irrigation purposes on county basis, Oklahoma, 1985. Source: Oklahoma Water Resources Board (1985).

and southern Oklahoma because prevention of water pollution would increase the available water supply by as much as 100%. Although water-quality problems are not widespread in Oklahoma, water salinity is a problem in the North Fork River and the Red River in southwestern Oklahoma. High levels of salinity have been found in the Cimarron and Salt Fork branches of the Arkansas River in the north. High concentrations of chloride and salts are a common problem in the drier parts of the United States due to natural and artificial causes such as improper irrigation practices.

In 1972 a desalination plant was built at the Foss Reservoir in Custer County, Oklahoma, to clean stored water. Work has been underway for 18 years to complete a project to control chlorides in the Arkansas-Red River Basins in Oklahoma. With passage of the federal Water Resources Development Act of 1986, the goal of de-chloriding the Red River may become reality and double the amount of water available for use by an addi-

tional 2 million acre-feet. The 1986 Act allocated \$177.6 million to divert salt-water springs that pollute the Red River.

Floodplain Management

The 1986 federal water law also allocated more than \$100 million for a flood control project along Mingo Creek in Tulsa, Oklahoma. In addition, the new law allows local governments and private businesses to engage in flood-control projects on a cost-sharing basis with the federal government. However, federal, local, and private construction projects are only one aspect of flood-damage prevention planning. Floodplain zoning by local governments to keep floodplains free of dwellings and related structures, as well as federally supported flood insurance programs, are other responses taken in recent years in an effort to manage floodplain and river-diversion problems.

The Oklahoma Water Resources Board acts as the state coordinating agency for the National Flood Insur-

ance Program. This program, which was established through the National Flood Insurance Act of 1968, makes flood insurance available to local governments that establish and enforce proper floodplain-management guidelines. In return for reduced insurance rates, communities are required to adopt and enforce land-use and flood-control measures that guide development in areas susceptible to flooding.

Local communities in Oklahoma had undertaken floodplain management activities even before the enactment of a law empowering such action. In 1978, 466 Oklahoma communities had been identified as containing flood-prone areas, and a majority of them already were covered under the federal flood insurance program. In 1980, Oklahoma enacted a Floodplain Management Act which facilitated the implementation of federal floodplain management programs in Oklahoma. The Oklahoma Water Resources Board is providing services to private and local communities by undertaking studies on flood hazards such as the delineation of 100-year floodplains the identification of the needs of communities facing flood-hazard potential.

Water Demand Management

Institutional Changes

The development of Oklahoma's water-works construction correlates to a new body of laws and regulations that affect almost every aspect of water management. Although the Oklahoma Water Resources Board is the principal water administration agency, a number of other agencies have jurisdiction over matters that either directly or indirectly affect water. For example, state agencies relating to environmental affairs coordinate their activities under the Task Force on Pollution Control Coordinate Board, which allows interagency communication.

Oklahoma is committed to a water development program based on the voluntary cooperation of water users. In this respect it is different from other states such as Arizona or Nebraska, where some degree of mandatory regulation applies to water use, especially in the case of ground water.

The Oklahoma Water Resources

Table 4.3 Water Resources Management Plan in Oklahoma

SUPPLY MANAGEMENT	DEMAND MANAGEMENT	RESEARCH AND ADMINISTRATION
Interstate Stream Water Use Compacts 1951-	Conservation of Water 1935-, 1981-	Hydrographic Surveys 1910-, 1949-72
State Water Transfer Plan 1970-80	Water Quality Control 1955-	Monitoring and Collection of Data 1960s-
Regional Local Water Transfer Schemes 1981-	Privatization of Groundwater Rights 1973-	Stream Water Rights Administration 1963-
Groundwater Recharge Program 1984 (1967) [†]	Market Sale of Water 1973-	Water Quality Standards 1968-
Weather Modification Program 1972 (1952)	Upstream Watershed Program * 1940s-	Flood Insurance Program 1968-
Desalination Program 1972-, 1987-	Water Navigation * 1959	Dam Safety Program 1979-
	Storage of Water 1963-	Clean Lakes Program 1980-
	Floodplain Management Program * 1980- (1953-)	Licensing of Water Well Drillers 1982-
	Water Recreation 1970s, 1980s	Agricultural Water Needs Assessment 1986-
	Financial Assistance Program 1982	

[†] Year of first voluntary efforts.

* Connected with federal agencies.

Source: Oklahoma Water Resources Board (various publications).

Board plays a key role in administering water laws efficiently. It has done an excellent job in undertaking research on various aspects of water use and development. Its numerous programs such as ground-water recharge, weather modification, financial assistance, water-quality analysis, hydrological surveys, well-level monitoring, salinity control, and floodplain studies are attempts to implement the Oklahoma Water Plan through cooperative efforts with private entities. In addition to its research and service functions, the Board engages in regulatory activities such as monitoring the safety of dams and reservoirs, licensing of well drillers, and controlling pollution of water. In recent years the Board has begun to give more attention to the conservation of water and the preservation of natural water sources.

Conservation of Water

Water conservation became a national policy goal with a presidential

directive issued in 1977. Oklahoma's water conservation program has consisted partly of waste prevention, partly of the release of water hidden under paper rights to reappropriation, and partly of scientific investigations to determine actual water availability of streams and ground-water basins. Recent hydrological studies undertaken by the Oklahoma Water Resources Board indicate that extra water is available for appropriation in streams designated earlier as fully appropriated. For example, a study completed in September 1986 on Beaver Creek in southwestern Oklahoma found that nearly 43,000 acre-feet of water were available for appropriation against 54,000 acre-feet already appropriated. In addition, the Canadian River and Little River study completed in December 1986 identified several million additional acre-feet of water available for appropriation.

These studies have addressed perceptions that most stream water in

Oklahoma is either fully appropriated or available for public use. Since most of the available supply has been appropriated for use, new users have had difficulty obtaining permits for stream water in western areas. These hydrological studies have provided some relief for those who need to use water from streams. Previously, they held only the possibility of trying to buy water from someone who already had an appropriative right. However, stream water is more difficult to purchase than ground water because there is no law allowing private ownership.

Another conservation technique becoming increasingly useful is the cancellation of paper or legal water rights for non-use. The Oklahoma Water Resources Board has regulatory control over the use of stream water such that if a consumer does not comply with the terms of usage and cannot show a valid reason for noncompliance, then the user is subject to reduction or loss of those water rights. Water recovered in this manner is then available for allocation to new applicants. From 1975, return of stream water for reappropriation increased in volume, reaching nearly 2 million acre-feet per year in 1985.

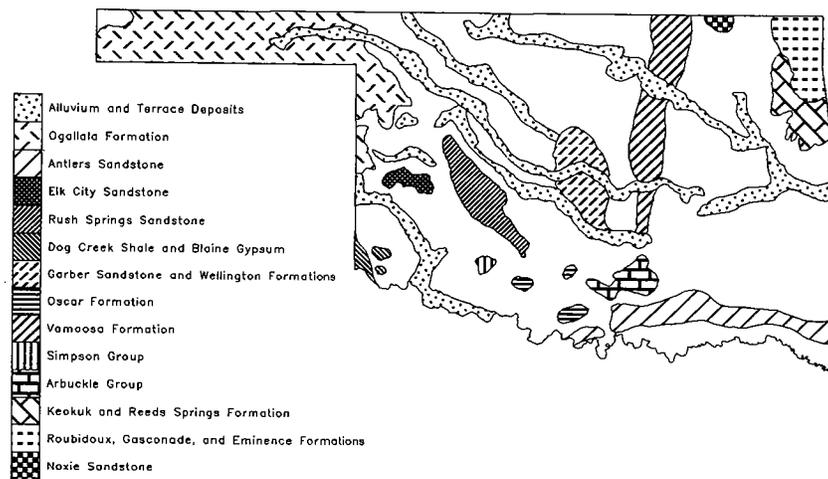
The Soil Conservation Service of the U.S. Department of Agriculture has been investigating separately, as well as jointly with the Oklahoma Water Resources Board, the water needs of agricultural crops grown with stream and ground water. Soil Conservation Service studies attempted to assess the irrigation water needs for optimum crop growth, which could help farmers and state agencies to decide the quantity of water to be used. Because of lack of data, estimates initially covered larger geographical areas and were very crude. But with improvements in data availability, estimates have been made for smaller areas and for shorter time periods (such as monthly or weekly) rather than for the entire growing season. In 1986, the Oklahoma Water Resources Board took an advanced step in this direction by preparing detailed estimates of water needs for major crops in Oklahoma. Such studies not only help reduce excessive water use but allow the Board to better allocate stream water resources for irrigation use.

There is no shortage of stream water in north-central and eastern Oklahoma. With ongoing hydrological studies and reappropriation of unused water, the status of western streams changes periodically, which provides for new water rights and permits for a variety of uses. Similarly, the availability of ground-water has been a problem in the western part of the state in view of its intensive use. Thus the Ogallala Formation, Rush Springs Sandstones in Caddo County, and Tillman Terrace deposits recorded rapid declines of their water tables. However, with drastic reductions in irrigation water use, the situation has become stable. Water Resources Board engineers found evidence that the water levels in the Tillman Terrace deposits have been increasing in the years following implementation of a new law which allocated water rights according to the availability of water in the aquifer. Since ground-water rights have attained the status of private property and can be sold on the open market, earlier predictions on water level declines may show a different trend (Map 4.6 indicates the geographical distribution of aquifers in Oklahoma). Oklahoma has 21 major aquifers and 150 smaller basins.

Water Quality Control

Oklahoma's water-quality improvement program received an unexpected boost from the Clean Water Act of 1987. Oklahoma was allocated \$19 million, which is a 55% federal portion of funded projects. The new law encourages state and local governments to undertake sewage treatment plants to protect and purify water. Water supply management affects water demand management when careful water management can prevent the pollution of usable water supplies.

Water pollution from point and non-point sources is found in the Canadian River below the Oklahoma City area and in the Tar Creek area in eastern Oklahoma. Northeastern lead-zinc and coal mining areas have been reported as sources of water pollution. However, when compared to other states, Oklahoma has very few problems related to water pollution. This is partly due to the water-quality program maintained by the Okla-



Map 4.6—Major ground-water aquifers in Oklahoma. Source: Pettyjohn and others (1983).

lahoma Water Resources Board, which has been working constantly to improve water-quality standards in the state since 1968.

As a leading oil and gas-producing state, Oklahoma has had hundreds of thousands of oil and gas wells drilled over the last 100 years. Surprisingly, even with the demand for drilling activity and its resulting water usage, pollution has been minimal. In 1980, the Tar Creek in northeastern Oklahoma was diagnosed as one of the critical hazardous waste sites in the nation by the U. S. Environmental Protection Agency. Remedial action to plug potentially dangerous abandoned wells and to build dikes and diversion structures to channel surface runoff away from the mines has progressed very well. The number of pollution complaints increased dramatically until 1984, but a downward trend has been noted since 1985.

Privatization of Water Rights

Oklahoma has taken several positive steps, trying to reduce the demand for water through water conservation techniques and more efficient use of water. More importantly, in the case of ground water, Oklahoma has accepted private ownership which has aided in conservation. The large reduction in the use of ground water for irrigated agriculture can at least partly be attributed to this change in policy. Events in recent years have

changed the gravity of the problem of ground-water depletion from that of a major concern to one of a manageable magnitude.

No other state has implemented a policy of allowing private ownership of ground water as has Oklahoma. Because ground water is now treated as private property, its owners can sell it or dispose of it any way that is profitable to them within certain legal restrictions. Official acceptance of the enhanced efficiency provided by market mechanisms in exchanging water rights signifies a sharp departure from the rigid water laws that have controlled water use for nearly a hundred years in the American West. This radical change in Oklahoma ground-water law has been recognized by water lawyers and resource economists as the first of its kind, and the rest of the country is waiting to see how effectively and equitably Oklahoma's new policy will work. Oklahoma's new policy is different from the mandatory controls introduced in Arizona and, to a limited extent, in the state of Nebraska. The privatization of ground-water rights and the ability to sell ground water could also reduce the excessive amount of paper rights now found in the state's ground-water rights records. A study covering six western Oklahoma counties revealed that the paper rights are almost twice the amount of water actually put to use in a given year.

WATER MANAGEMENT TRENDS IN OKLAHOMA

Navigation Canals

Despite its interior location in continental North America, Oklahoma has a water transportation system that connects it with the Gulf of Mexico. Since the Arkansas River is a major tributary of the Mississippi River, the U.S. Congress agreed to develop a navigation canal in the Arkansas River (the Arkansas Navigational System) to link the city of Tulsa with the national inland navigation canal system. The importance of the canal's economic benefits as a transportation system is discussed in detail in the chapter on transportation. The Arkansas Navigation System has the potential to function as a catalyst for rejuvenating and diversifying an economy seeking new direction from its historical dependence on oil and gas production.

Beginning in 1966, Oklahomans considered extending this navigation canal into Oklahoma City. The Central Oklahoma Project had another component, that of transporting water from southeastern Oklahoma to Oklahoma City. This idea was resurrected in 1980 as part of the Oklahoma Comprehensive Water Plan.

Water Recreation

Because of the heavy rainfall and abundant water in eastern Oklahoma, there are many lakes, rivers, and private developments that make this region a recreational attraction. The federal government is even considering incorporating this area into the national recreation system. More importantly, water-based recreation can positively benefit the development or improvement of the Oklahoma navigation canals.

Financial Assistance Program

Oklahoma's philosophy of promoting private and community-based water-resource development at local levels is represented by yet another concept implemented under Oklahoma's Financial Assistance Program. With federal money for small water-related projects dwindling and the problems of local communities in obtaining an assured supply of water increasing, the Oklahoma Legislature

created the financial assistance program in 1979. Under a statewide Water Development Revolving Fund the Oklahoma Water Resources Board assists cities, towns, and rural water districts with funds to remedy ailing and inadequate sewer and water systems. It gives low-interest loans over terms as long as 25 years and emergency grants of up to \$100,000. Since the inception of this assistance program, several communities have secured money for federal matching dollars to improve existing wastewater systems or build new ones. For example, through 1985, 88 emergency grant applications totaling \$6.5 million had been approved with 135 applications for \$12 million pending at year's end. New federal policy for encouraging local and private investments in these areas can give added strength to Oklahoma's new concept of financial assistance.

Interstate Cooperation

Oklahoma has several cooperative interstate stream agreements or compacts with its neighboring states. Such cooperation is an inevitable and logical step when rivers run through several states. The first agreement, with New Mexico and Texas, relates to the Canadian River and was ratified in 1951. In 1966 and 1973, two agreements were ratified with Kansas and Arkansas that address the Arkansas River. A fourth agreement, with Arkansas, Louisiana, and Texas, pertains to the Red River and was ratified in 1978.

However, a new form of agreement may arise in the near future if national attention given to the problem of ground-water depletion in the High Plains Region revives surface transfer plans considered earlier by the Army Corps of Engineers. Four separate proposals have been studied that tap water from eastern rivers, one of which traverses Oklahoma. Recently Texas passed a law to form an interstate committee, of which Oklahoma will be a member, to examine future prospects of water availability. The proposal to develop a Red River-Deep Fork navigation system could be effectively linked with such an interstate agreement between Texas and Oklahoma.

Market Sale of Water

The market sale of water will be the most important institutional change taking place in Oklahoma for some time. This trend will not only redirect water-use patterns and priorities in Oklahoma but will exert significant influence over water-resource laws in the rest of the country. Its effect on ground-water irrigation is yet to be seen, but there is no doubt that substantial changes will take place in the market competition for water use. One possible change could affect project-type irrigation undertaken by corporate farming on lands available for large-scale development. Without the incentive of cheap water for low-value, high water-consuming crops, such activities may diminish.

CONCLUSION

Oklahoma's past leadership successfully created the false impression that "water is Oklahoma's No. 1 problem." It is interesting to note that during the past few years, speakers at the Annual Governor's Water Conferences held in Oklahoma have not used such an alarming phrase in reference to the state's water situation. If Oklahoma had a water problem it was a problem of water surplus. While it is true that in the short-run Oklahoma will continue to face the rapid depletion of ground water due to extraordinary growth in irrigated agriculture, competitive market forces have begun to ameliorate such impacts. Oklahoma's new ground-water policy, which allows the price mechanism to operate in a competitive water market, will promote more rational water use and diminish waste in the future.

In sum, Oklahomans have managed their water problems remarkably well. They have responded to the low level of rainfall in the western parts of the state by developing and utilizing ground-water resources. The flash-flooding in the western region has been offset by farm ponds, watershed protection works, and small lakes. In the eastern region, public investments have helped to create major reservoirs, many in a short period of time. While these reservoirs have served multiple purposes in the western region, smaller private efforts also served multiple purposes in the east.

With the advent of new technological developments, private enterprise has directed itself in different beneficial ways. Attempts at weather modification first started as a private venture before the state showed an active interest; the same with ground-water recharge schemes. When farmers and ranchers realized the mistakes made in depleting the ground-water in Harmon County they organized a conservation district to recharge ground water. Later, this same private initiative led to the institution of flood hazard-zoning by some Oklahoma communities even before laws empowering such jurisdictions were passed. In addition, federally supported flood insurance is widespread among Oklahoma communities today.

Of course, pollution of water by natural and human causes has not been handled on private or community basis alone and has required state and federal intervention. At present, the state is providing financial assistance to Oklahoma communities for repairing or developing their sewer and water systems. All these water management activities had been envisaged by the Comprehensive Water Plan prepared in 1980. The Oklahoma Water Resources Board was instrumental in preparing a comprehensive water plan as well as in implementing it, thereby creating a water environment conducive to furthering economic development in the state. Certainly, water is not the number one problem in Oklahoma; water is, in fact, a solution to a variety of problems facing Oklahoma as it seeks to diversify and strengthen its economy.

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— Chapter 4 —
LIST OF ILLUSTRATIONS

Figures

4.1 — Annual precipitation, Oklahoma, 1920–87 _____	59
4.2 — Growth of conservation storage capacity in Oklahoma, 1962–87 _____	60
4.3 — Reported stream- and ground-water use in Oklahoma, 1968–85 _____	61

Maps

4.1 — Mean annual rainfall and average annual river discharge, Oklahoma _____	58
4.2 — Number, surface area, and water conservation storage area of lakes _____	63
4.3 — Reported ground- and stream-water use in each county _____	64
4.4 — Reported irrigation water use on county basis, Oklahoma, 1985 _____	65
4.5 — Reported non-irrigation water use on county basis, Oklahoma, 1985 _____	66
4.6 — Major ground-water aquifers in Oklahoma _____	68

Tables

4.1 — Changes in ground-water use for irrigation, 1970–85 _____	61
4.2 — Change in stream-water use for economic sectors excluding irrigation _____	62
4.3 — Water resources management plan in Oklahoma _____	67

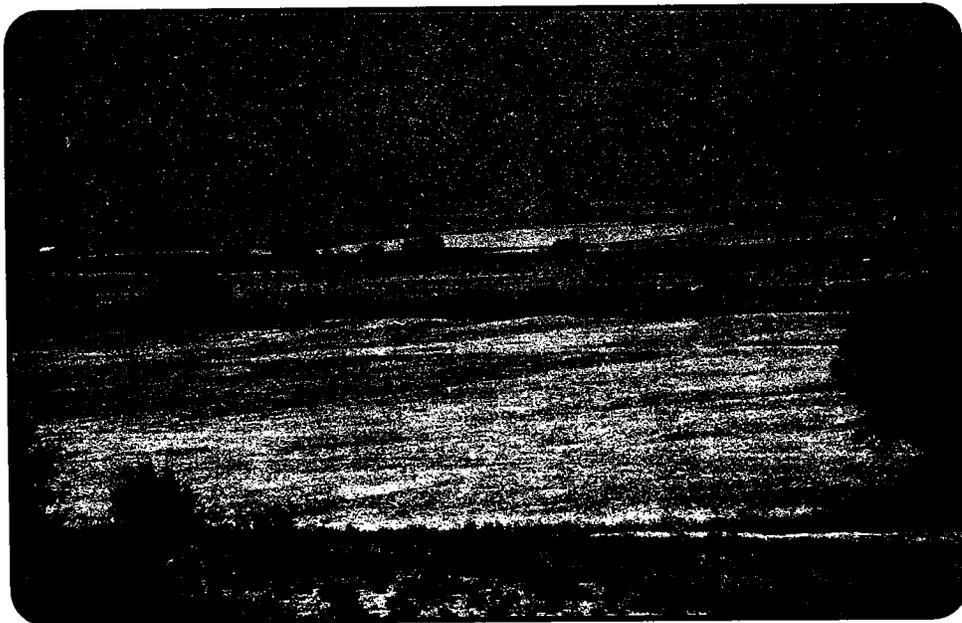
Oklahoma Resources

Chapter
5

The Wheat Farming System

by

Hans-Joachim Späth



Contents

Executive Summary _____	75
Introduction _____	76
Physical-Geographical Setting _____	76
Development of the Wheat Landscape _____	77
The Modern Dryland Wheat Farming System _____	78
Physical Properties of a Wheat Operation _____	78
Crop Production _____	79
Soil and Water Management Under Semiarid Conditions _____	81
Performance Evaluation _____	83
Water-Use Efficiency _____	83
Soil Moisture/Soil Erosion/Crop Yield Relationships _____	83
Production Cost-Return Relationships _____	85
Energetic Performance Assessment _____	86
The Marketing System for Oklahoma Wheat _____	89
Preparing Wheat for the Market _____	89
Export Markets for Oklahoma Wheat _____	92
Conclusion _____	93
References _____	93
List of Illustrations _____	94

The Wheat Farming System

Hans-Joachim Späth

Executive Summary.— Oklahoma shared greatly in and contributed decisively to the evolution of the wheat farming system in the North American Great Plains. Today wheat is the most important factor in Oklahoma's economy, besides beef and energy. This chapter will highlight the historical development of Oklahoma's wheat landscape and describe modern wheat farming's state-of-the-art system. It will assess the system's performance in terms of ecology, economy, and energy, and outline the marketing system for Oklahoma's wheat.

Oklahoma's natural endowment—mainly moisture/temperature relationships, topography, and soil fertility—is superbly suited for high-performance wheat production. The western half of the state receives 16 to 35 inches of rain annually and meets all quality requirements for it to serve as a national granary.

The Dust Bowl syndrome of the 1930s, 1950s, and the late 1970s was a result of complex interactions of physical, environmental, technological, and political factors. These included unpredictable precipitation, highly variable crop prices, limited experience with new machinery, ill-conceived land policies, and disproportionate wheat supply and demand. These periodic setbacks alternated, however, with extended phases of prosperity and social well-being in western Oklahoma wheat communities that were made possible through spectacular scientific and technological advances, favorable rainfall conditions, and growing demands for wheat in foreign markets. These ups and downs have transformed the wheat farming system from small-scale, subsistence farming to a robust, large-scale, high-technology industry.

Today's dryland wheat operations are guided by refined and flexible strategies for soil and water management. Wheat is planted in September and October and harvested after a growing period of about 300 days. Healthy winter stands provide grazing for thousands of animal units and grow back to yield 30–35 bushels per acre (bu/acre). Approximately 130–170 million bushels of wheat—worth about \$300 million—are harvested from about 5 million acres. During the past 10 years, more than 60% of Oklahoma's wheat has been rated at Grade 1 or 2; in many years more than 90% has been rated at this prestigious level.

Oklahoma participates in a very complex national marketing process for wheat. Collection and storage, grading and pricing, and ultimately, shipping, are major steps in this process. Approximately 400 privately owned, commercial, and cooperative storage facilities are located in western Oklahoma from which a variety of marketing options are realized. About 80% of Oklahoma's wheat reaches foreign markets as Grade 1 or 2 wheat, mostly via ports along the Gulf of Mexico. The former USSR, Japan, and African countries are among the favored destinations.

Recent economic ups and downs have streamlined, modernized, and strengthened the wheat farming system. Today, its resource base is healthy; state-of-the-art technology sustains progressive ecological and production performance and economic prosperity. Dependence on national farm policies regarding internal support and competition on external markets will continue to serve as a challenge and stimulation. Oklahoma's wheat system is highly competitive nationally and internationally. Transformation and modernization in the spirit of the past will be the key to a future filled with opportunities, and wheat will continue to contribute to Oklahoma's overall economic well-being.

INTRODUCTION

Dry farming has evolved as the dominant agricultural system of the Great Plains of North America. Although this system has predecessors in both the Old and the New Worlds, they provided little guidance for the unique evolution of dry farming in the Great Plains. Beginning as an ill-adapted introduction of humid-zone techniques of soil and water management, farming in the Great Plains ultimately adjusted to environmental constraints through locally developed land resource management principles. The system also adjusted to cope with dominant external economic and political forces, which contributed in shaping the dryland wheat farming system. In less than 100 years, this system has expanded over an entire continental landscape and has emerged as one of the major sources of global food supply.

Oklahoma shared greatly in and contributed decisively to this evolutionary experience; today wheat—unlike any other commodity—leaves its imprint on the economy, culture, and physical landscape of Oklahoma. Overall climatic conditions, soils, and topography of the High Plains of the Panhandle, most of the Rolling Red Plains of western Oklahoma, and the Reddish Prairies in the center of the State favor economical, mechanized wheat farming in large units. This fact, coupled with reliable but not excessive rainfall, makes this region the breadbasket of Oklahoma. Yet the ecological endowment of Oklahoma allows it to grow wheat in each of the 77 counties. Currently wheat is grown on more acres than all other cultivated crops combined. More than 7 million acres of wheat are planted each year in Oklahoma, and about 5 million acres are harvested, usually yielding more than 150 million bushels of grain annually. In addition, each winter, wheat crops supply hundreds of thousands of animal unit months of grazing. The total value of the wheat crop to Oklahoma is roughly one-third of a billion dollars annually. Oklahoma ranks between second and fifth place in total wheat production in the U.S. and ranks second in hard red winter wheat production. The claim "OK is Wheat" is well-founded.

This chapter has four objectives. First, it will assess the agro-ecological setting, the constraints, and the potential of Oklahoma's wheat landscape as the backdrop to regional agro-economic development. Second, it will explain the evolution of the physical and technical properties of the wheat farming system from a semi-industrial to a high-technology, energy-intensive one, and discuss the state-of-the-art soil and water management strategies. Third, it will evaluate the performance of the present dryland wheat system in terms of economy, ecology, and energy, taking into consideration overall production conditions, modern scientific and technological impact, and development trends. Lastly, it will discuss the role of Oklahoma wheat in an international market.

PHYSICAL-GEOGRAPHICAL SETTING

Agricultural production depends on the interactions of topography, soil resources, climate, soil moisture, and evapotranspiration. Precipitation in Oklahoma has a marked east-west gradient. The annual precipitation in the main wheat-growing region ranges from about 35 inches along the eastern boundary of the Reddish Prairie to only 16 inches in the High Plains of the western Panhandle. Although rainfall generally shows a pronounced summer maximum, some regional differences in the distribution of monthly precipitation occur. In the High Plains and the western portion of the Rolling Red Plains, a single maximum occurs in May or June. This is the area of summer fallowed wheat, allowing for one crop every other year. Farther east, a secondary maximum occurs near wheat-seeding time in September and October; combined with a higher annual precipitation, it adds to the certainty of obtaining wheat stands without a need for summer fallowing.

Temperature, as well as the amount of rainfall, affects the water available for wheat production. Effects of latitude and east-west gradient in elevation overlap and work in Oklahoma's favor: as elevation increases, temperatures become cooler. Thus, an inch of rainfall is more effective in crop production in the High Plains at 4,000–

4,500 feet than in the Reddish Prairie at about 1,000 feet. The gradient in elevation is in the range of 1,000–1,300 feet per 100 miles.

Precipitation–evaporation indexes describe the role of temperature in precipitation effectiveness and help to assess spatial variations of wheat production potential. West of Beaver County in the Panhandle, soil water is more limiting than fertility; east of Beaver County, precipitation is sufficiently effective for annual cropping, but soil fertility is the prime constraint. Beaver County itself, as well as the counties along the western border of Oklahoma, form a transition zone from summer fallowed to continuous rainfed cropping.

The High Plains wheatland soils are derived from Tertiary parent material; they are fine-textured and have adequate fertility so that response to fertilizer is limited under dryland conditions. The benefit derived from summer fallowing, therefore, is solely from water stored and not from an increase in available nitrogen or phosphorus. The soils of the Rolling Red Plains and the Reddish Prairies are derived from Permian materials and are not only erosive but also have a natural phosphorus deficiency. On these soils, the yield during the first 50 years of this century was about 10 bushels per acre. Manure applications to these soils could double the yield to about 20 bushels per acre.

Nitrogen fertility of the soils partly depends on tillage method and cropping system used. Because of less thorough mixing and aeration of the soil, stubble mulching releases less nitrogen than clean tillage or one-way plowing and may accentuate an existing need for nitrogen. Lower yields generally result. In the Panhandle, on the other hand, stubble mulching increases rather than decreases wheat yields compared with one-way plowing. Factors in the yield increase are more available moisture, a reduction in the straw/grain ratio due to less available nitrogen, and decreased damage from wind erosion. Although summer fallowing might increase nutrient availability in the Rolling Red Plains and the Reddish Prairies, a reasonable price for commercial fertilizer, the serious threat of soil erosion, and the

high yields obtained by continuous cropping in this higher rainfall zone are arguments against summer fallowing.

In sum, the natural endowment—mainly moisture/temperature relationships, topography, and soil fertility—throughout Oklahoma is superbly suited for high-performance wheat production; the western half of the state in particular, with 16–35 inches of annual rainfall, meets all quality requirements to serve as a national granary.

DEVELOPMENT OF THE WHEAT LANDSCAPE

During spring and summer, western and north-central Oklahoma's boundless carpet of wheat, waving gently in the constant breeze, gradually gives the patient observer a sense of calm and balance. From this prevailing scene, rural Oklahoma draws its emotional, physical, and spiritual strength. What are the highlights of the genesis of this wheat landscape? What were the motives and goals of the settlers who broke and wrestled with the grassland and developed one of the main pillars in Oklahoma's economy?

Initially, during the closing decades of the last century, settlers halted their move into the semiarid West between 95 and 98 degrees western longitude, where humid-zone soil management techniques provided an economically acceptable balance between production inputs and food output. In time, the spread of farmers throughout the western sections of Oklahoma was promoted by the slow westward expansion of population in the Great Plains and the opening of Indian Territory about 100 years ago, as well as periodic mitigation of climatic constraints, expansion of foreign markets, and improvements in soil management techniques.

The first farmers in the region needed technological ingenuity and ecological awareness in order to begin developing dry farming techniques to cope with climatic and economic uncertainty. Moreover, they had to deal with political and economic structures that affected the development of dry farming technology.

The introduction of heavy equip-

ment and powerful steam tractors, as well as the rapid expansion of foreign markets in post-World War I Europe, brought a significant settlement boom and a change in land use. The grassland was plowed and turned into wheat fields. The moldboard plow, a humid-zone tool for soil, moisture, and residue management, turned up topsoil, left field surfaces bare and unprotected, stimulated wind erosion, and minimized soil moisture harvest. Private experimentation and tests on government research stations between 1910 and 1930 led to the development of shallow-operating plows and harrows. These implements, however, allowed for a fallow efficiency (the percentage of fallow-season rainfall that can be stored as plant-available moisture in the root zone) of no more than 20% and produced an average wheat yield of about 12 bu/acre, and western Oklahoma's economy flourished on the basis of expanding wheat acreage in the 1920s.

This boom coincided with relatively high moisture supplies and contributed directly to the development of the Dust Bowl syndrome of the 1930s. High wheat production was achieved at the cost of indebtedness and increasing exploitation of marginal and vulnerable cropland, all implemented in an attempt to avoid economic bankruptcy. Diminishing rainfall and wheat prices in the 1930s initiated a cycle of further expansion of acreage and production (which were supposed to provide the farmer with means for meeting overextended financial obligations). In order to remain competitive, individual farmers acquired new machinery and further expanded their holdings to make the investment in machinery profitable. Cash flow and risk increased. Crop prices and rainfall determined the solvency of individual operators. When domestic and foreign demands decreased in the 1930s, the new farm technology created enormous wheat surpluses and price depression. For example, in 1931, wheat prices were at \$0.39/bu, which was 18% of the 1919 level. When prices fell, individual farmers paradoxically expanded their acreage and further increased their production, only to increase the overall surplus. By this time tenancy rates

and indebtedness had become so high that farmers were obliged to raise cash crops to meet their mortgage and rental payments.

The New Deal exacerbated this situation. The per capita agricultural loans and expenditures of the New Deal agricultural agencies were geared to absolute and percentage changes in farm income from 1929 to 1932, not to the genuine economic need. The government indirectly encouraged the selling of land by small farmers, the eviction of small tenant farmers, and the introduction of more powerful tractors and equipment to the post-1934 Plains.

The Homestead Act of 1862 was an early contributor to this pattern. Units of only 160 acres were available to new settlers, regardless of intended land use or of suitability of the land for a specific use. Subsequent land policy did not provide for land-use regulations, which might also have served as conservation devices. Western railroads, new settlers, land speculators, local businessmen, state and local government—all had different and often conflicting interests in both the timing and the volume of the general regional economic development.

In times of economic distress, the first to fail were settlers who were forced off their land. Land changed hands over and over and contributed to the general growth of individual holdings far beyond the 160 acres unit originally intended by 19th-century land policy. Passage of the Federal Crop Insurance Act of 1938, which established the Federal Crop Insurance Corporation to write all-risk crop insurance on low yields, seems to have come too late to halt the trend of farm aggregation. In the 1930s the average farm size in the central Great Plains was about 300 acres. The production cost-return balance collapsed along with the ecological production potential during the erosion process of the 1930s, when early soil management practices left field surfaces bare, and exposed topsoil was subject to severe wind erosion.

Another cycle of prosperous years began in the 1940s with high rainfall supplies and increasing demand for wheat from famine-stricken Europe. Small, one-way disk plows were de-

veloped by the mid-1940s and fallow efficiency levels improved by 20–24%, with yields increasing to 15 bu/acre. Land use restrictions were abandoned, and the farmer's willingness to protect the soil diminished. Sandy soils, suitable only for grazing, were brought back into wheat production. The introduction of the rod weeder in the late 1950s and of stubble mulching in the 1960s improved fallow efficiency levels by about 27%; average yields increased to about 23 bu/acre. By the time European agriculture was rebuilt in the 1950s, Oklahoma as part of the Great Plains produced an enormous surplus of grain. Diminishing rainfall and declining wheat demand again brought an end to economic prosperity; excessive soil erosion created a second Dust Bowl. Population density again decreased, farm sizes increased (Figure 5.1) and specialization continued.

Modern stubble mulching uses large sweeps and rod weeders. In the 1970s, fallow efficiency levels rose to about 33% and yields climbed from 20 to 30 bu/acre. When practiced in combination with fall weed control, stubble mulching improved fallow efficiency to about 35% and yields to about 35 bu/acre. Minimum mechanical tillage with herbicide applications, as sometimes practiced since the late 1970s and early 1980s, can increase these performance levels to 40% fallow efficiency and yield levels of 35 to 40 bu/acre. In spite of modern agrotechnology and training, soil erosion continued to threaten croplands

throughout western Oklahoma. Soil Conservation Service data document damage to crop land in the late 1970s and again in the early 1980s (Table 5.1). Yet a comparison between acres damaged and acres planted (Table 5.2) reveals that, from a long-term perspective, decisive progress has been made in containing soil loss and conserving natural productivity levels.

Increased production again has failed to mitigate economic hardship caused by market conditions. Since the 1970s production costs have not been offset by wheat prices. Government programs of the 1980s (like Payment-In-Kind) have not helped either. Small family farms have continually declined (Figure 5.1). The trend is towards corporate farms, and many young people continue to move to urban centers, slowing down the growth of rural population. The average size of a wheat farm in the 1960s was about 1,200 acres. The average acreage of 50 farms, randomly sampled and surveyed in 1986 throughout Cimarron, Texas, Beaver, Harper, and Woods Counties, was about 1,300 acres. These surveyed operators felt that if dryland wheat production is to provide the only farm income, then 1,500–2,000 acres are needed for crop production. Considering technological advancement such as high-yielding wheat varieties or chemical fertilizers, this farm size compares well with the 2,600 acres that had been identified in the early 1930s as the Great Plains dry farming equivalent of a 160-acre farm in the humid east of the United States.

A standard deviation of 690 acres for these sampled farms indicates that substantially smaller farms compensate insufficient dry-farming income by raising irrigated corn or livestock, or by off-farm wages.

In sum, the Dust Bowl syndrome of the 1930s, 1950s, and the late 1970s was a result of complex interactions of physical, environmental, technological, and political factors; they included unpredictable precipitation, highly variable crop prices, limited experience with new machinery, ill-conceived land policies, and disproportionate wheat supply and demand. These periodic setbacks, however, alternated with extended and sustained phases of prosperity and social well-being for the wheat communities in western Oklahoma. This success had been achieved through spectacular scientific and technological advances, favorable rainfall conditions, and growing demand from foreign markets. These ups and downs have transformed the wheat farming system from an initially small-scale subsistence-type system to a robust, large-scale high-technology industry.

THE MODERN DRYLAND WHEAT FARMING SYSTEM

Oklahoma's economic, social, and cultural well-being is closely tied to the success of the wheat farming system. Historically, agriculture and oil have been the mainstays of Oklahoma's economy. Wheat ranks second only to cattle in generating revenues for the state. To understand the wheat system is to understand the critical factor of Oklahoma's economic makeup. Exactly how specialized and successful is the operation of today's wheat farming system? What are the major physical properties and management options? And, finally, what is the system's performance level in economic and ecological terms, and in terms of cultural energy input/food energy output relationships?

Physical Properties of a Wheat Operation

Although a variety of technologies and procedures are practiced on the wheat farms of western Oklahoma, a typical system can be described. Hard red winter wheat (*Triticum aestivum*) is

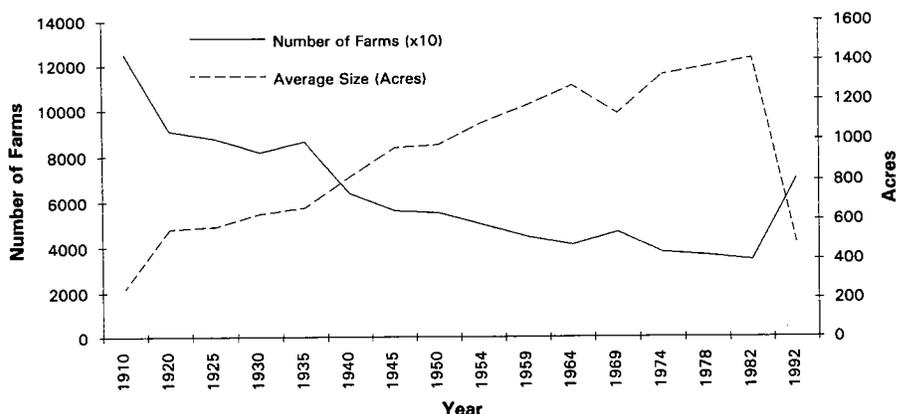


Figure 5.1 — Number of farms and average size of farms in Oklahoma, 1910–92. Sources: Oklahoma Department of Commerce (1988); Oklahoma Department of Agriculture (1992).

Table 5.1 -- Wind Erosion Conditions for Oklahoma

----- Land Damaged (Acres) -----					
Year	Number of Counties Reporting	Cropland	Rangeland	Other Land	Total Land Damaged
1969	17	35,126	47	102	35,275
1970	17	9,500	130	320	9,950
1971	17	88,800	1,900	2,000	92,700
1972	17	21,525	300	2,050	23,875
1973	17	87,820	3,200	1,500	92,520
1974	17	52,965	100	10,400	63,465
1975	17	238,725	400	900	240,025
1976	20	577,932	27,520	14,415	619,867
1977	20	198,220	2,925	5,695	206,840
1978	20	113,200	5,050	3,260	121,510
1979	30	139,600	3,940	4,405	147,945
1980	30	286,280	18,620	7,150	312,050
1981	30	393,520	9,400	4,280	407,200
1982	30	174,845	3,650	1,540	180,035
1983	30	235,575	2,685	900	239,160
1984	30	239,620	4,045	5,432	249,097
1985	30	228,910	6,780	5,260	240,950
1986	30	71,535	0	730	72,265
1987	30	114,370	628	2,430	117,428

----- Crops or Cover Destroyed on Land Not Damaged (Acres) -----					
Year	Number of Counties Reporting	Cropland	Rangeland	Other Land	Total Land Damaged
1969	17	3,340	0	0	3,340
1970	17	5,100	0	50	5,150
1971	17	23,800	2,100	4,800	30,700
1972	17	21,760	1,600	1,600	24,960
1973	17	22,550	3,400	750	26,700
1974	17	25,850	0	0	25,850
1975	17	74,650	2,250	700	77,600
1976	20	560,367	100	225	560,692
1977	20	132,050	5,200	700	137,950
1978	20	14,080	125	40	14,245
1979	30	13,920	85	195	14,200
1980	30	149,085	5,400	1,630	156,115
1981	30	56,740	2,140	1,725	60,605
1982	30	67,495	1,385	205	69,085
1983	30	58,925	470	0	59,395
1984	30	74,942	930	150	76,022
1985	30	29,380	580	400	30,360
1986	30	11,045	0	0	11,045
1987	30	10,190	5	100	10,295

Source: USDA - SCS (1988).

the prime cultivar. It is planted from September 15 to October 15, provided enough moisture is available in the topsoil. Shoedrills and sometimes disk-drills are used in this procedure. In the Panhandle, recommended planting rates are 15–30 pounds per acre (lb/acre), in western Oklahoma 45–60 lb/acre. Planted fields will be grazed during winter. After a growing period of about 300 days, wheat harvest begins in early June, often performed by migrating commercial combine crews. Only about one-quarter of a surveyed sample of farms operate their own

combines. The majority of the farms either have on-farm storage facilities or own storage space in a cooperative grain elevator in a nearby town. Others deliver their harvest directly to central grain elevators.

Weed growth begins immediately after harvest. Post-harvest weed control, therefore, often includes one 4-inch-deep sweep operation between July 25 and August 5 to destroy fall weeds in new wheat stubble and one 4-inch-deep cross-sweep operation between September 1 and 10 to kill volunteer wheat if needed. Under

wheat-summer fallow conditions, these operations mostly save up to 3 inches of available soil moisture, but they also reduce the rate of stubble on the field surface, which leads to increased soil moisture losses during the subsequent summer season. For continuous wheat in western Oklahoma, seedbeds are prepared late in September for planting before October 15. Under a wheat-summer fallow system, spring tillage begins between April 20 and May 10, with a 4-inch-deep one-way disk or a sweep operation. Fallowed fields are cultivated from May to August with sweeps and rodweeder; seedbeds are prepared between August 20 and September 1, applying the rodweeder with tong-attachments crosswise 3 inches deep. Stubble fields are worked four to eight times during the 14 months of the fallow season (Tables 5.3 and 5.4).

All field operations can be performed by one person using 150- to 250-horsepower tractors. Labor per acre per operation varies with the type and depth of tillage operation (Tables 5.3 and 5.4). Harvesting requires at least two persons, one driving the combine, the other the grain cart or truck to haul the grain to storage. Good yields range 30–35 bu/acre, depending on soil and rainfall conditions, and on tillage and cropping systems practiced.

Crop Production

Approximately 7 million acres have been planted statewide each year for each year since the 1970s; at the same time about 5 million acres are harvested annually (Figure 5.2; Table 5.2). Yields have seen a remarkable increase from the mid-20 bu/acre range in the 1970s to the mid-30 bu/acre range in the 1980s. Highest yields are achieved persistently in the Panhandle and the North-Central Crop Reporting Districts with more than 4 million bushels per county, reflecting the positive impact of optimum rainfall-temperature-management combinations (Map 5.1).

Currently, statewide annual wheat production ranges from 130 to 170 million bushels. The performance of the various wheat varieties differs greatly throughout the wheat landscape and from year to year (Table

5.5). Chisholm, TAM W-101, Vona, Scout, Pioneer 2157, and Siouxland are examples of high-performers. Continuous research provides real-time information to producers and assists in decision-making with respect to variety selection and acres to be seeded. More than 60% of Oklahoma wheat has been rated at Grade 1 or 2 over the past 10 years; in many years more than 90% is rated at this prestigious level (Table 5.6). For the past 10 years Oklahoma has ranked second among the 48 states in winter wheat production. The nationwide price depression, however, has resulted in declining total crop values (Table 5.7). Nonetheless, the total value of the winter wheat crop is more than \$300 million—more than two-thirds of which is export-generated—and has a significant impact on the economy of Oklahoma.

This general pattern of success varies throughout the wheat landscape, depending primarily on seasonal and local rainfall amounts, on the extent to which soil moisture budgets can be optimized by controlling weed growth, water intake, evaporation and runoff losses, and on local water-use efficiency and on soil erosion. The ecological performance assessment will focus on this issue. At the Lawton USDA Field Station on the Rolling Red Plains, comparisons of average yield data for continuous wheat and wheat-fallow suggest that in the southwest and west-central regions, fertility, rather than water, limits wheat yields, and commercial fertilizers are a more economical way of satisfying fertility needs and more conserving of the soil than summer fallowing. In Woodward (the north-central location of the Rolling Red Plains), fallowing serves mainly to increase yields in years of fair to high production rather than to reduce the risk of crop failure; therefore, fallowing is not considered to be a cropping practice well-adapted to this region, but rather one to be avoided because of greater loss of soil nitrogen and carbon. Finally, in the Panhandle and along the western border, continuous wheat fails to produce satisfactory yields due to lower amounts and increased variability of annual rainfall. Here, wheat has to be summer fallowed. Beaver County in the Panhandle and the western fringe

Table 5.2 -- Oklahoma Wheat Estimates, 1894-1991

Crop Year	Planted Acres (000's)	Harvested Acres (000's)	Yield per Acre (Bushels)	Production (000 Bu.)	Price per Bushel (\$)	Value of Production (000 Dollars)
1894		250	15.0	3,750	0.51	1,912
1895		275	8.0	2,200	0.48	1,056
1896		250	9.0	2,250	0.68	1,530
1897		650	18.0	11,700	0.76	8,892
1898		1,200	14.5	17,400	0.52	9,048
1899		1,527	13.3	20,309	0.53	10,764
1900		1,530	16.0	24,480	0.53	12,974
1901		1,490	14.0	20,860	0.64	13,350
1902		1,610	12.0	19,320	0.59	11,399
1903		2,280	14.0	31,920	0.64	20,428
1904		1,820	11.5	20,930	0.94	19,674
1905		1,940	9.0	17,460	0.70	12,222
1906		1,760	13.6	23,936	0.56	13,404
1907		1,040	9.5	9,880	0.83	8,200
1908		1,420	11.5	16,330	0.87	14,207
1909	1,264	1,169	12.0	14,028	1.06	14,870
1910	1,611	1,530	15.0	22,950	0.89	20,426
1911	1,788	1,180	8.0	9,440	0.88	8,307
1912	1,922	1,720	12.5	21,500	0.79	16,985
1913	2,086	1,940	8.5	16,490	0.76	12,532
1914	2,701	2,620	17.5	45,850	0.87	39,890
1915	3,208	3,080	12.5	38,500	0.97	37,345
1916	3,086	2,870	9.5	27,265	1.38	37,626
1917	3,735	3,100	11.0	34,100	2.10	71,610
1918	4,000	3,200	11.5	36,800	2.01	73,968
1919	4,723	4,718	14.0	66,052	2.10	138,709
1920	4,284	3,727	15.0	55,905	1.84	103,865
1921	4,271	4,100	13.0	53,300	0.99	52,767
1922	4,490	3,772	8.5	32,062	0.92	29,497
1923	4,227	3,847	11.0	42,317	0.88	37,239
1924	3,838	3,684	15.5	57,102	1.07	61,099
1925	4,512	3,610	8.3	29,963	1.46	43,746
1926	4,420	4,332	17.0	73,644	1.16	85,427
1927	4,765	3,812	9.2	35,070	1.25	43,838
1928	4,960	4,613	14.0	64,582	1.04	67,165
1929	4,868	4,576	11.2	51,251	0.96	49,201
1930	4,576	3,935	9.5	37,382	0.68	25,420
1931	4,615	4,407	17.0	74,919	0.33	24,723
1932	4,407	3,966	12.0	47,592	0.32	15,229
1933	4,419	3,093	10.2	31,549	0.68	21,453
1934	4,317	3,543	10.5	37,202	0.81	30,134
1935	4,749	3,366	10.0	33,660	0.86	28,948
1936	4,986	3,534	8.0	28,272	0.99	27,989
1937	5,784	4,736	14.2	67,251	0.96	64,561
1938	6,300	5,607	11.0	61,677	0.56	34,539
1939	4,851	4,277	14.1	60,306	0.65	39,199
1940	4,657	4,020	14.5	58,290	0.62	36,140
1941	4,983	4,502	10.7	48,171	0.93	44,799
1942	4,086	3,737	16.0	59,792	1.11	66,369
1943	4,086	3,588	9.5	34,086	1.38	47,039
1944	5,557	5,095	16.7	85,086	1.39	118,270
1945	6,335	5,910	12.5	73,875	1.45	107,119
1946	6,715	6,087	14.5	88,262	1.80	158,872
1947	7,051	6,696	15.5	103,788	2.17	225,220
1948	7,263	6,696	14.5	97,092	1.98	192,242
1949	7,481	6,629	12.8	84,851	1.87	158,671
1950	5,910	4,707	9.0	42,363	2.02	85,573
1951	6,265	4,095	9.5	38,902	2.20	85,584
1952	6,450	5,840	18.5	108,040	2.12	229,045
1953	6,966	5,898	12.0	70,776	2.13	150,753
1954	5,294	4,718	15.0	70,770	2.18	154,279

(continued on opposite page)

Table 5.2 -- continued

Crop Year	Planted Acres (000's)	Harvested Acres (000's)	Yield per Acre (Bushels)	Production (000 Bu.)	Price per Bushel (\$)	Value of Production (000 Dollars)
1955	4,923	3,020	8.0	24,160	2.05	49,528
1956	4,972	4,198	16.5	69,267	1.97	136,456
1957	4,276	3,442	12.5	43,025	1.93	83,038
1958	4,661	4,440	26.0	115,440	1.75	202,020
1959	4,987	4,529	20.0	90,580	1.77	160,327
1960	4,887	4,665	26.0	121,290	1.75	212,258
1961	4,887	4,618	24.0	110,832	1.80	199,498
1962	4,349	3,741	19.0	71,079	2.04	145,001
1963	4,740	3,591	21.0	75,411	1.90	143,281
1964	4,882	4,201	23.0	96,623	1.46	141,070
1965	5,321	4,747	28.0	132,916	1.36	180,766
1966	5,268	4,700	21.0	98,700	1.66	163,842
1967	6,480	5,217	17.0	88,689	1.47	130,373
1968	6,180	5,400	23.0	124,200	1.25	155,250
1969	5,450	4,350	28.0	121,800	1.23	149,814
1970	5,025	3,900	26.0	101,400	1.33	134,862
1971	5,050	3,600	20.0	72,000	1.42	102,240
1972	5,700	3,900	23.0	89,700	1.70	152,490
1973	6,000	5,260	30.0	157,800	3.56	561,768
1974	7,000	6,400	21.0	134,400	3.95	530,880
1975	7,400	6,700	24.0	160,800	3.43	551,544
1976	7,800	6,300	24.0	151,200	2.78	420,336
1977	7,800	6,500	27.0	175,500	2.32	407,160
1978	7,000	5,400	27.0	145,800	3.03	441,774
1979	7,000	5,700	38.0	216,600	3.91	846,906
1980	7,500	6,500	30.0	195,000	3.83	746,850
1981	7,700	6,400	27.0	172,800	3.83	661,824
1982	8,000	6,900	33.0	227,700	3.65	831,105
1983	7,800	4,300	35.0	150,500	3.51	528,255
1984	7,700	5,300	36.0	190,800	3.36	641,088
1985	7,800	5,500	30.0	165,000	2.91	480,150
1986	7,400	5,200	29.0	150,800	2.28	343,824
1987	7,200	4,800	27.0	129,600	2.45	317,520
1988	7,000	4,800	36.0	172,800	3.57	616,896
1989	7,300	5,700	27.0	153,900	3.79	583,281
1990	7,500	6,300	32.0	201,600	2.57	518,112
1991	7,400	5,000	28.0	140,000	2.85	399,000

Source: Oklahoma Department of Agriculture (1992).

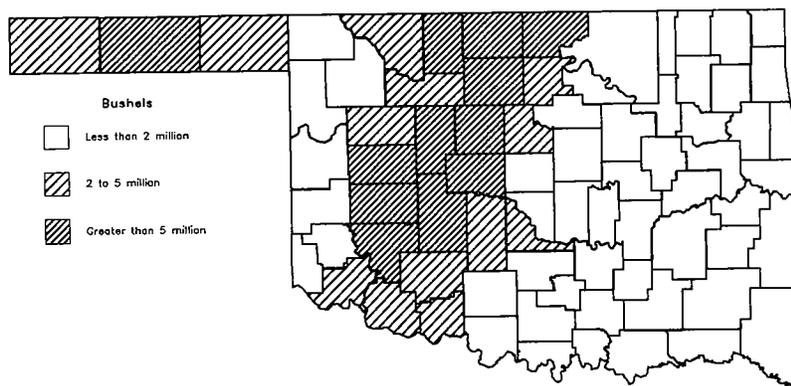
Dust Bowl. In western Oklahoma, this practice implies extending the non-cropped season between two crops to up to 15 months, from about June to September. The objectives of summer fallowing in the winter wheat-fallow rotation are to: (1) reduce weed growth from harvest to planting to an absolute minimum; (2) keep wheat stubble upright as long as possible in order to increase snow accumulation and reduce wind velocities at the field surface; (3) preserve a straw mulch of 1,000 lb/acre on silty clay loams and 1,700 lb/acre on sands and sandy loams until planting time to reduce wind impact, evaporation, and runoff; and (4) maintain a rough field surface with large soil clods during fallow and after planting. The results are (1) improved moisture penetration; (2) reduced evaporation and transpiration losses and maximized soil moisture storage; (3) improved plant nutrient availability (nitrogen); (4) improved seed germination; (5) minimized erosion hazards; and (6) minimized energy and financial inputs.

Achievement of these goals requires a high level of education and specialized training on the part of the farmer and excellent communication and cooperation between the farming community and the Agricultural Extension Service of Oklahoma State University. As a result, tillage techniques have changed constantly. As the capacity to retain straw mulches and control weeds throughout the fallow

of western Oklahoma form the transition zone between continuous wheat and summer fallowed wheat.

Soil and Water Management Under Semiarid Conditions

Soil management activities minimize the risk of crop failure caused by environmental constraints and optimize crop production in general. The farther west a wheat farm is located in Oklahoma and the more semiarid the climate becomes, the more summer fallowing represents the single most important practice to achieve these goals. Summer fallowing was universally adopted following the 1930s



Map 5.1 — Wheat production in Oklahoma by county, 1991. Source: Oklahoma Department of Agriculture (1992).

Table 5.3 -- Field Energy Budget for Unfertilized Summer Fallowed Wheat in Cimarron County, Oklahoma, 1983

Acres: 156		Legal Description: NE - 19 - 3 - 1			Crop Year: 1983	
Tillage Operation	Date	Width of Implement (inches)	Acres per Hour	Acres Done	Operation Energy (Kcal/1000 Acres)	
Sweep	82/08/15	35	25	156	Fuel Energy	13,716,500.00
					Labor Energy	19,186.24
					Embodied Energy	1,378,789.00
					Transport Energy	270,151.70
Sweep	83/04/15	35	25	156	Fuel Energy	13,716,500.00
					Labor Energy	19,186.24
					Embodied Energy	1,378,789.00
					Transport Energy	270,151.70
Sweep	83/05/25	35	25	156	Fuel Energy	13,716,500.00
					Labor Energy	19,186.24
					Embodied Energy	1,378,789.00
					Transport Energy	270,151.70
Sweep	83/06/15	35	25	156	Fuel Energy	13,716,500.00
					Labor Energy	19,186.24
					Embodied Energy	1,378,789.00
					Transport Energy	270,151.70
Sweep	83/07/15	35	25	156	Fuel Energy	13,716,500.00
					Labor Energy	19,186.24
					Embodied Energy	1,378,789.00
					Transport Energy	270,151.70
Sweep	83/08/25	13	5	156	Fuel Energy	31,003,920.00
					Labor Energy	92,813.71
					Embodied Energy	3,550,864.00
					Transport Energy	270,151.70
					Seed Energy	45,000,000.00
Crop Variety: Scout		Seedling Rate (lb/ac): 30.0				
<u>Harvest Date</u>	<u>Acres Harvested</u>	<u>Actual Yield (bu/ac)</u>	<u>Estimated Yield (bu/ac)</u>			
84/06/30	15 6	25.0				
		<u>Kcal/1000 Acres</u>	<u>Percent of Total Input</u>			
Total Fuel Energy:		99,586,390.0	68.03			
Total Labor Energy:		188,744.9	0.13			
Total Embodied Energy:		10,444,810.0	7.13			
Total Seed Energy:		45,000,000.0	30.74			
Total Fertilizer Energy:		0.0	0.00			
Total Herbicide/Pesticide Energy:		0.0	0.00			
Total Transportation Energy:		1,620,910.0	1.10			
Total Energy Input per 1000 Acres:		146,396,100.0				
Food (Output) Energy per 1000 Acres:		2,250,000,000.0				
ENERGY OUTPUT/INPUT RATIO:		15.36927				

ical operations and implements, residue rates remaining on the field surface at the end of the fallow season, fallow efficiency and crop yield levels, and food energy output/production energy input ratios.

Contour terraces are installed mechanically on some of the wheatland to control runoff and increase water infiltration rates. In general, however, sloping terrain is used as range land only, and water erosion is a localized minor problem.

Wind erosion can be a significant problem on sandy soils and on intensively tilled field surfaces. It occurs primarily after wheat has been planted, when ground cover is at a minimum. A second erosion maximum can occur during spring and early summer of the fallow season, when initial spring tillage reduces straw rates substantially and when wind speeds are at a maximum. Long-term erosion causes a change in soil texture (mainly a reduction of those medium-diameter soil particles that have the capability of forming erosion-resistant soil clods), and a significant loss in organic matter, phosphorus, and potash. The result is a reduction of the potential to store plant-available moisture. Increasing local soil-aridity and declining soil fertility are characteristic soil surface changes that occur wherever the process of desertification remains uncontrolled.

Field observations show that optimal fertility is the easiest, most effective, and profitable way of increasing wheat water-use efficiency. Nutrient-deficient wheat uses water at approximately the same rate as nutritionally balanced wheat, but produces a much lower yield. Eroded fields, therefore, require fertilizer supplements not only to offset the nutrient losses caused by erosion, but also to optimize reduced moisture supplies. Individual operators can control erosion more readily than resorting to these delicate management options after damage has occurred. They control wind erosion on fallowed land by providing large wind-resistant soil clods on the soil surface, by keeping the field surface rough and thus reducing wind speed and trapping drifting soil, by reducing field length along the main wind direction by strip cropping, by estab-

season has improved, fallow efficiency rates have gradually improved and have led to significant yield increases.

Tillage systems in use today are maximum tillage (or black fallowing or clean tillage), conventional tillage

(or bare fallow or semiclean tillage), stubble mulching (or conservation tillage), minimum (mechanical) tillage, and eco-tillage (or chemical tillage). No-till fallow has been introduced on a few farms on experimental plots. Each system features distinct mechan-

Table 5.4 -- Field Energy Budget for Fertilized Continuous Wheat in Woods County, Oklahoma, 1983

Acres: 158		Legal Description: NW - 8 - 25 -13			Crop Year: 1983	
Tillage Operation	Date	Width of Implement (inches)	Acres per Hour	Acres Done	Operation Energy (Kcal/1000 Acres)	
Moldboard Plow	83/05/15	8	4	158	Fuel Energy	62,768,890.00
					Labor Energy	111,535.00
					Embodied Energy	1,050,382.00
					Transport Energy	243,374.70
Double Offset Disk	83/07/20	18	9	158	Fuel Energy	27,897,290.00
					Labor Energy	50,988.14
					Embodied Energy	1,050,382.00
					Transport Energy	243,374.70
Fertilize	83/09/01	45	24	158	Fuel Energy	9,317,447.00
					Labor Energy	21,925.00
					Embodied Energy	1,050,382.00
					Transport Energy	243,374.70
Plant	83/09/15	17	17	158	Fuel Energy	12,811,490.00
					Labor Energy	29,191.26
					Embodied Energy	1,225,107.00
					Transport Energy	243,374.70
					Seed Energy	73,500,000.00
Crop Variety: TAM-105 Seedling Rate (lb/ac): 49.0						
Fertilizer	Date	Fertilizer %	Application Rate (bu/ac)	Kcal/1000 Acres		
Anhydrous	83/09/01	82	61	342,300,000.0		
Nitrogen	83/09/15	18	70	86,259,600.0		
Phosphorus	83/09/15	46	70	19,146,790.0		
Harvest Date	Acres Harvested	Actual Yield (bu/ac)	Estimated Yield (bu/ac)			
84/06/15	15 8	72.0	NA			
		Kcal/1000 Acres	Percent of Total Input			
Total Fuel Energy:		112,795,100.0	17.76			
Total Labor Energy:		213,640.0	0.03			
Total Embodied Energy:		4,376,254.0	0.69			
Total Seed Energy:		73,500,000.0	11.58			
Total Fertilizer Energy:		447,706,400.0	70.48			
Total Herbicide/Pesticide Energy:		0.0	0.00			
Total Transportation Energy:		973,498.6	0.15			
Total Energy Input per 1000 Acres:		639,564,893.0				
Food (Output) Energy per 1000 Acres:		6,480,000,000.0				
ENERGY OUTPUT/INPUT RATIO: 10.20169						

economic, ecological, and management terms depends on the degree to which farming strategies can overcome internal and external constraints to cultivation and the degree to which farm products provide a reliable basis for the well-being of farm families. Ecological, economic, and energetic performance can be expressed in terms of water-use efficiency, soil moisture/soil erosion/crop yield relationships, cost-return budgets, and in terms of cultural-energy input/food-energy output relationships. These analyses explain the success story of Oklahoma wheat.

Water-Use Efficiency

Production risks have been greatly reduced and overall water-use efficiency has gradually improved throughout western Oklahoma because of widespread adoption of modernized tillage technology. Water-use efficiency has increased from an early 0.30 bushels per inch of rainfall in the 1930s to about 0.70 bushels per acre per inch, a level which has been maintained since the mid-1960s. This overall progressive trend was maintained even through the late 1950s and 1960s, when rainfall reached record lows, since new technologies could offset these adverse moisture conditions.

Equation 1 presents an average soil moisture/grain yield function of

$$Y = -15 + 2X \quad (1)$$

in which Y = wheat yield in bu/acre, X = available soil moisture in inches, and r = 0.78, averaged for all wheat varieties and soils in the yield range of 15–40 bushels of wheat per acre, describing the performance levels on Oklahoma dryland farms in terms of their capacity to translate the ecological result of soil management decisions into food production. Equation 1 suggests that each inch of available soil moisture beyond about 7 inches will produce two bushels of grain per acre. This achievement is a most impressive documentation of ecological vigor and technical success of the farming system under given environmental conditions.

**Soil Moisture/Soil Erosion/
Crop Yield Relationships**

If nature's conservation and regeneration needs are neglected, dryland

lishing vegetative barriers to reduce wind speed and soil avalanching, and by maintaining a vegetative cover to protect the soil. Stubble mulching incorporates most of these conservation measures.

In sum, dryland wheat operations of today exhibit modern and scientifically oriented physical properties and they are guided by refined and flex-

ible soil and water management strategies. The large variety of adapted management options forms the solid base of a progressive industrialized wheat farming system with a promising future.

PERFORMANCE EVALUATION

The overall performance of the Oklahoma wheat farming system in

wheat farming stimulates the processes of soil erosion and deterioration of the natural production potential based on diminishing soil qualities. In order to assure long-term agro-ecological stability, dryland wheat farming systems have to reduce soil-loss rates to a level that is considered to be nondetrimental, not only from an economic but also from an ecological point of view.

Long-term destructive wind erosion has been avoided relatively successfully, considering the vast acreage planted and productivity levels that have been maintained in all counties over the past 20 years (Table 5.1). This stability has been achieved by controlling the system of agro-ecologi-

cal interrelationships, described in Equation 2:

$$F_{opt} = \frac{100 \times Re_{min}}{b \times d (100 - Ti)} - \frac{a + b \times c}{b \times d} \quad (2)$$

F_{opt} = optimized moisture supply in inches; Re_{min} = minimum residue rate in lb/acre for effective erosion control required on the field surface for a given soil texture at planting time, if no erosion control method other than stubble mulching is in use; Ti = residue loss due to mechanical tillage between harvest and planting time in percent of residue harvested; a = Y-intercept and b = slope of local grain/straw yield function; c = Y-intercept; and d = slope of local available moisture/grain yield function.

Equation 2 can also serve as a conservation and planning tool on a farm level. Components of this agro-ecological dry boundary concept are defined for western Oklahoma by Equation 1 and Equation 3:

$$Re = -1,500 + 160Y \quad (3)$$

Re = straw in lb/acre and Y = grain yield in bu/acre; data are averaged for all wheat varieties in use on the sample farms.

For semiarid western Oklahoma, average minimum residue rates for effective erosion control (Re_{min}) on silty clay loam are 1,000 lb/acre, on sandy loam 1,700 lb/acre. Residue loss rates (Ti) range 30–40% per disk plow operation, 10–20% per sweep operation, and 5–10% per rodweeder operation. Using data for a minimum tillage or eco-tillage system with a 30% mechanical straw reduction and a requirement of 1,250 lb/acre of standing stubble for effective wind erosion control as input for Equation 2, the system calls for an optimized moisture supply (F_{opt}) of 15.59 inches per crop.

If this amount of moisture can be made available for a crop, dryfarming by means of minimum tillage produces enough straw to prevent destructive erosion and to maintain agro-ecological stability. If a given tillage practice cannot provide for this required optimized moisture level (F_{opt}), either alternative wheat varieties with a different moisture/grain and/or grain/straw relationship have to be introduced in order to balance the Equation 2 by changing factors a , b , c , or d , or additional erosion control methods other than mulching (such as permanent grass wind barriers or reduction of field width along the main wind direction) have to help reduce locally required Re_{min} factors. If these options do not exist, the tillage system should be changed in order to provide for a reduced Ti -value. If none of these management options can balance Equation 2, agro-ecological considerations call for replacing wheat-fallow-wheat systems by, for example, grassland and appropriate conservative approaches to range management. These latter changes have only become necessary on sandy soils and in regions where soil profiles have been truncated due to high erosion rates in the past.

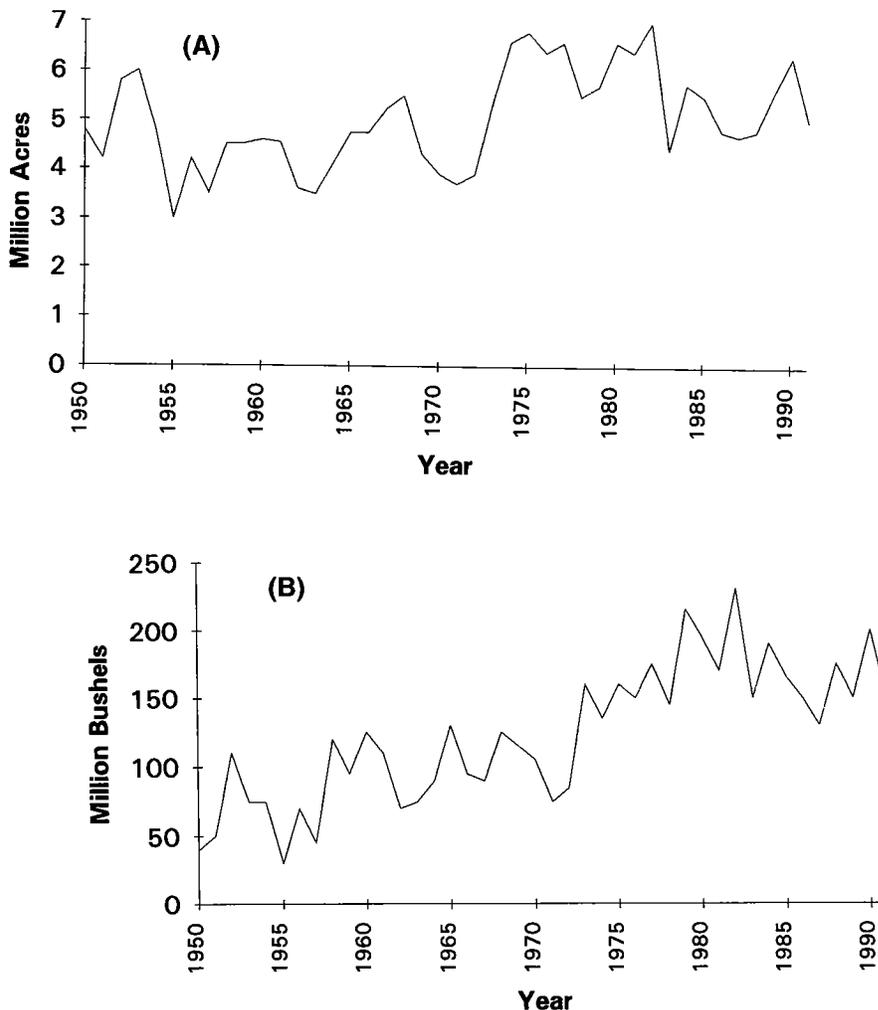


Figure 5.2 — (A) Oklahoma wheat harvested, 1950–91. (B) Oklahoma wheat produced, 1950–91. Sources: Miller and Hummer (1984); Oklahoma Department of Agriculture (1992).

Table 5.5 -- Oklahoma Wheat Varieties: Percentage of Seeded Acreage, Selected Years

Variety	1974	1975	1976	1979	1984	1986	1990
Chisholm	—	—	—	—	0.2	23.1	30.8
TAM	2.6	8.2	16.6	35.8	30.2	20.5	5.9
Vona	—	—	—	1.8	22.9	7.9	0.7
Mustang	—	—	—	—	—	6.1	0.7
Triumph Group	37.6	36.1	32.4	23.9	6.4	5.1	1.9
Triumph 64	9.5	12.1	13.7	12.6	4.9	3.2	—
Other Triumph	28.1	24.0	18.7	11.3	1.5	1.9	—
Scout (includes 66)	19.3	17.5	16.8	11.1	4.7	4.2	2.5
Hawk	—	—	—	—	1.3	4.2	0.8
Pioneer Group	—	—	—	—	0.5	3.7	29.7
Pioneer 2157	—	—	—	—	—	3.1	29.2
Other Pioneer	—	—	—	—	0.5	0.6	0.5
TAM 105	—	—	—	—	12.5	3.6	1.4
Payne	—	—	—	0.5	3.0	3.1	1.2
Wings	—	—	—	0.1	4.6	2.3	—
Newton	—	—	—	0.2	3.3	2.0	0.6
Wrangler	—	—	—	—	—	1.5	—
Arkan	—	—	—	—	—	1.3	1.5
Osage	—	—	—	4.3	0.8	0.6	—
Sage	—	0.3	2.1	5.0	0.8	0.5	—
Northrup King 812	—	—	—	—	0.6	0.5	—
Danne	9.9	9.1	7.6	3.2	0.8	0.4	—
Other/Unknown	30.6	28.8	24.5	14.1	7.4	9.4	22.3
TOTAL	100.0						

Source: Oklahoma Department of Agriculture (1992).

Production Cost-Return Relationships

The economics of wheat systems change drastically from year to year in response to the trend of real interest rates, commodity prices, and export demands. Other variables that determine economic prosperity of individual farmers are yield levels, taxes, government land use and pricing programs, management practices, cost, size, and depreciation of farm implements, acres farmed, planted and harvested, and number of fallow operations performed. The relative size of major input costs of dryland wheat production is shown in Figure 5.3. Land, machinery, and chemicals are the most costly inputs. In the early 1980s, gross production value of summer fallowed wheat was about \$53 per acre (Table 5.8); per acre production costs on the other hand were about \$5 for seed, fertilizer and pesticides, \$23 for power and equipment, \$4 for buildings, \$7.50 for labor, and \$30 for other production-related costs—\$25 of which were for land mortgage payments alone. The overall loss was about \$15 per acre. Farm returns and costs have remained unbalanced since the late 1970s. These facts,

however, should not be interpreted to the producers' disadvantage. The major variables, mechanisms, and forces driving the economic efficiency of the wheat farming system are out of the immediate control of individual operators; they are closely related to federal agricultural policies and the over-

all economic climate of the national agriculture industry. Nonetheless, the strongest and soundest components of the wheat farming system survive and flourish even today—in spite of the national farm crisis. These are the farms that traditionally have been operated under the guiding principle of "expand-after-you-earned-it." These are the farms that did not expand their acreage and implement inventory at inflated prices and with massive loans during the boom years. The declining number of family farms has to be interpreted within this context.

The data on economic performance can be interpreted more objectively when output/input information is related exclusively to the mere production process. For conventional stubble mulching, the tillage costs alone reached levels of \$17–\$20 per acre for the 1980 and 1981 crops. At yield levels of 35 bu/acre and 40 bu/acre and wheat prices as high as \$3.50 and \$4.00 per bushel, performance ratios of 7 and 8 show that direct production costs are very high in relation to wheat prices and that pricing for basic inputs requires reorientation in order to make returns worthwhile. This dollar input/output relationship has remained stable during the 1980s. So far, land purchases, equipment investments, and harvesting contracts use up presently small returns. Opera-

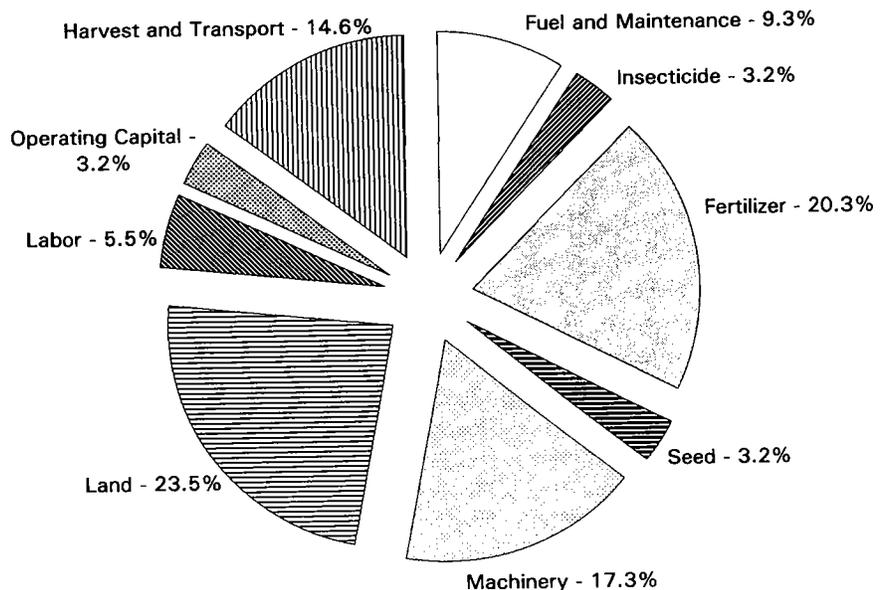


Figure 5.3 — Input costs of wheat production. Source: Oklahoma State University (1983).

Table 5.6 -- Oklahoma Wheat Quality, 1986-91

Dist. and Year	Cars Smpl.	Grade 1 or 2 (%)	Dock. (%)	Test Weight (lbs)	Moist. (%)	Total Dam. (%)	Foreign Mat. (%)	S & B (%)	Total Defects (%)	Protein (%)	DHV (%)
Panhandle											
1986	103	93.2	0.7	60.7	11.8	0.20	0.40	1.57	2.17	12.6	32.0
1987	189	84.7	1.1	59.6	11.0	0.48	0.11	2.30	2.90	11.4	33.4
1988	274	97.1	1.1	60.9	10.5	0.49	0.14	2.58	3.21	12.1	NA
1989	44	90.6	0.8	59.0	11.9	0.92	0.17	1.80	2.90	13.0	NA
1990	265	98.3	0.6	60.4	10.6	0.15	0.15	1.65	1.95	NA	NA
1991	121	100.0	0.5	61.3	11.8	0.00	0.20	1.99	2.19	NA	NA
West Central											
1986	684	62.9	0.7	58.5	11.9	0.39	0.49	2.18	3.06	12.0	16.0
1987	750	48.9	0.8	58.4	11.7	2.28	0.25	2.22	4.76	11.9	25.5
1988	1,151	87.6	0.7	61.3	11.0	0.94	0.24	2.39	3.56	11.4	NA
1989	788	88.4	0.7	59.8	12.6	0.34	0.30	1.22	1.86	12.2	NA
1990	1,152	93.1	0.7	60.5	11.0	0.31	0.27	2.24	2.82	11.1	NA
1991	650	90.8	0.5	59.7	12.3	0.70	0.40	1.10	2.20	12.0	NA
Southwest											
1986	1,872	69.6	1.1	59.0	12.0	0.54	0.16	1.97	2.68	12.2	27.8
1987	2,246	68.6	0.9	59.1	11.8	1.52	0.13	2.03	3.69	12.1	38.9
1988	2,473	95.2	0.9	61.6	11.2	0.38	0.12	1.89	2.38	11.2	46.2
1989	1,314	91.2	0.8	60.8	12.4	0.45	0.15	1.30	1.89	12.9	NA
1990	2,206	96.0	0.7	60.6	11.2	0.47	0.08	2.10	2.66	11.5	NA
1991	1,472	90.1	0.8	60.7	12.5	1.29	0.11	1.02	2.41	12.1	NA
North Central											
1986	1,230	65.4	0.8	59.0	11.7	0.79	0.23	2.00	3.02	12.0	21.1
1987	1,798	55.6	0.8	58.5	11.7	1.29	0.27	3.05	4.60	12.2	28.2
1988	2,613	93.9	0.8	61.4	11.1	0.43	0.16	2.63	3.22	11.6	46.4
1989	2,284	91.8	0.8	60.1	12.1	0.81	0.22	1.59	2.63	12.6	NA
1990	2,786	97.7	0.7	61.5	11.2	0.31	0.20	2.12	2.63	11.6	NA
1991	3,017	92.2	0.7	59.6	12.7	0.29	0.27	1.73	2.29	12.8	NA
State											
1986	4,069	64.5	0.9	58.9	11.9	0.58	1.25	2.03	2.84	12.1	23.5
1987	5,061	61.2	0.8	58.8	11.7	1.53	0.20	2.44	4.17	12.1	32.8
1988	6,906	93.0	0.8	61.4	11.1	0.52	0.16	2.33	3.00	11.4	46.4
1989	5,412	90.6	0.7	60.1	12.4	0.60	0.20	1.40	2.30	12.5	NA
1990	7,266	94.6	0.7	60.8	11.3	0.39	0.18	2.14	2.71	11.4	NA
1991	6,601	89.1	0.7	59.7	12.6	0.55	0.26	1.54	2.35	12.5	NA
Explanation of Column Headings:											
Dist.:	Crop Reporting District										
Cars Smpl.:	Cars Sampled										
Dock.:	Dockage										
Moist.:	Moisture										
Total Dam.:	Total Damaged										
Foreign Mat.:	Foreign Material										
S & B:	Shrunken and Broken Kernels										
DHV:	Dark, Hard and Vitreous										

Source: Oklahoma Department of Agriculture (1992).

tional costs need to be deflated and restructured, and land value must be stabilized, before overall farm budgets can be balanced and before operational profit margins can be re-established. Credit policies and government price-support programs play a vital role in a farmer's intricate endeavour to achieve a long-term budget balance. One such option to help solve the present economic performance crisis, one which also is within

the farmers' control, is a shift from widely used semiclean tillage towards minimum tillage, which achieves a maximum performance level at a minimum equipment inventory requirement and minimum direct production input. Time savings can be invested in off-farm cash-raising activities which could generate a yearly income of \$12,000-\$15,000.

The importance of the farm sector, however, results less from its relative

size than from the large numbers of counties that are highly dependent on farm income. For example, farm income amounted to 2.2% of total personal income in Oklahoma in 1986, much smaller than other major industrial sectors. In many counties, however, farm income represents a much larger portion of personal income. In 1986, the proportion of farm income to total income was greater than the state average in 48 counties and in 30 of these counties the proportion was at least three times the state average (Map 5.2). The wheat counties of the west are among these most prosperous counties. In fact, for 19 counties farm income accounts for at least 10% of total personal income.

To some degree family living expenses are indicative of the economic well-being and, in part, of the quality of life available to members of the wheat farming system. Food purchases hold the strongest position among cash expenses (Table 5.9). Family living expenses on wheat farms throughout the Great Plains show a decline of about 2% per year between 1978 and 1982, but family size has also decreased each year, so that living expenses per person increased slightly. These trends continued through the late 1980s. Comparing total living expenses with farm income/expense budgets suggests that present economic structures leave little room for elongated production setbacks caused by deteriorating agro-ecological growing conditions.

Energetic Performance Assessment

The true strength of the Oklahoma wheat farming system becomes obvious when production energy inputs are related to food energy outputs. This assessment obviously is targeted at the prime objective of a farm: food production. The central question here is, how many cultural energy units are required to produce one unit of food energy. As it stands, no other industry can boast output/input ratios of up to 20 as the dryland wheat farming system can. Energy budgets disaggregate all production inputs for individual fields per farm in energy units. They help identify the overall energetic performance and can suggest specific changes in farm management.

Table 5.7 Rank and Value of Production of Principal Crops and Livestock in Oklahoma, 1983-91

Item	1983		1984		1985		1986		1987		1988		1989		1990		1991	
	Rank	Value																
Cattle & Calves	1	1,081	1	1,084	1	1,050	1	1,134	1	1,222	1	1,290	1	1,371	1	1,437	1	1,533
Winter Wheat	2	528	2	641	2	480	2	344	2	318	2	617	2	583	2	518	2	399
All Hay	3	243	3	272	3	268	3	234	3	278	3	305	3	340	3	285	3	271
Poultry & Eggs**	5	113	5	142	5	125	4	174	4	169	4	213	4	269	4	254	4	259
Milk Production	4	167	4	158	4	160	5	157	5	157	5	152	5	172	5	178	5	155
Cotton Lint	7	40	8	42	6	67	7	44	6	98	7	68	7	47	6	116	7	56
Peanuts	6	46	6	51	8	45	6	61	7	57	8	62	6	61	7	99	6	69
Hogs & Pigs	8	40	9	39	9	36	8	41	8	43	9	37	9	37	8	51	8	43
Grain Sorghum	9	34	7	45	7	46	9	34	9	31	6	39	8	37	9	35	9	31
Soybeans	10	30	10	24	10	21	10	22	10	30	10	35	10	37	10	25	10	31
Corn for Grain	11	15	11	16	11	17	11	10	11	13	12	18	11	22	11	23	11	23
Catfish	—	—	—	—	—	—	—	—	12	9	17	—	3	19	1	17	2	17
Pecans	13	4	12	13	12	6	12	9	13	5	11	20	13	6	12	5	12	14
Oats	12	7	13	7	13	5	13	6	14	4	14	6	15	4	14	4	16	2
Sheep & Wool	15	2	15	3	15	4	14	5	15	4	15	5	14	5	13	4	14	4
Peaches	17	2	16	2	17	2	16	2	16	2	13	7	12	7	16	3	13	8
Barley	14	4	14	5	14	4	15	2	17	1	18	2	17	2	18	1	19	1
Rye	16	2	17	2	16	2	17	1	18	1	19	2	18	1	19	1	18	2
Angora Goats	—	—	—	—	—	—	—	—	—	—	16	4	16	4	15	4	15	4
Total Value		2,370		2,546		2,338		2,307		2,458		2,885		3,006		3,045		2,907

* Values in millions of dollars.

** Gross Income. Turkey production not included.

Source: Oklahoma Department of Agriculture (1992).

These energy budgets are also a means by which seasonal production energy flows can be monitored and production assessed, unaffected by regional and temporal fluctuations of costs for services, commodities, real estate, or inventory. Energy budgets, therefore, provide an objective and time-independent tool for evaluating and planning food production on both an economic and an ecological basis. Food production energy inputs are fuel, labor, machinery, seed, herbicides and pesticides, fertilizer, and tillage- and planting-related on-farm transportation. All other cultural energy inputs are not directly related to the production process.

Field energy budgets of two 1,700-acre farms in the summer fallow and the continuous wheat district serve as examples (Tables 5.3 and 5.4). Energy information is calculated as kcal/1,000 acres and as percent of total input. The energy output/input ratio describes the energy reproduction efficiency level per field under given tillage practices.

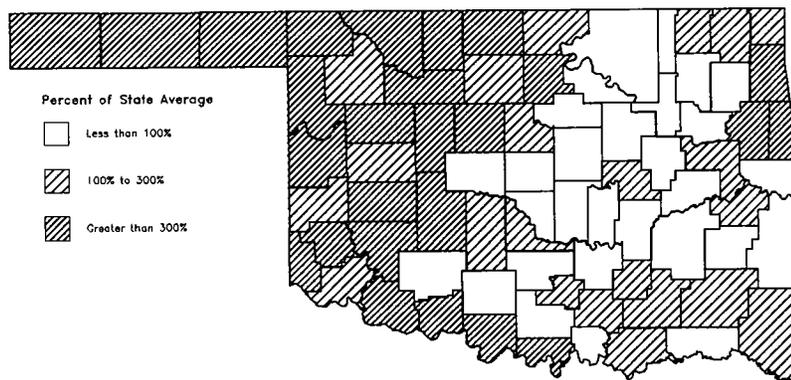
The results indicate that maximum energy efficiency for unfertilized wheat can best be achieved if fuel con-

sumption can be minimized. Fuel constitutes 60–75% of total input. Seeding rates performance tests might show potential savings of almost 25–40%. Farmers' estimates of potential savings in seed energy range from 10% to 30%. Fertilizer applications normally comprise 50–60% of total cultural energy input; these applications can improve grain yields by 5–15%. Fertilizer inputs will reduce energy efficiency levels by as much as 50%, however.

Production energy budgets can be converted to production cost budgets

by converting the individual energy units and the output into standard units (such as gallons, hours, or lb./acre) and by combining them with cost data applicable at the particular location and time of observation. A combination of both energy and fiscal budgets allows for an objective, comparative, and comprehensive production performance evaluation for a multitude of planning and management tasks.

Energy efficiency levels depend on the tillage system implemented (Table



Map 5.2 — Ratio of farm income to total income by county, 1986. Source: Oklahoma Department of Commerce (1988).

5.10). The fewer mechanical operations involved, the higher the rates of remaining straw. High crop residue rates lead to high fallow efficiency and yield levels; in turn, high yields and low cultural energy inputs result in high energy output/input ratios. Table 5.10 outlines a positive trend toward improving performance with decreasing agrotechnical impact. At least two-thirds of all farms operate within the energy efficiency range of 12–20. The meaning of this most positive result is, that for each energy unit invested in the production process, a field returns 20 food energy units.

Table 5.11 highlights the growing strength of summer fallowed and continuous wheat from west to east from a spatial perspective. Continuous wheat in the east of the wheat landscape seems to require increasing energy inputs with decreasing available moisture per crop. With 26 inches of available moisture, about 17 million kcal are necessary to produce one bushel of wheat per acre; with only 21 inches of available moisture about 22 million kcal are required per bushel of wheat. A similar trend prevails for summer fallowed wheat in the west. Here energy input requirements for unfertilized wheat decrease, as food output grows with improving moisture conditions. For fertilized summer fallowed wheat, however, high moisture supplies do not seem to be the dominant prerequisite for high yields or low energy inputs, as suggested by data from Cimarron East, Texas East, and Beaver West.

These analyses suggest the following conclusions. First, Oklahoma's dryland winter wheat systems operate much more efficiently with respect to energy use and reproduction than previous studies for worldwide wheat systems have shown. Second, production energy efficiency stands in sharp contrast to dollar efficiency. And third, crop production energy ratios can best be explained within the context of a simultaneous evaluation of the impact of major surrounding geo-ecological forces. Soil texture and resulting moisture holding capacity, rainfall frequency, timing and duration, and wheat varieties are the major driving parameters, and these tend to work in Oklahoma's favor.

Table 5.8 -- Farm Returns and Costs per Tillable Acre for Dryland Farms, 1981-82

	1981	1982
Farm Returns:		
Crop Returns	38.97	37.95
Livestock Return Above Feed	2.70	3.98
Custom Work	1.78	2.44
Other Farm Receipts	10.80	8.13
Gross Value of Farm Production	54.25	52.50
Farm Costs:		
Soil Fertility	1.89	1.57
Pesticides	0.83	1.52
Seed	1.85	2.15
Crop Total	4.57	5.24
Utilities	0.74	1.03
Machinery Repairs	6.21	4.47
Machine Hire	2.38	2.81
Fuel and Oil	6.39	5.23
Auto-Farm Share	0.29	0.33
Machinery Depreciation	7.32	9.11
Power and Equipment Total	23.33	23.00
Drying and Storage	0.74	3.46
Building Repair	0.37	0.49
Building Depreciation	1.04	1.44
Building Total	2.16	5.39
Labor Unpaid	5.19	4.71
Labor Paid	2.87	2.26
Labor Total	8.06	6.96
Livestock Supplies and Services	0.42	0.65
Insurance	0.81	0.87
Taxes	1.93	1.84
Miscellaneous	0.80	0.88
Interest Charge, Land 9%, Other	27.97	22.74
Other Costs, Total	31.93	26.98
Total Non-Feed Costs	70.05	67.57
Gain or Loss on Machinery and Buildings Sold	0.02	0.07
Management Returns	-15.77	-15.01

Source: Späth (1992).

In sum, eco- or chemical tillage, minimum tillage, stubble mulching, semi-clean tillage, and clean tillage portray the diversity of the present-day dryland wheat farming system in western Oklahoma. Ecological, economic, and energetic performance are highly variable within each tillage category.

Ecological performance assessment primarily focuses on the farming system's ability to optimize the availability of and conserve the major production factors, which in the case of dryland wheat are water and topsoil. Modern education and Extension Service support facilitate achievement of this management goal; today, water-use efficiency levels of 0.70 bushels per acre per inch of rainfall and 2 bushels of wheat per inch of available

soil moisture are among the highest in the Great Plains. These most desirable ecological scenarios provide for enough wheat straw production to conserve top soils and maintain soil productivity for succeeding crops.

Cost-return relationships need improvement; for more than a decade disproportionately high production and other fixed costs of about \$70 per acre—\$25 of which are for land mortgage payments alone—could not be offset by wheat production value of about \$53 per acre. These facts can only be explained within the context of the current national farm crisis. Nonetheless, farms that did not expand their acreage and inventory holdings at inflated prices and with excessive loans during the boom years

Table 5.9 -- Family Living Expenses, 1979-82

Item	1979	1980	1981	1982
Food	\$3,372	\$3,452	\$3,629	\$3,419
Savings and Other Investments	2,011	1,826	2,220	2,369
Health (Doctor, Drugs, Med. Insurance)	1,581	2,074	1,507	2,089
Housing, New and Remodeling	1,554	1,318	1,236	1,593
Home Furnishings and Equipment	1,460	1,444	1,190	1,175
Life Insurance	1,387	1,157	1,132	1,006
Income Tax (Federal and State, '78 Year)	1,304	1,065	1,094	958
Miscellaneous (Dues, Cash, etc.)	1,294	1,113	1,067	904
Clothing	1,151	803	940	820
Contributions	778	851	849	784
Household Operation	722	925	805	755
Personal Items	593	734	617	665
Gifts	415	586	557	540
Recreation	323	417	518	473
Education	308	215	436	333
Total	\$18,253	\$17,980	\$17,797	\$17,883
Average Size of Family	3.5	3.33	3.11	3.17
Average Expenditure per Person	\$5,215	\$5,399	\$5,723	\$5,641

are the ones that still flourish today and expand their holdings, as the number of family farms declines. Overall, the proportion of farm-to-total-income in the 1980s was greater than the state average in 48 counties, and in 30 of these counties the proportion was at least three times the state average. The wheat counties of the west are among these most prosperous counties.

The most objective and time-independent assessment of the wheat farming system, however, is obtained by means of energy input/output analyses, which describe the efficiency of farms in terms of their primary objective: food production. Oklahoma's wheat industry can boast output/input ratios of up to 20, a proud achievement on a national and international scale. The more conservative a tillage system operates in ecological terms, the more efficient it will be in energetic terms. Stubble mulching and minimum tillage are among the most efficient systems. Special research results from western Oklahoma provide a wide variety of management alternatives to individual wheat farmers to streamline their operations in terms of production energy input and food energy output—changes which will have a decisively positive impact on the farms' fiscal budgets.

THE MARKETING SYSTEM FOR OKLAHOMA WHEAT

On its way to national and international markets Oklahoma wheat is first collected and stored at strategically located points, then is graded and priced before shipment to worldwide consumers.

Preparing Wheat for the Market

The first step for most Oklahoma wheat involves delivery to a country elevator during the harvest season

(Figure 5.4). These local elevators are licensed public warehouses which receive wheat from the farmer for sale or storage. Oklahoma is home to approximately 250 separate grain companies which operate about 400 different facilities located primarily in the western half of the state. About half of these facilities are owned and operated by local cooperative associations. The remaining facilities are owned by corporations, partnerships, and sole proprietorships. Throughout the year, about 90% of total stocks are stored in off-farm facilities (Table 5.12).

Local cooperative associations are owned by local farmers. Earnings by the co-op are distributed to the farmers in the form of patronage, either in cash or stock, based on the volume of business conducted by the farmer with the co-op.

Farmers have several choices for marketing their wheat. The first choice is to sell wheat upon delivery to the country elevator. A second option is to place the wheat in storage for sale at a later date. Upon completion of the sale, the value of accrued storage costs is deducted from the payment received by the farmer. A third option, available to farmers who participate in federal crop programs, is a price-support loan. Price-support loans are available from the Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture (USDA).

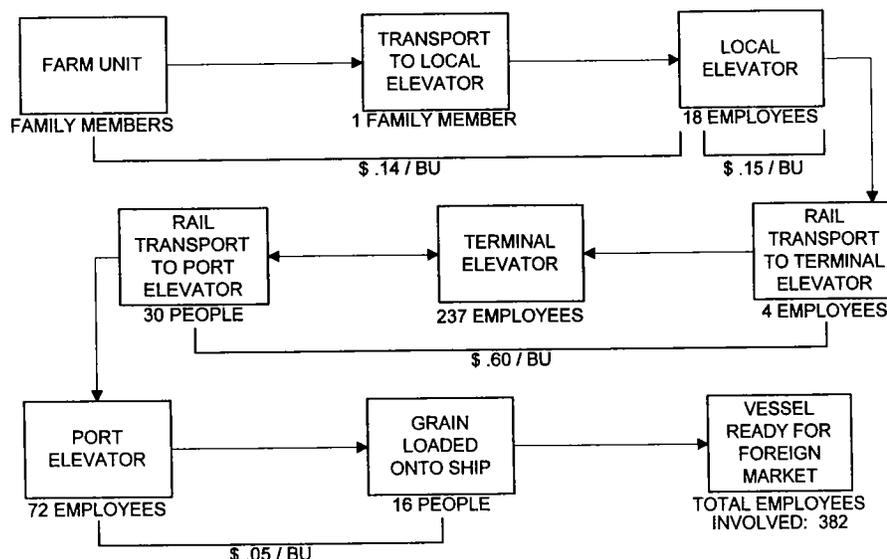


Figure 5.4 — Flow chart of Oklahoma wheat to Houston port. Source: Oklahoma State University (n.d.).

Table 5.10 -- Tillage Systems and Related Agro-Ecological Parameters: Average Values for All Wheat Varieties, Soil Series, and for Unfertilized and Fertilized Wheat

Tillage System	Number of Mechanical Operations	Remaining Residue ¹	Yield (bu/ac)	WUE (bu/ac/inch) ²	Energy Output/Input Ratio ³	Energy Input/bu/ac (Mil. Kcal)
Summer Fallowed Wheat						
Semi-Clean Tillage	4-6	22-30	28-32	1.6-2.0	12.4-19.2	4.7-7.8
Stubblemulching	4-6	39-59	21-47	1.4-2.7	4.8-26.2	5.0-18.8
Minimum Tillage	2-4	51-66	28-52	1.7-3.4	5.4-28.0	3.3-17.0
Eco-Tillage	1-3	73-90	38-50	2.1-2.8	7.2-13.6	6.8-12.5
Continuous Wheat						
Semi-Clean Tillage	3-6	12-24	37-60	1.8-3.0	3.4-5.7	15.6-31.5
Stubblemulching	4-5	34-66	21-59	1.6-2.8	3.1-5.1	10.3-36.0
Minimum Tillage	3-4	65-73	22-41	2.0-3.0	4.7-9.9	9.4-17.9

¹ Percent of original straw harvest on field surface at planting time. Mechanical reduction only; weathering and natural decomposition not considered.
² Water-Use-Efficiency: 35% rainfall from harvest -to-planting plus 100% rainfall planting-to-harvest.
³ Lower ratios for fertilized wheat, higher ratios for unfertilized wheat.

Table 5.11 -- Total Cultural Energy Requirement per Bushel/Acre of Wheat in Oklahoma and Total Yield per Acre

Region	County	Crop Rotation: Summer Fallowed (SF); Continuous (C)	Fertilized Wheat		Unfertilized Wheat		Available Moisture Harvest-to-Harvest ¹ Inches
			Mil. Kcal	bu/ac	Mil. Kcal	bu/ac	
West	Cimarron West	SF	—	—	9.8	21.3	29.50
	Cimarron East	SF	13.9	35.8	4.7	34.9	33.00
	Texas West	SF	9.1	42.8	6.6	29.9	29.75
	Texas East	SF	15.1	32.7	6.2	26.4	29.25
Center	Beaver West	SF	6.9	37.6	6.1	25.0	29.50
	Beaver West	C	14.7	25.6	12.3	20.4	16.00
	Beaver East	SF	—	—	—	—	33.00
	Beaver East	C	—	—	—	—	17.50
East	Harper West	C	22.1	28.9	—	—	21.00
	Harper East	C	16.9	41.5	—	—	26.00
	Woods West	C	17.9	32.4	—	—	21.00
	Woods East	C	17.5	49.4	—	—	23.00

¹ 35% of Harvest-to-Planting rainfall plus 100% Planting-to-Harvest rainfall.

Loans are for a nine-month period and storage costs are prepaid to the elevator. The amount of the loan is based on the volume of wheat pledged as collateral; the per-bushel amount of the loan is determined by federal law. Should prices fail to increase sufficiently during the term of the loan to return a profit to producers over and above the loan redemption costs, including interests and accrued storage costs, producers can forfeit the wheat and ownership of the wheat is transferred to the Commodity Credit Corporation.

Other options, available at the discretion of the U.S. Secretary of Agriculture, include loan extensions and entry into the Farmer-Owned Reserve. These options are most attractive to farmers who store wheat on their farms. Since most Oklahoma wheat is stored in commercial warehouses, these options are seldom used by the producer.

Eventually, most Oklahoma wheat is sold to the country elevators, which, in turn, have several merchandising options. They may resell the wheat to

an inland terminal elevator, a domestic flour mill, or to an exporter.

Inland terminals serve as concentration points for wheat and through economies of scale receive more favorable rates from transportation companies. The primary terminal locations include barge loading points on the Arkansas River in eastern Oklahoma and Enid in the north-central part of the state. Companies in Enid utilize unit trains—sets of matched cars loaded with one commodity for one destination—to secure favorable rates and a competitive advantage over smaller shippers.

Flour mills purchase wheat from a variety of sources. Wheat may be purchased directly from farmers, from country elevators, or from inland terminals. Oklahoma is home to four flour mills. In addition, Oklahoma wheat is routinely sold to flour mills in Texas.

Wheat is graded in order to help establish the value of a particular lot of wheat. Numerical grades are assigned to wheat to facilitate communication and the trade of wheat. The grading of wheat is based on official standards set forth by the USDA and measured by the Federal Grain Inspection Service. All export shipments must be accompanied by a certificate issued by the Federal Grain Inspection Service indicating the grade of the wheat. Virtually all export contracts specify U.S. Grade 2. More than 80% of Oklahoma wheat achieves ratings of Grade 2 or better (Table 5.6). Grades differentiate quality on the basis of weight per bushel (density, an indication of flour yield), damaged kernels, foreign material, and shrunken and broken kernels.

The Federal Grain Inspection Service is not required to establish grades on wheat sold between domestic points. Private agencies, designated and supervised by the Federal Grain Inspection Service, perform grading services on a fee basis as requested. Many transactions between exporters, inland terminals, and country elevators include grading by a designated agent. These transactions might alternatively call for "in-house" grades prepared by grain company personnel but based on USDA standards.

Grading of wheat by country elevators is generally less exacting than

Table 5.12 -- Stocks of Winter Wheat Grain, Oklahoma, 1983-91

Year	March 1 ¹		June 1		September 1 ²		December 1 ³	
	Off-Farm Stocks	Total Stocks	Off-Farm Stocks	Total Stocks	Off-Farm Stocks	Total Stocks	Off-Farm Stocks	Total Stocks
	----- 1,000 Bushels -----							
1983	101,920	120,136	91,258	100,366	170,482	208,107	132,475	155,050
1984	97,772	109,812	83,825	89,093	147,175	187,243	124,091	146,987
1985	95,074	110,338	88,500	97,086	168,787	206,737	160,680	183,780
1986	138,412	153,262	116,799	125,049	173,061	203,061	158,243	180,243
1987	130,733	143,733	103,049	110,549	140,211	166,211	136,192	151,192
1988	82,158	91,158	42,746	47,746	118,546	141,064	82,933	94,933
1989	45,749	52,294	24,027	27,027	92,249	112,246	67,641	78,641
1990	38,167	43,667	14,226	16,726	104,986	125,986	77,748	89,748
1991	47,411	54,411	17,003	20,503	75,225	94,225	51,162	59,162

¹ April 1 grain stocks prior to March 1, 1986.² October 1 grain stocks prior to 1986.³ January 1 grain stocks prior to December 1, 1986.

Source: Oklahoma Department of Agriculture (1992).

Table 5.13 -- Monthly Prices Received for Winter Wheat, Oklahoma, 1984-91 and Historic

Year	January	February	March	April	May	June
	----- Dollars Per Bushel -----					
1960	1.83	1.87	1.92	1.91	1.81	1.68
1970	1.29	1.29	1.28	1.29	1.24	1.20
1975	4.00	3.76	3.41	3.41	3.11	2.87
1980	3.98	3.88	3.62	3.39	3.63	3.57
1984	3.44	3.33	3.42	3.53	3.47	3.35
1985	3.36	3.34	3.27	3.28	3.03	2.93
1986	2.97	2.91	2.94	2.97	2.45	2.25
1987	2.35	2.43	2.46	2.48	2.54	2.30
1988	2.76	2.85	2.73	2.71	2.83	3.35
1989	3.98	4.02	4.11	4.11	3.99	3.87
1990	3.89	3.63	3.51	3.57	3.20	2.91
1991	2.29	2.37	2.50	2.53	2.54	2.50

Source: Oklahoma Department of Agriculture (1992).

Table 5.14 -- Monthly Farm Marketings of Winter Wheat in Oklahoma, 1982-90

Year	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
	----- Percent of Total Sales -----											
1982	3	6	18	9	7	5	18	10	9	7	5	3
1983	3	10	12	12	7	4	10	14	10	7	8	3
1984	2	20	20	17	7	4	2	4	7	4	9	4
1985	4	28	14	8	7	6	6	10	8	3	4	2
1986	6	28	14	5	6	5	3	7	10	7	7	2
1987	4	22	12	13	7	8	7	10	7	4	3	3
1988	5	28	11	9	9	5	5	9	10	2	5	2
1989	2	21	17	9	5	7	11	1	13	3	5	6
1990	2	25	15	6	5	5	5	8	13	7	6	3

Source: Oklahoma Department of Agriculture (1992).

at other points in the marketing chain. While the grades on farmer-delivered wheat at the country elevator are still based on USDA standards, factors such as damaged kernels are usually well within the limits of Grade 1 or 2. Generally the country elevator will check the test weight to establish the grade.

Two other factors, separate from the grade, are also measured at virtually all destination points in the marketing system. These factors are moisture and dockage. Moisture content relates to the wheat's ability to be stored. Oklahoma wheat averages 11.5–12.0% moisture, which is well within acceptable limits. Most import-

ers specify wheat should not exceed 13.5%. Country elevators will accept wheat up to about 13.5–14% moisture content. Higher levels are either discounted or refused for delivery.

Dockage refers to easily removed foreign materials in wheat. Dockage is reported to the nearest 0.1% on official inspections. The weight of the dockage is deducted from the weight of the wheat and receives no compensation.

Since the majority of Oklahoma wheat moves to export markets, those export markets play a large role in establishing the price for Oklahoma wheat. Apart from playing a role in establishing prices on the futures market, export activities also affect the price farmers receive relative to the futures markets. The futures exchange which trades contracts on hard red winter wheat is located in Kansas City, Missouri. Futures contracts represent a pledge to buy or sell a commodity at a given price at a specific time. Futures contracts are traded for selected months of the year and are traded as much as a year into the future. The cash price received by the farmer is based on the price of the nearest contract month.

The second component in the price for Oklahoma wheat is the Gulf basis, or the difference between prices in Kansas City and those offered in Houston. Basis reflects the relative demand which exists between interior and export locations (flour mills versus export). Gulf basis, as a practical matter, is always positive, meaning that wheat is always more valuable in Houston than in Kansas City.

The third factor in determining the price of Oklahoma wheat is the local discount subtracted from the Gulf price. This discount reflects the cost of transportation to move wheat into export position. In addition, the discount will reflect handling a merchandising margin which will be realized by the country elevator. Those margins and freight costs will vary from year to year and during a given year due to competitive factors.

The price paid to farmers reflects the price for the nearest contract month plus the Gulf basis minus the local discount. Futures prices can change from minute to minute during trading hours. Gulf basis is more

Table 5.15 -- Agricultural Exports: Oklahoma and the U.S., 1985-91

Commodity	Oklahoma						United States					
	1985	1986	1987	1989	1990	1991	1985	1986	1987	1989	1990	1991
	Million						Dollars					
Wheat & Products	353.2	203.6	196.3	552.7	290.8	183.1	4,525.9	3,546.8	3,119.4	6,330.7	4,477.1	3,128.8
Cotton & Linters	27.7	14.7	35.1	40.5	38.6	64.6	1,966.8	691.9	1,429.4	2,059.4	2,719.5	2,619.3
Soybeans & Products	11.8	11.6	13.7	18.3	18.8	11.2	5,267.1	5,578.5	5,747.0	5,822.0	5,284.0	4,651.4
Peanuts & Products	10.1	9.7	11.7	12.0	12.7	12.0	236.6	234.6	217.7	212.8	241.4	183.8
Seeds	3.2	3.3	3.3	4.5	5.2	5.6	352.3	366.4	369.6	498.9	572.7	618.4
Cottonseed & Products	2.2	2.3	1.4	2.1	1.5	1.9	151.7	113.3	56.1	106.8	94.3	77.2
Tree Nuts	0.5	0.2	0.3	1.7	1.0	1.1	512.0	491.6	593.7	688.5	742.3	819.7
Fruits & Preparations	0.1	0.1	0.1	0.2	0.3	0.6	1,200.1	1,237.0	1,466.0	1,800.2	2,188.1	2,424.1
Feed Grains & Products	--	--	--	--	--	--	7,600.6	4,707.2	4,661.7	8,345.8	9,070.9	6,904.7
Tobacco, Unmanufactured	--	--	--	--	--	--	1,587.9	1,317.5	1,203.9	1,273.9	1,359.2	1,532.8
Vegetables & Preparations	--	--	--	--	--	--	945.8	998.2	1,177.7	1,542.3	2,078.8	2,596.9
Rice	--	--	--	--	--	--	677.1	647.5	550.5	954.8	830.3	749.2
Sunflowerseed & Oil	--	--	--	--	--	--	390.4	206.1	153.4	153.8	139.2	141.7
Animals & Meat, Excl. Poultry	18.1	20.6	27.4	18.5	12	14.2	1,160.9	1,356.7	1,630.2	2,830.2	2,817.6	3,319.8
Hides and Skins	17.5	20.0	24.1	5.4	3.9	2.4	1,324.6	1,440.4	1,665.6	1,713.0	1,793.8	1,453.0
Animal Fats, Oils & Greases	9.0	7.3	6.8	1.7	1	0.7	607.9	476.5	416.8	530.8	459.2	418.6
Poultry & Products	3.2	3.5	6.7	6.5	15.2	15.3	392.8	455.3	594.3	721.2	901.8	1,004.0
Dairy Products	2.4	2.3	2.8	3.5	2.8	1.9	413.5	430.2	489.9	474.7	358.0	293.4
Feeds & Fodders	1.7	3.6	5.6	6.8	8.5	6.8	472.8	554.6	670.9	1,062.4	1,049.6	1,066.4
Other	10.0	8.2	9.7	21.9	27.8	35.3	1,414.0	1,456.4	1,660.0	2,488.6	3,041.9	3,605.8
All Commodities	470.8	311.0	342.2	696.3	440.0	356.7	31,200.8	26,306.9	27,873.8	39,610.7	40,219.6	37,609.0

Source: Oklahoma Department of Agriculture (1992).

stable and may change daily or weekly. Basis generally follows a seasonal trend, lower at harvest and increasing as the marketing year advances. The local discount is the most stable part in the equation and generally changes only when rail freight rates change. Monthly prices received by Oklahoma farmers for the first six months of selected years are shown in Table 5.13. The lowest returns are during the summer months, providing price advantages for those operators that can postpone their sales until winter or early spring. Monthly wheat marketing quota (Table 5.14) are the result of monthly prices and economic standing of individual operators. Maximum sales in summer reflect the need of one group of farmers to service their loans at the earliest time possible; and the second sales maximum in winter underlines the economic success and solvency of a great number of operations that can afford to postpone their sales until the market offers more rewarding returns.

Export Markets for Oklahoma Wheat

The U.S. wheat market is too efficient to be constrained by state bound-

aries. Exporters purchase wheat from inland terminals and country elevators. Oklahoma wheat is mixed with wheat from Texas, Kansas, Colorado, or Nebraska before it is loaded on a vessel bound for a foreign destination. Based on transportation and marketing patterns, it is estimated that 80% of Oklahoma's wheat is exported. Table 5.15 highlights the dominating role of wheat and wheat products in agricultural exports of both Oklahoma and the United States. To evaluate the export markets for Oklahoma wheat, one must analyze the export of hard red winter wheat shipped from ports along the Gulf of Mexico—the port area nearest to Oklahoma. Export destinations of hard red winter wheat vary from year to year, based on global supply and demand structures. Some of the prime destinations are South America, Eastern Europe, the former USSR, the Middle East, North Africa, Sub-Saharan Africa, China, and India (Figure 5.5).

Several factors determine which countries will choose to buy hard red winter wheat from the Gulf when buying U.S. wheat. The first is end-use properties of the hard red winter wheat. Hard wheat refers to the

wheat's hard gluten, the protein structure in wheat which gives bread dough its elasticity. Hard wheats are preferred for the production of bread. Soft gluten wheats are preferred for flat breads and cakes. Relative freight cost advantages compared to other U.S. port locations will also attract customers. This is especially true of some destinations in South America.

Most wheat importers are very price-sensitive, especially North African destinations and China. Even though hard red winter wheat may be better suited to the needs of these countries, they will choose between soft red winter and hard red winter wheat mainly based on price. Most soft red winter wheat is shipped from Gulf ports near New Orleans, whereas most hard red winter wheat is shipped from the North Texas Gulf near Houston. Even though China might receive more favorable freight rates from the Pacific Northwest area of the U.S., it prefers to take delivery from the Gulf. Wheat produced in the southern Great Plains and eastern U.S. has a lower incidence of TCK smut, a wheat disease which China does not want to risk importing. Since hard red winter wheat is the class of U.S. wheat

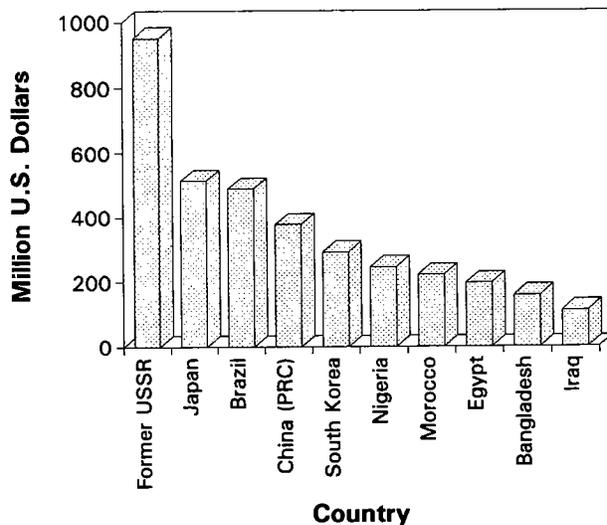


Figure 5.5 — Top 10 U.S. wheat buyers for marketing years 1984–85 (June–May). Source: Oklahoma State University (n.d.).

grown in the greatest quantity, it can often compete favorably with soft red winter wheat and other classes on a price basis.

Approximately 25% of the hard red winter wheat exported from Gulf ports comes from Oklahoma. Therefore, Oklahoma wheat producers are among the largest suppliers of wheat to world markets. This explains why Oklahoma wheat farmers' economic well-being is closely tied to export market potentials.

In sum, Oklahoma participates in a very complex national marketing process for wheat. Collection and storage, grading and pricing, and ultimately shipping are major steps in this process. Approximately 400 privately owned, commercial, or cooperative storage facilities are located in western Oklahoma, where a variety of marketing options are realized. About 80% of Oklahoma's wheat reaches foreign markets as Grade 1 or 2 wheat, mostly via ports along the Gulf of Mexico. The former USSR, Japan, and African countries are among the favored destinations.

CONCLUSION

Besides beef and energy, wheat farming has been the dominant industry in Oklahoma for several decades. Like beef and energy, wheat has gone through a number of cycles of ups and downs. These cycles, however, have only served to streamline, mod-

ernize, and ultimately strengthen the wheat farming system. Today, its resource base is healthy; state-of-the-art technology sustains progressive ecological and production performance and economic prosperity. Dependence on national farm policies regarding internal support and competition on external markets will continue to serve as a challenge and stimulation. Oklahoma's wheat system is highly competitive nationally and internationally; transformation and modernization in the spirit of the past will be the key to a future filled with opportunities. In that fashion, wheat will continue to make decisive contributions to Oklahoma's overall economic well-being.

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— Chapter 5 —
LIST OF ILLUSTRATIONS

Figures

5.1 — Number of farms and average size of farms in Oklahoma, 1910–92	78
5.2 — Oklahoma wheat harvested and produced, 1950–91	84
5.3 — Input costs of wheat production	85
5.4 — Flow chart of Oklahoma wheat to Houston port	89
5.5 — Top 10 U.S. wheat buyers for marketing years 1984–85 (June–May)	93

Maps

5.1 — Wheat production in Oklahoma by county, 1991	81
5.2 — Ratio of farm income to total income by county, 1986	87

Tables

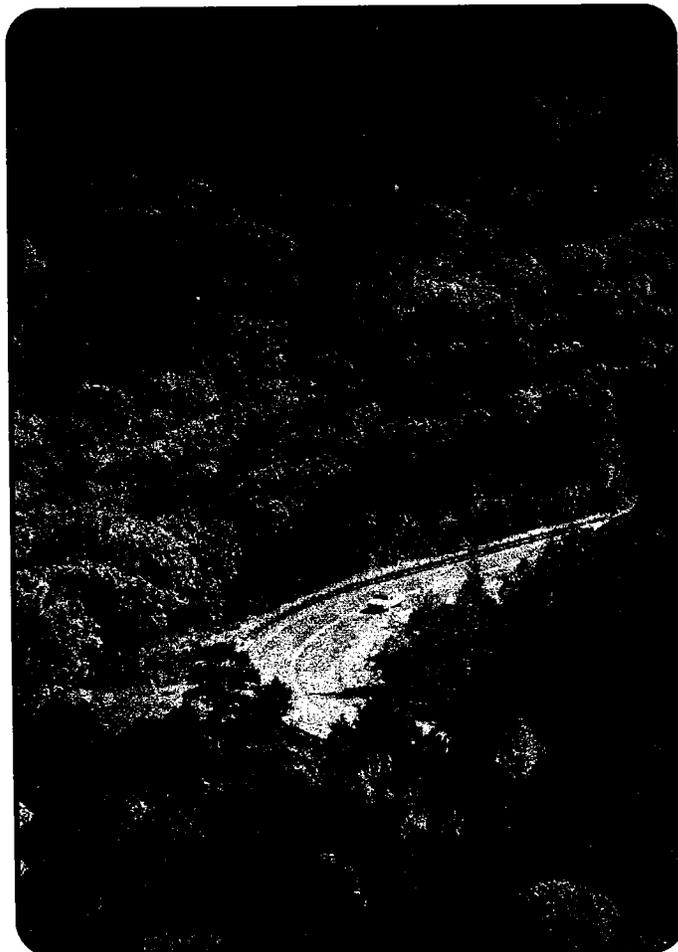
5.1 — Wind erosion conditions for Oklahoma	79
5.2 — Oklahoma wheat estimates, 1894–1991	80
5.3 — Field energy budget for unfertilized summer fallowed wheat in Cimarron County, 1983	82
5.4 — Field energy budget for fertilized continuous wheat in Woods County, 1983	83
5.5 — Oklahoma wheat varieties: percentage of seeded acreage, selected years	85
5.6 — Oklahoma wheat quality, 1986–91	86
5.7 — Rank and value of production of principal crops and livestock in Oklahoma, 1983–91	87
5.8 — Farm returns and costs per tillable acre for dryland farms, 1981–82	88
5.9 — Family living expenses, 1979–82	89
5.10 — Tillage systems and related agro-ecological parameters	90
5.11 — Total cultural energy requirements of wheat in Oklahoma and total yield per acre	90
5.12 — Stocks of winter wheat grain, Oklahoma, 1983–91	91
5.13 — Monthly prices received for winter wheat, Oklahoma, 1984–91 and historic	91
5.14 — Monthly farm marketing of winter wheat in Oklahoma, 1982–90	91
5.15 — Agricultural exports: Oklahoma and the U.S., 1985–91	92

Chapter

6

Transportation and
Communication

by
Michael E. Lewis,
Gary L. Thompson,
and
Binita Sinha



Contents

Executive Summary	97
Introduction	98
Assessment of Current Conditions	98
Railroads	98
Highways and Roads	100
Water Transport	103
Air Transport	105
Transportation Summary	105
Communications	105
Public Goals and Policies	106
Funding and Responsibility for Highway and Road Construction	106
Goals and Policy Recommendations for Highway Transport	107
Funding and Responsibility for Rail Transport	107
Rail Policy Plans and Goals	108
Funding and Responsibility for Air Transport	108
Planning Goals and Policy for Airport Development	108
Responsibility for Maintenance and Development of Waterways	109
Policies and Development Goals for Waterways	109
Conclusion	109
References	109
List of Illustrations	110

Transportation and Communication

Michael E. Lewis, Gary L. Thompson, and Binita Sinha

Executive Summary.—Oklahoma’s transportation and communication infrastructure provides a critical component of the economic development and continued prosperity of the state. Oklahoma’s highways, railroads, waterways, and airport facilities have developed through the cooperation and interaction of both private industry and government. State government continues to support the construction, maintenance, regulation, and operation of critical components of the transportation and communication infrastructure.

Oklahoma is a key transportation corridor for the flow of manufactured goods, agricultural commodities, and energy resources across the nation and around the world. The state’s central location within the heartland of the southern tier of the United States makes it a natural crossing point in the movement of products and information across the nation.

Within Oklahoma, a state and county road system that comprises more than 111,700 miles of hard-surfaced pavement, including three major federal interstate freeways and 10 state turnpikes, provides motor carrier access to virtually every town and city in the state.

In addition to an excellent road system, the Oklahoma State Legislature passed a bill intended to develop Oklahoma’s inherent geographic transportation advantages by encouraging the basing of motor carrier fleets in Oklahoma. The TISRAD Act also established a revolving fund, based on license fees, to be used for research directed toward improving Oklahoma’s competitive advantage as a trucking center.

Motor carrier transportation is closely integrated with both rail and water traffic in Oklahoma. Oklahoma’s rail system provides service to 70 of its 77 counties. There are five major interstate lines and an additional 15 short lines offering regional service totaling some 4,002 miles of track. The rail system includes interchange points, rail yards, and trailer-on-flatcar facilities that serve to expedite and integrate rail transportation with the most efficient mix of carriers and transport modes.

Trailer-on-flatcar facilities allow a enormous volume of raw material goods and agricultural commodities shipped from many points of origin in Oklahoma make trailer-on-flatcar facilities an important component of the state’s transportation infrastructure.

The McClellan–Kerr Arkansas River Navigation System links Oklahoma with both foreign and domestic maritime ports via the Tulsa Port of Catoosa, the Port of Muskogee, and smaller private port facilities along the waterway. Oklahoma’s total transportation infrastructure, favorable support services, and customs arrangements have been integrated into planning for the McClellan–Kerr system. The Tulsa Port of Catoosa includes an industrial and warehousing park that has been designated a Foreign Trade Zone. The Foreign Trade Zone status of this port provides a number of advantages to businesses engaged in international trade.

Two international-class airport facilities, Will Rogers World Airport in Oklahoma City, and Tulsa International Airport, experience the arrival or departure of a commercial airline flight every six minutes. Every major city in the United States is within four hours’ flying time of Oklahoma City. Air freight shipments predominate slightly at Tulsa International, while passenger movement tends to be greater at Will Rogers World Airport. In addition to the two large international airports, seven full-service commercial airports, 158 publicly owned general aviation airports, 53 privately owned airports, and 142 private air strips serve the state.

Modern communications technology and news media serve to efficiently move information throughout Oklahoma. Telecommunications networks continue to make the location of businesses and industries in the information age less dependent on the location of physical assets.

Thus, Oklahoma’s economic advantages include its location in the central-southern U.S. and its thriving transportation and information infrastructure.

INTRODUCTION

From the time of the early cattle drives across Indian Territory, Oklahoma has been a key corridor in the flow of goods and services across the nation. Following the early land rushes into the Unassigned Lands, Oklahoma continued to link southwestern and Pacific coast production, distribution, and marketing centers with Great Lakes transshipment points and the northeastern urban centers. Oklahoma's position as an intersection of southern routes across the nation grew and developed over time to serve a more complex and diverse national, as well as international, marketplace.

More than 100 years after the Oklahoma land rush of 1889, transportation and communications services continue to provide a critical infrastructure for the state's economic development and prosperity. This chapter examines the changing role and relative advantages of each of the current transportation modes in Oklahoma—motor carrier, rail, water, and air—as well as the means of communicating and disseminating information. The status of contemporary transportation corridors within Oklahoma is considered in light of the early role of Indian Territory as a passage to the marketplace. The functional role played by Oklahoma City and Tulsa, the state's two largest metropolitan centers, is also highlighted in terms of their transportation services and facilities.

During the state's developing years, rail lines superseded the early trails of cattlemen and traders. The advent of private automobiles and commercial motor freight transportation subsequently superseded some forms of rail transport as improvements were made in roads and highways. In the 1960s and 1970s, engineering technology made commercial navigation possible in rivers previously plagued by cycles of floods and shoals. Commercial air transportation reduced the time required to move people and commodities across the country from a matter of days to a matter of hours. As we move into the information age, the ability to rapidly transfer and receive large volumes of information through the use of worldwide communications networks has

made the location of central or regional offices and distribution centers possible in almost any place served by telecommunication lines.

Oklahoma's transportation system developed through the efforts of both government and private industry. Each of the various state and federal agencies involved in fostering and encouraging economic development through the transportation and communication infrastructure of Oklahoma is reviewed and discussed in the policy section of this chapter. Linkages between private industry and state government are also discussed.

As Oklahoma moves into its second century, a strong and responsive transportation and communication infrastructure will be necessary to move the state toward a more diversified and stable economic base. Knowledge and information, as well as goods and services, must be readily and rapidly available. Therefore, Oklahoma has a continuing commitment to funding and maintaining its transportation system and to fostering and incorporating advances being made in telecommunications.

ASSESSMENT OF CURRENT CONDITIONS

A unique attribute of Oklahoma's transportation infrastructure has been the rapidity of its development and transformation. Surrounding territories, and the Republic of Texas, attained statehood in the mid-19th century and subsequently followed the usual pattern of westward settlement and development. But the Indian Nations and Unassigned Lands that became Oklahoma followed a different path to statehood and economic development. A brief review of the unique development of Oklahoma's transportation infrastructure will contribute to a clear understanding of current conditions and trends among the state's transportation modes.

Much of Oklahoma was first assigned to resettled Indian peoples, mostly from the southern states, and later thrown open to white settlement in a series of "land rushes" in the last decades of the 19th century. While economic development under Indian leadership had been occurring since the late 1830s, Oklahoma did not actu-

ally become a state until 1907, with a union of both Indian and non-Indian settlers.

As a result of its late start, the development of Oklahoma's transportation infrastructure was compressed into a shorter time frame than in surrounding states. Some of the earliest land rush residents of Oklahoma lived to see the transportation of goods, commodities, and manufactured products pass from cattle and wagon trails to a dense network of railroad lines, then motor transport over hard-surfaced highways, and finally air and water transport from international airports and waterways.

Progressive attitudes toward rapid growth and change continue to characterize transportation in Oklahoma. This section reviews the critical points in the development of each transportation mode available in Oklahoma, and provides an assessment of current conditions and trends.

Railroads

Oklahoma's railroads trace their origins to the demand for Texas beef in northern industrial cities following the Civil War. Following attempts to reach railheads and river ports on the Mississippi River by way of the rough, heavily forested terrain of the Ozark plateau and Ouachita Mountains, the Texans turned their Longhorn cattle due north across the Red River into the rolling grassy plains of western Indian Territory. Their objectives were the ever-expanding terminals of railroad construction in Kansas. In 1879 alone, the Chisholm trail north to railheads at Abilene, Newton, and Wichita, Kansas, and the Western Trail to Dodge City, Kansas, were used to move 400,000 cattle to midwestern markets.

As railroad construction continued, these cattle trails provided established corridors for rail lines. In the 1890s the Chicago, Rock Island, and Pacific Railway (CRI&P) began to build south along the Chisholm trail, offering modern transportation to existing towns and leading to development of a number of new townsites. The chain of towns that includes Waurika, Duncan, Chickasha, El Reno, and Enid is a direct result of construction of the CRI&P line along the old Chisholm trail.

The Missouri-Kansas-Texas, known locally as the Katy (MKT) line, had a similar development in the eastern portion of the Indian Territory along the East Shawnee cattle trail. Before construction of the railroad, portions of this trail were also known as the Texas Road. The Texas Road was used to transport goods and commodities to army posts and Indian settlements of the Indian Nations.

Pressures for additional lines continued through the 1880s with 10 special bills for new rights-of-way introduced to Congress in 1885. One of the most important transcontinental routes to result from these bills was the Atchison, Topeka & Santa Fe (AT&SF) from Chicago to Galveston, Texas, which passed through the Unassigned Lands of central Oklahoma. Following its completion in 1887, this route carried some of the first white settlers into central Oklahoma during the land rush of 1889. This route subsequently became a major Texas-to-Chicago corridor and has proven to be a critical link in the national rail system. Ardmore, Pauls Valley, Oklahoma City, Guthrie, and Ponca City are some of the cities established along the AT&SF route.

In addition to these major rail lines, a dense network of secondary lines was established throughout the state. Between 1870 and 1907, an intricate system of 7,050 miles of railroad track was laid. Some of the shorter segments were financed and built by local groups of "boomers" anxious to have a rail outlet in their community. These groups financed construction of short lines and then sold them to interstate railroads in order to gain access to the major trunk lines. In some cases, this type of development led to inefficient duplications of rail service. Rail expansion was slowed in 1907 somewhat by the adoption of the State Constitution, which prohibited the sale of an intrastate railroad to an interstate railroad and allowed for more orderly development of the lines.

Railroad construction after 1907 was primarily directed towards development of Oklahoma's principal agricultural and mineral resources—wheat, cotton, and petroleum from western and central Oklahoma, lumber and coal from the eastern sections,

and lead and zinc from the Tri-State mining district in the northeastern corner of the state.

During the past 60 years, Oklahoma's railroads have experienced changes similar to those in the rest of the nation. Some mainline segments have been abandoned as railroad companies have sought to rationalize their systems by eliminating unprofitable or redundant lines. In Oklahoma this consolidation resulted both from the dynamic nature of the natural resource base and the rapid rise of truck transportation.

As diesel locomotives began to replace steam locomotives, fewer trains were needed to carry coal for steam engines from eastern Oklahoma coal mines. Crude oil and petroleum products from the central parts of the state were rapidly connected to pipelines, and the mines of the Tri-State lead and zinc district were closed in favor of newer sources of ore. At the same time, motor transport by truck or bus became more efficient as a result of a continuing program of road and highway construction.

Railroads in Oklahoma have responded to these shifts in the relative advantage of the various transportation modes by seeking to develop complementary linkages. The present rail line network integrates the advantages of both truck and water transport with rail cars to allow for the most cost-efficient and rapid movement of commodities by any combination of carriers. In many cases, rail, truck, pipeline, and water transport are combined to facilitate shipments, particularly those involving movement of high-bulk, low unit-value commodities.

Oklahoma's railroad system continues to be an integral component of the state's transportation infrastructure. While a significant portion of the goods and commodities formerly transported by rail have been transferred to truck and pipeline transportation, railroads remain the preferred mode for specific needs. The statewide rail network provides service to 70 of Oklahoma's 77 counties. In many regional urban centers, including Tulsa, Oklahoma City, Enid, Clinton, and Muskogee, several rail carriers provide competitive freight transportation services. There are five major

interstate lines, and another 15 shortlines offering regional service, totaling some 4,002 miles of track in service (Map 6.1; Table 6.1). The five major interstate lines or class-1 railroads serve almost all of the major cities in the state. The primary commodities shipped by rail are agricultural and petroleum products, mainly livestock, wheat, cotton, nuts, processed food products, refined petroleum products, coal, and nonmetallic minerals. The largest commodity group handled by the shortlines in 1991 was wood and wood products, followed by pulp and paper, farm products, nonmetallic minerals, and coal.

Oklahoma's railroads operate several rail facilities that serve to expedite and integrate rail transportation. These facilities include interchange points, rail yards, and trailer-on-flat-car ramps. Interchange points are dispersed throughout the state (Map 6.1); most are located in regional service centers. Rail interchanges allow rail cars to be transferred from one rail line to another, or stored while awaiting transfer and interchange to another railroad. Interchange facilities are mandated by the Interstate Commerce Commission for all common carriers for more efficient transport coordination and to increase a line's service capability. An interchange arrangement between connecting carriers establishes a through route that allows continuous movement of freight on a single billing. This means that transportation costs for shippers are lower and that freight shipments can be made to locations not directly served by the originating carrier.

Railroad freight yards are used for switching cars, making up trains, storing cars, or servicing railroad equipment. Rail car supply, terminal congestion, service level productivity, and utilization are all contingent on efficient rail yard operation. A seasonal requirement in Oklahoma is providing enough rail cars during times of peak demand; covered hopper cars are needed during the early summer wheat harvest, for example.

Trailer-on-flatcar or piggyback service integrates the comparative advantages of both truck and rail transportation. Several trailer-on-flatcar facilities are operated around the state

Table 6.1 Railroads Serving Oklahoma and Mileage of Track, 1991

Railroad Name	Track Mileage
Atchison, Topeka & Santa Fe	1,076
Union Pacific	1,034
Burlington Northern	866
Kansas City Southern	169
St. Louis Southwestern	57
Grainbelt Corporation	186
Kiamichi Railroad	157
Famrail Corporation	88
Wichita, Tillman & Jackson	84
South Kansas & Oklahoma	67
Austin, Todd & Ladd	46
Texas, Oklahoma & Eastern	40
Osage Railroad Company	35
Southeast Kansas Railroad	25
Port of Catoosa	20
Hollis & Eastern	14
Sand Springs	10
Tulsa Sapulpa Union	10
Northwestern Oklahoma	9
Southwest Railway Company	9

Source: Oklahoma State Department of Transportation (1992).

by five major Oklahoma rail carriers. Trucks transport large volumes of commodities to or from a trailer-on-flatcar facility. Semi-trailers can be driven directly onto railroad flatcars, disconnected from the tractor, and secured to the flatcar. At the rail destination, the process is reversed for final

delivery by tractor-trailer. The large volume of raw material goods and agricultural commodities shipped in Oklahoma from many points of origin makes trailer-on-flatcar a popular combination of transport modes.

Many commodities that pass through Oklahoma by rail benefit from storage-in-transit in state warehouses and fabrication-in-transit before final shipment. Storage-in-transit privileges save industrial warehouse users an average of 25% of transportation costs, and fabrication-in-transit creates savings up to 33% of total transportation costs accrued from the material source to Oklahoma, and then to the product's final destination.

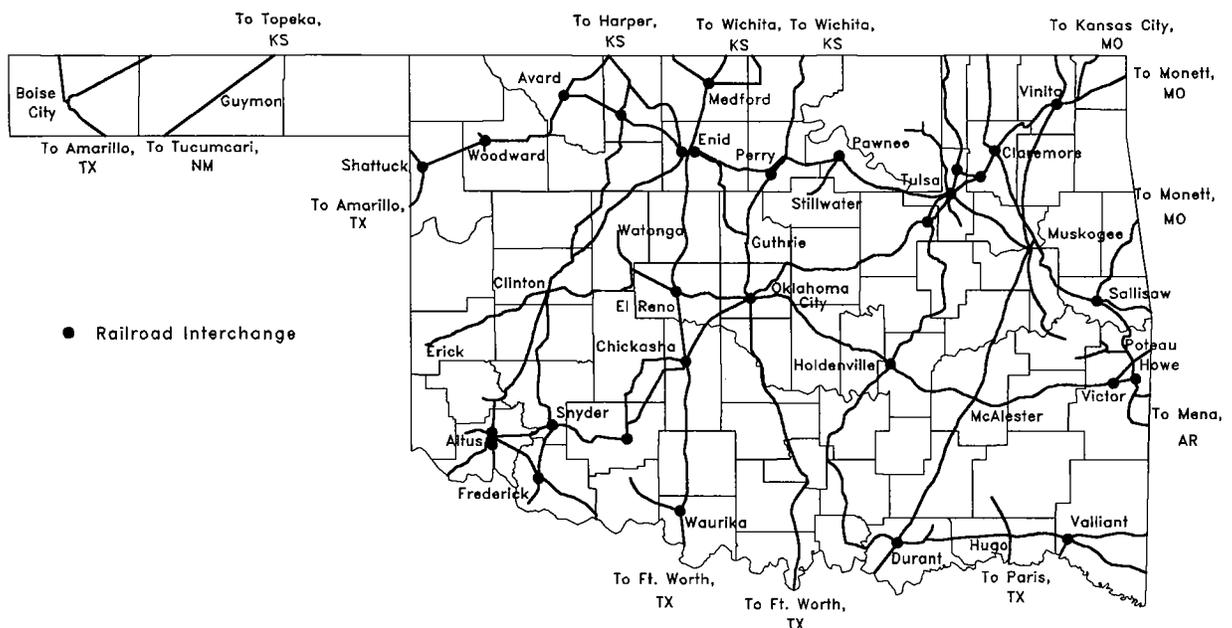
Highways and Roads

Oklahoma serves as a hub for southern routes on the transcontinental interstate highway network. The Will Rogers and Turner Turnpikes and connecting state expressways in Missouri and Illinois provide a continuous four-lane divided expressway from Chicago to Tulsa and Oklahoma City. From Oklahoma City, major highways radiate to the north, south, east, and west (Map 6.2). Interstate 35, roughly following the same corridor established by the early Chisholm cattle trail and the Atchison, Topeka & Santa Fe railroad line, for a major mar-

keting and transportation corridor between Oklahoma City and Dallas-Fort Worth.

People and commodities traveling north from Oklahoma City along Interstate 35 find ready access to the agricultural and industrial heartland of the United States. Southwest from Oklahoma City, the H. E. Bailey Turnpike cuts directly to a secondary arterial hub at Wichita Falls, Texas. Oklahoma City is also a major stop along Interstate 40, the principle southern east-west interstate freeway. Interstate 40 links Oklahoma City with Los Angeles to the west and to another major interstate hub at Memphis to the east. Both Oklahoma City and Tulsa, the state's two largest metropolitan centers, have easy-access "belt-line" throughways that provide rapid and safe routes around the downtown urban centers.

Oklahoma's highway and county road network developed rapidly following the first early automobile purchases in the state. The Oklahoma State Highway Department was mandated by the Oklahoma Constitution and implemented by legislation in 1911; in 1976, its name was changed to the Department of Transportation. Its first assignment was the ambitious task of connecting all 77 county seats by state numbered routes. The devel-



Map 6.1 — Oklahoma's railroad network. Source: Oklahoma State Department of Transportation (1992).

opment of these arterial highways, as well as sales of less expensive, mass-produced vehicles, moved automobile and truck transportation from the status of a curiosity among an elite group of residents, to the primary means of moving people and commodities within Oklahoma.

By 1925 the state highway network radiating out from county seats, was characterized by graded earth roads which were rapidly replaced by hard-surfaced roads of asphalt (89% of the roads) and portland cement (9.7% of the roads).

County roads in Oklahoma account for some 78% of the state's road mileage. The county road system has two groups of roads: (1) local rural road systems and (2) a collector systems of primary county roads fed by the local rural roads. The county collector network in turn links with the state highway system. Over half the county collector system is surfaced with asphalt, while most local rural roads are surfaced with gravel.

The Oklahoma state highway and county road systems total 111,765 miles and provide hard-surface access roads to virtually every section of the state. Oklahoma's public road density compares favorably with that of surround-

ing states, with approximately 1.63 miles of public road per square mile (Table 6.2).

The density of Oklahoma's road network reflects the distributional character of the state's population and its varied terrain. Eastern Oklahoma is a forested upland region of hills and valleys with a generally dispersed rural population and many small towns. The road network is dense and generally follows the valleys and ridgelines. Tulsa, Oklahoma, and Fort Smith, Arkansas, are transportation focal points.

Western Oklahoma is semi-open, rolling plains country, primarily devoted to large-scale agriculture, with a lower rural population density than eastern Oklahoma. The road network also tends to be less dense, with a more checkerboard pattern due to the absence of major topographic barriers and the region's settlement history under the rectilinear township and range land survey system. Enid, Woodward, Guymon, and Lawton, as well as Oklahoma City, are the major western transportation centers.

Improvements in Oklahoma's road system are shown in terms of decreased driving time from Oklahoma City to surrounding points (Maps 6.3 and 6.4). The lobes in Map 6.4 are a re-

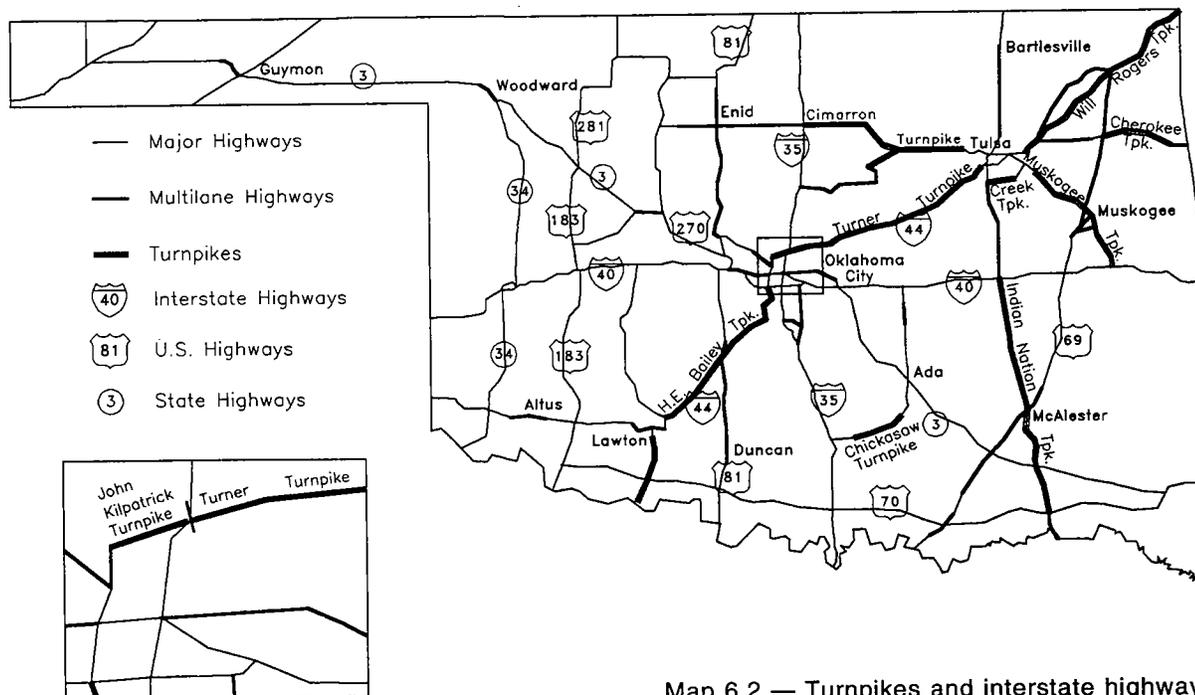
Table 6.2 Public Road Mileage and Density, Oklahoma and Adjacent States, 1990

State	Public Road Mileage	Land Area (Square Miles)	Road Density (mileage/mi ²)
Arkansas	77,085	52,082	1.48
Colorado	77,680	103,598	0.75
Kansas	133,578	81,783	1.63
Missouri	120,527	68,945	1.75
New Mexico	54,736	121,336	0.45
Oklahoma	111,765	68,656	1.63
Texas	305,951	262,015	1.17

Source: U.S. Department of Transportation (1990).

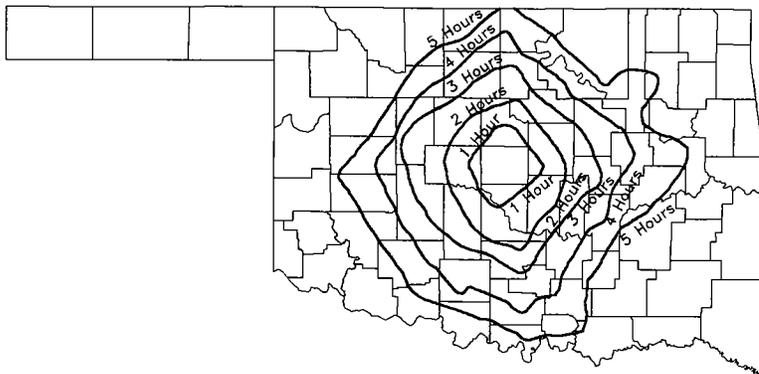
flection of improvements between 1925 and 1975 in the speed and ease of travel along the major interstate highways and turnpikes passing through Oklahoma City.

In addition to the state and federal highway system, Oklahoma has 10 limited-access turnpikes maintained by the Oklahoma Turnpike Authority. These toll roads facilitate rapid transportation throughout the state, linking all the state's major urban centers as well as improving connections with Interstate 40 and Interstate 35 (Map 6.2). Six of these turnpikes, opened

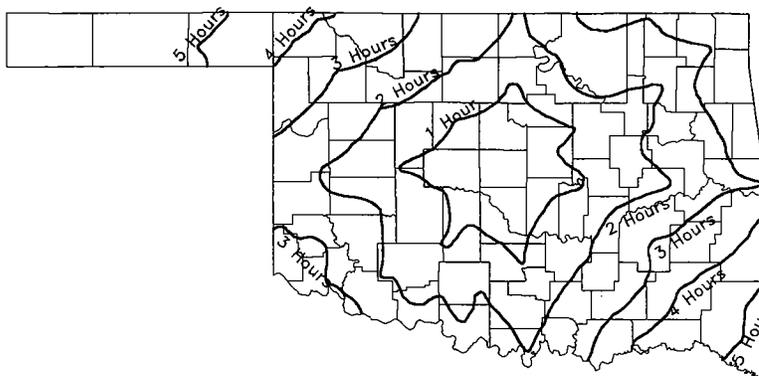


Enlargement of Oklahoma City Area

Map 6.2 — Turnpikes and interstate highways. Source: Oklahoma Turnpike Authority (1992).



Map 6.3 — Driving times from Oklahoma City, 1925. Source: Thompson (1977).



Map 6.4 — Driving times from Oklahoma City, 1975. Source: Thompson (1977).

between 1953 and 1975, have been designed and constructed to uniform standards providing two 12-foot traffic lanes in each direction, separated by a raised, grassy median.

The Turner, Will Rogers, and H. E. Bailey Turnpikes are designated segments of Interstate 44. The 86-mile-long Turner Turnpike, opened in 1953, provided the first direct limited-access highway link between Oklahoma City and Tulsa. From Tulsa to the Missouri state line near Joplin, Interstate 44 is maintained by the Oklahoma Turnpike Authority as the Will Rogers Turnpike. The Turner and Will Rogers Turnpikes thus link Oklahoma directly with St. Louis, Missouri (Map 6.2). The H. E. Bailey Turnpike, 86.4 miles long, cuts directly southwest from Oklahoma City to Wichita Falls, Texas, by way of Lawton, Oklahoma.

The Indian Nation Turnpike, 105.4 miles long, serves as a rapid transportation corridor within southeastern Oklahoma. It connects Interstate 40 at Henryetta with Hugo, near the Texas

state line at the Red River. Section A, from Henryetta to McAlester, was opened to traffic in 1966, while section B, from McAlester to Hugo, has been in service since 1970.

The Muskogee Turnpike runs for 53 miles from the Turner Turnpike at Tulsa to Interstate 40 at Webbers Falls via Muskogee, Oklahoma. In service since 1969, the Muskogee Turnpike provides a convenient transshipment point with the Port of Muskogee on the McClellan-Kerr Arkansas River Navigation System.

The Cimarron Turnpike cuts directly west from Tulsa to Interstate 35 and includes a connecting spur along the route that links Stillwater with the interstate and turnpike system. At its junction with Interstate 35, the turnpike ends and U.S. Route 64 continues on to Enid, Oklahoma. The Cimarron Turnpike was completed in 1975.

Between 1989 and 1992, the Oklahoma Turnpike Authority initiated and constructed four new turnpikes: the John Kilpatrick, Creek, Cherokee,

and Chickasaw roads. These new roads added 77.4 miles to the state turnpike system.

John Kilpatrick Turnpike, a four-lane, limited-access urban highway, begins at the intersection of the Turner Turnpike and Interstate 35. It proceeds westerly for 10 miles just west of Portland Avenue and Lake Hefner Parkway across northern Oklahoma City.

The Creek Turnpike, in Tulsa County, is a four-lane, limited-access urban highway that extends for 7.4 miles. It begins at U.S. 75 approximately 1 mile south of 96th Street and proceeds easterly 7.4 miles across the Arkansas River to its intersection at U.S. 64 and Mingo Valley Expressway extension.

The Cherokee Turnpike, a four-lane, limited-access rural highway in Mayes and Delaware Counties, begins at U.S. 412 east of the Neosho River midway between Chouteau and Locust Grove, and proceeds eastward for 32.9 miles to a connection with U.S. 412, immediately west of Flint Creek.

The Chickasaw Turnpike begins on State Highway 7, west of Sulphur. Located in Murray and Pontotoc Counties, it is a 27.1-mile-long, two-lane limited-access rural highway that joins State Highway 1, northeast of Roff.

In Oklahoma, as in most other parts of the U.S., truck transportation is the major competitor of rail transportation. Almost three-fourths of Oklahoma's manufactured products are moved by trucks (Figure 6.1).

The total number of trucks and truck-tractors registered in Oklahoma was nearly 925,000 in 1990, up from about 746,000 in 1980. All of the 6,237 miles of interstate and primary highways included in the federal-aid highway system, and all 555 miles of state turnpikes, are part of the national network of designated Truck Routes established by the federal Surface Transportation Act of 1982. The ability of trucks to compete with railroads is partially limited by their allowable weights on the federal and state highway system. Trucks are limited to 80,000 pounds of gross vehicle weight on the federal interstate system within Oklahoma, as they are in most other states. Primary and secondary state highways have a weight restriction of 90,000 pounds gross vehicle weight,

slightly higher than most other states. Maximum allowable vehicle weight on turnpikes is 108,000 pounds.

Water Transport

Prior to 1970 the Arkansas River and its tributaries in Oklahoma were subject to wide fluctuations in water level and a shifting channel that made commercial navigation uncertain and unreliable. Completion of the McClellan-Kerr Arkansas River Navigation System in 1970, with 17 flow-regulated locks and dams, vastly improved the reliability of barge transportation and gave Oklahoma water access to both foreign and domestic ports.

The 445-mile-long McClellan-Kerr Arkansas River Navigation System is one of the newest major additions to the 25,000 miles of the U.S. Inland Waterways System open to barge traffic (Map 6.5). The McClellan-Kerr system is open to barge traffic all year, and is capable of handling barges originating anywhere on the Inland Waterway System, from Minneapolis or Pittsburgh to Houston and New Orleans.

The economic value of water transport has been proven for many industries and commodities, including min-

erals, grains, iron and steel, coal, fertilizer, chemicals, forest products, and building materials. Barges are a very energy-efficient means of transporting these high-bulk, low unit-value commodities.

For these reasons and others, barge traffic increased between 1975 and 1985 on the McClellan-Kerr system since its completion in 1970 (Figure 6.2). Annual traffic volume during its first decade surpassed all projections, reaching 10.2 million tons in 1980. The volume of shipments fell to a 10-year low in 1988, increased by 22% in 1989 to more than 4,032,000 tons, and fell to 3.7 million tons in 1990, although this total was still higher than any year between 1985 and 1988. The potential operating capacity of the system has been estimated to be 35-45 million tons annually.

Barge transportation is faster than commonly realized. Barge transport from the Port of Catoosa at Tulsa to the confluence of the McClellan-Kerr waterway with the Mississippi River

generally takes three to five days. From the confluence with the Mississippi River Navigation System, barges reach destinations as far away as Pittsburgh or Minneapolis in two weeks or less.

About half of the materials transported on the McClellan-Kerr system during its first six years were internal trips from one point on the channel to another. Today about 90% of the transported tonnage is brought in from outside the system or is delivered beyond the Arkansas River Valley.

Both the Tulsa Port of Catoosa, at the head of navigation on the Verdigris River near Tulsa, and the Port of Muskogee, at Mile Post 396, near the confluence of the Arkansas, Grand, and Verdigris Rivers, have fully developed, publicly financed port facilities supported by adjacent industrial districts.

The Tulsa Port of Catoosa handled nearly 50% of the barge tonnage moved in 1990 on the Oklahoma segment of the McClellan-Kerr Arkansas River Navigation System. The tonnage of goods handled showed substantial increases from the time the Tulsa Port of Catoosa opened in 1971, until reaching a peak in 1980. Barge tonnage de-

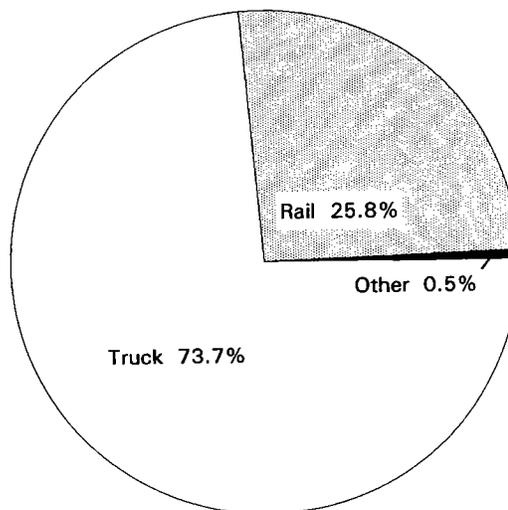
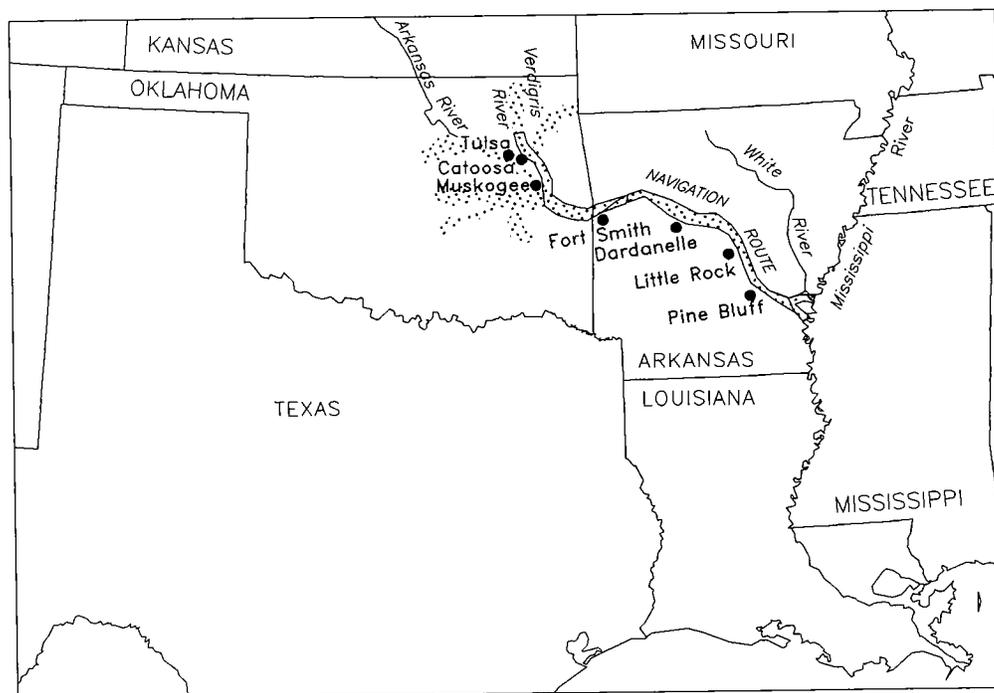


Figure 6.1 — Movement of Oklahoma manufactured products by transport mode, 1985. Source: Oklahoma Department of Commerce (1991).



Map 6.5 — McClellan-Kerr Arkansas River Navigation System. Source: U.S. Army Corps of Engineers (1982).

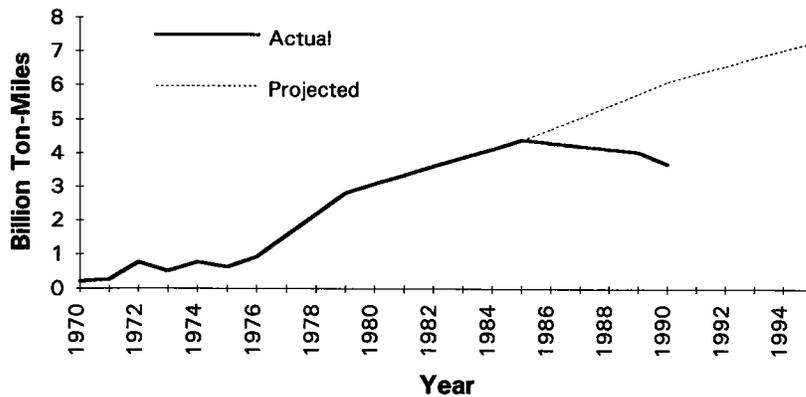


Figure 6.2 — Total ton-miles moved on the McClellan-Kerr Arkansas River Navigation System. Source: Oklahoma Department of Commerce (1991).

clined somewhat after 1980 and has fluctuated between 1.4 and 1.89 million tons each year since (Figure 6.3). Between 1971 and 1986, the major inbound cargos were manufactured goods and steel (51%); fertilizers, coal, and other dry bulk goods (46%); and various liquid goods, principally liquid fertilizer (3%). Petroleum products accounted for slightly more than two-thirds of the outgoing products in 1986, with agricultural products (mainly grains) providing nearly one-quarter, and the remainder divided between dry bulk goods and general dry cargo. However, there has been remarkable change in the kinds of goods shipped along the McClellan-Kerr waterway from 1980 to 1990. Chemicals, including chemical fertilizers, were the leading commodities in 1990, followed by wheat and petroleum products. The importance of coal and petroleum products declined conspicuously from 1980 to 1990, down from more than 50% to less than 20% of shipments by weight. This drop was taken up by chemicals, which increased from 9% to 36% of the shipments during the decade. Another commodity that gained importance during the last 10 years is farm products; its share increased from less than 20% to more than 30% between 1980 and 1990 (Figure 6.4).

The Port of Catoosa represents a public investment of more than \$100 million. A 1,500-acre industrial park has its own railroad branch to the Santa Fe and Burlington Northern lines, as well as heavy-duty access road to link the port with the Will

Rogers, Turner, and Muskogee Turnpikes. The Port of Catoosa is served by 35 regularly scheduled motor freight carriers. Additional facilities adjacent to Catoosa's slack water harbor include: a 720-foot dry cargo wharf with a 200-ton capacity overhead crane; more than 50,000 square feet of warehouse and transit shed capacity; a grain elevator with a 1.5 million bushel capacity and liquid cargo facilities, including pipelines and storage tanks with more than 300,000 barrel capacity; and roll on/roll off rail and road facilities that can handle in excess of 200 tons.

The Port of Muskogee, located downriver from the Port of Catoosa, has invested \$10 million in the development of port facilities and a 320-acre industrial park. The Port of Muskogee is easily accessible by six major state and federal highway

routes, including the Muskogee Turnpike and the Missouri-Pacific railroad. Port facilities include: a 25-ton and two 10-ton capacity overhead cranes, and a 45-ton mobile crane; 94,000 feet of warehouse and transit shed capacity; an oil storage facility; and a refueling station for tow boats.

In addition to public port authorities in Oklahoma, additional privately developed ports and loading facilities are located along the waterway. For example, Port Verdigris 33 is located at Mile 432 between Tulsa and Inola, Oklahoma. This port has a 50-ton crane and large petroleum and grain storage facilities available.

The total transportation infrastructure, as well as favorable support services, have been integrated into planning for the McClellan-Kerr Navigation System to provide a smooth transitional interface between transport modes. Port customers have available a complete selection of shipping services, including agricultural export services, container pools and shippers, Foreign Consular Offices, railroads, trucking lines, and U.S. Customs Offices. Long-distance shippers can utilize LASH and SEABEE barges, which allow loaded barges to be hoisted directly on board a "mother ship" for transport, reducing both handling and travel time.

International trade has become increasingly important along the waterway, particularly grain exports. Imports along the waterway are also expected to grow in the next 20 years. In order to encourage this type of devel-

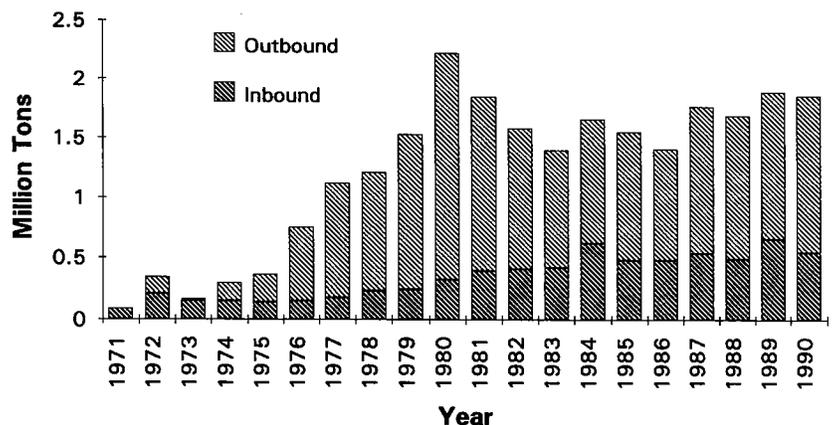


Figure 6.3 — Tulsa Port of Catoosa tonnage, 1971-90. Source: Oklahoma Department of Commerce (1991).

opment, the Port of Catoosa, along with the numerous firms in its industrial park, has been designated a Foreign Trade Zone. Goods can be imported, then stored, sold, displayed, or manufactured without being subjected to quota restrictions, most customs formalities, duty, or bonding. For U.S. businesses, duty is delayed on foreign goods shipped through a foreign trade zone until the goods enter U.S. trade channels.

The Foreign Trade Zone status of the Port of Catoosa provides a variety of advantages to businesses. Products manufactured in a Foreign Trade Zone using foreign materials may be exported again without any duty being paid on the foreign materials. A buyer can inspect and sample foreign goods before buying them and paying the customs duty. An importer can store goods in a Foreign Trade Zone until the next quota period, or until a more favorable price can be obtained on the U.S. market. These advantages, as well as others, make the Port of Catoosa a pro-business place for international trade.

Air Transport

Airports and air transportation services are a major strength of Oklahoma's transportation infrastructure, providing for the rapid movement of both people and commodities internationally and within Oklahoma. The expansion, improvement, and maintenance of air transport facilities is a major economic development goal of the state. Currently, there are 158 publicly owned and publicly utilized airports; seven are full commercial service facilities and the remaining 151 are general aviation airports. There are also 53 privately owned airports available for public use, 142 private air strips, and five military airport installations.

The two major international airport terminals in Oklahoma are Will Rogers World Airport in Oklahoma City and Tulsa International Airport. Major airlines providing regularly scheduled service at both Will Rogers and Tulsa International include American, Delta, Southwest, and TWA, besides United, Continental, and Northwest. Nearly every major U.S. city is less than four hours' flying time from

Oklahoma City or Tulsa.

Air freight services, customs house brokers, and freight forwarders are available in both Oklahoma City and Tulsa to facilitate and expedite shipments. Air freight movements predominate slightly at Tulsa International Airport, while passenger service tends to be greater at Will Rogers World Airport in Oklahoma City. Local commercial service from Oklahoma City or Tulsa to other parts of the state is available on private charters and regularly scheduled commuter airlines. In 1989 Will Rogers World Airport recorded an increase of 3% and Tulsa International Airport registered a 4.6% increase in the number of enplanements. These increases compensated for negative trends reported in 1988 at both airports. Freight originating at Will Rogers World Airport and Tulsa International Airport increased by 1.2% and 22.8%, respectively. In 1990, the total freight movement at Will Rogers World Airport was 25,643 tons, while at Tulsa International Airport it was 34,298 tons.

The Will Rogers World Airport in Oklahoma City also includes a Foreign Trade Zone covering a warehouse and industrial park on 640 acres. The Will Rogers World Airport Foreign Trade Zone functions in the same manner as the Foreign Trade Zone at the Tulsa Port of Catoosa, by allowing firms engaged in international trade to warehouse, manufacture, or assemble goods under favorable customs procedures.

Transportation Summary

From the early years of the cattle drives across Indian Territory to the advent of supersonic air travel and near instantaneous data communications, Oklahoma has moved forward in an effort to provide a safe, efficient, and rapid transportation and communication infrastructure. Each mode of transportation—motor truck or bus, rail car, river barge, or aircraft—is represented and integrated into an overall structure serving a wide variety of transportation needs.

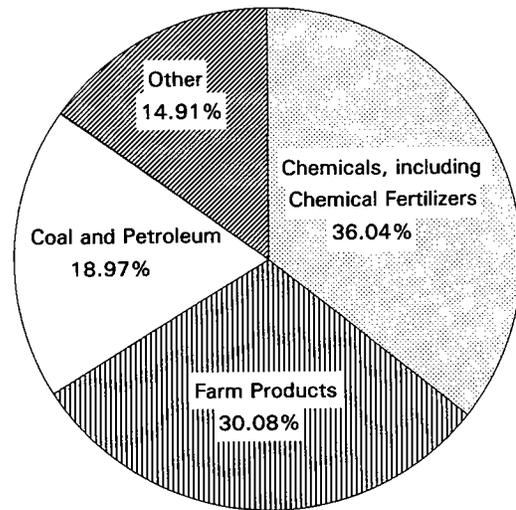


Figure 6.4 — Barge tonnage shipped in Oklahoma through McClellan-Kerr Arkansas System, 1990. Source: Oklahoma Department of Commerce (1991).

Oklahoma's transportation infrastructure continues to provide a strong support base for the economic development and maintenance of the state's economy into the next century. Oklahoma City and Tulsa are major transportation hubs. Oklahoma City is on the terminus of a growth corridor connected with Dallas-Fort Worth. Tulsa provides highway, air, and waterway terminals with access to U.S. and international markets. Both cities have Foreign Trade Zones, which provide a favorable setting for international trade, product assembly, and warehousing.

Oklahoma's smaller cities also are served by a variety of transportation modes, providing ready access to terminal markets throughout the country.

Communications

Access to technology and print media capable of providing rapid dissemination and retrieval of current information has become a prerequisite to competitive success in business. Advances in telecommunications networks and technology have reduced the need to locate industries and businesses near physical assets and conventional highways and increased dependence on centralized access to information exchanges.

Oklahoma's central location makes it a natural focal point for nationwide

information access. All the major telecommunications networks are accessible from Oklahoma, including General Telephone and Electronics TELENET; American Telephone and Telegraph ACCUNET and SKYNET, WATS, and MEGACOM 800; and U.S. Telecom UNINET. These telecommunication networks allow rapid transmission of data, voice, and video communications. Literally hundreds of machine-readable data-base market information and bibliographic referencing services are available through a variety of communication sources.

Future telecommunications industry plans call for development of an ISDN (integrated services digital network) for data, voice, and video transmission. This network will allow a wide variety of telecommunications equipment to convey information from one point to another in much the same manner as the internodal transportation of goods and commodities is carried out today.

In addition to access to the dynamic telecommunications developments of the future, Oklahoma provides a secure infrastructure of conventional telephone, newspaper, radio, and television communications media. Southwestern Bell Telephone Co. provides service throughout the state with 167 telephone exchanges. Many rural areas are also served by more than 40 local telephone companies. Oklahoma television and radio stations represent all the major networks, including Public Broadcasting Service.

The rural character of much of Oklahoma is reflected in the independent weekly newspapers published in 168 Oklahoma communities. Their circulation ranges from 32 for the *Duncan Eagle*, published each Thursday, to 28,770 for *The Black Chronicle*, published each Thursday in Oklahoma City. Daily and Sunday newspapers are published in 46 Oklahoma towns and cities.

PUBLIC GOALS AND POLICIES

Providing basic public services, such as an adequate transportation and communication infrastructure, insures that commodities and information can be moved safely, quickly, and efficiently from origin to destination. State government plays a critical role

in the provisions of these basic services. This section provides an overview and analysis of the goals and policies of those segments of Oklahoma government directly involved with the maintenance and regulation of the transportation/communication infrastructure that is necessary to the economic well-being of Oklahoma's businesses, industries, and residents.

Funding and Responsibility for Highway and Road Construction and Maintenance

Oklahoma's primary highways are maintained by two state agencies—the Oklahoma Department of Transportation and the Oklahoma Turnpike Authority. The Department of Transportation, budgeting over \$400 million in fiscal year 1990–91, is responsible for construction, maintenance, and administration of federal interstate highways, U.S. numbered routes, and state numbered routes within Oklahoma, except for turnpikes. The Department receives funds from three sources: the Oklahoma Road Users' Tax (partly from state gasoline taxes paid at the pump); the Federal Highway Trust Fund (made up of the federal gasoline tax paid at the pump); and legislature-appropriated monies from the General Revenue Fund.

The Oklahoma Turnpike Authority, formed in 1947, operates and maintains the 555-mile-long Oklahoma Turnpike System independent of the Oklahoma Department of Transportation. It is supported by tolls and a portion of the state fuel tax. Of more than \$40 million in tolls, approximately 50% comes from out-of-state vehicles. According to the 1992 Annual Report of the Oklahoma Turnpike Authority, if the tolls were eliminated the state would have to spend at least \$15–\$20 million per year to maintain the existing turnpikes.

The memberships of the authority consists of the governor (ex officio member), and members appointed by the governor, one from each of the turnpike districts. Turnpike construction is financed through the sale of public bonds, with a portion of turnpike revenues pledged toward payment of interest and redemption of the bonds. In this way Oklahoma is provided with a self-paying system of safe and rapid transportation without

undue burdens on its taxpayers.

The Oklahoma Turnpike System is inspected on an annual basis by an independent group of consulting engineers. The Annual Inspection Report of this group includes a review of the condition of pavements, shoulders, ditches, and signing, as well as operational facilities, in the entire system. Particular attention is given to bridges and overpasses.

Traffic safety on turnpike and highways is the responsibility of the Oklahoma Highway Patrol, a division of the Department of Public Safety. In addition to law enforcement troopers, the patrol provides two courtesy officers each on the Turner, Will Rogers, and H. E. Bailey Turnpikes (the three most heavily traveled turnpikes). The courtesy officers, trained as emergency medical technicians, provide roadside assistance of all kinds to motorists, are unarmed, are not empowered to make arrests, and are uniformed in a separate manner from law enforcement troopers. A similar service is provided by the Department of Public Safety on Interstate 35 and Interstate 40 within Oklahoma.

County and secondary roads connecting to state highways are constructed and maintained by county and municipal governments. These roads and their bridges are widely used for farm-to-market transportation of agricultural products, access to oil and gas producing areas for exploration and production, access to outdoor recreation areas, and by commuters. More than 87,000 road miles, some 78% of Oklahoma's streets and roads, are under county jurisdiction.

Expenditures for county roads and bridges are made from revenues collected at both the state and local levels. A total of 27 different sources of revenue, including gasoline and diesel fuel taxes, a tax on special fuels, a tax on oil and gas production (Gross Production Tax), and commercial vehicle license fees. Revenues from the fuel taxes and license fees are distributed based on county population and road mileage. The Gross Production Tax is distributed back to the producing counties. In fiscal year 1990–1991, out of the total amount collected, counties received approximately 22.4% of the fuel taxes, 37.63% of the bus mileage

tax and commercial vehicle license fees, and 6.71% of the gross production tax collections.

Additionally, in 1981, a County Road Fund was established by the state legislature. This fund is administered by the State Treasurer, who remits 20% of the vehicle license fees on private vehicles to the County Road Fund. The dollar amount of major tax revenues distributed to counties for roads is shown in Table 6.3.

Goals and Policy Recommendations for Highway Transport

The overall goals of the Oklahoma Department of Transportation are: (1) to foster safe, adequate, economical, and efficient transportation services in Oklahoma that promote public safety and energy efficiency while being compatible with the environment; and (2) to encourage alternative competing forms of transportation services within Oklahoma while recognizing the inherent advantages of each mode within a balanced, intermodal transportation sector.

The Department of Transportation produces *Needs Study and Sufficiency Rating Report*, which rates state and interstate highway adequacy on a 100-point scale. Various condition and design components are monitored, including surface width, surface type, foundation, drainage, wearing surface, stopping sight distance, and gradient. The condition and design of structures, primarily bridges and overpasses, is also assessed on a 100-point scale, with scores for roadway width, load limitations, length, hazards, substructure, superstructure, and deck condition. The 1991 report rated about 50% of the municipal highways to be in adequate condition, with 28% rated inadequate, and 22% rated tolerable. Among rural highways, 36% were found to be in adequate condition, 27% inadequate, and 37% tolerable. In the aggregate of all categories, 72% of the state's highways were rated adequate or tolerable.

Recognizing the importance of the transportation infrastructure for continued economic growth and development, the Governor's Infrastructure Advisory Task Force, in collaboration with the Oklahoma Department of

Economic and Community Affairs, completed an *Oklahoma Infrastructure Study* in 1986. The task force's recommendations were intended to increase the safety and efficiency of Oklahoma's highways and county roads, primarily by finding means of financing needed road improvements.

The task force pointed out that nearly \$100 million in annual revenues generated through fees and taxes paid by vehicle operators in Oklahoma were appropriated for public purposes other than transportation. The task force recommended that all annual revenues be allocated to a specific fund and used solely to maintain the transportation infrastructure of Oklahoma.

The task force also recommended that vehicle operators and owners be assessed a larger proportion of the costs they impose on the state's road system through increases in gasoline and diesel fuel taxes, or through fees on local vehicle license tags and local fuel taxes. Oklahoma's gasoline tax, for example, was 10¢ per gallon in 1986, ranking 38th among the states. Consequently, the 1987 legislature approved a 6¢ per gallon increase in the gasoline tax, and a 3¢ per gallon increase in the diesel fuel tax. The gasoline tax was revised to 16¢ per gallon and diesel tax to 13¢ per gallon. These increases have made Oklahoma's taxes equitable with surrounding state's fuel taxes. At the same time, the increased revenues provide additional funds for improving roads, highways, and bridges in Oklahoma.

Oklahoma has an inherent geographic advantage stemming from its central national location near the center of the United States and on the major southern transportation routes. Through passage of the Trucking Industry Self-Funded Research and Development Act (TISRAD) in February 1987, the legislature anticipates further development of Oklahoma as a hub for warehousing, marketing, and distribution of goods and materials transported by truck.

The TISRAD Act revised and simplified Oklahoma's truck registration and licensing system. Also, it set up a revolving research fund directed toward improving Oklahoma's competitive advantage as a trucking center.

Table 6.3 Major Tax Revenues Distributed to Counties for Roads, Fiscal Year 1990-91

Revenue Source	Dollar Amount
Diesel Fuel Excise Tax	\$11,371,493.12
Gasoline Excise Tax	59,911,665.19
Motor Vehicle Collections	26,907,510.26
Severance Tax on Gas and Oil	28,902,189.97
Special Fuel Use Tax	145,716.59
Total	\$127,268,575.13

Source: Oklahoma Tax Commission (1991).

Motor carrier registration was simplified by a permanent, non-expiring "base plate" form of registration. A commercial trailer pays an initial registration fee of \$43 and receives a non-expiring registration certification and identification plate for each trailer or semi-trailer. Once registered, an annual fee of \$4 keeps the registration in force. This system saves state expenses for mailing out annual metal tags, as well as lowering costs and administrative time for the industry.

In addition to registration fees, annual commercial motor carrier license fees are assessed by the Oklahoma Tax Commission. Fees for commercial trucks and tractors vary from \$27 to \$1,081 depending on weight and age.

TISRAD allocates \$400,000 of the license and registration fees to a private nonprofit research foundation working in conjunction with the Associated Motor Carriers of Oklahoma and a committee of state officials (including the lieutenant governor, members from the Oklahoma Corporation Commission, and the Oklahoma Tax Commission, the secretary of the Department of Transportation, and the commissioner of the Department of Public Safety). Research conducted by this group is intended to develop Oklahoma's presence in the national marketplace as a transportation warehousing and distribution center.

Funding and Responsibility for Rail Transport

Before 1970 railroads in Oklahoma had little need for state involvement. During the latter half of the 1970s, several major national railroads (including the Penn Central and Reading Railroads in the northeastern U.S.),

succumbed to increasing competitive pressures from alternative modes of transport. This nationwide plight of railroads resulted in greater government involvement in rail planning at both the national and state levels.

Oklahoma first became active in assisting and planning for railroad transportation in April 1976, when the governor of Oklahoma established the Department of Economic and Community Affairs (now the Department of Commerce) and gave it responsibility for rail planning as one of its objectives. This responsibility was transferred in September 1976 to the Oklahoma Department of Transportation.

Rail Policy Plans and Goals

Rail services in Oklahoma have traditionally been provided by privately operated rail carriers. Deregulation of the railroad industry has increased the exposure of railroads to competitive market pressures. Except for the short-line railroad serving the Port of Catoosa, all railroads in Oklahoma continue to be privately operated. Most Oklahomans believe that railroads should continue to be private business concerns, and that railroads should not be required by government regulations to retain uneconomical or nonessential rail services. Thus, for economic reasons, some rail lines in Oklahoma have been abandoned. However, the unique ability of the railroads to carry high-bulk, low unit-value commodities indicates railroads will continue to be a vital part of the overall transportation network serving Oklahoma.

The goals of the Oklahoma Department of Transportation are to promote a viable private railroad industry in Oklahoma. A major conclusion of Oklahoma's *State Rail Plan* is that economic growth, new industrial development, and improved rail service are the real keys to increasing rail traffic volumes in Oklahoma and ensuring continued and increasing viability of individual lines in the state.

The *State Rail Plan* was first drafted in 1978 in order for Oklahoma to qualify for federal funds under the Railroad Revitalization and Regulatory Reform Act (4R Act) enacted by the U.S. Congress in 1976. The purpose of the 4R Act was "to provide the means

to rehabilitate and maintain the physical facilities, improve the operations and structure, and restore the financial stability of the railway system of the United States, and to promote the revitalization of such railway system, so that this mode of transportation will remain viable in the private sector of the economy and will be able to provide energy efficient, ecologically compatible transportation services with greater efficiency, effectiveness, and economy." Federal assistance to states under the 4R Act continued from 1976 to 1981, with the states annually paying an increasing share of funds for rail planning and assistance.

Since 1981, most of the funding for state rail planning has come from the Department of Transportation's operating budget. The Rail Planning Branch has three primary sources of funds: the Federal Local Rail Assistance Program; Oklahoma Freight Cars Tax; and incomes received from railroads operating on state properties. Funds available between 1985 and 1991 varied from \$8.54 million to 1.01 million, excluding Federal reimbursements for highway-rail crossing improvements.

The problems faced by railroads during the 1970s have been significantly reduced through competitive market pressures, and innovations in integrated transportation planning that seek to interface rail transport with other modes of shipment.

The 1992 *State Rail Plan* update recommended improving the efficiency of the Oklahoma's rail system by adopting the RAILER Computer Program to monitor the maintenance performance of rail operators on state-owned properties; preparing a five-year rail improvement program to be reviewed annually; and preparing of a Rail Plan update biennially.

Funding and Responsibility for Air Transport

Oklahoma's air transportation industry, like the rail industry, is primarily governed by private business decisions, particularly since federal deregulation of the airline industry. The role of state government is to ensure that safe, adequate, and efficient airport facilities and air carrier services are available for commercial airlines and the public.

The principal state agency responsible for meeting the needs of the air transport industry in Oklahoma is the Oklahoma Aeronautics Commission. The Aeronautics Commission joined the Oklahoma Department of Transportation in 1976, but retained its originally legislated mission of encouraging, fostering, and assisting in the development of aeronautics in Oklahoma. The commission participates financially in airport development projects, as well as public aerospace education for teachers and students. Funds for publicly owned airport development come from both state and federal sources. The commission also furnishes a directory of Oklahoma airports, the Oklahoma Aeronautical Chart, and wind socks for aviation safety in Oklahoma.

Planning Goals and Policy for Airport Development

To foster and encourage airport development in Oklahoma, the Oklahoma Aeronautics Commission produced the *Oklahoma Airport System Plan* in 1985. The *Oklahoma Airport System Plan* documents all airport facilities in Oklahoma and describes a computerized monitoring program for use in planning additional airport facilities. The plan is also intended to coordinate the development of Oklahoma's air transportation infrastructure with the *National Plan of Integrated Airport Systems*.

Funding for public airport projects in Oklahoma must first be reviewed and approved by the Oklahoma Aeronautics Commission. Three categories of airports are recognized in the *Oklahoma Airport System Plan*, and funding recommendations are prioritized on the basis of these categories or classes of airports. The first category, the Primary Airport System, consists of the top 100 publicly owned airports in Oklahoma; these airports receive highest priority for funding and support. The Secondary Airport System is made up of smaller, less frequently used public facilities which may become part of the primary system through increases in use or demand for services. The third category of airports, the Tertiary Airports, consists of airports that are privately owned but publicly used. Tertiary airports re-

ceive lowest priority for assignment of limited funds for airport resource development. In some cases the plan recommends the transfer of some of these airports to public ownership.

Responsibility for Maintenance and Development of Waterways

The McClellan-Kerr Arkansas River Navigation System is the major commercial waterway in Oklahoma. Two federal agencies involved in the McClellan-Kerr system are the U.S. Army Corps of Engineers and the U.S. Coast Guard. The U.S. Coast Guard provides for navigation safety, marking of the navigation channel, pollution abatement, and enforcement of safety regulations and equipment requirements.

The Corps of Engineers is responsible for the operation and maintenance of the physical system, including locks, dams, pumping stations, and other waterway structures; channel reconnaissance, surveying, and dredging; hydropower generation; flood control; and recreation. To accommodate shipping traffic, a nine-foot minimum depth navigation channel is maintained in the navigation pools and dams of the system, even when there is nearly zero natural flow.

State agencies concerned with waterway development in Oklahoma include the Oklahoma Department of Transportation, the Waterways Division of the Oklahoma Department of Industrial Development, the Oklahoma State Department of Commerce, and the Oklahoma Port Authority. There are currently three local port authorities in Oklahoma: the City of Tulsa-Rogers County Port Authority in Catoosa; the Muskogee City-County Port Authority in Muskogee; and the Sallisaw Port Authority in Sallisaw. The port authorities have broad powers for the development, operations, and expansion of ports.

Policies and Development Goals for Waterways

Thousands of acres of land remain open for development along the waterway. Real estate suitable for specific types of development or usage is available from private interests, as well as from public developmental agencies and port authorities. Okla-

homa's policy is to continue to encourage and foster additional development of the McClellan-Kerr Navigation System's potential, and to integrate that development with complementary modes of transport.

Land above the ordinary high-water mark may be publicly or privately owned, while land below the ordinary high-water mark is considered public property and is administered by the U.S. Army Corps of Engineers. Much of the land adjacent to the McClellan-Kerr System in Oklahoma is owned in fee simple by the federal government; however, where the land is not allocated to other purposes, a lease can be obtained to permit corridor access across these lands to the navigation system.

CONCLUSION

The basic transportation policy of Oklahoma is to foster and encourage integrated private development of the various transport modes by providing the necessary physical infrastructure: adequate roads and highways, airports and aviation facilities, ports and waterways, and safe rail lines. The state has also actively fostered the creation of a trucking and warehouse distribution hub in Oklahoma by simplifying truck registration procedures and funding research devoted to improving the trucking industry's role in Oklahoma. These goals and programs are funded from taxes on the use of the physical infrastructure.

The major state agencies responsible for Oklahoma's transportation infrastructure and its operation, maintenance, and regulation are the Department of Transportation, the Corporation Commission, the Department of Commerce, and the Oklahoma Port Authority.

At the federal level, the U. S. Army Corps of Engineers and the U. S. Coast Guard maintain and service the McClellan-Kerr Navigation System. Other federal agencies, including the Department of Transportation, provide funds in support of transportation development.

In the field of communication, Oklahoma's central location relative to the rest of the nation makes it a natural focal point for nationwide information access. The major telecommunication

networks are accessible from Oklahoma, and plans for the development of an integrated services digital network are on the way. Presently, Oklahoma provides a secure infrastructure of conventional communication media.

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— Chapter 6 —

LIST OF ILLUSTRATIONS

Figures

6.1 — Movement of Oklahoma manufactured products by transport mode _____	103
6.2 — Total ton-miles moved on the McClellan-Kerr Arkansas system _____	104
6.3 — Tulsa Port of Catoosa tonnage, 1971-90 _____	104
6.4 — Barge tonnage shipped in Oklahoma through McClellan-Kerr Arkansas system, 1990 _____	105

Maps

6.1 — Oklahoma's railroad network _____	100
6.2 — Turnpikes and interstate highways _____	101
6.3 — Driving times from Oklahoma City, 1925 _____	102
6.4 — Driving times from Oklahoma City, 1975 _____	102
6.5 — McClellan-Kerr Arkansas River Navigation System _____	103

Tables

6.1 — Railroads serving Oklahoma and mileage of track, 1991 _____	100
6.2 — Public road mileage and density, Oklahoma and adjacent states, 1990 _____	101
6.3 — Major tax revenues distributed to counties for roads, FY 1990-91 _____	107

Oklahoma Resources

Chapter
7

Inventing the Future:
Education in Oklahoma

by
Herbert R. Hengst
and
Dan S. Hobbs



Contents

Executive Summary _____	113
Introduction _____	114
The Scope of Educational Opportunities in Oklahoma _____	114
Basic Education for Citizenship: K-12 _____	115
Education for Careers: Vocational/Technical Education _____	117
Teaching Programs _____	118
Proprietary Schools _____	119
Vocational Programs in Higher Education _____	119
Professional Training: The Colleges and Universities _____	120
Research in Higher Education _____	121
The Arts and Humanities _____	123
Conclusion _____	124
References _____	125
List of Illustrations _____	126

Inventing the Future: Education in Oklahoma

Herbert R. Hengst and Dan S. Hobbs

Executive Summary.— Education is Oklahoma's largest and most pervasive public enterprise. One-fourth of Oklahoma's 3.1 million people are formally enrolled in a school or college at any given time, and half of the households have a member who is a teacher or student. Some 75,000 jobs in education make a significant contribution to the state's economy. The value of education's role in the intellectual development and occupational training of Oklahoma citizens is incalculable. The transmission of knowledge from one generation to the next helps set humankind apart from other species. In the words of an earlier generation, education is "Oklahoma's Magic."

At the foundation of Oklahoma's learning system are the public schools, K–12. These schools, called "common schools" in Oklahoma, enroll nearly 600,000 pupils in 578 school districts and employ more than 40,000 certified teachers and support personnel. Private K–12 schools are also available to Oklahomans.

Oklahoma has one of the nation's premier systems of vocational training. The vocational-technical schools involve more than 300,000 individuals in a variety of programs each year. Additionally, post-secondary proprietary schools—private business schools, flight schools, health career schools, and the like—serve an estimated 25,000 adults each year. The vocational education provided by the vo-tech schools and post-secondary proprietary schools forms the basis for much of the advanced technical training carried out in the state's two-year colleges.

Oklahoma also has an impressive array of colleges and universities, both public and private. In 1890, the First Territorial Legislature established three institutions of higher education, giving citizens of Oklahoma Territory access to higher education even before they had access to secondary education. Today, Oklahoma enjoys a full range of higher institutions, including both public and independent universities and colleges. Together, these colleges and universities enroll approximately 240,000 students annually. Each year, this diverse higher education system turns out some 21,000 graduates whose diplomas range from two-year associate degrees to doctorate degrees. These graduates regularly move into Oklahoma's professional and technical work force, in agriculture, business, law, medicine, education, engineering, and a host of other fields. The backbone industries of Oklahoma's economy, agriculture and energy, are undergirded by two nationally recognized centers of excellence: the Noble Center for Agriculture and Renewable Resources at Oklahoma State University, and the Sarkeys Energy Center at the University of Oklahoma.

Oklahoma's colleges and universities play an important part in creating new knowledge through research. The state's universities carry out research in such areas as the biotechnology aspects of agriculture, design of industrial robots, laser spectroscopy, enhanced oil recovery, surfactant science, development of artificial blood, meteorological science, signal science, cancer research, and water quality research. In 1988, Oklahoma public higher institutions expended approximately \$123 million for programs of research, of which the State of Oklahoma was responsible for \$36.3 million and external sources (primarily the federal government) were responsible for \$86.5 million.

The recitation of benefits provided by education would not be complete without including the contributions of the arts and humanities to the quality of life in Oklahoma. If a vigorous and productive future is to be invented, the necessary technical and professional skills must be practiced in a nurturing environment. To this end, the educational system, from kindergarten through college, offers not only formal programs in literature, religion, music, and art, but also provides cultural opportunities through libraries, museums, theaters, orchestras, and dance companies.

INTRODUCTION

It was the spring of 1927. A high school senior was addressing an august panel of judges in the Fourth National Oratorical Contest. His topic was the Constitution. The judges included the President of the United States and the justices of the Supreme Court. The young man was small in stature, but an orator of great strength. His oration won him a three-month summer tour of Europe and whetted his interest in his own nation's capital and in the affairs of the world. After the tour, he matriculated at the University of Oklahoma as a student of government. At the University, he was a prize-winning orator, a member of the varsity wrestling team, and president of the student body. He was elected to Phi Beta Kappa and awarded a Rhodes Scholarship. The President of the University called this "Little Giant" the "brightest mind ever to come to this University." This native of Bug Tussle and McAlester, Oklahoma, went on to serve in the U.S. Congress for 30 years and to sit as the speaker of the House of Representatives. Twice, he was second in line to the presidency.

One of the ways education assists in "inventing the future" is by cultivating our nation's leaders. Carl Albert is an enduring example of Oklahoma's successful discharge of this educational responsibility.

The future does not simply emerge full grown like John Henry. It is a complex of the consequences of actions taken by a people in the very immediate present. Everything that happens in the present molds the future that will be enjoyed, or endured, by the next generation. The character of the future cannot be left to chance alone. The future must be "invented," and it must be the concern of every actor in the present. Education is the most basic of "future inventing" activities because acquiring, understanding, and using information are the foundation skills necessary to a people's success. Developing these skills is the primary goal and function of education.

This chapter describes the educational system that serves the people of Oklahoma. The chapter begins with an overview of the contemporary educational scene, from kindergarten

through graduate school. The next two sections describe public and private K-12 schools and vo/tech schools. These descriptions are followed by an introduction to Oklahoma's colleges and universities, a brief discussion of research activities in the higher education system, and a review of the role of the arts and humanities in Oklahoma education.

THE SCOPE OF EDUCATIONAL OPPORTUNITIES IN OKLAHOMA

Education in Oklahoma touches half the households in the state. It is readily accessible to the 3.1 million citizens of the state through local school districts and post-secondary institutions, a statewide instructional television system, a premier system of vocational training, and a regular program of extension and continuing education services. Individuals and businesses alike are well served by these opportunities. For the academic year 1990-91, the educational institutions, public and private, reported more than 820,000 enrollments; that represents approximately 26% of the state's population. In addition, the system served the needs of several hundred businesses (125 through vo/tech schools in 1990-91) by providing special training programs, professional development programs, and seminars/conferences.

The primary location of educational opportunities is the local school district. Oklahoma's 578 school districts are controlled by local boards of education under the leadership of the State Department of Education and the State Board of Education. These districts provided public "common" school education for 599,820 children and young people in the school year 1991-92. They operated more than 1,900 schools that year: 472 high schools, 305 middle or junior high schools, and 1,169 elementary schools. The high schools graduated 33,007 students in May 1991; an average 62.8% of them will continue their education in some form of post-secondary program, either immediately following graduation or at some point in subsequent years. The public schools were served by more than 42,000 certified personnel in the 1990-91 school year; master's degrees were held by

44% and just under 1% held doctorates. Fewer than 0.5% held less than a baccalaureate degree. Notwithstanding this level of preparation, the average teacher's salary in 1990-91 was \$25,580, somewhat less than munificent in comparison with the rest of the country.

There are also private, or independent, schools available to serve Oklahomans. They are located primarily in Oklahoma City and Tulsa. The private schools are designed essentially as college-preparatory schools, and they generally have deservedly good reputations. There are three such schools in Oklahoma City and one in Tulsa. The Catholic Church operates educational systems in each of the two dioceses in the state. These schools, also, are well reputed. In addition, there are other private academies and church-related schools in operation.

The public schools, under the leadership of the State Department of Education, emphasize the improvement of quality in their instructional and operational programs. Recent developments include: an upgrading of libraries through the provision of additional funds, an approach to more equitable funding for districts across the state, the establishment of media resource centers in schools, the provision of increased supervisory services located closer to the local schools, and increased support for experimental or "light house" programs in local schools. In addition, the state recently strengthened the certification requirements for teachers and introduced several administrative improvements.

The second part of Oklahoma's educational enterprise is the post-secondary segment. It consists of a vocational/technical system organized into districts, state-funded colleges and universities, and independent colleges, universities, and institutes. The vo/tech districts serve more than 300,000 students.

In 1989-90, colleges included in the state system were: (1) 14 community colleges (plus two technical campuses of Oklahoma State University), that served 97,916 students (a headcount figure); (2) 10 comprehensive/regional state universities that served 65,055 students; (3) one Osteopathic Medical College with 271 students;

Table 7.1 -- Enrollments in Oklahoma Public Schools by Level and Ethnic Group, Fall 1991

Level	Black (Non-Hispanic)	Alaskan or Am. Indian	Hispanic	Asian/ Pacific Islander	White (Non-Hispanic)	TOTALS
Elementary	30,650	37,681	9,711	3,271	218,373	299,686
Junior High	13,159	16,386	3,623	1,453	99,885	134,506
High School	10,025	13,557	2,619	1,621	85,655	113,477
Others	799	872	154	57	3,689	5,571
TOTALS	59,348	73,898	17,808	6,883	441,966	599,903

Source: Oklahoma State Department of Education (1992).

and (4) two doctoral-degree-granting universities that served 53,048 students.

These colleges, universities, and institutes—both public and private—enrolled a total of 240,184 students in 1989–90. During that academic year, they conferred 13,539 baccalaureate degrees; 1,023 first professional degrees; 3,925 masters degrees; and 342 doctoral degrees. The total number of students served, as well as the total number graduated, has remained relatively constant in recent years, in spite of the decline in the traditional college-age population.

Each type of post-secondary institution fulfills a special mission in the state system. The vo/tech schools provide training in a wide range of job specialties and serve business and industry through specific training programs. The community colleges are designed to be responsive to localities and find many opportunities to be of specific help. (The relationship between Rose State College in Midwest City and neighboring Tinker Air Force Base is a good example.) The comprehensive regional universities (outgrowths of an earlier system of teacher training institutions) provide a wide range of bachelor degree programs and enable many who would otherwise be limited by distance to benefit from higher education. The two public, doctoral-degree-granting universities offer a significant number of opportunities for advanced graduate study as well as sound and stimulating baccalaureate programs. For example, Oklahoma State University, which has several internationally recognized programs in agriculture, is

also noted for its engineering programs; among them is a study in robotics. The University of Oklahoma, long noted for its work in geology (especially petroleum geology), also has developed a history of science collection and program second to none and, more recently, a school of meteorology without peer. The independent and church-related colleges, with a modest but meaningful share of the enrollments in post-secondary programs, are well thought of generally. The University of Tulsa, Oklahoma City University, Oklahoma Baptist University, and Phillips University are considered the premier institutions in this group. Each has a rich history and a sound reputation.

The scope of educational opportunity in Oklahoma is, indeed, broad enough to achieve the goal of taking education at all levels to the people of the state.

BASIC EDUCATION FOR CITIZENSHIP: K-12

Providing educational opportunities for the children and youth of Oklahoma predates by many decades the formal establishment of the State of Oklahoma in 1907. Before the Civil War, following their tragic removal from the southeastern states, the Five Civilized Tribes established schools in the wilderness of Indian Territory. Each of the five nations operated a school system that included both elementary schools in neighborhoods and secondary schools, often called academies or seminaries. Each nation also designated an official to serve as a superintendent of public instruction. Money from tribal funds was set aside

to operate the schools and to provide scholarships for qualified young people to attend selected eastern colleges. Following the Civil War, the western lands of the Five Civilized Tribes were taken from them by treaties and set aside for the settlement of Indian tribes from other sections of the country. Each reservation in the western territory had at least one school. By 1889, when the first of these western lands was opened to white settlement, formal schooling as a part of the indigenous cultures was already an accomplished fact.

Oklahoma became a state on November 16, 1907, when President Theodore Roosevelt signed the Oklahoma statehood proclamation. The First Legislature established a system of free public schools. It created a State Board of Education and provided for a superintendent of public instruction, to be elected by the citizens. A textbook commission was established, and a school code that set certain course requirements for the schools was passed. All children 8–16 years of age were required to attend school. Other actions of the Legislature, with the exception of the “Jim Crow” codes passed during the Second Legislature, stamped Oklahoma as a progressive state, and it established a reputation for taking actions that were in the interests of the citizens of the state.

There are nearly 600,000 students in Oklahoma’s public education system. Table 7.1 presents information about grade level and ethnicity. School districts range in size (as measured by enrollments) from the largest, Tulsa, to the smallest, such as Coyle, with an average enrollment of 27 students in 1987–88. The median for school-district enrollment was 319 students in 1987–88, and that pattern continues.

Oklahoma’s local educational districts find uniqueness within a set of similar program elements. A core of content and skill studies provides a common education for the young of the state—an education that is held “in common.” In addition to teaching reading and other language skills, quantitative skills, science, history, geography, sociology, psychology, and, in a few places, a foreign language,

local schools find ways to particularize learning experiences for the children and youth they serve. Some schools also include agriculture, home and family living, economics, vocational, and other studies. Vocational studies are frequently coordinated with the Area Vocational District Schools. And, of course, all schools provide their students experiences in the fine arts, as well as counseling and guidance programs. There are programs designed to serve exceptional students as well, both those who have some physical or learning handicap and those described as especially gifted. Local traditions and resources play a part in each district's uniqueness, but perhaps the most significant contribution is made by the many individuals who are involved with the schools: members of the local boards of education, administrators, teachers, parents, students, and the people of the communities.

The State Department of Education encourages innovation in programs through its own efforts as well as those supported by the U.S. Office of Education and other federal agencies. Annual "Education Fairs" highlight "Prominent Practices in Education" in Oklahoma. The 1987 fair displayed 50 programs selected by a jury of experts from a statewide pool of exemplary programs. A brief review of these programs provides an insight into the dynamic nature of the public schools. Table 7.2 shows the distribution of the programs by level and content. It is interesting to note that fully half (25) of the selected programs were in the traditional academic disciplines. Language arts was the most frequently treated area. Most of those in the elementary grades dealt with improving reading skills, while others dealt with such themes as language structure and interpretive reading. The exemplary programs were distributed quite evenly across grade levels: 16 in the elementary grades, 13 in the secondary grades, and 15 that applied to all levels.

A comment on the content of one or two of the exemplary programs provides a "feel" for the nature of these exciting activities. For example, one of the high schools has an "advanced placement program" that

Table 7.2 -- Distribution of Selected Exemplary Programs in Oklahoma Schools by Content Area and Grade Level, 1987

Content Area	Pre-School	Elementary	Jr. High	Jr./Sr. High	Sr. High	All Levels	Out of School	TOTALS
Language Arts	0	5	1	0	1	2	0	9
Social Studies	0	5	1	0	2	0	0	8
Sciences	0	0	2	0	0	1	0	3
Mathematics	0	1	0	1	0	0	0	2
Foreign Lang.	0	0	1	0	0	0	0	1
Fine Arts	0	2	0	0	0	1	0	3
Physical Educ.	1	0	0	0	1	0	0	2
Coun./Guidance	0	0	0	0	2	1	0	3
Self-Develop.	1	3	0	0	0	2	0	6
General Academic	0	0	0	0	1	1	0	2
Special Education	0	0	0	0	0	3	0	3
Other	0	0	0	0	0	4	4	8
TOTALS	2	16	5	1	7	15	4	50

Source: Oklahoma State Department of Education (1988).

makes it possible for gifted students to study at the college level and to earn college credit for successfully completing such studies. In a different school district, eighth graders in a civics class interviewed their grandparents to learn about the social and economic impact of the Great Depression. A "children's art" program for kindergartners in another district taught children the skills of selecting and interpreting through art exercises. Programs like these are representative of activities in many of Oklahoma's schools.

A modest number of private schools also serve Oklahomans. The range of private and denominational Christian schools, as well as Montessori preschools and kindergartens, is extensive enough to satisfy most parents who desire such options. Most of these schools are concentrated in the two major metropolitan areas of the state, Oklahoma City and Tulsa, but private schools, most notably through the Catholic School system, do appear in other areas.

There are two major independent schools serving preschool to 12th grade in Oklahoma City. Casady School, which is operated by the Episcopal Church, regularly enrolls 1,000-1,050 students. It is a college preparatory school that takes pride in its academic strength. Heritage Hall School also offers preschool through 12th grade instruction. It takes pride in providing sound instruction in all

fundamental skills in an environment of rich educational experience.

A third private school in Oklahoma City, the Westminster Day School, serves children from preschool through eighth grade. Westminster offers programs for children with special needs and employs a child development specialist, a speech pathologist, and a psychometrist to facilitate these programs.

In Oklahoma City, the Catholic Church operates a system including eight elementary schools and two secondary schools. These schools served just under 3,000 students in the 1986-87 school year. The largest Catholic school is Bishop McGuinness High School, a school with a strong academic reputation, which serves primarily college-preparatory students.

All of the private Oklahoma City schools described are coeducational, admit students without restriction regarding race or religious preference, and offer some scholarship support, usually based on need alone.

Tulsa has one major private school that offers programs from preschool through the 12th grade, the Holland Hall School. Holland Hall, operated by the Episcopal Church, is a college-preparatory, coeducational school serving just under 1,000 students. It offers college level advanced placement courses.

The Catholic Church operates eight elementary schools and two high schools throughout the Tulsa Arch-

diocese. Three of the elementary schools are in locations other than the city of Tulsa. The total enrollment approaches 3,500 students annually (based on 1986 figures). The largest of the Catholic schools is the Bishop Kelly High School, which serves approximately 800 students. It is noted for its strong, and essentially college-preparatory, academic program.

There are also a number of smaller day schools operated by various Christian denominations in Oklahoma City, Tulsa, and throughout the state. Most are elementary schools, are small in enrollment, and usually are housed in churches or in the educational wings of church buildings.

Evidence of Oklahomans' determination to ensure the state the best possible public school education is found in House Bill 1017, which deals with the reform and funding of public schools. It was enacted in a special session of the Legislature convened by then Gov. Henry Bellmon in the summer of 1989. The reform movement in Oklahoma grew out of the national concern about the alleged failures of the public schools and the realization by state leaders that education was the key to economic well-being in Oklahoma. The Bill became law in August 1989 and provided both a list of reform mandates with compliance deadlines and an increased source of revenue to fund them. Major reform provisions of HB 1017 include the following: (1) the number of school districts to be reduced through consolidation or annexation; (2) the office of county school superintendent was abolished; (3) minimum eligibility requirements for school board members were established; (4) the Oklahoma School Testing Program was extended; (5) the State minimum teacher salary was increased and a five-year improvement schedule established; (6) limitations on class size were specified and a schedule for lowering them over a five-year period published; (7) the State Board of Education was required to develop new outcome-oriented accreditation standards; (8) established the Oklahoma Curriculum Committee and charged it with developing a statewide core curriculum by 1993-94; (9) required a half-day kindergarten for all children 5 years old by September

1; (10) established entitlement for all 4-year-olds to attend an early childhood program; (11) doubled state support for economically disadvantaged students; and (12) encouraged local school districts to promote community involvement through outreach programs.

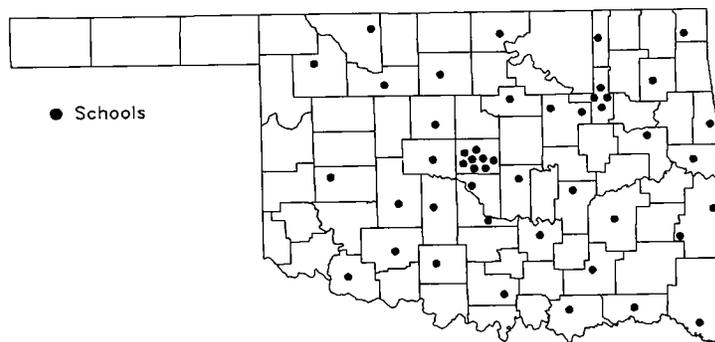
To fund such reforms, HB 1017 provided for an increase in the state sales tax from 4% to 4.5%, an increase in the corporate income and bank privilege tax rate from 1% to 6%, and variable increases in state personal income taxes. HB 1017 received widespread support from chambers of commerce, agricultural groups, and organized labor, as well as from educational groups.

After HB 1017's first year of implementation (1990-91), notable results could be identified. Several reforms of significance were initiated. Perhaps the most readily observable was the increase in teacher salaries. Provision was made for an average salary increase of \$1,500 for all certified school personnel. Reduction in class size was also an item on which much attention was focused. A survey of 25 representative school districts conducted by the League of Women Voters found that most were in compliance with the 1990-91 class size mandates. School district reorganization was also a topic of much interest and activity. During the first year of implementation, 10 districts consolidated to form five new ones, and 18 districts were eliminated by annexation. At the beginning of the 1991-92 school year, 578 Oklahoma school districts remained operational, a net reduction of 23 districts.

The legislation did have opposition, which had two dimensions: first, there was strong anti-tax sentiment in the state; and second, those opposed to the tax increases claimed that there were few if any "real" reforms in the Bill. The opposition coalesced around the call for no new taxes and mounted an initiative petition to repeal HB 1017. The well-organized opposition secured many more signatures than were required to ensure that the issue would be placed on a statewide ballot, and a special election was set for October 15, 1991. There was much debate between supporters and opponents, and it looked very possible that HB 1017 could be repealed. However, after a spirited campaign spearheaded by a coalition of education and business leaders, State Question No. 639 (to repeal HB 1017) was defeated, 428,680 to 360,318.

EDUCATION FOR CAREERS: VOCATIONAL/TECHNICAL EDUCATION

Oklahoma's vocational education system began with high school agriculture and home economics classes in 1917, growing out of the Smith-Hughes Act of the United States Congress of that year. That Act made possible a federal and state partnership which has now expanded to encompass many vocational programs, including business and office education, health careers, technical education, and trade and industrial education. Most of the programs were added after the Vocational Education Act of 1967, which broadened the concept of vocational education to include career



Map 7.1—Locations of Oklahoma area vocational/technical schools, April 1988. Source: Oklahoma State Department of Vocational and Technical Education (1988).

Table 7.3 -- Source of Funds for Vocational Education in Oklahoma, Fall 1992

Category	Amount (millions of dollars)
Federal Grants	\$17.0
State	83.9
Local Millage	99.4
Other	4.1
TOTAL	\$204.4

Source: Oklahoma State Department of Vocational and Technical Education (1992).

education. In addition, the Oklahoma vocational system provides training for workers in new and expanding industries, inmate training in correctional facilities, career guidance for displaced homemakers, and a variety of other services, including adult education.

Vocational programs are provided through 414 comprehensive schools and 27 area vocational/technical schools located on different campuses (Map 7.1). In 1990-91, some 67,000 secondary students were taught in the comprehensive schools, along with a few hundred adults. At the area vo/tech campuses, 14,000 high school students attend on a daily basis, and some 300,000 adults were enrolled part time in 1990-91.

The annual budget requirements for the vocational system topped \$204.4 million in 1992. The sources of revenue for these budgets included some \$17.0 million in federal appropriations, \$83.9 million in state appropriations, \$99.4 million in local ad valorem tax revenues, and \$4.1 million in other funds, primarily collections from sales and services and from student fees (Table 7.3).

Although vocational education began as a federal and state partnership, the current arrangement between state and local governments accounted for about 90% of the revenues available to the system in 1991. The federal government acts primarily as a catalyst for the vocational system, except in times of military or economic crisis. The bulk of the responsibility for vocational education has devolved upon the state government,

which gives leadership to the program and provides coordination for it.

Governance for the vocational system is provided by the State Board of Vocational and Technical Education, consisting of the State Superintendent of Public Instruction, the six appointed members of the State Board of Education sitting as ex officio voting members, and six other members appointed by the Governor. The Chairman of the Board is the State Superintendent of Public Instruction. The Director of the Department of Vocational and Technical Education serves as an ex officio, nonvoting member and is the executive officer of the board.

Administrative leadership for the implementation of board policy is provided by the State Director of the Department of Vocational and Technical Education assisted by a state staff of approximately 150 employees located in Stillwater. The State Director not only supervises the state staff and guides vocational programs of a statewide outreach nature, but also coordinates the various programs carried on in the comprehensive schools, the area vo/tech schools, the skill centers, the business assistance centers, and the inmate training centers.

Teaching Programs

Vocational education carries out its formal teaching agenda through seven broad program divisions. Each has its own state-level leadership staff to supervise the division's programs and to work with student organizations affiliated with the programs.

There are 443 programs of vocational home economics operating in the schools of Oklahoma. Giving support to these programs are 422 chapters of the Future Homemakers of America/Home Economics Related Occupations. These FHA/HERO chapters have a current membership of 14,627 students.

The second program area, vocational agriculture, is represented by 372 programs designed to provide agricultural and informational services to its student membership. Vocational agriculture is supported by the Oklahoma Future Farmers of America (FFA) in 372 chapters with a membership of 18,397 students.

The division of Industrial Arts/Technology Education, with more than 600 programs, seeks to meet the prevocational needs of technology education students by exposing them to the world of work and the various vocational education options in technical education. The affiliated student organization is the American Industrial Arts Student Association (AIASA), which currently operates 91 chapters with 1,771 members.

Health Occupations Education, with 84 programs, exists to provide training and vocational guidance for students interested in health careers. The oldest and largest program in the division is the practical nursing program. The affiliated student organization is called Health Occupations Students of America (HOSA). This organization currently has 84 chapters with 1,589 members in Oklahoma.

Trade and Industrial Education currently has 593 vocational education training programs in fields such as construction, automotive service, electricity and electronics, diesel engines, and computers. Support for the program area is provided through 597 chapters of the Vocational Industrial Clubs of America (VICA), with a membership of 9,812 students.

Programs in Marketing Education are concerned with marketing, management, and distribution of goods and services. The primary emphasis of the division is on small business development. Supporting the program area is the Distributive Education Clubs of America (DECA) through 60 chapters enrolling 2,547 members.

The division of Vocational Business and Office Education works with people 14 years of age and older in the teaching and upgrading of skills for business and office careers. Affiliated student organizations for this area are the Future Business Leaders of America (FBLA) and Phi Beta Lambda (PBL). The FBLA organization has 130 chapters and 4,107 members. The PBL group has 35 chapters and 1,225 members.

In addition to the formal teaching programs offered through the comprehensive schools and the area vo/tech schools, the Oklahoma State Department of Vocational and Technical

Education carries out a number of programs, including farm-related activities, in partnership with Oklahoma business and industry groups.

The Business and Industry Services division of the State Department of Vocational and Technical Education helps train workers for new and expanding industries in Oklahoma. Twenty-six area vo/tech schools at 42 campuses are now involved in training for industry. A recent addition to programs for Oklahoma business is the bid assistance program, established to help local businesses land government contracts. It operates 24 bid-assistance centers across Oklahoma. The State Department of Commerce cooperates in this effort.

The concept of management development groups is being developed into a new program. Management specialists are employed by an area vocational school; these specialists are then shared with local firms that buy into a group. This allows smaller firms access to expertise usually available only to large corporate firms. In the future, it looks like that this program will become statewide.

Small Business Management programs, at 22 locations across the state, also assist small businesses with their management problems. A special program, Farm Business Management, has been designed to help meet the needs of farmers, who have been under tremendous economic stress in recent years. Since its inception in 1978, this program has assisted more than 1,000 Oklahoma farm families with their financial management problems.

The vocational system's "special programs" are designed specifically to serve a variety of special populations with unique needs. Among these populations are inmates in correctional institutions, the disadvantaged and handicapped, dropouts, displaced homemakers, dislocated workers, and farmers. Inmates receive vocational training or assessment services at centers located in Granite, Ouachita, Stringtown, and McLoud. Inmates typically are trained for careers in welding, auto mechanics, air conditioning and refrigeration, carpentry, and auto body repair.

Disadvantaged and handicapped students are regularly served by voca-

Table 7.4 -- Number and Projected Costs of Occupational Programs in the State System by Institution, 1987-88

Institution	Number of Degrees	Projected FTE Enrollment	Operating Budget Needs, 1987-88
Oklahoma State University	5	116	\$ 330,733.00
OSU Technical Branch-Okmulgee	29	3,500	12,732,076.00
OSU Technical Branch-OK City	36	1,625	6,031,980.00
Central State University	0	31	98,544.00
East Central University	0	41	114,816.00
Northeastern State University	0	95	239,986.00
Southeastern Okla. State University	0	31	94,175.00
Southwestern Okla. State University	0	69	179,208.00
Sayre Junior College	4	59	128,405.24
Cameron University	5	351	1,173,337.00
Okla. Panhandle State University	0	55	194,847.00
Carl Albert Junior College	10	205	680,387.00
Connors State College	16	309	1,108,111.00
Eastern Okla. State College	20	523	2,029,081.00
El Reno Junior College	20	458	1,531,832.00
Murray State College	16	357	1,550,288.00
Northeastern Okla. A&M College	29	811	2,917,084.00
Northern Oklahoma College	19	289	1,025,964.00
Oklahoma City Community College	37	2,315	7,644,755.00
Rogers State College	19	509	1,676,777.00
Rose State College	36	3,148	9,277,751.00
Seminole Junior College	10	353	1,244,299.00
Tulsa Junior College	54	2,940	10,487,286.00
Western Okla. State College	20	288	1,036,289.00
TOTALS	385	18,478	\$63,528,011.24

Source: Oklahoma State Regents for Higher Education (1988a,b).

tional education. A new program in Oklahoma City (undertaken in cooperation with the Opportunities Industrialization Center, Inc., a community-based organization) works with high school dropouts. The Displaced Homemaker Program attempts to meet the needs of single parents or women who have lost their mates through death, divorce, or desertion. Oklahoma has 23 Displaced Homemaker/Single Parent programs in operation currently, and these programs served 5,472 individuals in 1990-91. The Dislocated Worker Program provided assistance to 2,300 men and women in 15 participating vo/tech schools during the most recent year. Such programs are meeting needs for special populations that probably would not be served by any other segment of education or by another governmental agency.

Proprietary Schools

The proprietary sector supplements the vocational training provided by the public schools through a series of private business schools,

beauty colleges, flight schools, health career schools, barber colleges, automotive training schools, and truck-driver schools. In 1992 the Oklahoma Board for Private Vocational Schools counted a total of 164 licensed schools. It is estimated that more than 25,000 adults receive full-time training in the proprietary schools during any given year. Those programs range in length from two weeks to two years, and range in the outcomes from training certificates to two-year associate in applied science degrees.

Vocational Programs in Higher Education

Both the public and private sectors of Oklahoma higher education offer two-year programs of vocational/technical education to prepare students for the changing world of work, which includes more and more sophisticated machines.

In 1987-88, there were 375 two-year programs of vocational/technical education at public institutions, primarily in the junior/community colleges and at the two technical

Table 7.5 -- Two-Year Technical Programs in Public Colleges by Occupational Type, 1988

AGRICULTURE	Dental Hygiene	Cabinet Making
Agri Business	Dental Lab. Tech.	Civil & Highway
Agri Engine Tech.	Gerontology Tech.	Computer-Aided Design
Agri Meats (Butchering)	Histologic Tech.	Computer Integ. Sys. & Robotics
Agri Production	Medical Assistant	Computer Maintenance
Farm/Ranch Mgmt.	Medical Emergency Tech.	Construction
Forestry	Medical Lab. Tech.	Diesel
Horticulture	Medical Technology	Drafting
Parks Mgmt.	Mental Health	Drafting & Design
Retail Floristry	Nursing (R.N.)	Dry Cleaning Tech.
	Occupnl. Therapy Asst.	Electrical (Engr. Tech.)
BUSINESS	Physical Therapy	Electro-Mechanical
Accounting Associate	Radiologic Tech.	Electronics (Engr. Tech.)
Airport Mgmt.	Respiratory Therapy	Energy Bldg. Renovation
Banking & Finance	Surgical Tech.	Environmental Safety
Business	Veterinary Tech.	Environmental Science
Bookkeeping and Acctng.		General Engineering Tech.
Commercial Art	HUMAN SERVICES	Geology
Community Journalism	Art & Marketing	Graphic Arts
Computer Ops. Mgmt.	Broadcasting	Gunsmithing
Computer Programming	Corrections	Heating Air Refrigeration
Computer Science	Country Western Music	Industrial Electrical Tech.
Consumer Economics	Driver Safety Educ.	Industrial Plant Maint.
Court Reporting	Fire Protection	Industrial Supervision
Credit Union Mgmt.	Fire Fighting Tech.	Industrial Technology
Data Processing	Funeral Services	Instrumentation
Fashion Merchandising	Interpreter Training	Jewelry Mfg. Design
Legal Assistant Admin.	Labor Studies	Machinist Tech.
Legal Secretary	Law Enforcement/	Manufacturing Tech.
Logistics Mid-Mgmt.	Police Science/	Mechanical Design
Marketing & Merchandising	Criminal Justice	Mechanical Engineering
Medical Secretary	Library Tech.	Mechanical (Power)
Middle Mgmt.	Mass Media Comm.	Metallurgical
Office Admin/Office Asst.	Outdoor Leadership	Numerical Control Machinist
Paralegal Training	Phlebotomy	Numerical Control Service
Personnel Admin.	Postal Service Leadership	Petroleum Engineering
Property Mgmt.	Right-of-Way Mgmt.	Petroleum Land Tech.
Purchasing/Materials Mgmt.	Security & Loss Prevention	Plumbing and Pipefitting
Real Estate & Insurance	Technical Theater/Drama	Printing
Retail Mgmt.	Travel & Tourism	Shoe, Boot, & Saddle
Secretarial Admin.		Surveying
Secretarial Science	ENGINEERING/INDUSTRIAL	
	Architectural	Systems Maintenance Admin.
Small Business Mgmt.	Automotive Body Paint	Tech. Illustration/Writing
Stenographic	Automotive Machinist	Telecommunications
Transport./Traffic Mgmt.	Automotive Serv. Mgmt.	Upholstery (Furniture)
Word Processing	Automotive Technology	Watch & Micro-Repair
	Automotive Trim	Welding
HEALTH	Bio-Medical Equipment	
Dental Assistant		

Source: Oklahoma State Regents for Higher Education (1988b).

branches of Oklahoma State University located in Okmulgee and Oklahoma City (Table 7.4). Some 18,483 full-time equivalent enrollments were budgeted in vocational/technical programs, representing approximately 35,000 individuals. Career fields included agriculture, health, home economics, and public services. The projected cost of providing these occupa-

tional programs was approximately \$63.5 million annually.

Collegiate programs of occupational education are built upon the base of vocational courses provided in the high schools and the area vocational schools. Typically, they are more theory-oriented and require more knowledge of mathematics than vocational courses. For instance, tech-

nical programs include architectural technology, which utilizes geometry and computer science to help design and produce architectural plans and specifications, and veterinary technology, which draws upon biology, laboratory technology, and medicine. Some technical programs, such as nursing, laboratory technology, dental hygiene, and veterinary technology, qualify their graduates for licensure for professional or technical practice. In other technical programs, such as word processing, computer technology, accounting associate, forest technology, and meats processing technology, individuals acquire skills that qualify them to work in a corporation or business. Other technical programs include library technician, law enforcement technology, commercial art, and airport management. Table 7.5 is a listing of some 150 technical programs available at Oklahoma institutions of higher education.

In sum, vocational education in Oklahoma contributes in a vital way to the development to the state's work force. Hundreds of thousands of Oklahomans each year enter the world of work through programs of vocational and technical education in the comprehensive high schools, the area vo/tech schools, the post-secondary proprietary schools, and the two-year colleges of the state (Tables 7.6 and 7.7).

PROFESSIONAL TRAINING: THE COLLEGES AND UNIVERSITIES

Oklahoma demonstrated a commitment to higher education even before statehood. The first Oklahoma Territorial Legislature in 1890 established an embryonic "system" of higher education that included the university, the agricultural college, and the normal school. Even earlier, by the mid-19th century, in the eastern half of present-day Oklahoma (which the Five Civilized Tribes called the Indian Nations) the Cherokees had established male and female seminaries designed to provide "advanced" education for its young people. Furthermore, several schools were established by various missionary groups in the Indian Nations before the Civil War.

From these beginnings, Oklahoma has developed a system of institutions including public and independent

Table 7.6 -- Secondary Vocational Enrollments, 1990-91

Grade Level	Vocational Enrollments	Total Secondary Enrollments
9	16,025	42,562
10	11,971	38,939
11	17,866	38,460
12	21,453	36,209
TOTAL	67,315	156,170

Source: Oklahoma State Department of Vocational and Technical Education (1991).

Table 7.7 -- Adults in Vocational Education by Selected Category, 1990-91

Category	Total
Adult Training & Development	221,008
Industry Training & Development	35,789
Part-Time Adult	18,028
Tinker Air Force Base	1,281
Clerks & Treasurers	1,116
Inmate Training Centers	1,503
Displaced Homemakers/Singles	5,472
Nontraditional Careers	850
Full-Time Adults	15,477
TOTAL	300,524

Source: Oklahoma State Department of Vocational and Technical Education (1991).

universities and colleges (Map 7.2); 37 are fully accredited by the regional accreditation association. These 37 include three doctoral-research universities, 10 public regional-comprehensive universities, six independent church-related four-year colleges, 14 public two year colleges, and four independent two-year colleges. Because the institutions are distributed throughout the state, a very high percentage of the population has ready access to either a state or private institution or both. In terms of the number of public institutions per capita, Oklahoma ranks in the upper fifth among the 50 states, another indication of a commitment to access. The state has achieved considerable success in providing access to higher education for all interested and eligible citizens. Access includes both availability of opportunity in terms of "spaces" provided and in terms of physical proximity to institutions.

Many Oklahomans take advantage of the opportunities offered through the state's public and private institutions (Table 7.8). Other information worthy of note is that women outnumber men in lower division and unclassified enrollments, which suggests that their full utilization of higher education services is in the early stages of development.

A five-year comparison indicates that the enrollments in 1989-90 were consistent with the period. Unduplicated headcount enrollments ranged from a low of 235,721 in 1984-85 to a high of 243,870 in 1982-83. This relative stability is remarkable in view of the economic problems faced by the citizens of the state during the same period. Fall semester headcount enrollments (Table 7.9) show a general upward trend of approximately 20% over the past 15 years. Spring semester enrollments, however, did not keep pace.

The State Regents for Higher Education maintain records on 30 different program categories. During 1986-87, 10 of those program categories accounted for nearly four-fifths of all enrollments in Oklahoma's public and private colleges (Table 7.10). Only about one-quarter of the enrollments were in liberal arts or general education programs; the majority of enrollments (55%) were in career-oriented programs. Business management and business technology accounted for 22% of the enrollments; engineering, engineering technology, and computer technology accounted for 12%; the health professions and their service technologies accounted for 5%; and

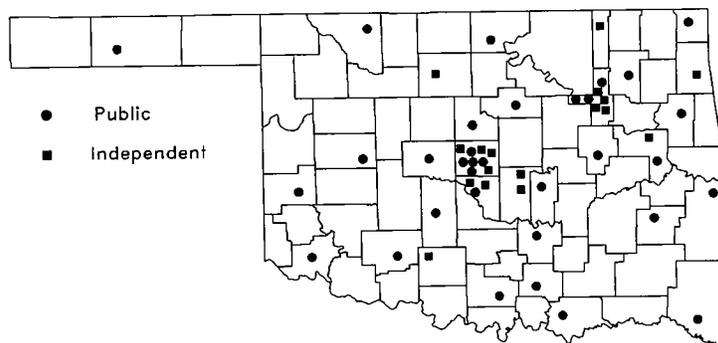
education accounted for 13%. This career-oriented pattern of enrollments is consistent with patterns seen across the nation. Oklahoma's students of higher education are looking to their working futures and are preparing for service in areas deemed critical to the economic well-being of society.

The programs noted above are the responsibility of the faculties of the several institutions, and it is proper to note the central role faculty members play in the success of any academic endeavor. Faculties in Oklahoma colleges and universities have achieved remarkable levels of success.

Another aspect of higher education in Oklahoma is an extensive continuing education program that takes studies directly to the people. In addition, four Higher Education Centers have been established in Tulsa, Ardmore, Enid, and Idabel. An Instructional Television Service is also in operation, and it is being expanded to provide a broader range of services. The Agricultural Extension Service, operating from Oklahoma State University (OSU), provides assistance to urban and suburban gardeners as well as to clients on farms and ranches, and those in agri-business.

RESEARCH IN HIGHER EDUCATION

Research is one of the three major functions of colleges and universities, along with instruction and public service. Instruction is concerned with the transmission of knowledge, research with the creation and synthesis of knowledge, and public service with making knowledge directly available



Map 7.2—Locations of public and independent institutions of higher education in Oklahoma, 1988. Source: Oklahoma State Regents for Higher Education (1988).

Table 7.8 -- Higher Education Unduplicated Headcount Enrollment, 1989-90

	Male	Female	Total
Public	97,014	119,276	216,290
Private	12,192	11,702	23,894
TOTAL	109,206	130,978	240,184

Source: Oklahoma State Regents for Higher Education (1991).

Table 7.9 -- Fall Semester Headcount Enrollments in Oklahoma Public Colleges, 1976-90

1976	127,536
1977	131,367
1978	130,346
1979	133,570
1980	140,799
1981	142,719
1982	149,016
1983	154,469
1984	148,469
1985	149,281
1986	150,364
1987	151,030
1988	152,445
1989	149,765
1990	153,054

Source: Oklahoma State Regents for Higher Education (1991).

Table 7.10 -- Unduplicated Headcount Enrollments in Oklahoma's Higher Education Institutions, 1986-87

Academic Program Area	% Enrollment
Arts and Sciences (General)	24
Business Management	15
Education	13
Business Technology	7
Engineering Technology	5
Engineering	4
Health Professions	3
Computer Technology	3
Social Sciences	3
Health Serving Technologies	2
Others (20 categories)	21
TOTAL	100%

Source: Oklahoma State Regents for Higher Education (1987b).

to the public. Each of these functions is vital to the higher education enterprise, and they are related in symbiotic fashion. Out of instruction grows

research, and out of research come applications to help solve social, economic, governmental, and other societal problems. This section is an overview of research projects and their funding in the state's public system of higher education.

In 1988, Oklahoma's public colleges and universities expended approximately \$123 million on research and development programs. Such programs increase Oklahoma's economic potential in the fields of agriculture and industry and improve the quality of life through improvements in health care, the arts and humanities, and government. Organized research, funded primarily from state appropriations, accounted for \$36.3 million. Sponsored research and other sponsored programs accounted for \$86.5 million. This category of research is funded primarily by the federal government, but private foundations, corporations, and individuals also contribute to the total. The funds expended for these activities constituted about 14% of the total expenditures for public higher education in 1988. Table 7.11 presents a picture of research funding by source for the years 1982-88.

The doctoral research universities, the University of Oklahoma and Oklahoma State University, along with the University of Oklahoma Health Sciences Center, are responsible for about 84% of all research and development programs. The two research universities conduct research in the following fields, among others: biotechnological aspects of agriculture; industrial robot design; electro-optical materials, including laser spectroscopy; enhanced oil recovery; ground water; meteorological science; and particle physics. Biological research on cancer, physiology, and hematology is carried out at the University of Oklahoma Health Sciences Center. The Noble Center for Agriculture and Renewable Resources at Oklahoma State University and the Energy Center at the University of Oklahoma are examples of research programs designed to compete internationally. Table 7.12 presents a breakdown of expenditures for research and development by type of institution and agency.

In 1988, faculty members at Oklahoma's colleges and universities attracted more than \$86 million from the federal government and private sources. Of that, engineering research received approximately \$34 million; research in the health sciences received about \$23 million; and agriculture received about \$19 million.

Oklahoma university scientists have developed nationally recognized expertise in a number of research areas which include, at OSU, laser science, telemetry and signal science, web-handling, and water quality studies, and, at OU, energy science, meteorology and space science, surfactant research, and water resource management. Faculty members at the University of Oklahoma Health Sciences Center compete successfully at the national level in such fields as cardiac science, hematology and other blood related science, molecular biology, alcohol and drug abuse, genetics, and in many cancer studies including bone marrow investigations, cancer prevention and diagnosis, and pediatric oncology.

In 1987, the Federal Aviation Administration awarded the University of Oklahoma \$14 million, primarily for the training of air traffic controllers. The next largest award, \$5.6 million, went to Oklahoma State University from the U.S. Department of Agriculture (from Smith-Lever funds) for extension purposes. Several other large awards in 1987 are reported in Table 7.13.

Some 160 grants, each for more than \$100,000, were made to Oklahoma higher education institutions for programs of research and training in 1988. The level of external funding to State System institutions in 1988, a total of \$86.5 million, represents an increase of \$14.0 million over the previous year.

Oklahoma is examining its role in what is becoming an international economy. In order to compete successfully, Oklahoma must be able to produce goods and services more efficiently than its competitors in other states and other nations can. Only by learning how to do things better and faster can a nation or a state improve its work force and its economy. Research being conducted by faculty

members in the state's colleges and universities can promote increased productivity. Funds allocated to college and university research help produce a higher quality of life and, therefore, may be thought of not as expenditures but as investments in inventing the future.

THE ARTS AND HUMANITIES

Alexander Pope once observed, "so vast is art, so narrow human wit." A discussion of education in Oklahoma must include those aspects of "art" that can expand wisdom, or "wit" as Pope says.

It is a primary assumption of this chapter that a proper education contributes to enlarging the life of an individual and the individual's society. This view is not unique; both popular and professional literature reflect current concern for the "quality of life." It is not enough to prepare individuals merely to survive in contemporary society. Both the individual and the society require more.

A concern for the "quality of life" holds that a good life is more than having an adequate income, reasonable living conditions, ample opportunities for entertainment, and safe streets. There must be something in the total environment that gives meaning to all such aspects of everyday life, that helps all those mundane activities "make sense," at least in a secular way. The "quality of life" in a given community is enhanced when earning a livelihood contributes to personal and social development as well as to the Gross National Product.

The fine arts and the humanities are central to a community's "quality of life" index. The humanities, as defined by the Oklahoma Foundation for the Humanities, are "studies in the disciplines of history, literature, languages, philosophy, linguistics, archaeology, jurisprudence, the history, theory, and criticism of the creative and performing arts, ethics, comparative religions, and those aspects of the social sciences employing historical or philosophical approaches." It is generally agreed that "art" is concerned with the creation of objects of the imagination for their own sake, without concern about the practical utility of the object. The fine arts include

Table 7.11 -- Expenditures for Organized Research, Sponsored Research, and Other Sponsored Programs, 1982-88

Year	Organized Research	Sponsored Research and Other Sponsored Programs	Totals
1982	\$28,269,229	\$57,846,762	\$86,115,991
1983	33,852,267	65,947,360	99,799,627
1984	30,548,230	63,188,551	93,736,781
1985	32,189,979	67,957,017	100,146,996
1986	35,632,055	72,050,726	107,682,781
1987	33,521,007	75,154,663	108,675,670
1988	36,282,442	86,488,278	122,770,720
% of Increase 1982-88	28.3	49.5	42.6

Source: Oklahoma State Regents for Higher Education (1988a).

painting, drawing, sculpture, poetry, music, dance, and drama. These arts are practiced not only in academic and professional settings, but also in the broader community where they are often known as "folk art."

The study of the arts and humanities is alive and well in all 578 of the school districts of Oklahoma. All of the larger school districts include formal instruction in art and music in both the elementary and secondary divisions; smaller school districts frequently are able to provide such instruction only in the secondary division. It is customary at the elementary level to consider art and music instruction supplemental to more traditional academic and skill instruction. However, in recent years, the trend in elementary school music instruction has been toward improvement and expansion through better teacher preparation and the use of Orff instruments. Art and music are elective studies in high schools, frequently through performing music groups and studio-type art courses. Practically all (except the very smallest) high schools in the state have instrumental and choral organizations. These programs are actively coordinated through statewide professional organizations. Students regularly perform in annual contests where their abilities and achievements are evaluated and ranked. Marching bands and mixed choruses are the predominant form of musical expression and training available to the high school students in Oklahoma, although the largest of the schools offer broader experience, including orchestras that perform symphonic works.

There appears to have been a narrowing of experience, however, at least in vocal music programs. Smaller vocal performance groups are emerging, and the mixed chorus or choir with a broader repertoire is not so dominant. Opportunities for learners to develop an appreciation for other art forms are fostered by the Arts in Education Section of the State Department of Education and the community agencies with which it cooperates.

Creative or expressive writing incorporates elements of both the humanities and the fine arts. Students at all levels are stimulated to develop their creative/expressive writing skills. Many schools publish collections of student writing in journals or yearbooks.

There are other programs in the arts that serve special needs of young people in Oklahoma schools that demonstrate the commitment of our art teachers and educational leaders. One noteworthy program is Very Special Arts—Oklahoma (VSA-O), an outgrowth of the Adaptive Arts program. Its published purpose is "to establish effective year-round programming which addresses all art forms for the handicapped population in Oklahoma." Although this program offers opportunities to individuals beyond school-attending age, its usual focus is in the schools. Three model projects operated successfully in 1986-87, one of them at the Oklahoma School for the Deaf, Sulphur. It was a three day "Very Special Arts Festival" that involved 200 high school hearing-impaired and deaf students from 10 high schools in Oklahoma and five

Table 7.12 -- Research Expenditure by Type of Institution, 1988

Type of Institution	Research Expenditures	Expenditures (%)
Doctoral Universities	\$59,264,410	48.3
Regional Universities	11,135,920	9.0
Two-Year Colleges	4,791,768	3.9
Nine Constituent Agencies*	47,578,622	38.8
TOTALS	\$122,770,720	100.0

*Includes OU-HSC, Geological Survey, and OSU agricultural agencies.
Source: Oklahoma State Regents for Higher Education (1991).

Table 7.13 -- Selected Large External Awards, University of Oklahoma and Oklahoma State University, 1987

Institution	Project or Program	Amount
OSU	Signal Processing	\$1,000,000
OSU	Morocco Coop./ OSU-Nebraska	900,000
OU	Mesoscale Meteorological Studies	850,000
OU-HSC	Saint Francis Hospital Project	750,000
OU	Electron Microscope Project	750,000
OU	Multifunctional Resource Center	517,000
OU	Continuing Higher Education Program	486,000

Source: Oklahoma State Regents for Higher Education (1987a).

other states. Its program included 30 teacher/student workshops featuring recognized leaders in education and theater for the hearing-impaired, artists in residence, and a theater competition of plays performed by the students from Sulphur and from the Louisiana School for the Deaf. "Imagination," a play written and performed by students from the Oklahoma School for the Deaf, was recognized by Very Special Arts—USA as among the best five (out of 120) submitted in its national competition. Another model program included a carefully planned dance program for handicapped adults, a student-constructed sculpture, and a poetry anthology. The third model program focused on training teachers to provide special experiences in the arts for "mainstreamed" handicapped students.

Oklahoma's public and private colleges and universities offer rich op-

portunities in the arts and humanities. They all provide musical instruction and performance opportunities as well as professional training. There are symphonic orchestras, a wide variety of performing ensembles, musical theater productions, and student and faculty recitals. Oklahoma City University has gained fame as a training ground for successful singers, several of whom have become well-respected on the concert and operatic stages of the country. The marching band of the University of Oklahoma, "The Pride of Oklahoma," has received the prestigious Sudler Trophy, which is presented each year to the nation's outstanding university marching band by the John Philip Sousa Foundation.

The Western History Collection and the History of Science Collection at the University of Oklahoma are without peers in America. Langston University has developed a remarkable Black History Center, with special emphasis on the life and struggles of Blacks in Oklahoma. All institutions publish campus newspapers, ranging from daily papers at the major universities to weekly papers at the smaller institutions. The University of Central Oklahoma regularly publishes a student literary journal that demonstrates the ever-present vigor and curiosity of the student population.

The visual arts are represented by statuary on campuses, by exhibition halls, and by art museums as well as by art history studies and studio instruction. Museums are not limited to the major university campuses. For example, St. Gregory's College, a junior college operated by the Benedictines, is the home of a remarkable art museum. The Mabee-Gerrer Museum houses works by Fr. Gerrer, a

long-time art teacher and artist at St. Gregory's, as well as other works from around the world.

The special contribution made by arts and humanities faculty members is one of higher education's important services to the community. These men and women—through teaching and performance in such areas as literature, music, dance, theater, painting, and sculpture—add a significant dimension to Oklahoma's "quality of life."

CONCLUSION

Oklahoma provides educational opportunities to its citizens, and to citizens of other states and nations, through local school districts, a considerable number of private day schools and academies, vo/tech school districts, and public and private post-secondary institutions. In 1990 these schools and institutions enrolled well over three-quarters of a million individuals. State agencies involved in the policy development and coordinating activities are the State Board of Education and its Department of Public Instruction, the State Board of Vocational and Technical Education, and the State Regents for Higher Education. The K-12 schools are generally modest in size and support, but they have been able to produce quality programs for both talented learners and less-gifted students.

Vocational education makes a vital contribution to the upgrading of Oklahoma's work force and the development of the state's human capital. Each year, hundreds of thousands of Oklahomans enter the world of work through programs of vocational and technical education in comprehensive high schools, area vo/tech schools, post-secondary proprietary schools, and two-year colleges.

Higher education in Oklahoma has a broad mission and a goal of making training and education opportunities available across the entire state. There are opportunities in vocational and career preparation programs, in the arts, humanities, and sciences, and in more esoteric realms of knowledge. Colleges and universities also provide a wide range of services to the individual and corporate citizens of Oklahoma. Such services range from train-

ing/instruction to the most advanced research.

In a democratic society, it is not enough to educate a small elite to provide leadership for the whole. Rather, it is necessary to foster achievement in all aspects of community life. As John Gardner, former Secretary of Health, Education, and Welfare, pointed out in his book, *Excellence*, "A nation which values a mediocre philosopher above an excellent plumber will soon find out that neither its theories nor its pipes will hold water." All citizens need to participate in "inventing the future"; education prepares them to succeed. Education adds not only to the economic well-being of the people and the state; it also places value on individual growth and contributes to the development and maintenance of Oklahoma's "quality of life."

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— Chapter 7 —
LIST OF ILLUSTRATIONS

Maps

7.1 — Locations of Oklahoma area vocational/technical schools, 1988 _____	117
7.2 — Locations of institutions of higher education in Oklahoma, 1988 _____	121

Tables

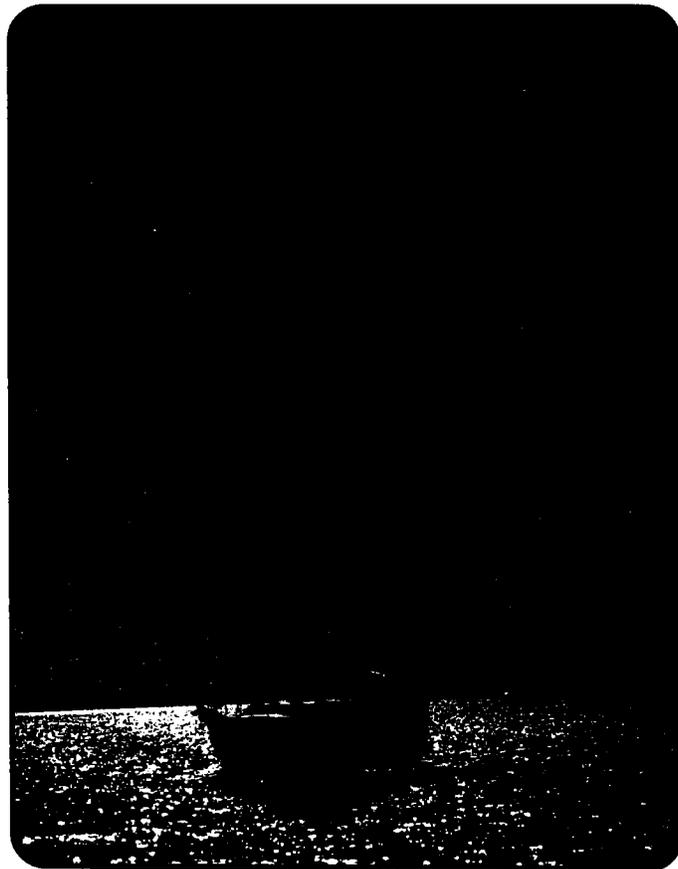
7.1 — Enrollments in public schools by level and ethnic group, fall 1991 _____	115
7.2 — Distribution of exemplary programs by content area and grade level, 1987 _____	116
7.3 — Source of funds for vocational education in Oklahoma, fall 1992 _____	118
7.4 — Number and projected costs of occupational programs, 1987–88 _____	119
7.5 — Two-year technical programs in public colleges, 1988 _____	120
7.6 — Secondary vocational enrollments, 1990–91 _____	121
7.7 — Adults in vocational education by selected category, 1990–91 _____	121
7.8 — Higher education enrollment, 1989–90 _____	122
7.9 — Fall semester enrollments in public colleges, 1976–90 _____	122
7.10 — Enrollments in higher education institutions, 1986–87 _____	122
7.11 — Expenditures for organized and sponsored research, 1982–88 _____	123
7.12 — Research expenditure by type of institution, 1988 _____	124
7.13 — Selected large external awards, OU and OSU, 1987 _____	124

Oklahoma Resources

Chapter
8

Recreation and
Quality of Life

by
Henry Eisenhart



Contents

Executive Summary	129
Introduction	130
Oklahoma's Recreation Resource Base	130
State Parks and Recreation Areas	131
State Authority and Responsibility	131
Water Resources for Recreation	132
Outdoor Recreation Opportunities	133
Fishing and Hunting	133
Trails	133
Forests, Rocks, and Fossils	133
Tourism: Oklahoma, State of Many Countries	134
Commercial Recreation	136
Municipal and Local Recreation	137
Conclusion	137
References	137
List of Illustrations	138

Recreation and Quality of Life

Henry Eisenhart

Executive Summary.—Oklahoma offers a wide variety of leisure-time activities and public recreation resources with 35 state parks, 25 recreation areas, 12 historical and cultural monuments, five scenic rivers, two national forests, one intrastate waterway, and many wildlife and waterfowl management areas. Extensive local and municipal park systems and rural programs offer opportunities for hiking, swimming, camping, and other outdoor endeavors.

A moderate climate encourages outdoor activity almost year round. Seven state-operated lodges and resorts utilize the geography unique to their particular area and offer a variety of facilities and programs. Black Mesa (Oklahoma's highest point), Red Rock Canyon, Alabaster Caverns, and a beautiful river system offer a rich diversity in geologic and geomorphic development. Water is a predominant recreation resource, particularly in eastern Oklahoma, with as much as 50 inches of rainfall annually in some places. A series of dams and watershed developments have created a water recreation paradise, attracting anglers, boaters, skiers, and swimmers from all over this region. Called the "Frontier Lake State," Oklahoma has more than 5,500 miles of lakeshore.

Oklahoma is divided into six recreation "countries" named for their unique physical and cultural amenities. The northwest and Panhandle region, noted for its friendliness and hospitality, is called Red Carpet Country. Green Country, northeastern Oklahoma, has lush foliage and thick forests. The Kiamichi Mountain range that rolls through southeastern Oklahoma gives its name to this area, noted for the spectacular fall foliage of burnt orange, red, and golden yellow. South-central Oklahoma, Lake Country, is the favorite water playground, boasting Lake Texoma, the state's most popular recreation spot, Lake Murray, and others. Great Plains Country includes the expansive plains of southwestern Oklahoma and the great Oklahoma prairies. Finally, Frontier Country is the geographic center of Oklahoma, where the state's frontier began after the Oklahoma Land Run of 1889.

For those interested in Oklahoma's historical heritage, there are hundreds of museums, monuments, memorials, and cultural remnants of the development of the Indian territories and early statehood. The National Cowboy Hall of Fame, National Softball Hall of Fame, Will Rogers Memorial, Gilcrease Museum, and many other places have captured the essence of Oklahoma through Western art, artifacts, and memorabilia.

The University of Oklahoma and Oklahoma State University offer a great many recreational facilities and opportunities for state residents. They provide the backdrop for state sporting interests and they vie for national championships in intercollegiate athletics each year. A strong network of two- and four-year colleges provides a rich variety of physical fitness, drama, organized sports competition, and community service programs.

Regional and national attractions include the Oklahoma City Zoo, one of the top 10 zoos in the country; the Kirkpatrick Center, featuring hands-on science exhibits and a planetarium; the Western Heritage Center; the State Fair, one of the country's finest; the Oklahoma Arts Center; and the Oklahoma Museum of Natural History at the University of Oklahoma. The metropolitan areas of Tulsa and Oklahoma City provide highly developed park systems, professional sports, national attractions in the entertainment field of performing artists, convention centers, and even two large theme parks: "White Water Bay" in Oklahoma City and "Big Splash" in Tulsa.

If variety is what you are looking for, you'll find it in Oklahoma. There are emerald-green mountains, golden prairies, and vast plains. There is a constant breeze and clear blue skies. There are cowboys and Indians, rodeos, concerts, festivals, fairs, hunting, fishing, hiking, camping, and a myriad of other recreation opportunities. Oklahoma is one of the most diverse, beautiful, and recreationally abundant states in the South and West.

INTRODUCTION

Prairie, Indians, cowboys, intercollegiate and interscholastic athletics, water resources, and sunshine all combine to form the basis for Oklahoma's recreation and tourism industry. Oklahoma's "character" is both mystifying and compelling, yet provides a captivating backdrop for vacations, sightseeing, and cultural inquiry, as well as outdoor recreation.

The state's outdoor recreation system covers a significant area of land and water and engages a vast number of its citizens both as participants in and providers of recreation activities. This system's size and diversity make it difficult to understand, accurately describe, and, most importantly, successfully administer (Table 8.1). Our challenge is to find a balance between satisfying the recreation needs of an expanding recreating public while protecting our non-renewable natural resources and ensuring recreational opportunities for the future.

Today, the benefits of recreation are appreciated more than ever, providing the following:

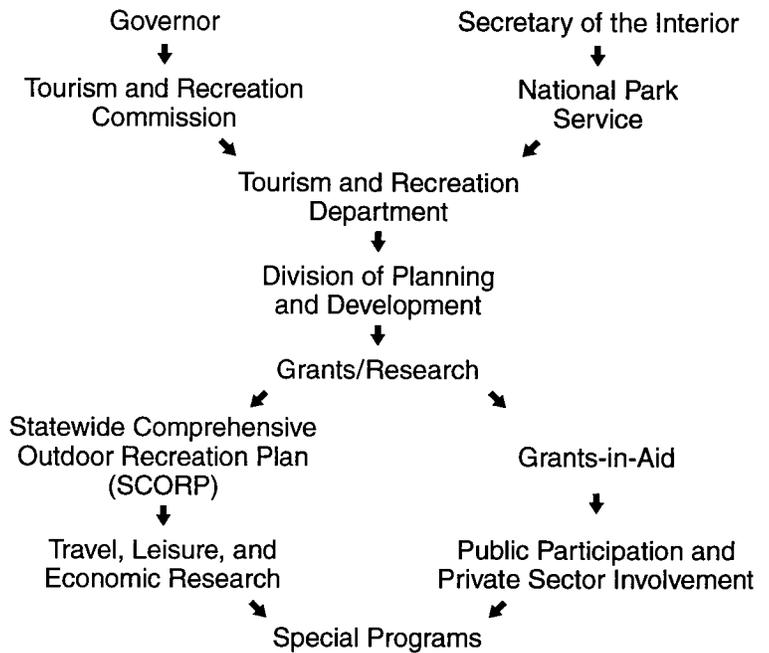
- 1) opportunities and surroundings that can contribute significantly to enhancing "quality of life";
- 2) a means for interaction with, and interpretation of, the natural and cultural environment;
- 3) an important public service for which federal, state and local public agencies expend more than \$10 billion across the nation each year; and
- 4) economic growth, both nationally and within the state, through personal expenditures and federal contributory programs.

That recreation has become widely recognized as a necessity is reflected in the fact that Oklahomans from various age and economic groups spend more than \$1.5 billion on recreation each year, and visitation to state parks and recreation areas increases each year.

OKLAHOMA'S RECREATION RESOURCE BASE

Public recreation resources in Oklahoma encompass approximately 2 million land acres and 1 million water surface acres. Local recreation areas, those administered by municipalities, counties, towns, and school systems,

Table 8.1 Organization of Federal and State Recreation Agencies



Source: Oklahoma State Department of Recreation and Tourism (1992).

account for the greatest number of individual developments and recreation opportunities, but the least total acreage.

Water-oriented recreation opportunities are provided by two major river systems, the Red River and the Arkansas River, together with numerous flatwater areas. Oklahoma's 32 major lakes and reservoirs account for approximately 575,000 surface acres of water. With the addition of stream waters, rivers, smaller reservoirs, and accountable farm ponds, the total acreage exceeds 1 million surface acres. Water and land acreage are generally accessible and provide excellent opportunities for many outdoor recreation activities, including boating and water sports, fishing, and hunting. Similarly, many public amenities such as golf courses, tennis courts, swimming facilities, hiking trails, and camping areas are very accessible to Oklahoma residents and visitors alike.

A variety of federal, state, and local agencies are responsible for managing Oklahoma's recreation estate. At the federal level, the National Park Service, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of En-

gineers are the primary managers of recreation lands in the state (Table 8.2). In addition, the Department of Interior's Bureau of Reclamation surveying, engineering, and construction projects normally include recreation development. The joint-use concept of recreation management has been particularly successful in the development of Oklahoma's recreation resources. Although many of the reservoirs are intended for flood control, irrigation, and, in some cases, hydroelectric power production, recreation is a major by-product of this development.

The Oklahoma Department of Tourism and Recreation and the Oklahoma Department of Wildlife Conservation are the primary state managers of recreation properties (Table 8.2). At the local level the responsibilities for recreation management normally fall under the jurisdiction of a municipal recreation and parks department. In addition, several other agencies, including the Grand River Dam Authority and the Scenic Rivers Commission, manage individual sites.

Private enterprise provides many recreational opportunities throughout

Table 8.2 Oklahoma's Recreational Inventory: Local, State and Federal Holdings

Agency	Land	Acreage Water	Total
City Governments	38,949	51,530	90,479
School Districts	2,564	249	2,813
County Governments	7	0	7
Oklahoma Colleges and Universities	23,660	4,212	27,872
Grand River Dam Authority	0	69,050	69,050
Oklahoma Tourism & Recreation Department	84,698	46,013	130,711
Oklahoma Wildlife	715,238	2,120	717,358
U.S. Army Corps of Engineers	79,680	432,337	512,017
U.S. Forest Service	249,010	91	249,101
National Park Service	4,645	2,346	6,991
Bureau of Indian Affairs	54	0	54
Bureau of Reclamation	7,121	6,070	13,191
TOTALS	1,205,626	614,018	1,819,644

Source: Oklahoma State Department of Recreation and Tourism (1992).

the state in four general areas: private for-profit; private nonprofit; individual; and corporate.

The profit-oriented private sector enterprise, or commercial recreation establishment, usually provides specialized services and facilities that complement public resources and services. Examples of commercial developments are resorts and lodges, private campgrounds, marinas, athletic and fitness clubs, country clubs, and amusement and theme parks. These places provide amenities that are often beyond the financial capability of state or municipal agencies and comprise an important component of the total recreation network in Oklahoma (Table 8.3).

The private, nonprofit providers of recreation services are groups such as the YMCA, YWCA, organized church recreation programs, and Scouts. A great many Oklahomans use private land holdings and private resources such as hunting lands, private fishing lakes and ponds, residential swimming pools, and corporate development. Business organizations in Oklahoma are aware of the health and morale benefits associated with recreational opportunities and make a variety of programs, activities, and services available to employees. Private sector recreation is growing rapidly in Oklahoma. The following facts from the state Department of Tourism and Recreation illustrate the importance of recreation as an economic resource:

- Tourism is Oklahoma's *second largest industry*.

- U.S. travelers spend nearly \$3.0 billion a year in Oklahoma, including expenditures on all commercial recreation activities as well as the hotel and convention business.

- These expenditures directly generate approximately 60,000 jobs in recreation and leisure services within the state.

- Employees in these jobs earned nearly \$615.0 million in wage and salary income.

- Travel spending also generates approximately \$200 million in state and local tax revenue each year.

STATE PARKS AND RECREATION AREAS

The development of the state park system in Oklahoma began in 1931 when the legislature appropriated \$90,000 for the purchase of land specifically for park development. Project construction began in 1933 and Lake Murray State Park, the first property, was completed in 1937. Today the Division of State Parks (a division of the Oklahoma State Department of Tourism and Recreation) includes 35 state parks, 25 recreation areas, and 12 historical monuments and museums (Map 8.1; Tables 8.4, 8.5). Facilities that are included at these state parks are:

- *Camping:* 165 camping areas, 4,644 total camp sites.

- *Shelters:* 144 group shelters and 207 individual shelters.

- *Cabins:* 191 cabin units that accommodate 820 visitors.

- *Marinas:* 13 marinas, nine enclosed fishing docks, 10 boat rentals, five paddle boat rentals, and 11 bait shops.

- *Golf courses:* four nine-hole courses; five 18-hole courses.

- *Swimming:* 14 swimming pools; three beach areas.

- *Other facilities:* 27 parks with hiking trails, nine with stables, five with nature centers, numerous boat ramps and picnic areas.

State Authority and Responsibility

In 1972, the 33rd Oklahoma legislature enacted the "Oklahoma Tourism and Recreation Act" consolidating various state agencies dealing with tourism; the marketing of Oklahoma's recreation resources; park development and maintenance; and economic and industrial development. This act, which created the Department of Tourism and Recreation, charged this new government entity with "promoting the development and use of the state's lodges, parks, and recreation areas; promoting tourism through publicity and dissemination of information; assisting in the promotion of events sponsored by municipalities, associations, and organizations commemorating special events of local or historical interest; and [serving] as a clearinghouse for state, municipal, and private recreation and tourism operations."

State government is responsible for acquiring, protecting, and developing a system of outdoor recreation resources and facilities for its citizens that are of a regional or statewide significance. This includes park land, forests, natural areas, wildlife management areas, reservoirs, historic landmarks, trails, and scenic rivers.

A second responsibility is planning and coordination, through the development and implementation of a statewide comprehensive outdoor recreation plan. This plan establishes statewide priorities and objectives for the development and use of Oklahoma's considerable outdoor natural recreation resources.

The state must also provide administrative and technical assistance to individual municipal and county

Table 8.3 Major Recreation Issues in Oklahoma**Environmental Quality and Preservation**

1. Long Range Planning
2. Water Quality and Preservation
3. Littering and Vandalism
4. Funding at Parks
5. Appropriate Waste Disposal

Behavioral Needs

1. Increase Public Awareness
2. Security and Law Enforcement
3. Cultural and Historical Preservation
4. Outdoor Environmental Education
5. Enlarge Recreation Experience

Recreation Activities and Facility Trends

1. Management and Operation
2. Accommodation of Popular Activities
3. Promotion of Activities
4. Increase Number of Support Facilities
5. Improve Facility Design

Economic and Human Constraints

1. Available Funding
2. Inflation
3. Role of the Private Sector
4. Disposable Income
5. Energy

Source: Oklahoma State Department of Recreation and Tourism (1992).

agencies in the development and delivery of their recreation and leisure services. Acting as a clearinghouse for federal grant programs is an additional responsibility for state government, which contributes to the coordination of statewide recreation projects. Finally, the state has an obligation to continue to provide contemporary scientific data regarding state resources and citizen behavior. This includes supply and demand data, needs analyses, participation rates and patterns, trends, and projections. This information is then made available to all responsible public and private recreation service providers.

One of the major concerns regarding Oklahoma's recreational potential, and continued development, is the level of federal and state funds that are appropriated for recreation and other "quality of life" venues. Federal recreation monies are becoming scarce and revenues generated through state tax plans are being proportionately earmarked for more essential public services. This situation places an additional emphasis on devising new

methods for generating sources of revenue, specifically for recreational endeavors and developments.

Although traditional tax-based programs, facilities, and services still receive annual funding, it is becoming more acceptable to require recreation participants to pay for recreational opportunities and experiences. Some new considerations that will help defray the burgeoning expenses of state-supported recreation include:

- Expanded and increased user fees.
- Park entrance fees (now free).
- Issuing recreation licenses or passes.
- A state excise tax on recreation equipment.
- Hotel and resort taxes for recreation.
- State lottery with percentage going to park areas.
- A state natural resource trust fund.
- A non-profit foundation.

State surveys have revealed that, in general, user charges are acceptable to the general public and in fact justified because of the potential to upgrade certain facilities and services. State park resorts, cabins, and restaurants charge for lodging and food. There is a charge for use of group camps, group lodges, and recreational buildings. A daily fee is charged for campsites, both for recreational vehicles as well as tent camping. Slip spaces at the various marinas are rented to boat owners. Green fees are collected at state-run golf courses and there is an admission charge for swimming pools and public beaches where lifeguards and bathhouses are provided. State lodges make available recreational vehicles and equipment or rental items for patrons. These include sailboats and motorboats, fishing equipment, bicycles, golf equipment, and tennis gear. The revenue from these fees and charges partially offset the state park operating costs.

Water Resources for Recreation

Two great river systems drain Oklahoma: the Arkansas River, which carries two-thirds of the runoff, and the Red River. The Arkansas, a swift, snow-fed stream originating in the highlands of the Colorado Rockies, enters Oklahoma, gathering in the north the Salt Fork, the Chickaskia, the

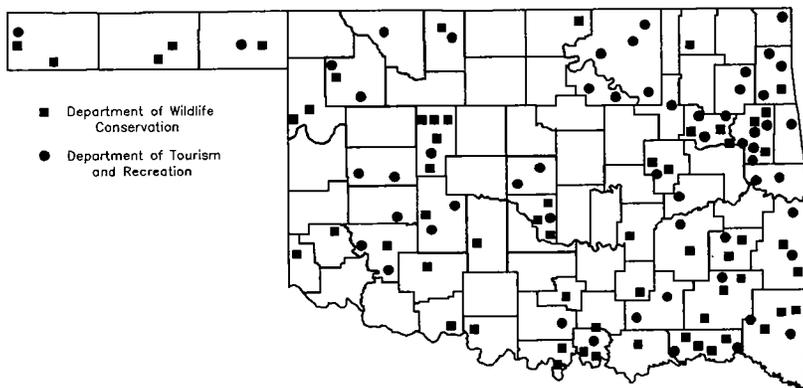
Cimarron, the Verdigris, the Grand, and the Illinois Rivers. Its principal southern feeder is the Canadian River. The North Canadian, formed at the junction of the Beaver River and Wolf Creek in the northwestern corner of the state, enters the Canadian River near Lake Eufaula. Gaines Creek, a southern tributary of the Canadian River, flows in a southerly direction across Pittsburg County. This river was called the South Canadian by early settlers. The Red River, forming on the high plains of the Texas Panhandle, delineates Oklahoma's southern border, collecting in its course the waters of the North Fork, the Washita, the Boggy, the Blue, and the Kiamichi.

Eastern Oklahoma, with its abundant rainfall, forest lands, and many Corps of Engineers dams and projects, is a water recreation paradise. As Oklahoma's topography changes from eastern forests to central prairies to western plains, annual rainfall and drainage systems become less conspicuous and recreation resources fewer in number.

Oklahoma has more than 200 lakes—60 in excess of 1,000 acres in size—and more than 1.3 million surface acres of water. The quality of Oklahoma's lakes is as impressive as the quantity of water available. Weather conditions allow for use of water resources almost year-round and the fishing and waterfowl programs are outstanding. Primary water-related activities include swimming, skiing, sailing, and fishing. In addition, many state parks are located adjacent to large bodies of water providing excellent camping facilities, scenic trails, and miles of beaches.

Other recreation areas of interest include more than 600 designated historical sites, a statewide trail system, several federally designated scenic rivers, two scenic highways, and a great many privately owned lakes and ponds that are utilized locally for recreation. Some current facts about America's Frontier Lake State include:

- Oklahoma has more man-made lakes than any other state.
- Oklahoma has invested more than \$1.25 billion in water development over the past 50 years.
- Oklahoma has more than 200 lakes and a water-to-land ratio of 1:44 acres.



Map 8.1 — Recreation areas of Oklahoma. Source: Oklahoma State Department of Tourism and Recreation (1992).

- Oklahoma has 5,596 miles of shoreline, which is 2,000 miles more than the Atlantic and Gulf coasts combined.

- Oklahoma ranks 17th in the U.S. in the amount of inland water.

- Oklahoma has more than 800,000 licensed fishermen and collects over \$4.5 million each year in boat and motor taxes.

- Oklahoma has five designated scenic rivers (Map 8.2). The designation of these waterways by the National Park Service as “scenic” categorizes them as exceptional outdoor recreation areas and experiences for individuals pursuing such activities as camping, canoeing, or hiking. This designation also means special environmental protection measures regulate the development of river-related activities and commercial enterprise. Most importantly, it sets up strict environmental guidelines regarding pollution discharge and damage to the surrounding natural habitat.

OUTDOOR RECREATION OPPORTUNITIES

Fishing and Hunting

With more than 600,000 acres of reservoirs, thousands of ponds and watershed lakes, and nearly 23,000 miles of streams and rivers, Oklahoma provides some outstanding settings and opportunities for anglers. Oklahoma ranks third in the United States in the amount of fishable freshwater available and an estimated 200 million pounds of fish are living in these waterways. Each year fishermen catch about 3.8 million pounds of fish

from Oklahoma’s reservoirs and ponds.

Striped bass are a very popular gamefish and are well established in a number of lakes. The largemouth bass is perhaps the fish most sought after by sportsmen and is the number one catch in Oklahoma waters. Besides white bass, walleye, and the smallmouth bass, Oklahoma lakes contain three species of catfish. Also popular are crappie and bluegill, or freshwater perch. In addition, the prized rainbow trout can be caught in two of Oklahoma’s streams.

The key word to describe hunting opportunities in Oklahoma is variety. Whitetail deer abound, particularly in the eastern forested areas. Wild turkey, pheasant, quail, and dove are plentiful and, in season, provide the outdoorsmen with many substantial hunting opportunities. There is challenging upland bird and waterfowl hunting, as well as small game hunting, including three species of rabbit, the prairie chicken, and squirrel. Oklahoma has 48 wildlife department management areas and two national grasslands and national forests that combine for approximately 850,000 acres of public hunting land.

Trails

Oklahoma has an excellent trails system designed for four types of sports opportunities: hiking, canoeing, off-the-road vehicles (ORVs), and horseback riding. Hiking trails are varied and range from less than 1 mile to more than 60 miles in length and can be enjoyed by everyone from the

casual sightseer to the cross-country backpacker (Map 8.3). Nature trails are short, easy-to-walk pathways that often feature interpretive markers, signs, and corresponding brochures. Day hike trails generally range from 1 to 5 miles in length and often cross undulating and hilly terrain. Backpacking trails offer more of a physical challenge, usually traversing rugged terrain and presenting more remote natural regions of the state.

Canoeists can enjoy seven canoe trails in eastern Oklahoma. Located along some of the state’s most beautiful rivers and streams, these scenic routes flow through lush green hills as well as heavily forested mountains. Float trips are very popular on the Illinois River in northeastern Oklahoma; commercial establishments rent canoes and coordinate float trips for a single day or overnight.

The use of ORVs for recreational purposes is a national trend and a rapidly growing outdoor sport. Oklahoma is particularly well-suited to providing ideal areas for ORV operators. There are eight specifically designed motorcycle/ORV areas within the state, providing a variety of terrain features, including sand dunes, beaches, hills, rugged rock outcrops, and water. These areas are accessible for four-wheel drive vehicles, dirt bikes, dune buggies, and motorcycles.

One of the most pleasant ways to experience America’s Frontier Lake State is on horseback, and Oklahoma offers a great variety of scenic equestrian trails. The 25-mile equestrian trail in Robbers Cave State Park winds through pine, oak, and hickory forests and features one of the few designated equestrian campgrounds in the nation. Other Oklahoma horse trails encircle lakes, climb mountains, and follow streams through National Forest lands and across prairies and other vast plains, providing an ideal outdoor experience.

Forests, Rocks, and Fossils

Oklahoma is blessed with one of the most diverse landscapes in the southwest, which includes a variety of forests. Approximately 24% of Oklahoma, or about 10.3 million acres, is covered with forest growth ranging from statuesque pines to scrub oaks.

Table 8.4 Properties Belonging to the Oklahoma Division of State Parks

State Parks	Recreation Areas	Monuments/Museums
Alabaster Caverns	Adair	American Indian Hall of Fame
Arrowhead	Bernice	Black Kettle Museum
Beaver	Boggy Depot	Cherokee Courthouse
Beavers Bend	Boswell	Chouteau Memorial
Black Mesa	Cherokee/Disney	T.B. Ferguson Home
Boiling Springs	Cherokee Landing	Murrell Home
Fort Cobb	Clayton Lake	Pawnee Bill Museum
Foss	Feyodi Creek	Pioneer Woman Museum
Fountainhead	Heavener Runestone	Seay Mansion/Chisholm Trail
Great Plains	Heyburn	Tucker Tower
Great Salt Plains	Honey Creek	Western Trails
Greenleaf	Little Sahara	
Hochatown	Okmulgee	
John Miskelly	Raymond Gary	
Keystone	Salina	
Lake Murray	Sallisaw	
Little River	Sequoyah Bay	
Osage Hills	Snowdale	
Pine Creek	Spavinaw	
Quartz Mountain	Spring River	
Red Rock Canyon	Twin Bridges	
Robbers Cave	Upper Spavinaw	
Rocky Ford		
Roman Nose		
Sequoyah		
Spiro Mounds		
Talimena		
Tenkiller		
Texoma		
Wah Sha She		
Walnut Creek		
Wister		

Source: Oklahoma State Department of Recreation and Tourism (1992).

The type and density of timber in different parts of the state is determined by the elevation, annual precipitation, and soil composition of each region.

Southeastern Oklahoma is renowned for its mountainous beauty and is the site of Ouachita National Forest. Near the Arkansas border, the national forest features the breathtaking Talimena Skyline Drive, the only road in the Southwest built expressly for its view. This scenic route stretches across the crest of the majestic Ouachita Mountains and winds through mile after mile of towering hardwoods and evergreen pines. Beautiful any time of year, the drive is especially spectacular in the autumn, when the foliage explodes into brilliant colors.

The far southeastern corner of the state receives more than 50 inches of rain annually and is covered with verdant forests. Timberland in the region includes commercial pine, bottomland hardwoods, cypress, loblolly,

shortleaf pine, and pine/oak forests. Other parts of the state offer their own unique beauty and recreation opportunities. Central and northeastern Oklahoma primarily feature post oak/blackjack oak forests, while smaller native trees such as pinon, juniper and scrub oak occur along the streams and canyons of northern and southwestern Oklahoma. Tourists flock to Oklahoma from late September through November to tour the fall foliage areas that burst into a breathtaking array of red and golds as the deciduous forests prepare for winter.

Those interested in rock and fossils will find Oklahoma to be particularly obliging in yielding an array of interesting finds. Basic rocks native to the state are limestone, dolomite, shale, sandstone, gypsum, chert, halite, coal, granite, and quartzite. Flint, jasper, agate, petrified wood, and a wide variety of other rocks can also be found.

The oldest exposed layers of Pre-

Cambrian and Cambrian rocks are in the Wichita Mountains in southwestern Oklahoma and in the Arbuckle Mountains in the south-central area of the state. In northwestern Oklahoma, rock collectors will find selenite crystals in Great Salt Plains State Park. The Alabaster Caverns State Park provides an underground show of multi-colored alabaster formations, unique in shape, color, and configuration.

The barite "rose rock" is native to Oklahoma and is the official state rock. Located primarily in south-central Oklahoma's Garber Sandstone, the reddish-brown sandy crystals of barite (barium sulphate) form unique petal-like clusters that resemble a rose in full bloom.

Fossils can be found in all parts of Oklahoma. The area around Bartlesville in northeast Oklahoma is well known for horn coral, while oyster shells abound in southeastern Oklahoma, gastropods in the south-central regions, and fern fossils in eastern Oklahoma.

TOURISM: OKLAHOMA, STATE OF MANY COUNTRIES

There are a great many physical and cultural attractions to see and enjoy in Oklahoma. With a rich history, an important link in this nation's development, a diverse cultural background, and so much natural beauty, Oklahoma is an outstanding tourist destination. Because of the state's diversity, each region has individual uniquenesses and characteristics that have been recognized and portrayed as a "country" (Map 8.4).

The northwestern sector of Oklahoma, including the Panhandle, is called "Red Carpet Country," most noted for agriculture and the hospitable and friendly nature of the people who reside there. A land of sweeping plains, this area has been home to the Plains Indians and offers some intriguing historic sites. In addition to several wildlife refuges, state parks, and recreation areas, there are the Pioneer's Museum, the Cherokee Strip Museum, the Homesteader's Sod House, and the Chisholm Trail Museum, all reflecting the heritage of the pioneer settlers and native Americans who originally tamed and settled these lands.

Table 8.5 Summary Description of Special Use Parks

Interpretive Park

Interpretive parks vary in size and are located wherever a unique cultural, historical or natural feature is located. The primary purpose of an interpretive park is to aid visitors in experiencing the unique or outstanding aspects of its feature. County, municipal, park districts, state, federal, or special districts may administer the area.

Recreation Corridor

A recreation corridor can be any length, preferably longer than one mile. It is established to protect, preserve, and maintain existing natural and cultural corridors, to link population centers, and to provide recreation opportunities along these corridors by utilizing watercourses (e.g., streams, rivers, canals), utility rights-of-way, and abandoned railroad rights-of-way. Administrative responsibility for recreation corridors may be federal, state, county, municipal, or special agency.

Lakeside Area

Lakeside areas range in size from 5 to 30 acres and are located on the shores of a lake or reservoir where boats are allowed. The primary purpose of a lakeside area is to provide local communities a boat ramp to launch their boats. Facilities must include a boat ramp and a parking lot and may include picnic facilities and restrooms. Federal, state, and municipal agencies may administer these areas.

Roadside Park

A roadside park ranges from one-tenth acre to 40 acres and is located alongside any major highway, interstate, or turnpike. The primary function of a roadside park is to provide an aesthetic area where motorists can relax and break from their drive. Facilities may include a parking lot, picnic tables, and restroom facilities. State government and the Turnpike Authority have administrative responsibility for these areas.

Special Use Facility

Special use facilities vary in size depending upon facilities and activities included. They are administered by any public, quasi-public, or private agency. Special use facilities support recreation activities that are very popular by themselves or in conjunction with related facilities requiring a highly specialized resource base. Most facilities that are not managed by public agencies, such as golf courses, group camps, and zoos, fall into this category.

Source: Oklahoma State Department of Recreation and Tourism (1992).

North-central Oklahoma encompasses parts of three regions or countries: Red Carpet Country, Green Country, and Frontier Country. "Green Country" is so named because of the lush foliage resulting from great annual rainfall and good soils. "Frontier Country" is where the state's frontier began after the Land Run of 1889, a popular cultural theme throughout the state's history.

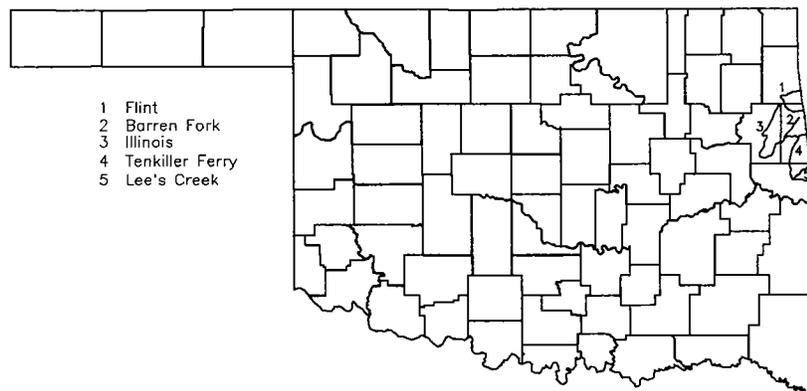
North-central Oklahoma has a rich Indian heritage which is exhibited in the Osage Tribal Museum and the Osage County Historical Museum. Oil is another factor in the cultural development of Oklahoma, and Bartlesville and the Phillips family have preserved a great deal of the state's petroleum development history. At the Will Rogers Memorial and Museum, near Claremore, visitors can see a

great deal of personal memorabilia of this popular American. Stillwater is the home of the National Wrestling Hall of Fame and several art and heri-

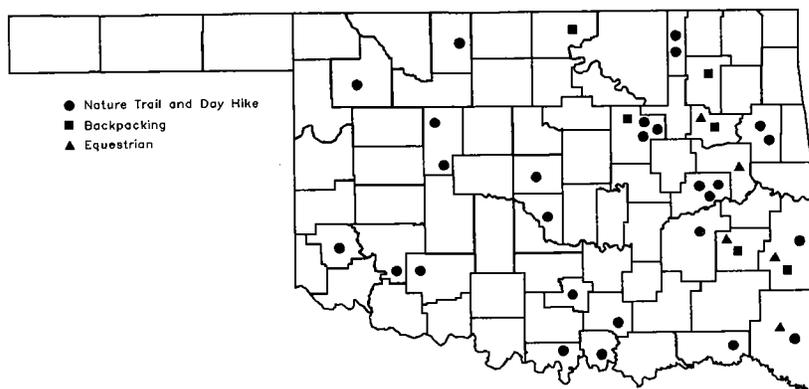
tage centers. North-central Oklahoma offers several state parks and recreation areas, including Keystone Lake, a major water recreation area.

Northeastern Oklahoma is the heart of "Green Country," a land of sparkling streams, wooded hills, and lush green landscapes. This area also offers lakes. Grand Lake is one of the state's largest, with almost 60,000 acres of water and 1,300 miles of shoreline. Shangri-La Resort on Grand Lake offers the utmost in luxury accommodations and recreational opportunities. The beautiful Illinois River runs through "Green Country." The legacy of the Cherokee Indians is portrayed through exhibits at the Cherokee Heritage Center and the Cherokee National Museum. Western Hills Guest Ranch is located on Fort Gibson Reservoir, near Wagoner and Sequoyah State Park. Muskogee hosts an annual azalea festival that is a major regional attraction.

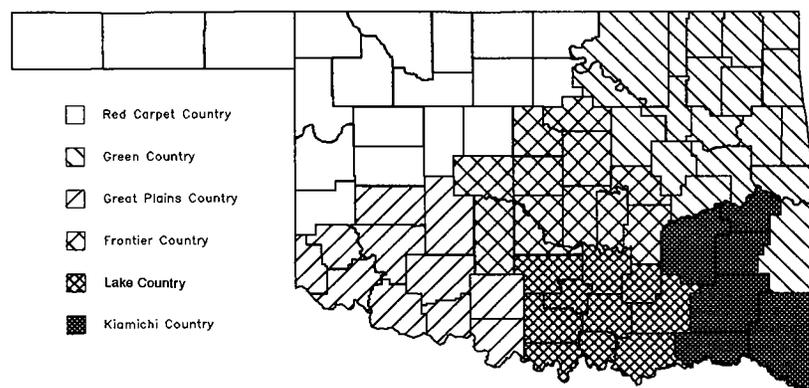
Southeastern Oklahoma is one of the most bountiful and beautiful forested mountain areas in the southwest. The Ouachita National Forest is a favorite attraction in the fall, as well as for year-round hiking, camping, and scenic driving. In addition to the Talimena Skyline Drive, southeastern Oklahoma has some exceptional state park developments. Beaver's Bend State Park is one of the most heavily used, and nearby is Robber's Cave State Park, which sports an interesting history and abounds in folklore. Archaeologists appreciate Spiro Mounds, remnants of an Indian culture that flourished in the area from approxi-



Map 8.2 — Scenic rivers of Oklahoma. Source: Oklahoma State Department of Tourism and Recreation (1992).



Map 8.3 — Oklahoma's trail system. Source: Oklahoma State Department of Tourism and Recreation (1992).



Map 8.4 — Oklahoma's "countries." Source: Oklahoma State Department of Tourism and Recreation, Division of Marketing.

mately 800 to 1350 A.D. Both Arrowhead and Fountainhead State Lodges are located on Lake Eufaula, Oklahoma's largest body of water. Oklahoma's first horse racing track is located at Sallisaw in the east-central portion of this region.

Southwestern Oklahoma, climatically different from the eastern counties, offers some spectacular scenery and many participative opportunities. "Great Plains Country" boasts the rugged Wichita Mountains and Quartz Mountains, which are renowned for their day hiking trails and rock climbing potential. Anadarko boasts Indian City, U.S.A., where the visitor can enjoy an authentic replication of Plains Indian dwellings and demonstrations of native American dancing, arts, and handicrafts. The Museum of the Great Plains in Lawton houses historical and archaeological exhibits detailing prehistory through the 1900s, includ-

ing ancient mammoth skulls and tusks. At the Wichita Mountain Wildlife Refuge, one of the world's largest buffalo herds roams free on the 59,000-acre preserve that is open to the public.

The south-central region of Oklahoma provides Lake Texoma and its resort, a favorite vacation place for Oklahomans and Texans; the beautiful Turner Falls near Davis; and the Chickasaw National Recreation Area in the Arbuckle Mountains. A rich recreational area, south-central Oklahoma has a great many lakes and attracts tourists from surrounding states who annually utilize these state-managed outdoor recreation resources.

COMMERCIAL RECREATION

Oklahomans are fortunate to have a wealth and variety of natural resources that can support the public's need and demand for outdoor experiences.

Commercial recreation establishments include the manufacturers, wholesalers, and retailers of recreation equipment, apparel, and services. They offer resorts, country clubs, athletic contests, concerts, and sporting goods. They bring the circus to town, operate the racetracks, run the bowling alleys and the movie houses, manage the ski areas, build the marinas, and operate the health spas. They are businesses large and small and they are abundant in Oklahoma.

Although each city, county, or town provides some basic recreation necessities, Oklahoma follows a national pattern in attempting to attract and develop commercial recreation and leisure enterprises that will ultimately help the economy (local and state) as well as provide recreational opportunities. Oklahoma's State Fair is considered one of the best in the United States. For more than two weeks each September, residents and visitors can enjoy exhibits featuring arts and crafts, agriculture, outdoor activities, and other topics at the State Fairgrounds in Oklahoma City. The State Fair is a celebration of the lifestyles, hobbies, professions, and interests of Oklahomans. It not only provides an ideal setting for fun and relaxation, but brings a great economic boost to the local economy.

Oklahoma is noted for its cowboys, and rodeos are a year-round occurrence. Several Oklahomans are world famous as rodeo performers and rodeo remains a very popular state leisure activity.

Oklahoma is also noted for its outstanding collegiate athletic teams. The University of Oklahoma and Oklahoma State University continually produce national champions in a variety of athletic endeavors and have programs recognized nationally, not only for their success on the field or court, but as a source of pride for state residents as well. Many institutions of higher education in Oklahoma provide excellent intercollegiate sports programs, student recreation, intramural competition, and physical education programs.

Professional sports are popular in Oklahoma as well. The Oklahoma City 89ers and the Tulsa Drillers, both professional baseball teams, belong to

the Texas Ranger Major League farm system and are integral parts of their communities' recreation systems.

Horse racing is the newest commercial recreation venture in Oklahoma. The first racetrack, Blue Ribbon Downs, opened in Sallisaw in 1985 and has proved a financial and spectator success. Another success is the \$80 million Remington Park racetrack, which began operation in Oklahoma City in 1988. Oklahoma is known for breeding great horses, particularly Quarter Horses, and the state should now be able to capitalize on this investment by having horse breeders keep their stock in Oklahoma for the race seasons.

MUNICIPAL AND LOCAL RECREATION

Although almost every community in Oklahoma provides some form of leisure services for its citizens, there is great diversity among cities in their needs and capabilities for development. Oklahoma City and Tulsa are, by far, the two largest and most cosmopolitan municipal entities in the state and these cities offer a great deal in the way of public and commercial recreation. Oklahoma City, the state capital, is noted for its suburban lakes, parks, and well-established public golf courses. Rich in historical tradition, Oklahoma City is the site of the State Museum of Oklahoma, whose exhibits trace the territorial and state history. Oklahoma City also is the location of the National Cowboy Hall of Fame, the National Softball Hall of Fame, and the Kirkpatrick Center, which features the Omniplex and Planetarium. The Omniplex is a "hands-on" science center, while the Planetarium offers views of the night skies and visual effects recreating voyages to other planets, stars, and galaxies. The Center also houses the Oklahoma Air and Space Museum, the Center of the American Indian, and other specialized exhibits.

Next to the Kirkpatrick Center is one of the city's largest and most popular attractions, the Oklahoma City Zoo and Aquaticus. One of the top 10 zoos in the nation, it features one of the few marine life and dolphin show exhibits in the Southwest. Oklahoma City has several major theme parks,

including Frontier City, an amusement park with an Old West orientation, and White Water Bay, a water park that is a huge attraction in the summer. Oklahoma City has many cultural attractions, including a world-famous symphony orchestra, the annual Arts and Crafts Fair, the Oklahoma Art Center, and the Oklahoma State Fair and Park grounds.

Tulsa is a startling mix of the Old West and the new. It is a bold, young, cosmopolitan city nestled in the rolling hills of northeastern Oklahoma. Surrounded by seven large lakes, the Tulsa area is rich with natural and man-made recreational resources that attract visitors from around the globe. Tulsa has an outstanding park system, including Mohawk Park, a 2,800-acre wooded natural park that is one of the largest city-owned parks in the nation.

One of the best examples of Tulsa's ongoing cultural investment is the Performing Arts Center in downtown Tulsa. The Center has six levels and comprises a 2,400-seat music hall, a 450-seat performing theatre, and two experimental theatres. Among resident performing groups are the Tulsa Philharmonic Orchestra, the Tulsa Ballet Theatre, and the Tulsa Opera.

Tulsa is home to the Thomas Gilcrease Institute of American History and Art. A veritable treasure of western art, this outstanding museum has more than 5,000 works of art, 250,000 Indian artifacts, and 70,000 books and documents. Other places of interest are the Philbrook Art Center, Tulsa Rose Gardens, and the Expo Square Complex, which includes an amusement park, the Tulsa Speedway, and an exhibition center that hosts many trade shows and exhibits.

The Arkansas River flows southeastward through Tulsa and provides aesthetic and active recreation along its developed banks. The Tulsa Run is one of the state's most popular road races each fall, and the annual Great Raft Race on Labor Day is a community celebration. Tulsa University and Oral Roberts University, both private institutions, are located in Tulsa, and through their resources and student activities provide additional recreational facilities and opportunities for Tulsa residents.

CONCLUSION

The quality of life in Oklahoma is truly exceptional. There is geographic diversity, cultural diversity, and climatic diversity that provide a breadth of places, landscapes, and people who share the same pride, heritage, and expectations for the future. Oklahoma's recreation resources are boundless, and state leaders and individual communities are all aware of the importance of recreation and leisure in the daily lives of their citizens. A strong commitment to the continuing development and preservation of a high standard of living in a quality environment is evident everywhere in Oklahoma.

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— Chapter 8 —
LIST OF ILLUSTRATIONS

Maps

8.1 — Recreation areas of Oklahoma	133
8.2 — Scenic rivers of Oklahoma	135
8.3 — Oklahoma's trail system	136
8.4 — Oklahoma's "countries"	136

Tables

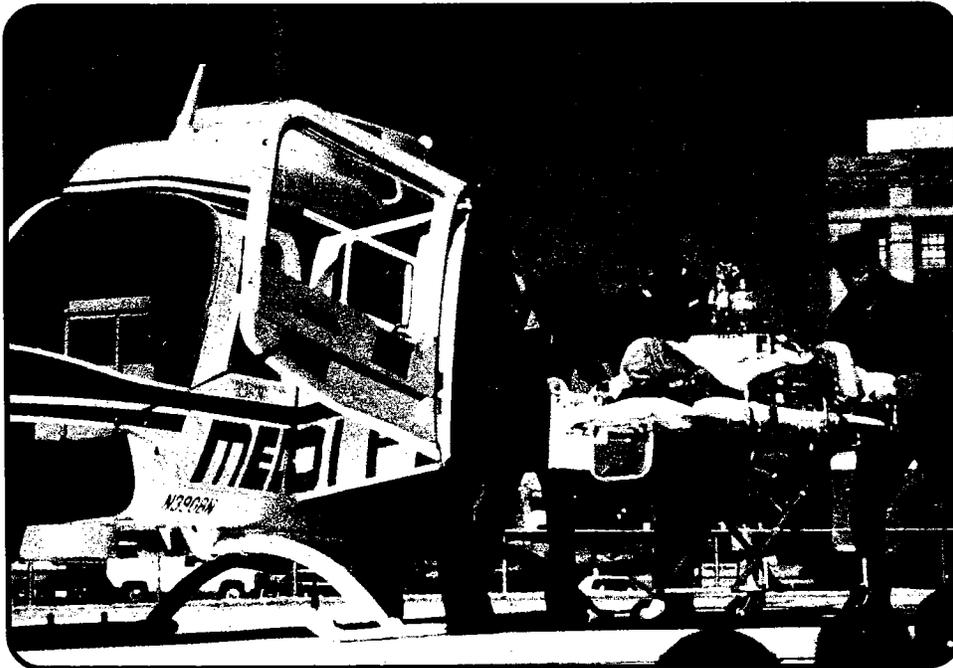
8.1 — Organization of federal and state recreation agencies	130
8.2 — Oklahoma's recreational inventory: local, state, and federal holdings	131
8.3 — Major recreation issues in Oklahoma	132
8.4 — Properties belonging to the Oklahoma Division of State Parks	134
8.5 — Summary description of special use parks	135

Oklahoma Resources

Chapter
9

The Health Care
Delivery System

by
Ivan Hanson



Contents

Executive Summary	141
Introduction	141
The Health Care Delivery System and Disease	142
Personal Health Care Delivery Sectors	142
Restorative and Preventative Programs	143
Institutional Sector	146
Education and Research	148
Education	148
Research	149
Public Health and Regulatory Sectors	150
Federal Agencies	150
State Government	150
Public Regulators	151
Financial Aspects of the System	151
Expenditures for Health Care	151
Workers' Compensation	152
Role of Health Care Sector in State Economy	152
Major Goals for the System	152
Acquired Immune Deficiency Syndrome (AIDS)	152
Development and Distribution of Health Manpower	153
Economics of the Health Care Delivery System	153
Health Education	153
Long-Term Care for the Elderly and Physically Handicapped	153
Medically Indigent Health Care	153
Mental Health Care	153
Rural Health Care	153
Issues, Trends, and Developments	154
Managed Care	154
Hospitals	154
Indigent Care	155
Conclusion	155
References	155
List of Illustrations	156

The Health Care Delivery System

Ivan Hanson*

Executive Summary.—The four leading causes of death in Oklahoma, as in the nation as a whole, are heart disease, cancer, stroke, and accidents. Neonatal deaths have declined by about half in the last 10 years.

Personal health care is delivered in both private and public settings. Oklahoma has 159 hospitals: 129 short-term, acute care facilities; 12 federal hospitals; and 18 special, long-term, restricted-admission hospitals. Most residents are located within 30 minutes driving time (about 25 miles) of a hospital. The dominant tertiary care referral locations are Tulsa and Oklahoma City.

About 402 licensed nursing homes are distributed throughout each of the 77 counties. Additional schools, homes, and shelters for the disabled and mentally retarded are licensed or operated by the state.

Other facilities provide alcohol and drug treatment, ambulatory surgery, and end-stage renal disease treatment. In addition, many special organizations provide hospice care, home health care, and emergency medical services.

Research in health and medical services is conducted at all major universities. A new state agency, the Oklahoma Center for the Advancement of Science and Technology (OCAST) funds basic and applied research and development, and promotes the transfer of new technology into the commercial sector for successful business development. Within OCAST, the Oklahoma Health Research Program is funded at \$2 million annually.

Federal and state governments have many roles in health care as purchasers, providers, and regulators. This chapter identifies seven federal agencies and 26 state offices (including 14 state boards) that supervise aspects of health care ranging from licensing physicians to certifying the need for hospitals and nursing homes.

Per capita U.S. health care expenditures in 1986 were estimated at \$1,820; the comparable figure for Oklahoma was \$1,614. The percentage of personal income Oklahomans spend for health care is about the same as the national average, but the cost is less. Oklahomans make a higher proportion of direct, out-of-pocket payments than the national average because of a relatively large number of uninsured in the state.

Ten health maintenance organizations, based in Tulsa and Oklahoma City, are licensed in Oklahoma. Several case management programs are being developed to care for frail elderly and for AIDS patients.

In summary, Oklahoma has a complex mixture of public and private organizations and programs to purchase, provide, and regulate health care services. Changes are being introduced to provide cost-effective care. State money is invested in health education, and in research and development in the health field.

INTRODUCTION

A state plan identifies eight major health goals:

- 1) Develop preventive education programs and case management for AIDS patients;
- 2) Continue to monitor production of health manpower;
- 3) Secure the financial future of small rural hospitals;

4) Emphasize, through health education, knowledge and personal health practices that promote good health behavior;

5) Develop cost-effective systems for caring for the growing elderly population;

6) Explore options for providing care to the medically indigent;

7) Reduce the incidence of mental illness and alcohol and drug abuse, and develop a full range of public and

private comprehensive treatment services;

8) Continue to explore options for assuring adequate distribution and provision of medical care to rural areas.

This chapter briefly reviews the incidence of disease patterns in Oklahoma. It also discusses personal health services provided by private and public agencies. The major education and research providers are identi-

*Deceased.

fied, as are the public health and regulatory activities of governmental agencies. Finally, it summarizes the financial aspects of the system, outlines the major goals, and discusses some special issues and trends.

THE HEALTH CARE DELIVERY SYSTEM AND DISEASE

The health care delivery system is influenced by disease patterns in Oklahoma, which are quite similar to trends for the U.S. as a whole. During this century, the leading causes of death have shifted from infectious diseases (influenza, pneumonia, tuberculosis) to chronic diseases (heart disease, cancer, stroke) and accidents (which are particularly high among young people) (Fig. 9.1). The substantial reduction in deaths caused by infectious disease is attributed to immunizations, improved sanitation and water supplies, and public health and other community actions that interrupt the spread of disease. The health care delivery system is oriented toward restorative medicine because of the current dominance of chronic diseases as leading causes of death.

The 1980–86 incidence in Oklahoma of communicable, reportable diseases is shown in Table 9.1. Gonorrhea is the most common, but its incidence decreased as the threat of AIDS changed sexual patterns. Few deaths

are reported from communicable diseases since most are noted and treated in a timely manner.

A contemporary discussion of communicable diseases must include AIDS. The number of Oklahoma cases through May 1988 was 242, of which about half had died. The transmission categories generally mirrored the U.S. patterns, except that only 5% of the Oklahoma cases were attributed to I.V. drug use, compared with 18% nationally. The cases were predominantly white males. Oklahoma ranked about 27th among the states in the number of cases and had fewer than 1% of all U.S. cases. Strong prevention and education programs have been established.

Neonatal and infant mortality rates are additional measures of a population's general health status. Both have declined noticeably for all races between 1975 and 1986 (Table 9.2). Native Americans reported the lowest neonatal and infant death rates, followed by whites and then blacks. Oklahoma has a high fertility rate for teen-age women. Many babies born to mothers in this age group have low birth weights and other complications, which require extensive, expensive neonatal care. Increased access to prenatal care, through the combined programs of the Oklahoma State Department of Health and the University

of Oklahoma College of Medicine, has contributed to the decline in neonatal and infant death rates.

For most people, the private sector is the principal entry point into the delivery system. In recent decades, it has matured into a very complex, sophisticated, high-tech diagnostic and treatment system. Simultaneously, the public sector has evolved into a substantial purchaser and provider of direct services to the very young, the very old, the indigent, and the chronically ill. This public sector responsibility is added to the traditional obligations of preventing illness through education and regulation. Many of the public health care services have been made possible by federal government expenditures, which now overshadow state and local government spending.

PERSONAL HEALTH CARE DELIVERY SECTORS

Oklahoma's health care delivery system mirrors, in many ways, the pluralistic U.S. system, which combines private and public participants to serve a wide variety of needs and circumstances. Personal health care is delivered in both private and public settings. This section describes the entry into the private sector and the personal health care delivered in the public sector by a variety of agencies. It

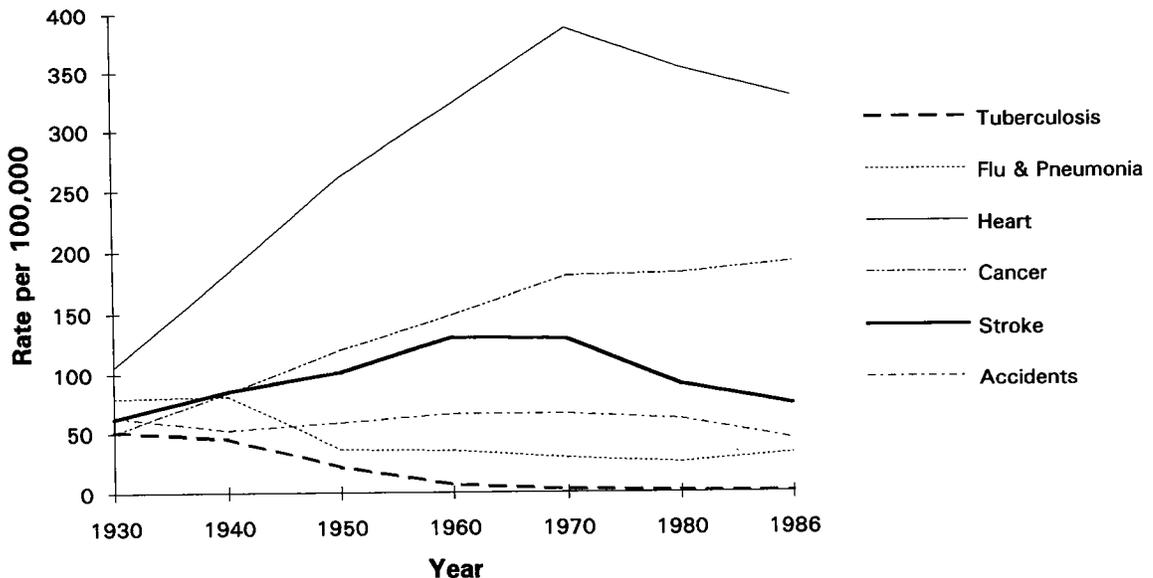


Figure 9.1 — Leading causes of death in Oklahoma, 1930–86. Sources: Oklahoma Health Planning Commission (1985); Oklahoma State Department of Health (1986).

Table 9.1 Reported Communicable Diseases in Oklahoma, 1980-86

Disease	1980	1981	1982	1983	1984	1985	1986
AIDS				5	12	23	52
Amebiasis	39	26	14	13	8	15	9
Aseptic Meningitis	86	109	218	366	125	153	154
Botulism	0	0	0	0	1	1	1
Brucellosis	9	8	8	6	7	4	0
Campylobacter				210	213	298	258
Congenital Rubella Syndrome	0	0	0	0	0	0	0
Diphtheria	0	0	0	1	0	0	0
Encephalitis	18	29	47	35	21	30	22
Giariasis				271	368	328	245
Gonorrhea	13,844	15,909	16,021	15,230	13,088	13,005	12,415
Hepatitis A	395	342	810	829	530	482	343
Hepatitis B	226	256	358	351	206	253	217
Non A-Non B Hepatitis				53	59	76	62
Unspecified Hepatitis	237	168	329	211	117	85	50
Haemophilus Influenzae Invasive Disease				173	209	268	250
Kawasaki Disease				9	10	18	4
Legionnaire's Disease				12	19	21	20
Leptospirosis	1	0	0	4	0	1	0
Malaria	12	8	8	9	12	8	12
Measles (Rubeola)	775	6	30	1	8	1	39
Meningococcal Infections	30	47	33	38	30	34	74
Pertussis	30	2	9	348	247	207	134
Poliomyelitis	0	0	0	0	0	0	0
Rabies	0	1	0	0	0	0	0
Rabies (Animal)	246	219	191	108	103	111	62
Reye's Syndrome				12	15	2	5
Rocky Mountain Spotted Fever	77	99	88	218	116	93	104
Rubella	8	4	3	1	0	2	0
Salmonellosis	386	433	485	598	424	465	480
Shigellosis	255	475	427	241	213	287	288
Syphilis	120	185	209	211	198	215	165
Tetanus	1	2	1	0	2	1	1
Toxic Shock Syndrome				12	20	18	37
Tuberculosis	333	381	335	331	262	264	267
Tularemia	24	44	36	34	23	20	13
Typhoid Fever	6	5	3	3	4	2	2

Source: Oklahoma State Department of Health (1987b).

also covers the institutional sector—hospitals, nursing homes, and other facilities, as well as the health professionals working in those settings.

Restorative and Preventive Programs

One traditional way of organizing the complex world of personal health and medical care is to distinguish between restorative and preventive services. Restorative medical care focuses on diagnosis and treatment of acute or chronic illness. Most people use this kind of care at many times during their lives. The private sector has provided most of the restorative services and only some preventive services, such as immunizations. The public sector, on the other hand, has been the

primary supplier of preventive services, through local, state, and federal agencies. In recent decades, however, it also has become the provider of restorative services, particularly to special populations. This section describes how both the private and public sectors provide personal health care through restorative and preventive programs.

Private Sector Services

Restorative medical care services are provided on a daily basis under the supervision of more than 5,200 physicians (Doctors of Medicine and Doctors of Osteopathy) who practice in the state. For most Oklahomans, whose personal health care is in the private sector, the normal entry into

the system is through an office visit to their personal physician. That physician may be in solo practice or increasingly, in a multispecialty group practice. Medical technologies in Oklahoma have expanded enormously and include neonatal intensive care units, burn units, magnetic resonance imaging, helicopter and surface ambulance systems, heart and lung transplants, and bone marrow transplants. This sophistication has attracted leaders in the field.

Working with the private physician in the ambulatory care setting is a team of health care professionals: physician assistants, nurse practitioners, registered nurses, licensed practical nurses, nursing assistants, dietitians, pharmacists, physical therapists, occupational therapists, phlebotomists, chemists, radiation therapists, guidance counselors, and social workers. As the practice of medicine becomes more sophisticated, new allied health specialists perform the tests and operate the equipment. As the team leader, the physician consults with the patient and orders tests and evaluations by other professionals. Services in ambulatory clinics are expanding as the reimbursement system tries to minimize high-dollar in-hospital care.

An individual's point of entry is influenced strongly by who pays for the care. Most people who have a private physician are covered by group health insurance (including health maintenance organizations) through their places of employment; Medicare, which covers the elderly; or Medicaid, which covers some low income people. Some individuals, frequently the self-employed, are covered by private insurance policies or pay for care through direct, out-of-pocket payment. Most insurance plans require the individual to pay some portion of costs through deductibles or co-insurance.

For individuals without third-party coverage, entry into the system can be more difficult. Special systems are available for designated groups such as veterans, Native Americans, or military dependents. Others may seek entry through local health departments or voluntary clinics that dispense free or low-cost care.

Table 9.2 Oklahoma Infant and Neonatal Mortality Rates, by Race, 1975-86

Race	Total Infant ^a Mortality Rate (per 1,000 live births)			Neonatal ^b Mortality Rate (per 1,000 live births)		
	1975	1980	1986	1975	1980	1986
White	15.4	11.5	9.8	11.0	7.3	5.8
Black	26.4	21.8	17.8	19.6	14.9	10.4
Native American	11.1	12.9	6.3	5.2	7.6	3.6
All Races	16.1	12.7	10.3	11.4	8.1	6.1

^a Infant death = death of child less than one year old.

^b Neonatal death = death of baby before 28 complete days of life.

Sources: Oklahoma Health Planning Commission (1985); Oklahoma State Department of Health (1987).

Specialty clinics, such as drug and alcohol treatment centers, guidance clinics, or family abuse shelters are other entry points for some people. Many of these clinics are publicly supported, but some are privately owned.

When a physician orders hospitalization, the admission may be to a primary-, secondary-, or tertiary-care hospital. Many local, particularly rural, hospitals are primary-care facilities with limited services and specialties. Patients who need specialty care are referred to secondary- or tertiary-care facilities, predominately in Tulsa and Oklahoma City.

Extended care is available through a network of special schools, room and board homes, skilled and intermediate care facilities, and specialty hospitals for the mentally retarded and mentally incompetent. Nursing homes provide for the frail elderly.

General Public Health Services

Personal health services also are delivered through the public sector. The traditional leader in provision of general public health services is the Oklahoma State Department of Health. The main offices are in Oklahoma City where the program administrators, public health laboratory, and the environmental, health education, and institutional regulatory services are headquartered.

On the front lines of service delivery are the local health departments, which are located in 65 of the state's 77 counties. The remaining 12 counties receive minimal services from the central office or through neighboring counties.

Local health departments are staffed by a medical director, administrative director, nurses, sanitarians, child guidance personnel, and administrative support staff. Services are provided in the department, at alternative sites, and through home visits. Specialized services of nutritionists, social workers, nurse practitioners, and others are offered on a regional basis.

The focus of programs is on prevention through screening and intervention at the individual level. Examples of such programs are:

- Administration of more than 350,000 doses of vaccine annually, principally to day-care, Head Start, and kindergarten children, and to adolescent and adult females in health departments and family-planning clinics;
- Screening of newborns for genetic diseases and hearing loss;
- Prenatal, postpartum, and supplemental food programs for pregnant and breast-feeding women, and for infants and children nutritionally at risk;
- Individual, group, and family therapy as part of child guidance programs;
- Screening and treatment for sexually transmitted diseases, including AIDS;
- Screening, referral, and follow-up for colorectal, cervical and breast cancer, diabetes, sickle cell and iron deficiency anemia, hypertension, and heart disease;
- School education for dental health;
- Surveillance, follow-up, and intervention for Reye's Syndrome, toxic shock syndrome, bacterial meningitis, hepatitis, and tuberculosis.

Welfare and Indigent Health Care

The Department of Human Services is responsible for several major programs, including Medicaid, social welfare and rehabilitation, and the teaching hospitals at the University of Oklahoma. This summary of their services focuses principally on health and medical services, but many of their other functions also indirectly affect the health status of Oklahomans. The Department's programs and services can be divided into four broad categories.

- I. Programs for children (generally younger than 18 years):
 - A. Day care for children of low-income families whose parents are working outside the home, are in job training, or are seeking employment;
 - B. Licensing of day-care centers, family day-care homes, and child placing agencies;
 - C. Foster care for children who can no longer live with their parents;
 - D. Adoption services, counseling, and support;
 - E. Child protective services for abused, maltreated, or neglected children;
 - F. Medical services for crippled children;
 - G. Health care and social services for disabled children who receive federal Supplemental Security Income (SSI) benefits;
 - H. Early and periodic screening, diagnosis, and treatment for persons under 21 who are eligible for Medicaid;
 - I. Court-related and community services for juveniles with law violations, behavior problems, and who are beyond parental control.
- II. Programs for the aged (generally older than 64 years):
 - A. Adult protective services for persons over 18 who cannot protect their own interests;
 - B. Older Americans Act programs, including congregate meals, transportation, senior centers, and in-home and community services;
 - C. Ombudsmen services on behalf of patients in nursing

- homes and other long-term care facilities;
- D. Nontechnical medical care by trained providers to help low-income elderly or disabled whose health problems would otherwise require nursing home care;
 - E. Home maintenance aide services to help clients function at home;
 - F. Elderly adult day care for persons 60 or older.
- III. Programs for the financially, medically, and socially needy from all age groups:
- A. Aid to families with dependent children (AFDC);
 - B. Emergency assistance of limited, short-term help for persons who do not meet other program requirements;
 - C. State supplemental payments (SSP) for needy aged, blind, and disabled;
 - D. Medicaid—medical care for low-income people;
 - E. Food stamps, used like money to buy food by eligible, low-income households;
 - F. Cash benefits to help low-income people pay heating and cooling bills;
 - G. Child support enforcement to help families find missing parents, establish paternity and obtain child support, and remain financially independent.
- IV. Programs for the blind, the deaf and the physically or mentally disabled from all age groups:
- A. Vocational, rehabilitative, and visual services to help needy persons with disabilities to function independently and to be gainfully employed where feasible;
 - B. Institutions, group homes, sheltered workshops, and community services for mentally retarded and other developmentally disabled children and adults;
 - C. Schools for the blind and the deaf.

Mental Health Services

The Oklahoma State Department of Mental Health is responsible for developing and maintaining programs

to prevent and care for mental illness and substance abuse in Oklahoma.

There are three state mental hospitals, plus an adolescent hospital. The Department operates five strategically placed community mental health centers and has contracts with 16 private community mental health centers in 10 cities around the state.

In recent years, the department has followed the policy of deinstitutionalization of the mentally ill and has reduced the number of inpatients at the three major mental hospitals. This has been supplemented by lodge programs, supported employment, supervised apartments, and other community alternatives, such as nursing-home care for stabilized elderly patients, and residential drug and alcohol programs for adolescents.

Alcohol and drug treatment programs are operated at the three state hospitals and at 44 treatment centers throughout the state. A relatively new program at 16 facilities deals with domestic violence.

During fiscal year 1987, there were decreases in the number of clients in most programs, reflecting a reduction in state funds for mental health services. However, programs for victims of domestic violence and sexual assault were up 31% and residential home care services were up 31%.

Indian Health Service

The Indian Health Service (IHS) has been an agency of the U.S. Department of Health and Human Services since 1954. The IHS delivers to Native Americans comprehensive inpatient and ambulatory medical services; dental care, mental health and alcoholism services; preventive health, health education, and health manpower development programs.

The Oklahoma City area office of IHS is the largest of 11 such offices in the United States, and it is responsible for the health of more than 210,000 people, 20% of the Indian and Alaska Native service population.

Native Americans in Oklahoma have lower death rates than the overall U.S. population for diseases of the heart, cerebrovascular disease, cancer, suicide, and infant mortality. They tend to have higher death rates from accidents, diabetes, and liver disease

than the overall U.S. population.

There are five hospitals and 22 outpatient clinics in Oklahoma sponsored by the Indian Health Service. IHS hospitals are located in Ada, Claremore, Clinton, Talihina, and Tahlequah. Some of the facilities are being managed by tribes under contract to the IHS.

Emergency Medical Services

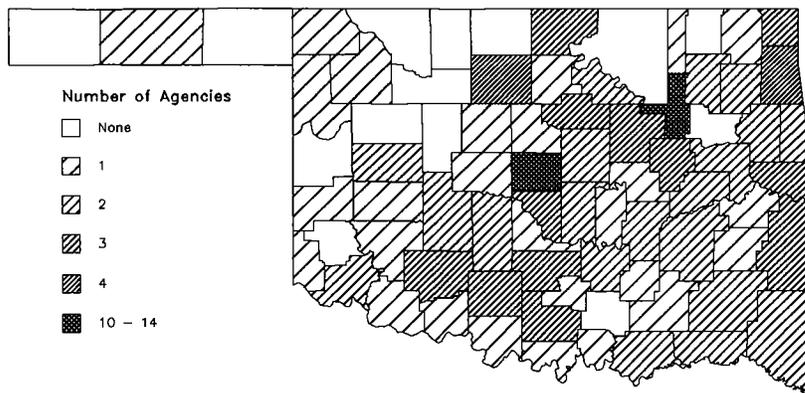
The Oklahoma State Department of Health licenses ambulance services (200 in 1986). Most services (173 in 1986) provide basic life support, which means they meet the minimum state standards for providing emergency medical care 24 hours a day, 365 days a year. The remaining agencies provide one or more of the three additional, higher levels of life support: the advanced level; the advanced/cardiac level; and the paramedic level. There were 2,000 licensed emergency medical technicians statewide in 1986.

Ambulances made 166,076 runs in 1986, which equals approximately one ambulance run for every 20 Oklahoma residents. Slightly more than half of the runs (89,400) were defined as emergencies; the remainder (76,600) were nonemergency transfers, usually between medical facilities.

Home Health Care and Hospices

The basic function of home health care agencies is to provide nursing care in the home, often a viable alternative to care in a hospital or nursing home. The number of agencies has grown substantially since 1975 as the reimbursement systems have changed to minimize hospital stays. There were 159 agencies that provided home health care in 1986 (Map 9.1). They were evenly divided among hospitals, county health departments, and profit/nonprofit agencies. (Since that time, the county health departments have elected to relinquish certification for Medicare reimbursement, although they continue to provide care.)

Hospices, which are becoming increasingly available in Oklahoma, are similar to home health care, but are not identical. This relatively new movement, imported to the U.S. from



Map 9.1 — Distribution by county of Medicare-certified home health care agencies in Oklahoma, 1986. Source: Oklahoma State Department of Health (1987).

England, is devoted to caring for the terminally ill at home. Hospices provide nursing care and other support services to the dying patient and the family, allowing the patient to die at home rather than in a hospital.

Voluntary Health Agencies

Voluntary health organizations are not-for-profit organizations which depend on donations and charitable contributions for their income. Their programs range from prevention and health education to direct patient care. Many are state or local chapters of national associations. Others are uniquely local, special-purpose organizations.

The American Red Cross is one example of a national organization which has local affiliates throughout Oklahoma. The Red Cross collects and supplies blood, assists in organ transplantation services, and provides disaster relief as well as a variety of other services. The American Lung Association, the American Heart Association, and the American Cancer Society also have active local affiliates or chapters. In addition to education and prevention services, they sponsor research and assist patients in a variety of ways.

Visiting Nurse Associations are autonomous local units that provide direct patient care in the home, as an alternative to hospitalization.

The system of restorative and preventive services is a complex mixture of public and private organizations and programs. This combination has been successful in bringing Oklahoma

along with the rest of the nation in extending life span, reducing death from infectious disease, and providing health care for the needy.

Problems continue in providing access to care for the indigent and care for the elderly. The uniform availability of services is of concern as changes in reimbursement systems, which discourage inpatient care, bring financial pressure on rural hospitals.

Institutional Sector

The institutional sector consists of short-term, acute-care hospitals; special/long-term/restricted-admission hospitals; nursing homes, which include some beds for the mentally retarded; and other facilities such as alcohol and drug treatment centers, special facilities for the mentally retarded and mentally incompetent, a large variety of children's shelters, homes, schools and mental health facilities, ambulatory surgery centers, and end-stage renal disease programs. In each of these categories, ownership of facilities is distributed among private for-profit and not-for-profit organizations, federal, state, and local governments (Table 9.3).

Hospitals—Short-Term

There are about 159 hospitals distributed throughout Oklahoma. Most (129) are short-term, acute-care facilities; 12 are federal hospitals, mainly short-term; and 18 are special long-term restricted-admission hospitals. The facilities are distributed throughout the state, but the largest concentrations are in the Tulsa, Oklahoma

City, and Lawton metropolitan areas.

Short-term, acute-care hospitals are principally medical-surgical facilities; 41% are owned by state or local government; 38% are owned by not-for-profit corporations; 10% are investor-owned; and 10% are owned by the federal government. Other short-term facilities include nine private and four public psychiatric treatment centers.

The policy objective of the Oklahoma Health Planning Commission that all Oklahoma residents be within 30 minutes driving time (about 25 miles) of a hospital has been reasonably well achieved. There are small gaps in this coverage only in sparsely populated areas of extreme southeast and northwest Oklahoma (Map 9.2). The two major locations for dominant tertiary care are Tulsa and Oklahoma City.

St. Francis in Tulsa, licensed for 935 beds, is the state's largest hospital. The smallest is the seven-bed Community Health Center hospital in Wakita. Rural and urban hospitals have an average of 66 beds and 220 beds, respectively. There is excess capacity in the short-term hospitals, particularly in the parts of the state where there are considerable overlaps in the 25-mile hospital radius. In 1986, the statewide occupancy rates for short-term acute-care hospitals was 46.5% (Table 9.4). Rural areas historically have lower occupancy rates (about 39%) than do urban areas (about 50%). Both Tulsa and Oklahoma City received public attention for excess bed capacity in the past decade, even before the mid-1980s massive changes to the reimbursement system, which tended to reduce both number of admissions and length of stay in Oklahoma and the nation as a whole.

Hospitals—Federal

Federal hospitals include Veterans Administration facilities, military hospitals, correctional facilities, and U.S. Public Health Service Indian hospitals. The Veterans Administration Medical Center in Oklahoma City is a tertiary facility with 423 beds. The Veterans Administration Hospital in Muskogee has 194 beds and is linked with an outpatient center in Tulsa. There are military hospitals at Tinker Air Force Base, Midwest City (53

Table 9.3 Inpatient Facilities in Oklahoma, 1986

Type of Facility	Number	Beds
Acute-Care Hospitals	129	15,519
General Federal Hospitals	12	1,277
Special/Long-Term/Restricted Admission Hospitals	18	3,656
Nursing Homes	424	34,241
Skilled Nursing Facilities	29	1,287
Intermediate-Care Facilities	373	29,576
Intermediate-Care Facilities/Mentally Retarded	18	1,824
Personal-Care Facilities	1	84
Other Inpatient Facilities		
Alcohol/Drug Treatment Centers	31	734
Contracted Room and Board Homes		
Mentally Retarded	62	572
Mentally Incompetent	30	1,100
Schools for Mentally Retarded	3	1,473
Children's Residential Mental Health Facilities	3	155
Residential Children's Homes/Schools	29	1,951
Children's Shelters	41	587
TOTALS	1,203	94,036

Sources: Oklahoma Health Planning Commission (1987); Oklahoma State Department of Health (1987).

beds); Altus Air Force Base (20 beds); and Fort Sill, Lawton (208 beds). One federal corrections facility at El Reno has a 25-bed hospital. The six Indian Health Service hospitals are located at Ada (53 beds); Claremore (60 beds); Clinton (20 beds); Lawton (52 beds); Tahlequah (61 beds).

Hospitals—Special/Long-Term/Restricted Admission

The category of special/long-term/restricted-admission hospitals includes a variety of public and private facilities. They can be classified as rehabilitation, chronic-care, or psychiatric hospitals.

Rehabilitation facilities include the Rehabilitation Institute of Oklahoma (244 beds, owned by Hospital Corporation of America) and O'Donoghue Rehabilitation Institute (120 beds, owned by Oklahoma Teaching Hospitals) located in Oklahoma City. Hillcrest Medical Center in Tulsa (classified as an acute-care hospital) also has 50 rehabilitation beds.

Chronic-care facilities include the J. D. McCarty Center for Children with Developmental Disabilities at Norman (60 beds). Five state institu-

tions with a total of 866 beds, operated as veterans centers, are located at Ardmore, Clinton, Norman, Sulphur, and Tahlequah. Other specialized, restricted-admission facilities include the student health centers at Oklahoma State University and the University of Oklahoma. The remaining facilities are private psychiatric units.

The State of Oklahoma operates four long-term, psychiatric hospitals with a total of 1,943 beds. They are located at Vinita, Fort Supply, and Norman, which has two facilities. There

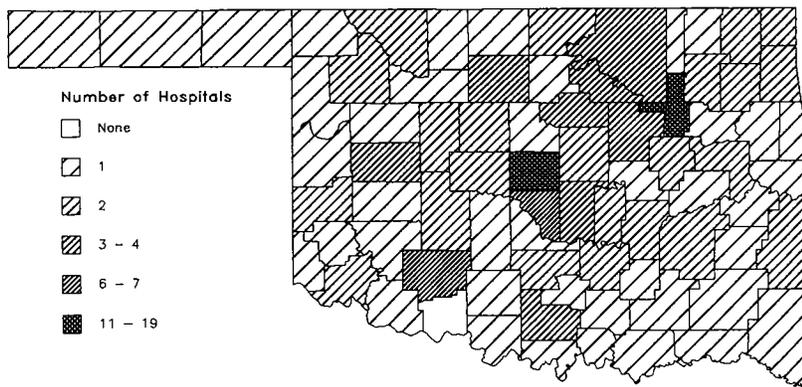
are about 3,389 psychiatric beds in public and private hospitals in Oklahoma (about 1.03 licensed psychiatric beds per 1,000 population). This number includes 785 in general hospitals, 315 in specialty psychiatric hospitals, and 2,289 in public hospitals of all kinds. In addition, there are 1,344 beds in free-standing psychiatric and alcohol residential treatment centers.

Nursing Homes

Nursing homes are the most numerous long-term care facilities. Oklahoma has 402 nursing homes licensed by the Oklahoma State Department of Health (Map 9.3). They are distributed throughout each of the 77 counties. There are three types of nursing homes: skilled, intermediate, and personal care. A skilled nursing home is one that provides 24-hour medical services, skilled nursing care, special dietary services, and personal care and supervision to three or more persons who, because of physical or mental infirmity, need such service. An intermediate-care facility provides 24-hour personal care and supervision to persons unable to care for themselves completely but who do not require skilled nursing care. A personal-care home provides services to three or more persons who do not require routine skilled nursing care or intermediate care. Most nursing homes are proprietary operations; few are publicly owned.

Other Facilities

The largest category of other health facilities licensed by the Oklahoma



Map 9.2 — Distribution of licensed acute-care hospitals in Oklahoma, 1987. Source: Oklahoma Health Planning Commission (1988).

Table 9.4 Utilization of Hospitals in Oklahoma, 1986

	Short Term Acute-Care	Federal	Special/ Long-Term/ Restricted Admission
Number of Facilities	129	12	18
Bed Distribution	15,519	1,277	3,656
Patient Days	2,631,322	274,091	802,915
Occupancy Rates	45.5%	58.8%	60.2%

Source: Oklahoma Health Planning Commission (1987).

State Department of Health includes a variety of schools, homes, and shelters for children. A few, such as the state schools for the mentally retarded, are owned by the state, but most are privately operated with contracts and licenses awarded by the state. In the next largest facility group licensed by the Oklahoma State Department of Health are some 54 alcohol and drug treatment centers: 22 are for outpatient treatment only but 32 have a total of 796 short-stay beds.

The 13 ambulatory surgery centers are relatively new phenomena. They provide in-and-out, same-day surgery. Most are located in Oklahoma County and Tulsa. The trend toward outpatient surgery is growing in Oklahoma as elsewhere in the United States.

End-stage renal disease treatments are available at 25 sites licensed by the Oklahoma State Department of Health. Most, but not all, are hospital-based.

Distribution of Health Professionals

There were approximately 4,511 allopathic and 710 osteopathic physicians in Oklahoma in 1986. Statewide, there were 158 physicians per 100,000 population, compared to approximately 218 per 100,000 for the U.S. as a whole.

Map 9.4 shows the distribution of physicians by county in Oklahoma. The state average is one physician for each 723 people. The two metropolitan counties of Tulsa and Oklahoma have 61% of all physicians in the state. Eight counties in the state are listed as primary care shortage areas, which

means they need more primary care physicians. Those eight counties are Beaver, Coal, Haskell, Latimer, Logan, McClain, Roger Mills, and Tillman. An additional 14 counties have facilities or service areas that need physicians.

There are 15,202 registered nurses and 8,563 licensed practical nurses employed in Oklahoma. There is one nurse for each 139 people. Map 9.5 shows the population/nurse ratio for each county in the state. About 80% of the RNs and LPNs in Oklahoma are employed. As in other parts of the U.S., there is concern about a growing shortage of nurses due to several reasons: decline in the number of college-age students; rising tuition and educational expenses; and attractiveness of other professions for women. At the same time, the growth of outpatient services have increased the demand for nurses and made acute-care hospital nursing more intense.

The distribution of dentists is shown in Map 9.6. Oklahoma had 42.88 dentists per 100,000 population (1984); in the nation as a whole, there were 56.3 dentists per 100,000. Enrollments in the University of Oklahoma College of Dentistry have declined in this decade.

The demand for physical therapists and occupational therapists is growing due to the need for rehabilitation among the elderly and developmentally disabled. In 1987, there were 2.88 physical therapists per 10,000 population in Oklahoma, compared to 3.59 per 10,000 nationally.

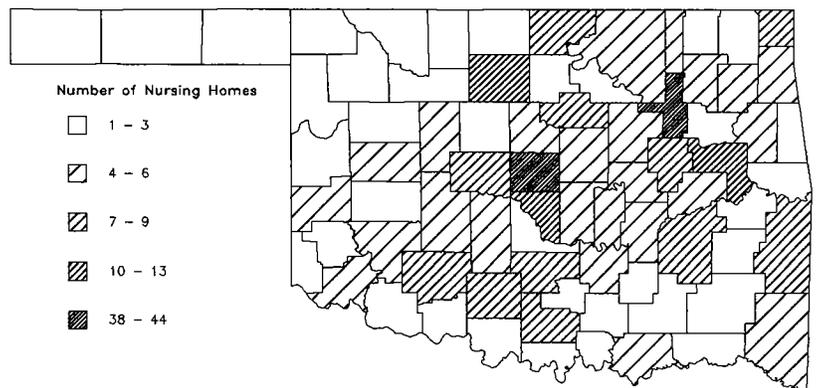
EDUCATION AND RESEARCH

Education

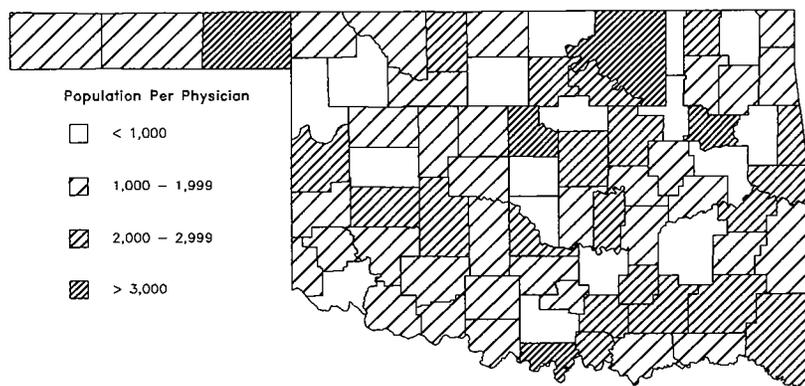
Oklahoma has many institutions that educate health professionals in these principal categories: physicians, nurses, dentists, dental hygienists, dental assistants, optometrists, physical therapists, occupational therapists, sanitarians, health educators, hospital and health administrators, nursing home administrators, and a substantial number of assistants in several professions.

There are two medical teaching centers in Oklahoma: the University of Oklahoma Health Sciences Center and the Oklahoma College of Osteopathic Medicine and Surgery. The older and larger of the two is the University of Oklahoma Health Sciences Center, which has Colleges of Medicine, Dentistry, Nursing, Public Health, Allied Health, and Pharmacy, as well as a Graduate College. Its base of operations is the Oklahoma City campus where all the programs are headquartered. Programs in medicine, nursing, and public health also are offered at the Tulsa Medical Center campus. All programs involve teaching, research, and service.

The Oklahoma College of Osteopathic Medicine and Surgery was organized in the 1970s as a free-standing institution in Tulsa. The 1988 Oklahoma Legislature merged it administratively with Oklahoma State University in Stillwater, but the facility will remain in Tulsa. The College is affili-



Map 9.3 — Distribution of licensed nursing homes in Oklahoma, 1986. Source: Oklahoma State Department of Health (1987).



Map 9.4 — Population/physician ratio in Oklahoma counties, 1987. Source: Oklahoma Health Planning Commission (1988).

ated with the Oklahoma College of Osteopathic Medicine in Tulsa.

Oklahoma's only College of Dentistry is part of the University of Oklahoma Health Sciences Center. The College of Public Health, located at the University of Oklahoma Health Sciences Center, is one of only 24 accredited schools in that profession in the United States. There are pharmacy colleges at the University of Oklahoma and Southwestern State University at Weatherford. The College of Veterinary Medicine is at Oklahoma State University, Stillwater.

Research

Research into the delivery of health and medical services is conducted at all institutions where allopathic, osteopathic, and veterinary medicine practitioners are educated. Research in the basic sciences and social sciences related to health care is carried out at the main campuses of the University of Oklahoma (Norman) and Oklahoma State University (Stillwater). Most of this work is organized through the Graduate College and Research Administration at each university.

The Oklahoma Center for the Advancement of Science and Technology (OCAST) is administered in the Oklahoma Department of Commerce. Its mission is to stimulate innovation in new and existing businesses by:

- Supporting basic and applied research and development, where new ideas are generated and converted into new products and processes.
- Facilitating technology transfer, so

that new products and processes can be moved out of the laboratory and into the commercial sector.

- Promoting the successful commercialization of new technologies by Oklahoma businesses.

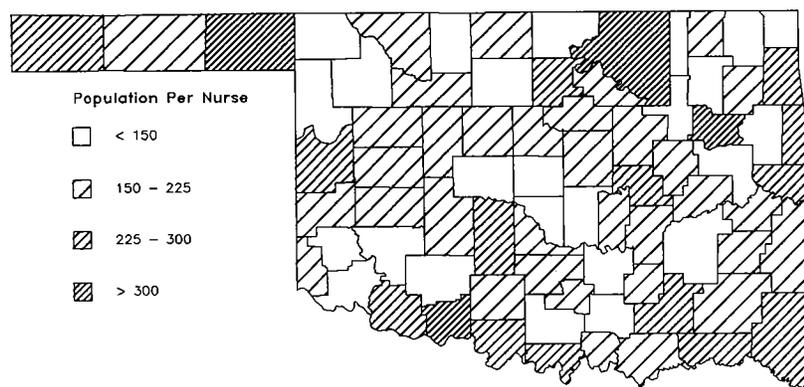
Through OCAST, about \$22 million in state dollars are appropriated annually for eight programs aimed at supporting research and the translation of research findings into commercial applications. Of particular interest to the health field is the Oklahoma Health Research Program, funded at \$2 million per year, to support scientific inquiry into:

- 1) The causes, diagnosis, prevention, and treatment of human disease and disabilities and mental health and emotional disorders;
- 2) New knowledge and methods for improving the availability of health care services; and

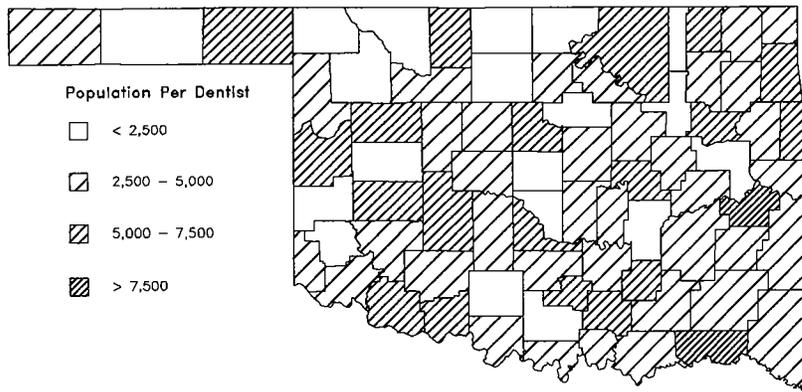
3) The development of new products and services that form the basis of new high-technology health research and care industry for this state.

Other OCAST programs include: the Centers of Excellence challenge funding program for basic and applied research and technology transfer; an Eminent Scholars challenge funding competition to encourage the creation of endowed chairs at Oklahoma universities; a Research Equipment challenge funding competition to purchase state-of-the-art research equipment; an Applied Research challenge funding competition, for researchers in universities and private enterprises; a Small Business Innovative Research (SBIR) incentive program to enable more Oklahomans to apply for and win federal SBIR grants; a matching funds competition for Oklahomans who win federal SBIR grants; and an Oklahoma Technical Resources Network for providing information on research resources available in Oklahoma to established, new, or relocating businesses, other researchers, and state and local government economic development agencies. These programs use state money to leverage private and federal investment in targeted areas of research and business activity.

One of the oldest, largest, and most widely known health science research organizations in Oklahoma is the Oklahoma Medical Research Foundation. It maintains a large facility at the University of Oklahoma Health Sciences Center where research in several of



Map 9.5 — Population/nurse ratio in Oklahoma counties, 1987. Source: Oklahoma Board of Nurse Registration and Nursing Education (1987).



Map 9.6 — Population/dentist ratio in Oklahoma counties, 1987. Source: Oklahoma Oklahoma Health Planning Commission (1988).

the medical sciences is conducted. Recently, it opened a Tulsa office, which specializes in health policy programs.

PUBLIC HEALTH AND REGULATORY SECTORS

Federal and state government have many roles in health care—purchasers, providers, and regulators. This section identifies the major federal and state agencies involved in health-related issues and the major state agencies involved in regulation.

Federal Agencies

Several federal agencies operate health facilities or maintain offices in Oklahoma.

Department of Health and Human Services

This is the largest federal health agency; it funds research and purchases services. The Public Health Service includes Alcohol, Drug Abuse, and Mental Health Administration. The Indian Health Service cares for Native Americans. The Administration on Aging carries out the Older Americans Act. The Social Security Administration manages the major retirement program. The Health Care Financing Administration (HCFA) manages Medicare, the medical services program for retirees and certain other eligible people, and Medicaid, the medical program for low-income people.

Department of Defense

This federal agency operates hospitals and clinics for employees of the armed forces. There are three military

hospitals in Oklahoma. The Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) provides funding for some health services to active duty dependents, retirees and their dependents.

Veterans Administration

The VA provides inpatient and outpatient acute and long-term care for veterans and their dependents. Pensions and disability payments, education and rehabilitation, and home loan guarantees are also provided. There are two major hospitals and long-term care facilities.

Department of Agriculture

Research and support programs promote a secure food supply. Inspection and grading services ensure the quality of food. This agency also implements food and nutrition programs, which include: food stamps; surplus food; and the Women, Infant and Children Program (WIC) that provides food and nutrition education to low-income, pregnant women, and to children up to age 5.

Department of Transportation

Highway safety is important to reducing traffic accidents. Accidents of all kinds, including traffic, are the fourth leading cause of death.

Environmental Protection Agency (EPA)

The EPA monitors programs to influence air quality, water quality, solid waste disposal, and toxic waste management.

Department of Labor

This federal agency is the administrative home of the Occupational Safety and Health Administration, which promotes safety and health standards in the work place.

State Government

Many state agencies provide or regulate health services.

Oklahoma State Department of Health

Preventive services affect everyone in the state. Direct services for certain population groups were described above. A nine-member Board of Health, appointed by the Governor and confirmed by the State Senate, appoints the Chief Administrative Officer, the Commissioner of Health. Services are delivered through the main office in Oklahoma City and through local, county health departments.

Oklahoma State Department of Mental Health

This department develops and maintains programs to prevent and care for mental illness and substance abuse in Oklahoma. It plans, funds, operates, and certifies programs. The Department is governed by a seven-member Mental Health Board, appointed by the Governor and confirmed by the State Senate, which hires the Commissioner of Mental Health as the Chief Administrative Officer.

Oklahoma Department of Human Services

This agency grants public assistance to needy individuals who qualify under the Oklahoma Social Security Act. It also provides medical care for public assistance recipients and others who meet eligibility standards. The Department is governed by a nine-member Oklahoma Public Welfare Commission, which hires the Chief Administrative Officer.

Oklahoma Water Resources Board

The Board has extensive statutory authority for planning and managing to meet the state's long-range water needs and to protect water quality by issuing water quality standards. It administers a financial assistance pro-

gram for municipal and rural water systems. It is governed by a nine-member board appointed by the Governor and confirmed by the Senate.

Oklahoma Department of Veterans Affairs

Oklahoma has five veterans centers licensed as specialized hospitals where counseling and assistance to veterans and their dependents are offered. The Department also provides financial assistance to the American Legion Children's Home in Ponca City. It is governed by the War Veterans Commission.

Oklahoma Cerebral Palsy Commission

The J. D. McCarty Center for Children with Developmental Disabilities in Norman provides care, rehabilitation, and education to persons under age 31 who have cerebral palsy.

Oklahoma State System for Higher Education

This is an important coordinating board of control for the state colleges and universities. It receives funding for the institutions from the legislature and apportions it among the various colleges and universities.

Physician Manpower Training Commission

This commission provides financial assistance through educational scholarships and loans to medical and nursing students. An important objective is to attract graduates to non-metropolitan areas of the state.

State Department of Education

As the principal state agency for funding to local school districts, this department plays an important role in school health education. It administers the U.S. Department of Agriculture's child nutrition programs, does comprehensive health education, special education programs for exceptional children, driver education, and safety.

Public Regulators

State regulation applies principally to the areas of health manpower and the environment. Environmental problems are monitored by several state agencies.

Health Manpower

In order to assure high quality manpower, many of the health care professions require their practitioners to be certified or licensed. Special boards, composed principally of health professionals in each discipline, carry out the licensing activities. These boards include:

- Board of Governors of Registered Dentists
- Board of Veterinary Medical Examiners
- Department of Registration for Professional Sanitarians
- Oklahoma Board of Nurse Registration and Nursing Education
- Oklahoma Health Planning Commission
- Oklahoma State Board of Licensed Social Workers
- Oklahoma State Board of Medical Examiners
- Oklahoma State Board of Nursing Homes
- Oklahoma State Board of Osteopathic Examiners
- Oklahoma State Board of Pharmacy
- Oklahoma State Board of Podiatry
- State Board of Examiners in Optometry
- State Board of Examiners of Psychologists
- State Board of Examiners for Speech Pathology and Audiology

Environmental Health Services

Strong environmental protection plays an important part in maintaining a safe environment, both for work and for daily life. Local and state health departments maintain strong links in order to respond to complaints and crises.

Department of Pollution Control

The Department coordinates pollution control programs of the seven state agencies that have statutory responsibility for environmental pollution control. It may take action if any of the agencies are unable to meet their responsibilities. It also is the comprehensive water quality management agency and administers the Clean Lakes Program.

Oklahoma State Department of Health

The Department monitors circum-

stances and issues permits and licenses in the areas of:

- 1) Air and water pollution;
- 2) Dairies, hotels, motels, eating and drinking establishments, food processors, and wholesalers;
- 3) Water and sewer operators, plumbers, electricians, hearing aid dealers and fitters, the alarm industry, barbers, and camp operators;
- 4) Disposal of solid waste and hazardous waste, including radiation and radioactive substances;
- 5) Indoor air pollution, bedding, general occupational health, product safety, medical devices, and community noise.

The Superfund Program (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA]), funded by the federal Environmental Protection Agency, is administered by this department. Five sites currently are on Oklahoma's Superfund list: Tar Creek, Sand Springs Petrochemical Complex, Hardage/Criner site in McClain County, Compass Industries landfill in west Tulsa, and Tinker Air Force Base (Midwest City).

Under the federal Resource Conservation and Recovery Act (RCRA) and the Underground Injection Control Program (UIC), the state conducts the hazardous waste program. Currently there are 60 permitted sites, including treatment, storage, and disposal facilities.

The Oklahoma State Department of Health licenses nursing homes, room and board homes, and hospitals; certifies nursing homes for Medicaid and hospitals for Medicare; and inspects jails.

Oklahoma Water Resources Board

This board regulates industrial waste discharges, water well drillers, surface water dams, and users of ground and surface water for other than domestic uses.

FINANCIAL ASPECTS OF THE SYSTEM

Expenditures for Health Care

In 1986, per capita health care expenditures for the U.S. were estimated at \$1,820; the comparable figure for Oklahoma was \$1,614. Oklahomans

spent about 13.2% of their personal income for health care, which is close to the national figure of 13.5%. Oklahomans spend less for hospital care and physicians' services and more for nursing home care, dentists, drugs, and medical sundries.

Where does the money come from? Compared to national trends, Oklahomans purchase more medical care through direct, out-of-pocket expenditures, and less through private health insurance (Table 9.5). The high percentage of private, direct payments is due to low rates of employer-provided insurance and private insurance in Oklahoma. About 25% of the nonelderly Oklahoma population is uninsured.

The Oklahoma State Department of Health operated on an \$89 million annual budget in fiscal year 1987. More than 41% came from federal funds, 36% from state appropriated funds, and the remainder about equally from local tax sources and user fees.

In the same year, the Department of Human Services operated on an annual budget of \$1.1 billion, the largest component of which (42.5%) was for medical services administration, including Medicaid. The Department also operates the Oklahoma Medical Center, which is the teaching hospital complement of the University of Oklahoma Health Sciences Center in Oklahoma City.

The Department of Mental Health operated in fiscal year 1987 with a budget of \$111.1 million: hospital care, (53%); community mental health centers (25%); drug and alcohol programs (10%); other programs (less than 2% each).

During the 1980s, the prospective payment system brought about substantial decreases in hospital admissions and length of stay, both nationally and in the State of Oklahoma. For example, from fiscal year 1985 to fiscal year 1986, the number of persons served decreased by 16.7% and the number of hospital days decreased by 13.9%.

Workers' Compensation

Employers may be liable for employees' accidents or exposures to dangerous substances that affect their health. Such claims are filed through

the Workers' Compensation Court (Table 9.6). Most of the occupational disease awards are for respiratory system problems.

Role of Health Care Sector in State Economy

Health care is included with business and other services as part of the service sector, the fifth largest sector in contribution to Gross State Product. In 1985, health care was the largest component of the service sector and accounted for 30% of employee earnings. Oklahoma's economy is rapidly becoming service-based as growth in other sectors decreases.

Employees' real earnings in the health, business, and other services sector in Oklahoma grew an average of 3.7% per year from 1980 to 1986. Only the military sector and the state and local government sector had comparable growth, 3.7% and 4%, respectively.

During the decade of the 1970s, the average annual growth rate of state government expenditures for health services was 2.7%; during the first half of the 1980s, the annual growth rate averaged 8.1%. Even that high rate of growth was eclipsed by the legal-judiciary system, which grew at 10.4% annually during the early 1980s. In fiscal year 1986, 18%, or \$947.5 million, of state government expenditures were for health services; Medicaid accounted for \$478 million.

MAJOR GOALS FOR THE SYSTEM

The Oklahoma Health Planning Commission, on behalf of the citizens of Oklahoma, has established goals and objectives to guide the growth and development of Oklahoma's complex health care system. The Commission consists of five persons appointed by the Governor. Two represent the general public, and the other three are ex-officio: the Commissioner of Health, the Commissioner of Mental Health, and the Director of the Department of Human Services. A professional staff develops and processes information.

Public participation in the planning process is formalized through a State Health Planning Advisory Board and Local Health Planning Advisory Councils. These groups are made up

Table 9.5 Sources of Health Care Expenditure, Oklahoma and the U.S., 1985 and 1986

Source	Oklahoma 1985	U.S. 1986
Direct Payments	36%	25%
Private Health Insurance	23%	31%
Medicare	19%	17%
Medicaid	10%	10%
Other Government	11%	14%
Philanthropy	1%	3%

Sources: Oklahoma Health Planning Commission (1988); U.S. Department of Health and Human Services, Health Care Financing Administration (n.d.).

of persons representing the interests of consumers as well as most of the organizations, both formal and informal, involved in the delivery of health services in the state.

The professional staff and the advisory groups work together to develop position papers, which eventually culminate in recommendations for goals and objectives. Public hearings are held, and a plan is adopted by the Oklahoma Health Planning Commission.

The plan is not a formal mandate; rather, it attempts to bridge the gap between what currently exists and what is desired in the future. It stresses those health matters over which state government has responsibility for operation and control, and, thus, approaches the articulation of state health policy.

Health issues given priority in the 1988 plan include: AIDS; development and distribution of health manpower; economics of the health care delivery system; health education; long-term care for the elderly and physically handicapped; medically indigent health care; mental health care; and rural health care.

Acquired Immune Deficiency Syndrome (AIDS)

AIDS is a major concern in Oklahoma, as it is in the entire nation. The number of cases in Oklahoma at the end of May 1988 was 242, of which about half had died. The state has organized education, voluntary testing and counseling, and medical care sys-

Table 9.6 Workers' Compensation in Oklahoma, 1982-86

Court Orders for Death and Disability					
Year	Number of Orders		Amount Awarded		
1982	17,528		\$ 82,272,460		
1983	17,250		\$ 96,250,244		
1984	18,262		\$ 114,545,438		
1985	20,017		\$ 122,550,193		
1986	26,035		\$ 137,766,326		

Occupational Disease Cases Filed					
Year	Total Claims	Uncontested Claims	Contested Claims	Awarded	Average Award
1984	493	291	202	\$ 1,542,135	\$ 7,634
1985	887	580	307	\$ 2,138,205	\$ 6,965
1986	705	470	235	\$ 1,043,678	\$ 4,441

Source: State of Oklahoma Workers' Compensation Court (1986).

tems to deal with the problems. Oklahoma has a statewide primary and secondary school education program that focuses on preventing the spread of the virus. A Governor's Task Force has developed recommendations in several sectors aimed at education and prevention. The Oklahoma State Department of Health has established a special AIDS Division within the Epidemiology Service that also focuses on voluntary testing, education, and counseling in the adult population. The State Department of Mental Health is expanding prevention and control programs among substance abusers. A state interagency task force, chaired by the Department of Human Services is coordinating programs.

Development and Distribution of Health Manpower

In Oklahoma, as in other states, the education and distribution of skilled health manpower requires constant attention. The planning groups continue to gather data and review the system for producing physicians, nurses, physical and occupational therapists.

Economics of the Health Care Delivery System

Major changes have taken place in the U.S. health care reimbursement system in the decade of the 1980s. These changes have reduced the reliance on acute-care hospitals in Oklahoma. The health plan has a goal of

ensuring availability of health care within 30 minutes driving time for every citizen in the state. Most parts of the state are adequately covered; however, the stability of some hospitals could be in jeopardy. Many rural hospitals are small, have large population bases of elderly and low-income people, depend on Medicare and Medicaid funds for large proportions of their income, and may be technologically overextended. In the future it may be necessary to redefine rural health care institutions to allow for the development of new organizations (less sophisticated than accredited hospitals and more extensive than typical nursing homes). Attention must be given both to making health insurance accessible to every state citizen and to providing catastrophic health insurance.

Health Education

School health, community health education, and patient-provider communication programs are vital to the state. Emphasis is placed on knowledge and personal health practices that promote health. Special attention is directed toward adolescents to minimize accidents, teen pregnancy, suicide and homicide, nutritional disorders, and substance abuse. The use of health education to promote positive behavior change recognizes: (1) an association between detrimental lifestyle and behavior patterns; (2) the substitution of prevention for curative medicine; and (3) the need to control

health care costs through reduced utilization of services.

Long-Term Care for the Elderly and Physically Handicapped

Long-term care was conceived formerly as custodial care for the elderly in nursing homes. Now, it is seen as a complex array of health and social services for both younger and older Oklahomans in many settings. Health planners see the need for: long-term care insurance; alternate delivery organizations, particularly for the noninstitutionalized elderly and for physically and mentally handicapped persons; gerontology education programs for all health providers; quality assurance programs; preadmission review; and certificate of need standards. Developing cost-effective systems to care for a growing elderly population is a challenge.

Medically Indigent Health Care

The medically indigent include: persons who can no longer afford the rising cost of insurance premiums; working poor without coverage; retirees; employees of bankrupt organizations; widows and divorcees; families with catastrophic illness; uninsurable persons with preexisting conditions. Attention will be given to exploring risk pools for these people. A Council on Health Care Delivery has been recommended to study the incidence of medical indigency in Oklahoma and the care and financing options available.

Mental Health Care

The emphasis in mental health goals is on the development of accessible and affordable services that minimize both the incidence and costs (personal, social, and economic) of mental illness and substance abuse.

Rural Health Care

Rural health goals include improved financial viability for rural hospitals, equitable distribution of health manpower, optimal public health programs, expanded community mental health programs, and a statewide "911" emergency access number. The evolution from full-service hospitals to primary-care centers may be an important component in

maintaining institutional services within 30 minutes driving time for all state residents. These facilities should be linked to referral centers through a formal network. In 1986 state legislation provided financing for the development of "911" emergency numbers through a tax on the base charge of each phone line. About 60% of Oklahomans are included in areas developing "911."

ISSUES, TRENDS, AND DEVELOPMENTS

Managed Care

Managed care is a relatively new term but one that is rapidly growing in use. The thrust of managed care is to provide new organizations and rules for financing and delivering health care. It refers to a variety of options, the aim of which is to provide cost-effective care.

Health Maintenance Organizations (HMOs)

There has been substantial growth in the number of prepaid health insurance programs, HMOs, in the U.S. during the past decade. HMOs are new to Oklahoma, but they have grown both in number and in membership. In 1981 only 4,300 individuals were enrolled in HMOs; by 1986 that number had soared to 150,000.

Ten HMOs are licensed to operate in the state; several are part of national operations. All are based either in Tulsa or Oklahoma City, although they serve adjacent counties as well. Their organizational names are Equicor, Multimed, PruCare, TakeCare, Aetna Choice, Health Accord, HMO of Oklahoma, Metlife, Pacificare, and Physicians Health Plan.

Eldercare

Eldercare is one of the early case-management programs in Oklahoma, designed for the aged population defined as frail and at risk. The program maximizes the independence of the individual at home or in the community by coordinating health and social services. The goal is to eliminate, or delay as long as possible, entry into a nursing home. Eldercare managers function as the client's enabler, service broker, and advocate. The managers

acting on behalf of their clients seek out existing community services: nutrition, medical care, transportation, socialization, homemaker, and respite services.

The program is funded by state appropriations to the Oklahoma State Department of Health at a cost in fiscal year 1986 of \$3,875,470. Most of the money was spent for direct services for the elderly; a maximum of 6.5% was spent on equipment and administration. Generally, the program spends only about \$39 per client per month in purchasing direct services. The Eldercare managers seek other third-party funding, volunteer services, and family support averaging about \$507. Expenditure per client is considerably less than the estimated \$1,023 per month cost of nursing-home care. In fiscal year 1986, almost 5,000 clients were served, and about 3,000 received extensive services. The program is run through 29 contract sites which serve 34 counties. The geographic area includes about 65% of the population over 65 (Map 9.7).

AIDS

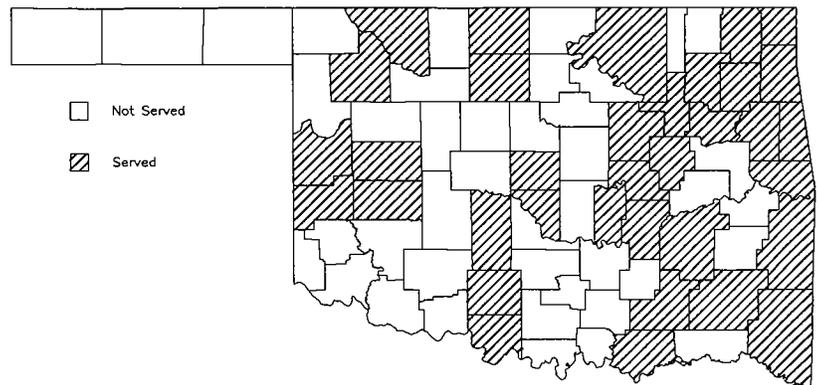
The Department of Human Services is working with state agencies and other private individuals and organizations to design and implement a case management system to handle AIDS cases in the most effective way, medically and economically. This particular system, modeled after systems found in states that have much higher incidences of AIDS, was called for by a Joint Resolution of the Oklahoma Legislature.

Long-Term Care Management Authority of Tulsa

Oklahoma is pioneering a new approach to meeting long-term care needs. The City and the County of Tulsa created an 11-member public trust, the Long-Term Care Management Authority of Tulsa. The purpose of the Authority is to consolidate both public and private funding in order to create quality, cost-efficient, long-term care services for elderly and disabled persons. Through the Long-Term Care Project of the Community Service Council of Greater Tulsa, Inc., the Authority is exploring the feasibility of becoming the financial intermediary between funders and the local providers of care. In addition to clients and their families, funders include public and private insurers. In conjunction with the Tulsa Business Health Group, the Authority is exploring the development of long-term care insurance as a means for funding the rising costs of long-term care for the disabled elderly.

Hospitals

Major nationwide modifications in the reimbursement by Medicare and some private health insurance companies in the 1980s have had substantial impact on the system for delivering care. One outcome has been the substitution of ambulatory care for inpatient care as a major cost saving factor. Patient days (as inpatients) decreased 23%, and admissions to acute-care hospitals decreased 21% during the period 1982-86. Length of stay decreased very slightly from 6.439 to



Map 9.7 — Counties served by Eldercare management in Oklahoma, 1986. Source: Oklahoma State Department of Health (1986a).

6.24 days. In 1982, Oklahoma hospitals' occupancy rate was 61%, which decreased to 46% in 1986. These trends mirror the national situation.

In 1986, 59 acute-care hospitals reported a net loss from operations, while 68 facilities reported a net gain from operations. When income from nonoperating revenue was included, however, 85 hospitals reported a net gain from operations.

If these trends continue, some of Oklahoma's hospitals—mostly small, acute-care, rural hospitals—will experience higher degrees of financial risk. There is excess capacity and underutilization of beds in some places. However, in some rural areas, elimination of facilities would impair the state goal of providing hospital care to all Oklahomans within 30 minutes driving time.

The Oklahoma Health Planning Commission has recommended the development of limited-service hospital or primary-care facilities that would serve as cost-effective alternatives to full-service hospitals.

Indigent Care

In spite of the progress made in the United States over the last 20 years to provide health care to special groups, an increasingly noticeable group is without coverage. This is true in Oklahoma also. The group called "medically indigent" may include middle-income families without insurance, the poor without public assistance, the working poor whose employers do not provide coverage, the temporarily unemployed, and certain groups of retirees.

Public and private hospitals in Oklahoma estimate charity and bad debt write-off make up 8.9% of gross patient revenues. Similarly, private physicians, dentists, and other health-care providers have substantial levels of nonpayment. A substantial provider of ambulatory and inpatient acute care for the indigent is the Oklahoma Medical Center on the University of Oklahoma Health Sciences Center campus.

National catastrophic health insurance may be one solution, but it is years away. In the meantime, the Oklahoma State Legislature is considering legislation to create a state insur-

ance pool. Nine other states have such pools.

The Tulsa Business Health Group, a coalition of 20 large employers, has a Robert Wood Johnson Foundation grant which led to the Tulsa Program for Affordable Health Care. The Tulsa Community Medical Society, the Tulsa District Osteopathic Society, the Tulsa Hospital Council, and the Metropolitan Tulsa Chamber of Commerce collaborate on the project.

The project offers a health insurance package, the Tulsa Health Option, to small firms and their employees. Health maintenance organization (HMO) and preferred provider organization (PPO) options enroll nearly 12,000 employees. More than 10% are employees of small firms (20 or fewer workers) where health benefits had not been an option previously.

CONCLUSION

Oklahoma's health care delivery system is a complex mixture of public and private organizations and programs. This combination has been successful in moving Oklahoma forward with the rest of the nation in extending life span, reducing death from infectious disease, and providing health care for the needy.

Problems will continue to exist for some time in providing access to care for the indigent and care for the elderly as our population ages. The uniform availability of services is of concern, particularly as reimbursement systems change to discourage expensive, inpatient care. This brings financial pressure on rural hospitals, heavily dependent on Medicare reimbursement.

Most important, however, major changes are being made in the health care delivery system to provide cost-effective care. Managed care systems in the form of health maintenance organizations, preferred provider organizations, and case management are thriving.

The state has indicated a willingness to promote health care improvements through advanced education and research. An important component is the Oklahoma Center for the Advancement of Science and Technology (OCAST) which provides funding to researchers and business to de-

velop new knowledge and to translate it into commercial enterprises.

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— Chapter 9 —

LIST OF ILLUSTRATIONS

Figure

9.1 — Leading causes of death in Oklahoma, 1930-86 _____ 142

Maps

9.1 — Distribution of Medicare-certified home health care agencies, 1986 _____ 146

9.2 — Distribution of licensed acute-care hospitals in Oklahoma, 1987 _____ 147

9.3 — Distribution of licensed nursing homes in Oklahoma, 1986 _____ 148

9.4 — Population/physician ratio in Oklahoma counties, 1987 _____ 149

9.5 — Population/nurse ratio in Oklahoma counties, 1987 _____ 149

9.6 — Population/dentist ratio in Oklahoma counties, 1987 _____ 150

9.7 — Counties served by Eldercare management in Oklahoma, 1986 _____ 154

Tables

9.1 — Reported communicable diseases in Oklahoma, 1980-86 _____ 143

9.2 — Oklahoma infant and neonatal mortality rates, by race, 1975-86 _____ 144

9.3 — Inpatient facilities in Oklahoma, 1986 _____ 147

9.4 — Utilization of hospitals in Oklahoma, 1986 _____ 148

9.5 — Sources of health care expenditure, Oklahoma and the U.S., 1985 and 1986 _____ 152

9.6 — Workers' compensation in Oklahoma, 1982-86 _____ 153

Oklahoma Resources

Chapter
10

Forest and Nonfuel
Mineral Resources

by

Mark Meo,

Kenneth S. Johnson,

and

Kenneth V. Luza



Contents

Executive Summary _____	159
Introduction _____	159
Forest Resources _____	160
Forest Types of Oklahoma _____	160
Historical Development of Forestry in Oklahoma _____	160
Forest Biomass Resources _____	162
Timber Resources of Eastern Oklahoma _____	163
Oklahoma's Forest Industries _____	164
Forest Products Industry Performance _____	166
Resource Assessment and Development Strategies _____	167
Nonfuel Mineral Resources _____	167
Nonmetallic Minerals _____	168
Metallic Minerals _____	173
Conclusion _____	174
References _____	175
List of Illustrations _____	176

Forest and Nonfuel Mineral Resources

Mark Meo, Kenneth S. Johnson,
and Kenneth V. Luza

Executive Summary.—Oklahoma has 7 million acres of forest land that support more than 350 million tons of forest biomass. The state's forest resource is concentrated in the east, particularly in the southeastern corner, which supplies more than 50 million cubic feet of timber products each year. This regional concentration provides opportunities both for increasing forest resource utilization and for increasing the growth of the wood products industry. Efforts to improve forest management are noteworthy. Also, significant shifts in stand size and in age/class distributions have been brought about by intensive pine harvesting and maturing hardwoods.

Active timber management activities have occurred in almost one-third of eastern Oklahoma's timberland. Although the forest resource is estimated to be accumulating more than 5 million tons of biomass annually, improved stocking would allow biomass to accumulate at a greater rate. The availability of surplus timber at competitive prices possibly could serve as a stimulus to continued growth in the forest industry. For example, between 1970 and 1980, Oklahoma's employment in the forest products industry—wood furniture, lumber and wood products, and paper and allied products—grew at a faster rate (57%) than the nation's all-industry average (22%). Oklahoma's total earnings in the forest products industry nearly doubled, while the nation's earnings increased by 27%. During the 1970s, Oklahoma's forest products industry increased its share of the national forest products industry employment and earnings. Above average growth accounted for this performance. In 1980, Oklahoma had 2,500 more employees than it would have had if it had grown at the average rate for the industry between 1970 and 1980.

The challenge before Oklahoma's forest land owners and managers, therefore, is to raise the average level of stocking on the state's timberland. The utilization of the forest resource of the state would be enhanced by improving the structure of the forest resource. This could be accomplished by conversion from hardwoods to pine on sites capable of producing adequate growth of pine. This change, in addition to an improvement in the level of growing stock per acre, would provide a significant increase in the quantity and quality of Oklahoma's forest resource.

To accomplish these goals, the transfer of information to landowners and potential investors must be improved. While the opportunities for profitable investments in forest management and utilization are not certain, some measures could improve the overall situation.

Oklahoma's nonfuel mineral resources have been produced from every one of the state's 77 counties. Nonfuel mineral resources, which previously have encountered transportation barriers against their export to other regions, have the potential to make a significant contribution to the state's economy if market demands become more favorable. For some minerals, such as iodine, recent industrial investments in western Oklahoma seem to indicate a growing demand. Currently, the number of workers employed in mining, exclusive of oil and gas, is relatively small, approximately 2,400.

The value of nonfuel mineral production in Oklahoma was \$260 million in 1990. Oklahoma ranked 35th in the nation in 1990, and accounted for 0.8% of the nation's total nonfuel mineral value. Construction materials represented most of the output value; crushed stone, portland cement, iodine, glass sand, gravel, and gypsum were the leading commodities.

INTRODUCTION

Oklahoma's forest and mineral resources have been exploited widely, but not always wisely, throughout the history of the state. Forests, and the timber they produce, aided Native Americans and early settlers by serv-

ing as vital raw materials for both community and industrial development. Mineral resources, particularly nonfuel minerals, have been mined and processed for a variety of uses since before statehood. There is strong potential for these two resources to

continue to contribute to Oklahoma's development.

This chapter discusses Oklahoma's forest and nonfuel mineral resources and specifically addresses the contribution that the beneficial use of each is making to the state, as well as op-

portunities for improving current resource management to aid future development. The chapter begins with an overview of the types of forests that grow in Oklahoma and the historical factors and activities that have shaped the development of the forest resource. Then, the current forest biomass base is presented, followed by a discussion focused on the timber resources of eastern Oklahoma, where forests and forest industries are concentrated. The major forest industries are briefly discussed, and their performance is assessed. Next, a number of strategies for improving aspects of the state's forests and forest products industries are noted. Finally, nonfuel mineral resources are reviewed with respect to both their current, and their potential, contribution to the state's economy.

FOREST RESOURCES

About 16% of the total land area of Oklahoma, about 7 million acres, is classified as forest land. Approximately 4.7 million acres are considered commercial forest; they produce products for industry valued at more than \$182 million annually. Oklahoma's commercial forest areas are chiefly in the 17 eastern counties that comprise the Ozark Plateau and the Ouachita Mountains. Favorable environmental conditions are sufficient for good tree growth, and local topography is too irregular for agricultural use other than tree grazing. The Ouachita Mountains are the most densely forested section of Oklahoma. Pines dominate the higher elevations and oaks generally grow at lower elevations, but there is considerable mixing at all levels.

Forest Types of Oklahoma

The forests of Oklahoma are comprised of four major associations: (1) the pine-mixed hardwoods of southeast Oklahoma; (2) the oak-hickory association, primarily in the state's northeastern corner; (3) the post oak-blackjack oak association stretching across east-central Oklahoma from Texas to Kansas (the Cross Timbers); and (4) the bottomland association found in aquatic floodplains. Each of these associations is described in general terms (following Wheatcraft and

Lewis, 1986). There is likely to be considerable variation at specific sites.

Pine-Mixed Hardwood Association

This association, which covers 1.6 million acres of southeastern Oklahoma, is the most commercially significant association in the state although it accounts for only 23% of the state's total forest cover (Fig. 10.1). The pine-mixed hardwood forest association, which is found in the Ouachita Mountains, is dominated by mixed stands of shortleaf pine (*Pinus echinata*) in association with various oaks (*Quercus* sp.) and hickories (*Carya* sp.). There are pure stands of shortleaf pine throughout the region and naturally occurring stands of loblolly pine (*Pinus taeda*) in the extreme southeast corner.

The climate of this region is characterized by high humidity and annual precipitation that ranges from an average of 42 inches at the northwest edge of the association to 56 inches in the southeast corner. Due to the rugged topography of the area, the soils are typically thin, low in productivity, and poorly drained. The land is used primarily as woodland, but there is a significant amount of cattle grazing. Little agriculture activity takes place. The forests of this timber type provide the raw material for the majority of Oklahoma's wood processing firms.

Oak-Hickory Association

This association is the one most prevalent in Oklahoma; it accounts for 37% of the total forest cover (more than 2.6 million acres). The association is found primarily on the Ozark Plateau in the northeastern corner of the state, but it frequently also is found intermixed with the pine-mixed hardwood association in southeast Oklahoma. Its climate is characterized by high humidity and an annual rainfall of 38–44 inches. The oak-hickory association is comprised of a variety of species including red oak (*Q. rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), post oak (*Q. stellata*), pin oak (*Q. palustris*), blackjack oak (*Q. marilandica*), pignut hickory (*C. glabra*), black hickory (*C. texana*), and bitternut hickory (*C. cordiformis*).

Post Oak-Blackjack Oak Association

This association accounts for 28% of the state's forestland and covers 2 million acres in a north-south belt west of the heavily forested portion of the state. Early settlers in Oklahoma called this area the Cross Timbers because of the difficulty it posed for travel. The association occupies long, narrow, irregular belts in sandy or alluvial deposits in the prairie region. The forests of this association are frequently open and scrublike; post oak, blackjack oak, and black hickory dominate the overstory.

The post oak-blackjack oak association has a drier climate than the types previously described; most of the association receives annual rainfall of 32–40 inches. The region is characterized by rolling hills that have been roughened by weathering processes. The soils are generally coarse in texture and poor, but they have undergone extensive conversion to agricultural uses, such as row crops or pasture.

Bottomland Association

Bottomland or floodplain forest comprises 12% (835,000 acres) of Oklahoma's total forest cover. The bottomland forests extend from the low, humid coastal plain region of eastern Oklahoma to the high, semi-arid region found in the Panhandle. As a result of the widespread distribution of this association, there is not a single species association. In the west there are scattered growths of willow species (*Salix* sp.) and cottonwood (*Populus deltoides*). Mixtures of elms (*Ulmus* sp.) and oaks are found as one travels eastward. Black oak, pecan (*Carya illinoensis*), sycamore (*Platanus occidentalis*), and black walnut (*Juglans nigra*) become more common to the south and east. In the southeast corner of the state, there are forests of bald cypress (*Taxodium distichum*), blackgum (*Nyssa sylvatica*), and sweetgum (*Liquidambar styraciflua*).

Historical Development of Forestry in Oklahoma

During the 1820s and 1830s, the Ozark Plateau and the Ouachita Mountains and their adjacent areas were settled by the Cherokees and the

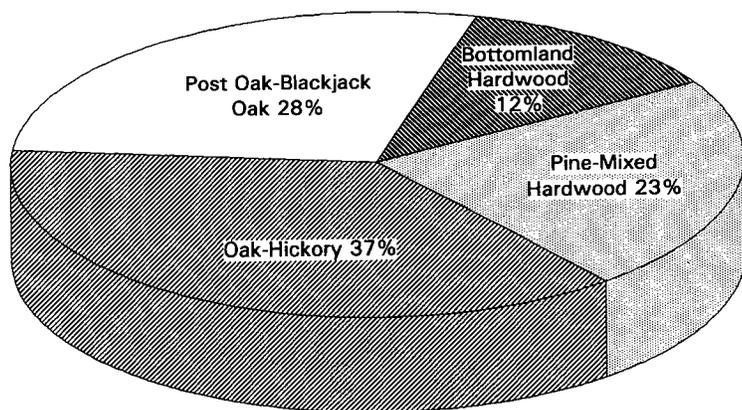


Figure 10.1 — Oklahoma forest land by forest type, 1990. Source: Agricultural Experiment Station (1990).

Choctaws, respectively, when members of the Five Civilized Tribes were forced to relocate from their traditional homes in the southeastern United States. Demand for new housing soon led to active timber felling in the region. Harvest and sale of timber concentrated in areas near streams capable of carrying log floats. After the end of the Civil War, growing settlements in bordering states stimulated enough demand for timber that Chief Allen Wright of the Choctaw Nation financed the construction of the first steam sawmill, at Boggy Depot. Soon, another sawmill opened at Atoka, but transportation of finished lumber to consumers remained difficult.

In 1872, completion of the Missouri-Kansas-Texas Railroad linked the Cherokee, Creek, and Choctaw Nations with the Gulf Coast region of Texas and Louisiana. Not only did the railroad make it possible to mill and market lumber at a profit, but it also enabled the development of an active trade in railroad ties and posts. As a result, several sawmilling towns developed. Stringtown was the first important lumber center to emerge along the railroad. Shortly after completion of the railroad, Stringtown had as many as 22 sawmills cutting pine logs into lumber. Royalties for the lumber produced, based on the board foot stumpage, were paid to the Choctaw Nation.

In 1886–87 the St. Louis–San Francisco Railway was built from Fort Smith through Wister to Talihina, then along the Kiamichi River valley to Antlers and Hugo, and on to Paris,

Texas, its termination. A lateral to this track was constructed in 1902, from Ardmore eastward through Marshall, Bryan, Choctaw, and McCurtain counties. In 1888, an 80-mile track from Wister Junction to McAlester brought rail transportation to the northern side of the Ouachitas.

The proximity of water in combination with the expanding availability of rail transport proved to be a strong stimulus for mill construction. Many milling towns were built along the southern periphery of the Ouachita Mountains where the upland met the coastal plain. Within the Ouachitas, lumbering also stimulated additional settlements and brisk commercial activity. Large quantities of lumber were produced from mills concentrated along the Kiamichi River at settlements such as Kosoma, Rodney, Eubanks, Crum Creek, Stanley, and Clayton. The lumber was transhipped by rail to Kansas City. Logs to supply the mills were hauled from adjacent forested ridges by horse and mule teams.

When timber had been removed in areas close to the mills, portable mills were employed to maintain production. Although timber and lumber hauling by ox teams, mules, and horses was generally slow, productivity along the Kiamichi River increased sharply after the completion of the St. Louis–San Francisco Railway in 1893. The Long–Bell mill at Antlers, for instance, increased production to a daily output of 100,000–150,000 board feet of lumber.

Improving industrial activity had a

noticeable effect on the royalties levied by the Indians. The Choctaw Nation, for instance, which set royalties on walnut, cypress, ash, oak and pine, and cottonwood, doubled its walnut royalty between 1882 and 1897. Yet royalty collection by the Choctaws was problematic. Curran reports that numerous mill owners or operators evaded royalty payments to the Choctaws in part because the Nation failed to employ a sufficient number of mill inspectors.

There were turbulent periods for the timber and lumber industries between the late 1800s and the early 1970s. A good case in point is the Choctaw Lumber and Coal Company, which operated several large mills at Bismark (Wright City) and Broken Bow. It built a private railroad in 1910, which later connected the company's Oklahoma holdings with similar operations in southwestern Arkansas. Under subsequent ownership by the Dierks Lumber Company (from 1921), Choctaw Lumber continued to expand. In 1926, Dierks built the company town of Pine Valley in the Kiamichi Valley. It averaged a population of 1,500 during its period of greatest activity, 1928–40. Yet, by 1942, when most of the accessible timber of desirable size had been cut, the mill was closed. By 1953, the railroad and all buildings, except for offices, had been dismantled and removed.

Lumbering activity was also important in other parts of Oklahoma, including the Ozark section of the Cherokee Nation. Beginning at the turn of the century, white oak was cut for barrel stave bolts and sold in Missouri for manufacture of whiskey barrels. In later years, a variety of trees were cut to supply ties to the growing railroads operating in the region. In western Oklahoma, cottonwood was cut primarily for use as board lumber.

Concerns about forestry conservation were raised early in the 1900s by Chief McCurtain of the Choctaw Nation, who sought to limit the allotment of forested lands to private individuals. Despite agreements by the U. S. Department of Interior to create timber reserves of some 1.4 million acres in Choctaw lands in 1906–07, the majority of this acreage had been acquired by private interests by 1917. It

was during this period that Oklahoma pine forests underwent relentless cutting. Large scale lumber production, which began in earnest around 1910, involved clear-cutting, a practice that could be characterized simply as "cut out and get out." Exploitation for quick profit led to a decline in the quantity and quality of Oklahoma's forests.

State initiatives to promote forest resource conservation began in the early 1920s with the formation of the Oklahoma Forestry Association. As a result of its activities, the State Forestry Commission was formed in 1925. A forest nursery was established at Oklahoma State University in 1926, and a second nursery was started at Broken Bow in the 1940s to aid reforestation efforts. By 1946, when a Department of Forestry was established at OSU, the merits of forest land management had become a reality. Widespread acceptance of the value of conservation and the expanding practice of growing trees as a marketable crop, are helping to establish a sound resource base; if managed wisely, it should keep Oklahoma's lumber mills in continuous production.

Forest Biomass Resources

Approximately 44 million acres of Oklahoma's total land area (17%) is classified as forest land (Fig. 10.2). Forest land is defined as land that is at least 10% stocked by forest trees of any size, or formerly had such tree cover and is not currently developed for nonforest use. In 1982 it was estimated that Oklahoma had 7 million acres of forest land, 67% classified as timberland. The remaining 33% was classified as unproductive or was reserved from the production of timber crops.

The total area of forest land in Oklahoma has declined since the early 1900s when forest land is estimated to have covered 19 million acres (40% of the state). At the beginning of this century, forests covered 50% or more of the land area in 33 counties. Currently, only six counties, primarily in eastern Oklahoma, have 50% or more forest cover. Sixteen counties have at least 25% of their land in forest (Map 10.1).

Forest-land area has been declining at an increasing rate. In 1956, the aver-

age annual loss was 121,000 acres. Twenty years later, it had increased to almost 272,000 acres. Timberland also has been decreasing, but not as rapidly as forest land. In 1956, the average annual loss was 52,000 acres; it has been reduced to less than 5,000 acres in 1976. In recent years, the primary cause for loss of forest land has been conversion to pasture. Other causes include conversion to cropland, water development projects, and commercial and residential development.

Private land owners outside of the forest industry, who own 74% of forest lands, include farmers, individuals, and businesses (Fig. 10.3A). By the definition used for forest land, timber conversion facilities are not operated by land owners in this class. Industrial forestry firms own approximately 25% (1 million acres) of the state's timberland.

Public ownership of forest land in Oklahoma accounts for 836,000 acres. The federal government owns half of the public forest land (3% of the state's total forest land). More than half of the federal forest land is in the Ouachita National Forest. It is administered by the U.S. Department of Agriculture Forest Service, which practices multiple-use management that includes timber production. The other public agencies responsible for management of public forest land emphasize nontimber uses such as parkland, wildlife refuge, or reservoir buffer.

The productivity of Oklahoma's

forests is estimated by classification of forest land by site index. The site index is based on the height of one or more free-growing dominant or codominant trees of a specific species in the forest type at a given age. As the site index value increases, so does the expectation of greater wood fiber production. Most of Oklahoma's forest lands have a site index of 50 (feet) or less. Only 14% of the state's forest land has a site index of 65 or greater. Of the remainder, the majority has a site index of 20.

In regard to their site index classification, forest lands vary considerably by ownership. Both forest industry and National Forest lands have an average site index of 50, and nonindustrial private owners have more than 3.1 million acres with a site index of 50 or higher. This forest land acreage of site 50 or higher exceeds the combined total of all forest land of a similar ranking owned by other groups in the state.

Land currently classed as timberland accounts for 70% of the forest biomass in Oklahoma. The remainder is unproductive land that offers little potential for economic production. The state's timberland has a high portion of its total woody biomass available as valuable stem wood. Timberland stem wood resources account for 56% of the total biomass compared to 42% on other forest land.

If only the yields of the National Forests (70 tons per acre) and forest industry lands (85 tons per acre) are

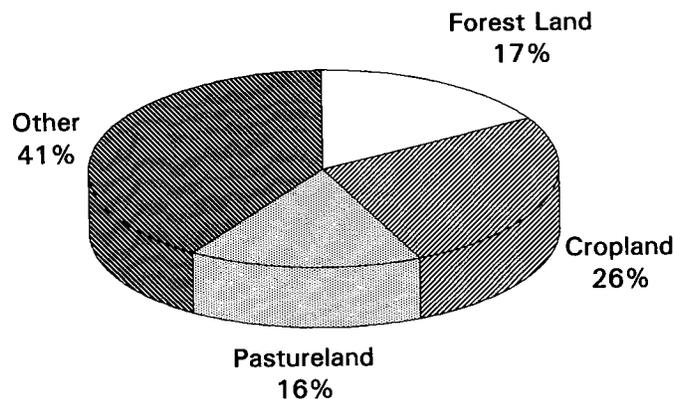
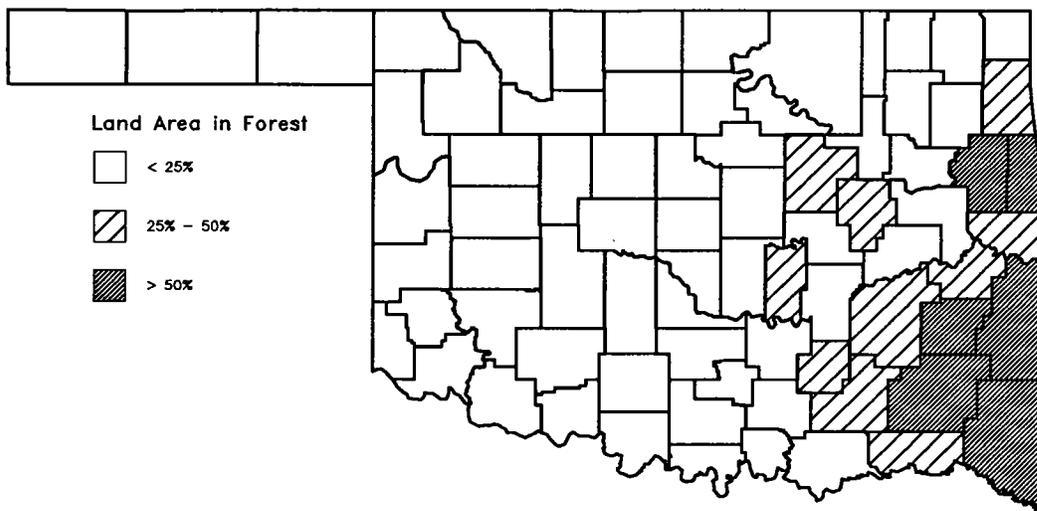


Figure 10.2 — Distribution of land in Oklahoma by major land use, 1990. Source: Agricultural Experiment Station (1990).



Map 10.1 — Percent of total land area in forest by county, 1982.

considered, Oklahoma's biomass productivity is comparable to the average of 80–85 tons per acre in other southern states. However, due to lower biomass yields on other Oklahoma timberlands, the average productivity is only 46 tons of biomass per acre (the lowest in the southern states).

Because the forest industry land holdings have a high level of growing stock per acre, their percentage of the state's forest biomass is greater than their percentage of forest land area. More than 219 million tons (85%) of the economically available biomass is found on private lands.

Annual growth in Oklahoma's timberland woody biomass exceeds total annual removals by more than 5.7 million tons. Of the estimated 14.5 million tons of annual growth in 1976, an estimated 8.2 million tons was stem wood. The remaining 6.3 million tons (bark, branchwood, stumps, roots) was available as fuel or fiber. The annual increase in stem wood is estimated to be 8.2 million tons, and the removal rate is only 5 million tons per year. In addition, 2.5 million tons of stem wood is available from forest land owned by miscellaneous private landowners, where total annual growth exceeds total removals by 4.5 million tons. Average annual growth rates are highest on National Forest and forest industry lands. The average annual removal rate is highest on forest industry land, where it equals the rate of growth.

Oklahoma's forest lands do not compare favorably with other timber-producing states in the South. Production of forest fiber per cubic foot of growing stock in Oklahoma is comparable to that in other southern states, but Oklahoma's forests have a much lower level of stocking and, thus, significantly lower biomass yields. At present production efficiency, a 50% increase in growing stock per acre could produce an additional 55 million cubic feet of forest fiber per year. In addition, forest resources could be utilized more effectively since they are concentrated in the eastern part of the state. With annual net accumulations of 5 million tons, improved stocking would increase the amount of available biomass. Other potential areas of improvement include converting from hardwoods to pine on suitable sites, improving the transfer of information to private landowners and potential investors, and offering selected incentives to use forest resources more efficiently and effectively.

Timber Resources of Eastern Oklahoma

The heavily forested region of southeastern Oklahoma, where most forest industry and National Forest lands are located, contains most of the state's pine and oak-pine forests (1.7 million acres) and oak-hickory forest (1.5 million acres). The northeastern region of the state contains mostly oak-hickory forests (1.1 million acres),

owned by farmers and other private interests.

In 1956, forest land in eastern Oklahoma was estimated at 5.2 million acres. Due to clearing for agriculture, this total declined 5% to approximately 4.9 million acres by 1966. Continued conversion of forest land to agriculture intensified the decline. Between 1966 and 1976, forest lands were reduced by 12% to approximately 4.3 million acres. By 1986 this trend had been arrested and even reversed. Timberland area has increased by 10% to approximately 4.7 million acres.

The hardwoods that dominate in the northeast and southeast (96% and 66% of basal area, respectively) are comprised of white oaks, red oaks, hickories, and elms. The most common softwood is shortleaf pine, followed by loblolly pine. As pine plantations gradually replace natural pine stands, however, loblolly pine is growing in importance. From 1976 to 1986, loblolly pine almost quadrupled in concentration, growing from 5% to 19% in a decade.

Pine forests (stands with more than 50% stocking in pines) increased from 847,000 acres in 1976 to 956,000 acres in 1986. Currently, shortleaf pine accounts for 71% of all pine forest acreages and 87% of the pine stands dedicated for sawtimber and poletimber. Oak-pine types contain 25–50% stocking pines. Hardwoods often dominate the stocking in young pine plantations

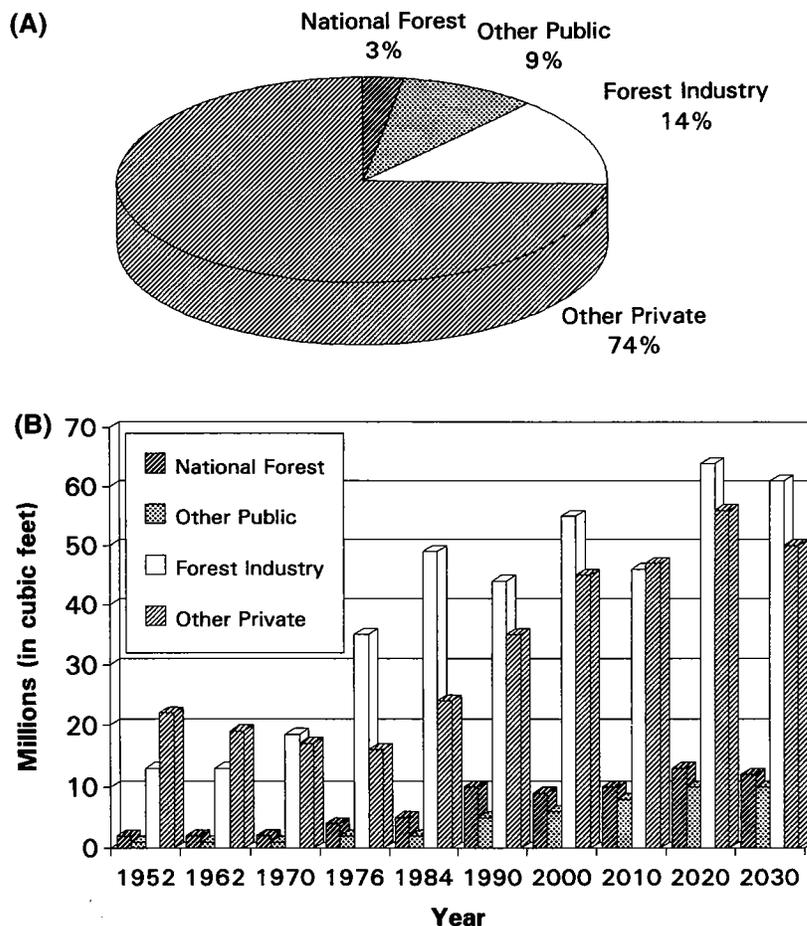


Figure 10.3 — (A) Distribution of Oklahoma forest land by ownership type, 1990. (B) Timber harvest in Oklahoma from 1952 to 2030 (projected). Source: Agricultural Experiment Station (1990).

but are subsequently surpassed by pines either naturally or through stocking control. Nearly all of the softwood is concentrated in the four southeastern counties of Latimer, Le Flore, McCurtain, and Pushmataha, where the proportion of forest land in pine or oak-pine exceeds 35%. The current structure of timberland stands and the age/class structure reflect ongoing trends in forest-land management.

Stand sizes are sorted into four classes: nonstocked, sapling-seedling, poletimber, and sawtimber. While public timberland has shifted to the larger size categories, forest industry holdings now have more than half of all their timberland classified as nonstocked or sapling-seedling, following intensive harvesting. Age/class distributions by forest type and stand origin also indicate a shift toward planted pine. For pine and oak-pine

timberland less than 10 years of age, 85% of the stands showed evidence of artificial regeneration.

Average net annual growth of softwood growing stock declined from 56 to 46 million cubic feet since 1976. Almost all of the decline occurred on forest industry timberland. While net growth declined, annual softwood harvest removals increased from 47 to 54 million cubic feet. Again, most of the increase was on forest industry timberland. In eastern Oklahoma overall, growth declined and removals increased. Causes for the decline in net annual growth include disease and poor weather, an increase in the number of rough and rotten trees, and an increase in the number of poorly stocked timber stands.

In 1986, eastern Oklahoma's timberland was producing timber at only 30% of maximum potential. Poor stocking and a high proportion of cull

tree stocking were the primary reasons for the situation. Due to the prevalence of low productivity sites, these conditions are somewhat inherent to the state's timberland. On 60% of all timberland there is less than 60% stocking of growing-stock trees, the minimum threshold. In addition, 76% of all timberland has more than 30% stocking of rough and rotten trees. Whereas only 11% of softwood basal area is classified as rough or rotten, 57% of all hardwood basal area is in rough or rotten trees.

Despite the relatively good condition of eastern Oklahoma's pine forests, there are several opportunities exist for improvement. Specific management actions include the control of competing vegetation followed by regeneration of poorly stocked stands. High volume natural pine stands should be thinned. Application of pine management options to hardwood stands would indicate regeneration or restocking control because of the low stand density and high occupancy of rough or rotten trees.

The outlook for eastern Oklahoma's timberland, however, is promising. While hardwood types have shifted a bit, most pine stands have been less volatile. In addition, little permanent clearing of pine timberland has taken place and most pine harvests have been followed by adequate regeneration. Although growth of softwoods is slower than removals currently, volume and growth should increase rapidly as current stands of young pine plantations attain harvestable sizes. An increasing shift from natural shortleaf pine to plantation-grown loblolly pine is also expected. As a result of recent problems affecting agriculture, it is expected that little or no hardwood types will be cleared for crops in the near future. The current balance between growth and removals is likely to stabilize as removals and stocking balance out.

Oklahoma's Forest Industries

Oklahoma's eastern forests (Fig. 10.4) supply more than 55 million cubic feet of timber products (roundwood) to the forest products industry each year. Although most of the timber output consists of softwoods, the proportion fell slightly between 1976

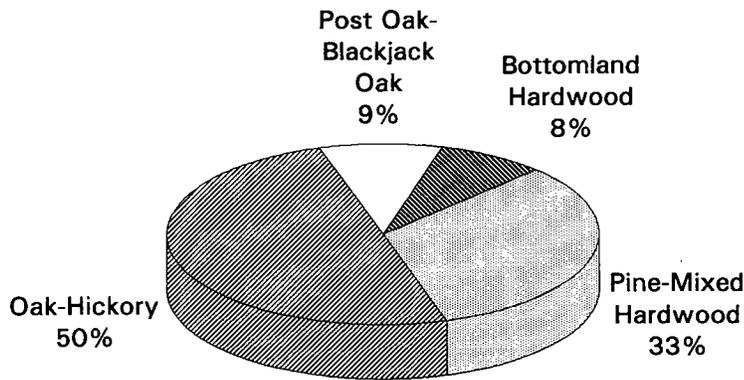


Figure 10.4 — Distribution of eastern Oklahoma forest land by forest type, 1990. Source: Agricultural Experiment Station (1990).

and 1986 to about 75% of the total output. Almost the entire softwood harvest (99.3%) originates from only five of the state's southeastern counties while the hardwood harvest is more evenly distributed among eastern counties (Maps 10.2 and 10.3). The forest industry in eastern Oklahoma employs more than 3,500 people, most of them in paper and paperboard plants. Other forest-based industries located in this part of the state are logging and sawmills (Fig. 10.5).

Saw logs and pulpwood are by far the most common products harvested from Oklahoma's eastern forests; they account for more than 75% of the annual harvest. Saw logs make up more than half of total timber production (57.1%). Pulpwood accounts for 18.3% of production and the remaining shares are supplied by poles and posts (15.2%), veneer logs (8.3%), and miscellaneous wood products (1.1%). Most of Oklahoma's saw-log production is processed into lumber within the state; a few of the larger mills account for more than 85% of all saw-log receipts. Hardwoods are processed by smaller mills. In 1984, 97 wood-using mills, located primarily in the eastern section of the state, were operating in Oklahoma (Map 10.4).

Oklahoma's saw-log production has remained relatively stable around 1984's reported production of 186.3 million board feet. The major fraction (70.6%) of the saw-log volume is comprised of softwoods, chiefly shortleaf pine (86.2%). Almost all (98.1%) of the softwood saw-log production comes from Le Flore, McCurtain, and Pushmataha counties. The remaining fraction of saw-log volume is comprised mostly of red and white oak (61.4%) of which about two-thirds (68.4%) is provided by the three softwood intensive counties.

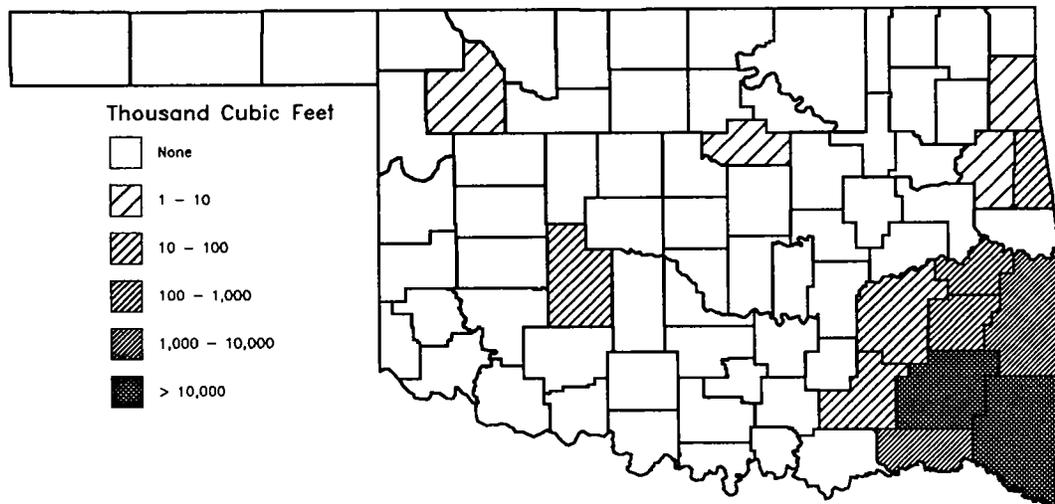
In 1984, sawmills in Oklahoma received 177.8 million board feet of saw logs, which were processed primarily by large sawmills that have an output of at least 3 million board feet. Large mills, which have been increasing

their share of wood production over the years, processed 97% of all softwood receipts and 59% of all hardwood receipts. This trend is underscored by the finding that about 50% of all logs cut in the state were taken across county lines to reach a sawmill for processing.

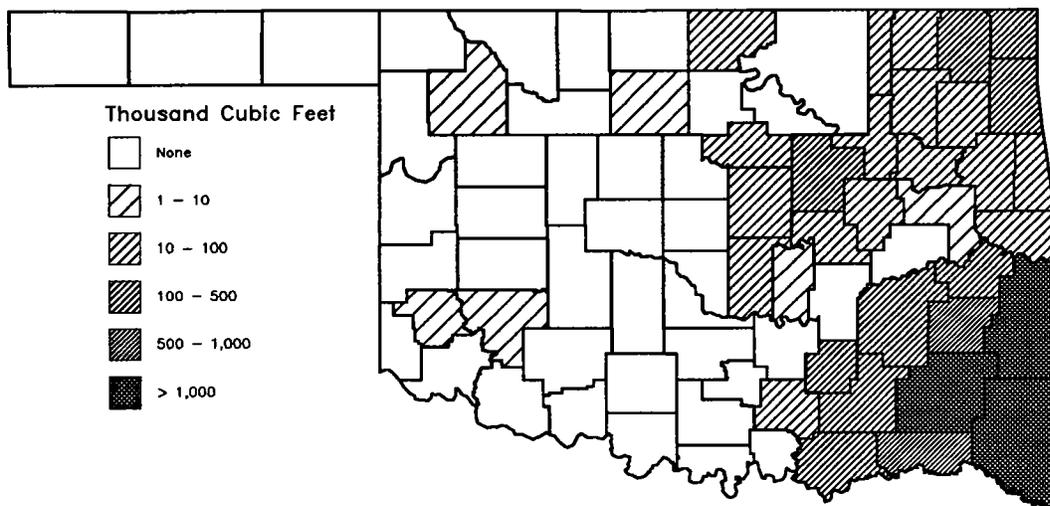
The number of sawmills operating in the state has fluctuated markedly since 1966. Between 1972 and 1975, the number of operating sawmills fell from 103 to 83 and it reached 66 by 1978. In 1984, a total of 84 sawmills were in operation. Since the number of larger mills has remained fairly steady at 7-10, the variability is due mostly to smaller mills that are sensitive to market conditions.

Oklahoma's pulpwood production has fluctuated widely in recent years and has fallen substantially since 1978. Since only a small number of pulpmills draw timber from Oklahoma's eastern forests, any changes in the pulpwood consumption rate of one or more of these mills will greatly affect annual production. For instance, Oklahoma imported 297,066 cords of pulpwood in 1978 and produced 348,752 cords of pulpwood of which only 63,177 cords were exported. In contrast, Oklahoma produced 125,388 cords of pulpwood in 1984, all of which was exported out of state.

Production of poles and posts has increased over time. In addition, production has shifted more to poles, thus increasing the cubic foot volume.



Map 10.2 — Softwood production by county.



Map 10.3 — Hardwood production by county.

All pole and post production is from softwoods supplied primarily from Choctaw, McCurtain, and Pushmataha counties (96.3%).

In contrast to poles and posts, veneer-log production has declined over time. Oklahoma produced 29.3 million board feet of veneer logs in 1984, which was a decrease of almost 21% from 1978 when production was almost 40 million board feet. The major portion of veneer logs (98.2%) is comprised of softwoods, chiefly shortleaf pine (85%). Walnut and pecan comprised the bulk (98.8%) of hardwood production. Le Flore, McCurtain, and Pushmataha counties accounted for 98.2% of all veneer-log production.

The conversion of wood into primary products generated 46.7 million cubic feet of residues in 1984. More than 90% of coarse and fine wood residues result from processing saw and veneer logs. Oklahoma's forest industries convert almost all of these residues into byproducts. Most of it is used as a source of fiber and pulp in paper production. The rest is used for charcoal, fuel, and animal bedding.

Forest Products Industry Performance

In 1980, Oklahoma's major employment sectors were comprised of services (14.7% of total employment), retail trade (13.6%), manufacturing (13.4%), and state and local government (13.3%). Classified as a manufac-

turing activity, the forest products industry includes (1) lumber and wood products; (2) wood furniture manufacturing; and (3) paper and allied products. Forest products are exported to customers outside of Oklahoma, but overall the state is a net importer. This finding means that while the forest products industry is a basic industry in eastern Oklahoma, the industry does not account for any excess employment at the state level. In the decade ending in 1980, the forest products industry's importance in eastern counties increased.

In 1980, the forest products industry had total earnings of \$104 million and employed approximately 7,500 people. The lumber and wood products section employed 43% of the total, but paper and allied products

est products industry. This amount, which represents the income payments made directly to workers and businesses, underscores the finding that paper and allied products had the highest productivity of all forest industry activities. During the period 1972 to 1977, value added in paper and allied products grew by about one-third, and dollars per worker hour grew by 43%. As a result of recent investments in capital facilities, productivity gains in this segment of the industry exceeded the average for the South during the same period. In 1990, paper and paperboard accounted for about one-third of the total state forest industry employment, and logging accounted for slightly more than 25% (Fig. 10.6).

Based on measures of state eco-

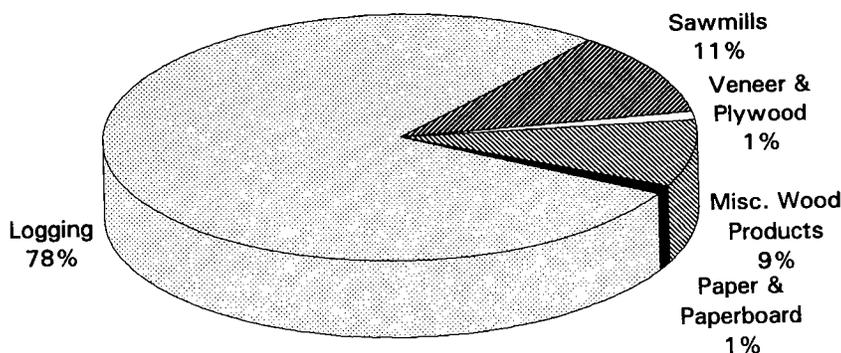
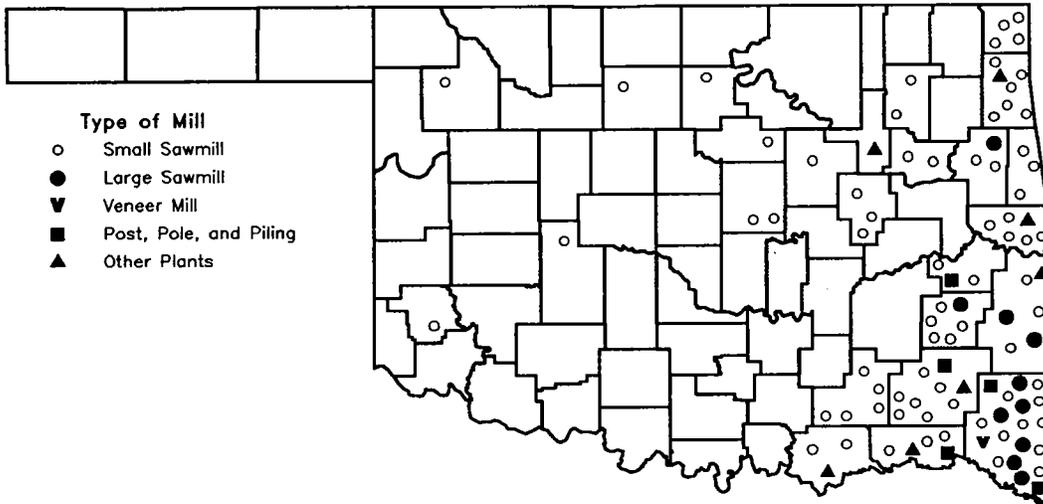


Figure 10.5 — Distribution of forest industry establishments in eastern Oklahoma by type of operation, 1990. Source: Agricultural Experiment Station (1990).

brought in \$48 million, the largest share of total earnings. Between 1970 and 1980, the growth rate for paper and allied products was 116%, five times the national average for all industries. Employment in lumber and wood products increased by 59% in the same period, but employment in wood furniture manufacture barely changed.

In 1977, paper and allied products accounted for 46% of the \$182 million of value added by manufacturing in Oklahoma's for-



Map 10.4 — Location of wood-using mills in Oklahoma, 1984.

economic dependency, only four southern states (Florida, Kentucky, Oklahoma, and Texas) failed to produce forest products in excess of state needs in 1980. In comparison, the forest products industry in Arkansas, Mississippi, and North Carolina was so large that it accounted for approximately one of six basic employees. In comparison with the South and the nation, Oklahoma's major forest products industries had higher gains in employment between 1970 and 1980. Indeed, employment in the forest products industry generally grew faster in the south than in the nation as a whole, and the growth in employment in Oklahoma's forest industry greatly surpassed the national rate and ranked first among the southern states.

Oklahoma's industry ranked fifth for average earnings among the southern states. With respect to the rate of change in earnings, Oklahoma ranked sixth for rate of change during the 1970s. State earnings are shaped significantly by the higher earnings associated with paper and allied products, due largely to the higher job skills required and the presence of unions in pulp and paper manufacturing. As a consequence, capital productivity of the forest products industry in Oklahoma was exceeded by only three southern states in 1977 (Georgia, Louisiana, and Alabama). In contrast, North Carolina, with its em-

phasis on lower waged, labor-intensive wood furniture manufacturing, ranked last among the southern states for dollar per worker hour, yet first that same year in production of value-added manufacturing.

Resource Assessment and Development Strategies

In 1980, the forest products industry was the 10th largest employer in Oklahoma. The majority of its estimated 12,000 workers were employed by sawmills and post and pole operations. Because the current harvest of yellow pine equals annual growth, there will not be significant increases in pine pulpwood production in the future without the application of intensive timber management and reforestation practices. There are opportunities, however, for forest industry development in eastern Oklahoma. Since hardwoods are plentiful in the region, hardwood timber harvests can be increased.

The three most significant obstacles to additional forestry development in eastern Oklahoma are:

- inadequate information about the private owners of timber land (Improving the knowledge base about them is vital because skillful management by these landowners is important to the success of strategies for forest products development.);
- absence of hardwood timber markets;

- absence of furniture industries in Oklahoma.

In addition, until recently, there was no regional group or organization that actively supported improved timber utilization or promoted product development in the forest products industry. Enactment of the Oklahoma Economic Development Act of 1987 and the activities of RedArk Development have helped to remedy this problem.

In conjunction with activities targeted to foster economic development in southeastern

Oklahoma, the U.S. Army Corps of Engineers has suggested several projects that would help the region overcome its obstacles to forestry development. Specifically, they have recommended: (1) an active program to promote wood-product development for industrial growth; (2) a land ownership survey to help improve timber management; (3) a marketing survey to estimate the potential for new products and forest products industrial development; and (4) development of strategies to stimulate demand for hardwoods within the region, including the development of a wood chipping facility, a hardwood concentration yard and dry kiln, and a modular home manufacturing plant.

NONFUEL MINERAL RESOURCES

Oklahoma's nonfuel mineral wealth is tremendous and is evenly distributed throughout the state. Nonfuel minerals include both nonmetals (such as limestone, gypsum, salt, shale and clay, iodine, and sand and gravel) and metals (such as lead, zinc, and copper). Numerous and varied nonfuel mineral industries are active in 69 of Oklahoma's 77 counties. Although nonfuel mineral activity is widespread in the state, some of the most important regions are the Wichita, Arbuckle, and Ouachita Mountain uplifts in the south, and the Ozark uplift in the northeast (Map 10.5). In these areas, some of the

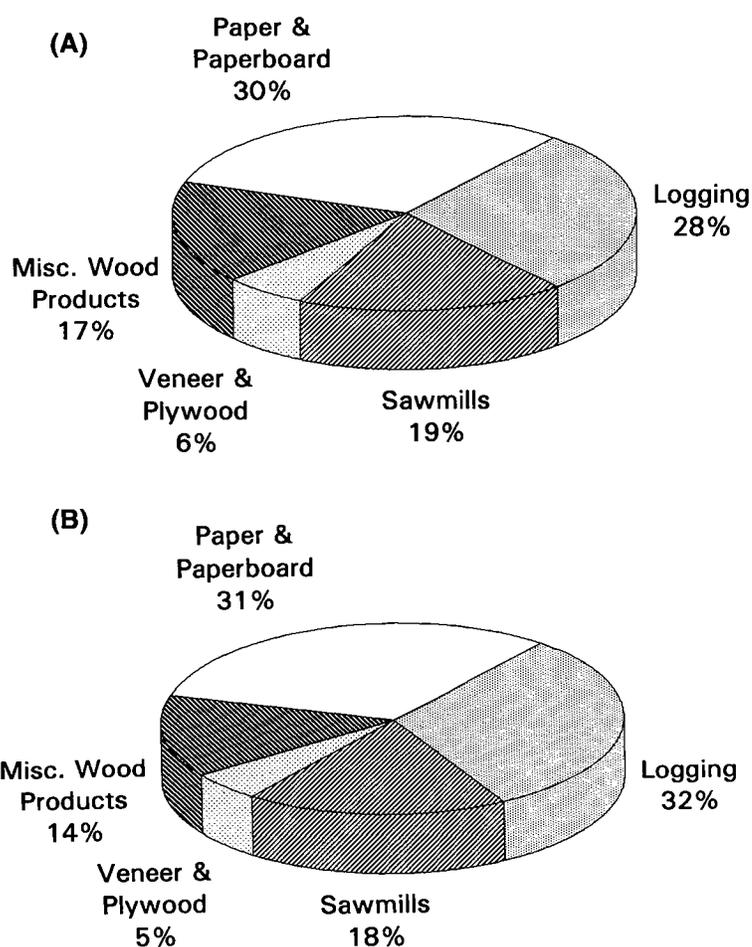


Figure 10.6 — Distribution of (A) employment, and (B) wages and salaries in the Oklahoma forest industry by type of operation, 1990. Source: Agricultural Experiment Station (1990).

state's unique rock and mineral deposits are exposed at the land surface.

The value of all of Oklahoma's mineral production (including petroleum, coal, and nonfuel minerals) reached a high of \$11 billion in 1983, and was \$6.3 billion in 1990, making the mineral industry the greatest source of revenue in the state in recent years. The nonfuel minerals contribution to the state's wealth in 1990 was \$260 million, and in 1991 it was estimated to be about \$261 million (Table 10.1).

Many of the data in this part of the chapter are based upon reports by Johnson (1969a, 1977), Morris (1982), and the Oklahoma Department of Mines (1991); the reader is referred to these reports, as well as other reports that are separately referenced for several of the commodities.

Nonmetallic Minerals

Nonmetallic minerals are widely distributed in Oklahoma (Map 10.6), and many of them are being mined for local, regional, and national markets. Crushed-stone and building-stone resources include the limestone, dolomite, and granite deposits; other major construction resources are cement (made from limestone and shale) and the extensive sand and gravel deposits along the modern and ancient riverways. Glass sand, which is a high-purity silica sand, is used for glass making, foundry sands, ceramics, and abrasives. Enormous reserves of gypsum in the western part of the state are mined for wallboard, for plaster, for use as a retarder in portland cement, and as a soil conditioner. Thick layers of rock salt underlie most of western Oklahoma, and natural

springs of salt water emit brine to the several salt plains. Oklahoma iodine, produced from deep brines in the northwest, is the nation's sole domestic supply. Other important nonmetallic minerals in Oklahoma include clays and shales (to make brick and tile), and tripoli and volcanic ash (abrasive and/or absorbent materials).

The total estimated value of nonmetallic mineral production in Oklahoma during 1991 was \$261 million, and the state ranked 35th in the nation. Leading nonfuel commodities during 1991 were crushed stone (\$83 million), portland cement (\$66 million), iodine (\$30 million), glass sand (\$23 million), sand and gravel (\$22 million), and gypsum (\$11 million).

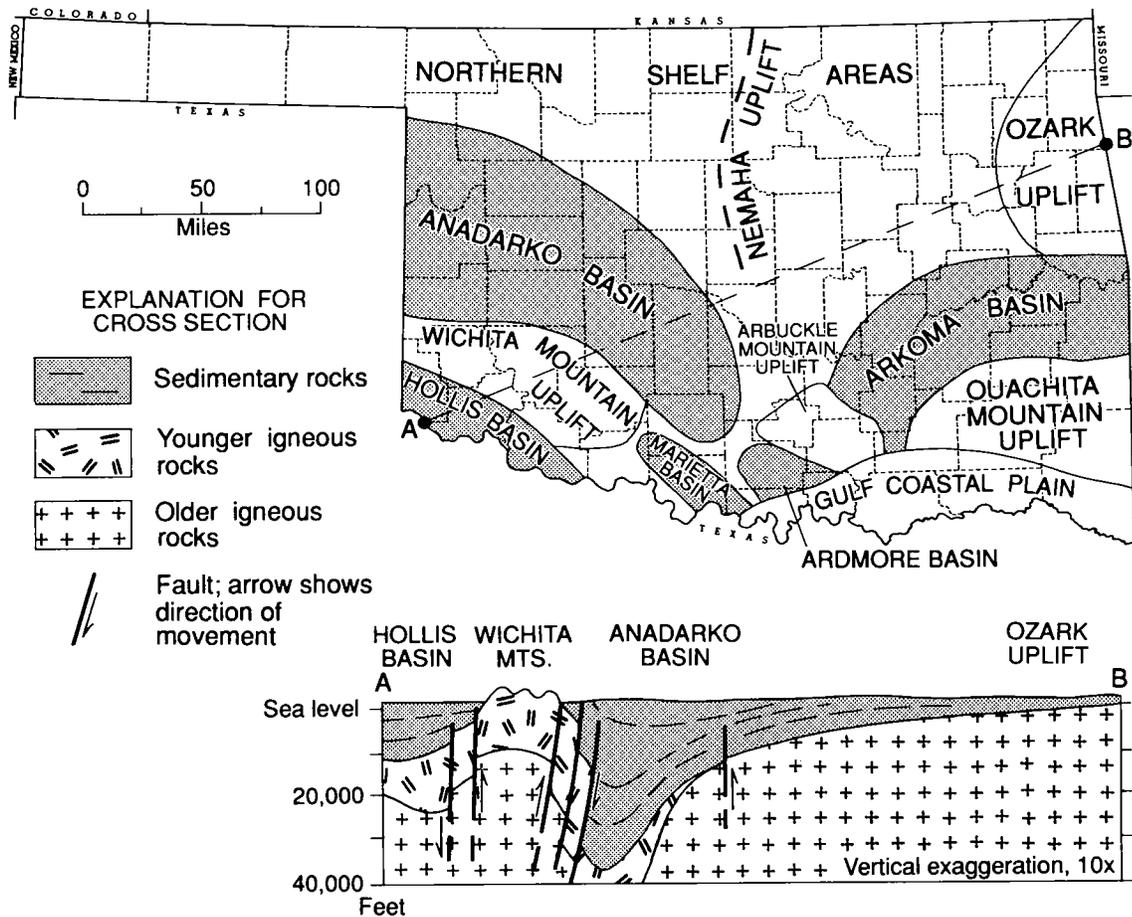
The following descriptions of Oklahoma's nonmetallic minerals are arranged alphabetically.

Asphalt

Asphalt is an oil-based commodity, but because it has been used mainly as a road-surfacing and tar material in Oklahoma it is considered herein as a nonfuel mineral resource. Asphalt forms where crude oil migrates upward near the land surface. The lighter hydrocarbons evaporate, and the thicker, heavy residue impregnates the rocks as rock asphalt or fills voids as a tar-like substance called asphaltite.

The major sources of rock asphalt and asphaltite are in sedimentary rocks in and around the Arbuckle and Ouachita Mountains of southern Oklahoma. Additional smaller deposits occur in sedimentary rocks surrounding the Wichita Mountains and in northeast Oklahoma. From the state's large reserves, about 3 million tons of asphalt were produced between 1891 and 1960, chiefly from asphaltic sandstones and limestones in the Sulphur and Dougherty districts of the Arbuckle Mountains. Principal mines for asphaltite were operated near Page, Sardis, and Jumbo in the Ouachita Mountains; these shaft mines and surface mines operated between 1890 and 1916.

Most of the rock asphalt and asphaltite mined in Oklahoma was used as paving material for roads in Oklahoma and adjacent states. Petroleum refineries now produce the large quantities of asphaltic material



Map 10.5 — Major geologic provinces of Oklahoma.

needed for road construction and maintenance, and all natural-rock-asphalt quarries are currently inactive. Future demands for asphaltic materials and/or heavy oils could be satisfied readily by the vast reserves that remain in the state.

Cement

Raw materials for the manufacture of portland cement and masonry cement are limestone and clay or shale. Oklahoma has abundant reserves of both these resources, and they are discussed separately elsewhere in this chapter. Three cement plants currently are operating in Mayes, Pontotoc, and Rogers Counties: production in 1991 was estimated at approximately 1.7 million tons, with a value of above \$66 million (Table 10.1).

Chat

Chat, which consists of crushed limestone, dolomite, and chert, was

produced as a waste byproduct of mining and milling of lead-zinc ores in the Tri-State district of northeast Oklahoma. The material, which now exists in large piles in the Miami-Picher area of Ottawa County, has been used as road metal, railroad ballast, concrete aggregate, and rock fill.

Chemical Raw Materials

Oklahoma has vast reserves of certain high-purity minerals suitable as raw materials for various chemical industries. Major deposits of limestone, dolomite, and glass sand are in the south-central and eastern parts of the state, whereas gypsum and salt are widespread in the west; these individual resources are discussed elsewhere in this chapter. The abundance and purity of these minerals should enable manufacture of caustic soda, soda ash, chlorine, sulfur, sulfuric acid, lime, sodium silicate, and other chemical products. Oil, natural gas, and wa-

ter, needed in the manufacture of these products, are plentiful in most parts of the state, and bituminous coal is abundant in eastern Oklahoma.

Clay and Shale

Clay and shale are present in almost every county in Oklahoma, and deposits suitable for manufacture of red brick and tile products are widely distributed. Light-firing clays, low-grade refractory clays, and clays suitable for making pottery are present at a few localities, and clay suitable for making lightweight aggregate is common in the eastern portion of the state.

Most of the shale deposits in Oklahoma contain illite as the dominant clay mineral, and the illite is associated with varying mixtures of clay-sized quartz and other clay minerals. Chlorite, kaolinite, montmorillonite, and mixed-layer clays generally are of lesser importance, although each of these clays is predominant in certain

Table 10.1 -- Non-fuel Mineral Production in Oklahoma¹

Mineral	1989		1990		1991	
	Quantity	Value (000's)	Quantity	Value (000's)	Quantity	Value (000's)
Cement (Portland) - thousand short tons	1,236	\$39,360	1,544	\$60,457	1,686	\$65,754
Clays - metric tons	565,956	1,619	631,302	3,156	686,480	3,391
Gypsum (crude) - thousand short tons	2,523	14,369	2,184	11,154	2,036	10,624
Iodine (crude) - kilograms	1,505,714	23,947	1,972,849	30,486	1,926,478	29,558
Sand and Gravel:						
Construction - thousand short tons	* 8,500	* 20,000	9,235	21,993	* 9,300	* 22,300
Industrial - do	1,216	18,310	1,258	22,984	1,250	22,800
Stone:						
Crushed ² - do	23,598	81,969	* 25,300	* 89,500	24,500	83,100
Dimension - short tons	8,290	762	* 8,138	* 684	8,000	700
Tripoli - metric tons	W	W	18,801	155	NA	NA
Combined value of cement (masonry), feldspar, gem stones, lime, salt (1990-91), stone (crushed granite), and values indicated by "W"	XX	\$18,695	XX	\$19,608	XX	\$22,416
Total	XX	\$219,031	XX	\$260,177	XX	\$260,643

* = Estimated

NA = Not available

W = Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure

XX = Not applicable

¹ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).² Excludes certain stones; kind and value included with "Combined value" figure.

Source: U.S. Bureau of Mines (1992).

localities. In addition to these common shales, there are several types of specialty clays in parts of Oklahoma: small- to moderate-sized deposits of bentonitic clay (montmorillonite) are associated with, and altered from, volcanic ash, mainly in northwestern Oklahoma.

Shale has been an important part of the construction industry in Oklahoma since before statehood. More than 120 brick plants, most of them in the central part of the state, have operated since 1888. Also, shale is one of the major ingredients used at the three cement factories now operating in the state. In 1990, 26 companies were producing clay and shale in many different parts of Oklahoma; and in 1991, the state produced an estimated 686,480 metric tons of clay and shale valued at about \$3.4 million (Table 10.1).

Dimension Stone

Oklahoma has a variety of sandstones, limestones, dolomites, and

granites suitable for building and ornamental purposes, and native stone has been used extensively in residence and building construction. The quality of some sandstones in eastern Oklahoma and oolitic limestone in southern Oklahoma compares favorably with any in the nation, and several of the limestones and dolomites have unusual beauty and texture. The various types of dimension stone are discussed further in this chapter under the rock names. In 1991, Oklahoma produced about 8,000 tons of dimension stone valued at an estimated \$700,000 (Table 10.1).

Dolomite

There are large reserves of high-purity Cambrian dolomite in the Arbuckle Mountains. The stone is quarried for high-purity material at one site and is quarried for crushed stone at two other sites in the Arbuckle region. The high-purity Royer Dolomite is about 500 feet thick in the area, and

other dolomite units are also 400–500 feet thick. There are smaller deposits or thinner beds, generally of lower purity, in the Wichita Mountains, in Delaware and Osage Counties, and in widely scattered Permian outcrops of western Oklahoma. Several of these deposits are worked for dimension stone and/or crushed stone.

Current and potential uses of dolomite are for fluxing stone, glass manufacture, refractories, dolomitic lime, magnesium metal, fertilizers, feeds, and as a soil conditioner. Quantity and value of current production are included the estimates for crushed and dimension stone (Table 10.1).

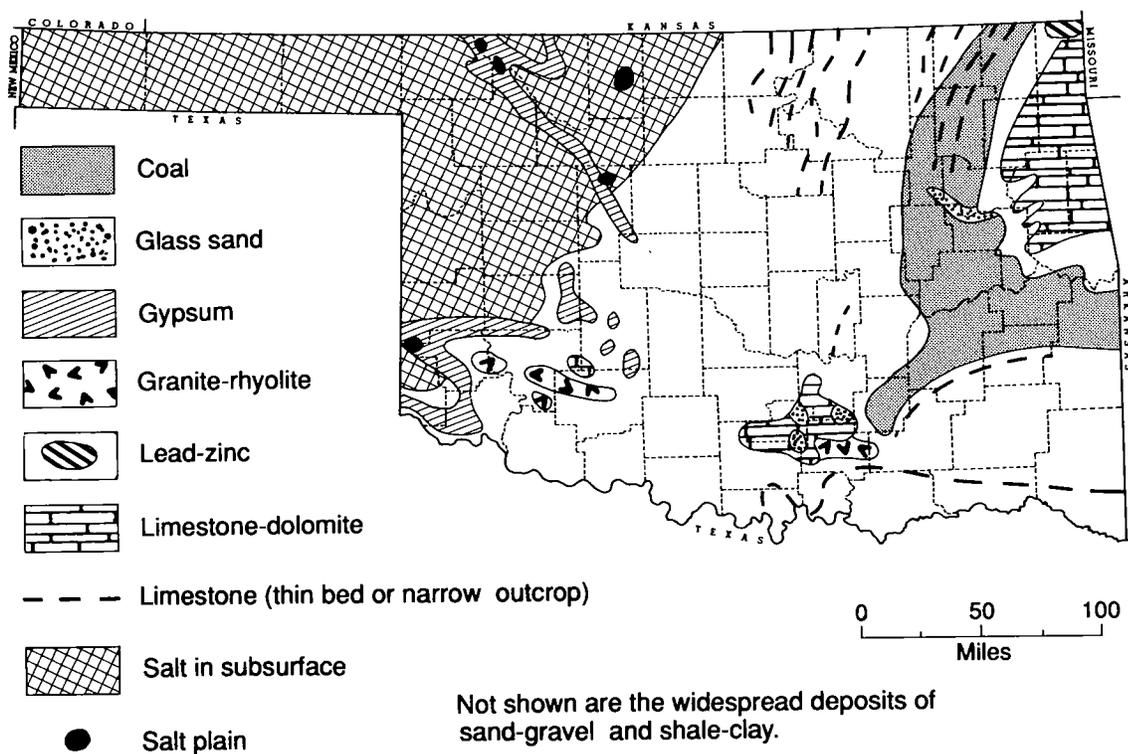
Glass Sand

Large deposits of high-purity silica sand (Ordovician Simpson Group) are worked at two places (Johnston and Pontotoc Counties) in the Arbuckle Mountains region, with plant-run sands containing 99.8% silica and normally only 0.01–0.03% iron oxide. Ordovician sand almost as pure is present in northeastern Oklahoma, and scattered exposures of Cretaceous sands with 98.5–99.5% silica are reported south and east of the Arbuckles. Alluvial sand from the Arkansas River is being specially treated in Muskogee County to produce a high-purity feldspathic sand for glass manufacture: the processed sand includes about 75% quartz (silica), about 25% feldspar, and less than 0.04% iron oxide. In 1991, Oklahoma's production of glass sand (reported as industrial sand in Table 10.1) was estimated at 1.25 million short tons, with a value of about \$23 million.

A number of glass-manufacturing plants in eastern and central Oklahoma produce a variety of glass products, including bottles, jars, window panes, tumblers, tableware, and Pyrex glass. Sand also is shipped out of the state for glass making, foundry sands, ceramics, and the manufacture of sodium silicate. One glass-sand plant produces ground silica for use in ceramics, abrasives, and inert filler.

Granite

Granite and similar rocks of the Wichita and Arbuckle Mountains of southern Oklahoma are produced extensively as dimension stone for the



Map 10.6 — Distribution of principal nonpetroleum mineral resources of Oklahoma.

monument and building trades; crushed granite and rhyolite are produced mainly for railroad ballast (stone in the railroad bed) and, intermittently, for building aggregate and riprap. Granite and similar rocks in Oklahoma are Precambrian and Cambrian in age. Colors are red, pink, gray, and black, and the textures range from fine to coarse crystalline. At present, nine companies (in Greer, Kiowa, Johnston, and Murray Counties) regularly produce granite and rhyolite from quarries; in 1990, the state produced about 3.5 million short tons of granite and rhyolite. The major production (2.7 million tons) was from Johnston and Murray Counties, where granite and rhyolite are being quarried for railroad ballast. The value of granite and rhyolite production is divided among several categories (dimension stone and crushed granite) in Table 10.1.

Gypsum

Enormous reserves of high-purity Permian gypsum crop out in western Oklahoma. Blaine Formation gypsums in the northwest and southwest are 5–30 feet thick and 95–99% pure,

and the Cloud Chief gypsum of Washita and Caddo Counties is 25–100 feet thick and 92–97% pure. Anhydrite crops out only locally, but it is present underground where there is overburden of 25–100 feet or more.

Total gypsum reserves in Oklahoma are estimated at 48 billion short tons. Gypsum typically forms hills in the semiarid climate of western Oklahoma, and the gypsum layers are nearly flat lying, without folds or faults. Thus, the reserves are well suited for open pit mining or quarrying. Oklahoma ranks fifth nationally in crude gypsum production (1989 figures); 14 companies in 9 western counties produce about 2 million tons annually. The value of gypsum produced in 1991 was estimated at about \$10.6 million (Table 10.1). Present uses are for plaster, for wallboard, as a retarder in portland cement, and as a soil conditioner. In the future it may be used as a source of sulfur.

Helium

Helium, a colorless, odorless, and nonpoisonous gas, is the second lightest of all elements. Helium was extracted for many years from natural

gas at the U.S. Bureau of Mines plant near Keyes, in Cimarron County, but production has ceased. The helium-producing field is largely depleted, although some reserves still remain.

Iodine

Iodine is a grayish-black, nonmetallic element that is solid at ordinary temperatures. In Oklahoma, it is dissolved in iodine-rich natural brines (>300 parts per million iodine) 6,000–10,000 feet below the land surface in the Woodward, Vici, and Dover areas in the northwestern part of the state. Iodine-rich brines are produced from wells drilled in these areas, and the iodine is then treated chemically and precipitated from the brine; after being stripped of its iodine, the waste brine is treated and then reinjected into the producing formation. The Oklahoma brines are the richest known iodine brines in the world. They range from 100–1,560 parts per million iodine and are 300–350 parts per million iodine in most of the producing wells.

Oklahoma's production of iodine began in 1977. Since 1987, when iodine production in Michigan ceased,

Oklahoma has been the sole source of domestic iodine in the United States. Oklahoma produces about 12% of the world's annual output. At present, three companies operate three major plants and one miniplant in northwest Oklahoma, and annual production is about 1.9 million kilograms, valued at about \$30 million (Table 10.1). A new plant is under construction in Woodward to make about 50 iodine-derivative products from the iodine being produced. Major products that use iodine include catalysts, stabilizers, animal feeds, disinfectants, pharmaceuticals, photography, and colorants.

Lime

Quicklime, made by calcining high-purity limestone, has many chemical and industrial uses, in addition to its uses in construction and agriculture. High-calcium limestone in Sequoyah County is being mined to produce lime, and there are other deposits of high purity in northeastern, south-central, and southeastern Oklahoma.

Limestone

Limestone is abundant in northeastern Oklahoma, in the Wichita and Arbuckle Mountain areas, and in southeastern Oklahoma. It is used mainly as aggregate (crushed stone) in concrete, in building roads, and in other construction, but it also is used in making cement, dimension stone, and chemical-grade lime. In western and Panhandle districts, extensive deposits of caliche are acceptable substitutes for some purposes, and at other places dolomite is quarried for crushed stone.

Major limestone formations of the Arbuckle and Wichita Mountains are several hundred to several thousand feet thick, and, because they crop out over large areas, they are an almost unlimited reserve of stone. The principal market for stone from these two areas is the Oklahoma City metroplex, although some stone also is shipped to major cities out of state. Usable limestones in the southeast, northeast, and north-central parts of the state commonly are 10–50 feet thick, and they are quarried to provide stone mainly for local markets.

At present, more than 20 companies are quarrying limestone at more

than 30 sites in Oklahoma, and the annual production is 25–30 million tons. Almost all of the limestone production is reported as crushed stone in Table 10.1, and the value of crushed stone produced in 1991 was estimated at about \$83 million.

Salt

Thick sequences of Permian rock salt (NaCl) underlie most of western Oklahoma at depths ranging from 30 feet to more than 3,000 feet (Map 10.6). Individual salt beds are 5–25 feet thick and are interbedded with thinner layers of shale and anhydrite. The depth and thickness of salt beds in the region make them suitable for either underground or solution mining. No attempts have been made at opening a conventional underground dry mine in Oklahoma, but such mines have operated in the same salt beds for many years in Kansas, just 60 miles north of the state line. Solution mining of salt has been carried out near Sayre, in Beckham County; high-salinity brine and salt precipitated from the brine by evaporation are marketed.

There are a number of major natural salt plains and salt springs along the rivers of western Oklahoma. Saturated brine, formed by dissolution of salt in the shallow subsurface, is discharged at 11 natural salt springs or salt plains in the state; emissions range from 150 to 3,000 tons of salt per salt plain each day. These natural springs have been used commercially since the beginning of this century, and they were used even earlier by Native Americans. Several small salt producers have tapped salt plains in the northwest and southwest in the past, and each company produced about 2,000–10,000 tons of solar salt per year. At present, a single major producer of solar salt is operating on the Big Salt Plain near Freedom, in Woods County.

Oklahoma's vast salt reserves, estimated at 20 trillion tons, are virtually untapped. Production from the one solar-salt plant in Woods County during 1990 was about 105,000 tons. The salt was used primarily in recharging water softeners and for stock feed, but other potential uses include chemical industries (chlorine, caustic soda,

soda ash, and sodium), human consumption, and snow removal.

Sand and Gravel

Sand and gravel, which are essential to almost all types of construction, are widespread and available in most parts of Oklahoma. Principal deposits are along present-day major rivers, in terracelike remnants of Pleistocene river beds, and in Tertiary deposits covering much of the northwest. Gravels are common in the western third of the state, as well as in and around the Wichita and Arbuckle Mountains, and in Cretaceous rocks south of the Arbuckle and Ouachita Mountains.

Sand and gravel are used in the building industry chiefly as aggregate, which is the term used for inert and hard, fragmental material that is bound by a cementing material to form portland cement concrete, mortar, or plaster. In the paving industry, sand and gravel are used as aggregate in both asphaltic mixtures and portland cement concrete.

In 1990, more than 180 companies operated sand and gravel pits in 52 of Oklahoma's 77 counties. Construction sand and gravel produced in 1991 was estimated to be 9.3 million tons, and it was valued at \$22.3 million (Table 10.1). Industrial sand and gravel consists mainly of glass sand, described elsewhere in this chapter.

Sandstone

Sandstone is a common rock type in most parts of Oklahoma. Deposits in the eastern half of the state are mostly hard, are gray, brown, or buff, and some are suitable for dimension stone or aggregate. Those in the western half of the state are mostly soft or loose, are reddish-brown, and are only locally suitable for building material. Sandstone is quarried as dimension stone at several sites in east-central Oklahoma, and it has been quarried for riprap and aggregate at several places in the eastern half of the state.

Stone

Oklahoma has many types of stone that can be used in the construction industries. Sandstones, limestones, dolomites, and granites are widely

distributed in most parts of Oklahoma, and each of these resources is discussed separately elsewhere in this chapter.

Tripoli

Tripoli is a white or cream-colored, microcrystalline form of high-purity silica that is porous, lightweight, and friable. It is derived from a parent siliceous sedimentary rock from which soluble carbonate minerals have been leached. There are important tripoli deposits in northeast Oklahoma, and the first mine was opened in the Missouri-Oklahoma tripoli district in 1869. Tripoli deposits typically are 2–20 feet thick, and they occur in Mississippian-age cherty limestones beneath 2–10 feet of overburden.

After quarrying, tripoli is dried, crushed, and screened to various grain sizes. The ground tripoli is used mainly as a mild abrasive or in buffing and polishing compounds. It is prized for its abrasiveness, porosity, permeability, absorption, and low specific gravity. Only one company operated in 1990, in Ottawa County, and it produced about 18,800 metric tons with a value of \$155,000 (Table 10.1).

Volcanic Ash

Small to large deposits of uncemented volcanic ash occur in western and east-central Oklahoma. They result from local accumulations of ash and dust blown from volcanoes that erupted in New Mexico, Wyoming, and other western states during Tertiary and Pleistocene times. Some of the ash deposits are altered in part to bentonite clays.

Volcanic ash is used as an abrasive, mainly in polishing powders, scouring soaps, and cleansing powders; it also can be used as an admixture in pozzolan cement and as an insulating compound. In recent years, two companies have been mining volcanic ash in Beaver and Okfuskee Counties; production for the last 5 years has ranged from 543 to 3,775 tons.

Miscellaneous Minerals

Several other nonmetallic minerals occur in small or low-grade deposits: Barite nodules, veins, and concretions occur sparingly in some shales and

sandstones south of the Wichita Mountains and in central and south-central Oklahoma. At a few localities, there are surface concentrations of high-grade nodules that may have possibilities for limited production. Celestite and minor amounts of strontianite are associated with dolomite and gypsum in eastern Washita and Custer Counties, but these deposits apparently are small and not commercial. Diatomite deposits are small and of low grade, and they are widely scattered in western Oklahoma.

Phosphate occurs as nodules, plates, and lenses in several limestones and black shales of eastern Oklahoma and the Arbuckle Mountains. The P_2O_5 content of nodules and plates is generally 15–30%, whereas that of the whole rock commonly is 1–10%. Quartz occurs as large vein deposits in the Ouachita Mountains, especially in central McCurtain County.

Metallic Minerals

Although metals are not being produced currently in Oklahoma, the lead-zinc mines in northeastern Oklahoma contributed significantly to the state's early development. The major metallic mineral resources in Oklahoma are lead, zinc, and copper, and these metals occur at scattered sites throughout the state. Lead and zinc were developed commercially in the northeast corner of the state (Map 10.6) and copper in the southwest. Iron, titanium, manganese, and uranium also occur in Oklahoma, but they are not now produced. Some germanium, gallium, and cadmium were produced as by-products during the smelting of the zinc ores from northeastern Oklahoma.

Lead and Zinc

Deposits of lead and/or zinc occur in the Ouachita, Arbuckle, and Wichita Mountains. However, the most significant production of lead and zinc came from the Oklahoma portion of the tri-state mining district of northeastern Oklahoma, southeastern Kansas, and southwestern Missouri. Approximately 1.3 million tons of lead and 5.2 million tons of zinc have been produced in Ottawa County since 1891, and Oklahoma led the U.S. in zinc production almost every year

from 1918 through 1945. The ore occurs in Mississippian-age limestones and dolomites. The first discovery and earliest mining operations in Ottawa County were in the vicinity of Peoria, Oklahoma. The Peoria Mining Co. was one of the first companies to develop properties near Peoria in 1891. The principal ores were galena, sphalerite, and zinc silicate. Most of the workings were shallow (less than 50 feet deep), and drifts were developed 6–8 feet in height and 10–20 feet in width. Much of the ore from the Peoria Camp was hauled by wagon and later by truck to Joplin, Missouri, and/or Galena, Kansas. The absence of rail transportation made marketing of the ore very expensive. The mining history for the main part of the Picher field began in 1902, about 1.5 mile northeast of Lincolnville, when ore was discovered on Abrams land and Julia Whitebird land. The first recorded output of concentrates from the Lincolnville areas was in 1904, and peak production occurred in 1909.

The next major discovery was made in 1905 near Commerce at the southwest side of the field. The early mines in this area were comparatively shallow, at depths of 90–130 feet. As the ore was followed northwestward in succeeding years, however, depths increased to as much as 250 feet by 1911, and eventually to more than 320 feet.

Exploration, stimulated by the richness of the Commerce ores and by the recognition of a northeasterly trend in some of these ore runs, led to the discovery of the main part of the field in 1912. In 1914, Picher Lead Co. (now Eagle Picher Industries, Inc.) discovered ore on the Crawfish land and on several adjacent Indian-land allotments (northwest Picher, Oklahoma). Near the close of 1917, the Oklahoma part of the field was fairly well defined by producing mines. It was estimated in 1918 that 230 mills were built or were under construction in the Oklahoma part of the field.

The 1920s marked the maturity of the field. In the latter half of the 1920s, zinc recovered from reworked tailings became an important factor in total zinc production.

The 1930s witnessed the growth of central milling in the field. The milling

practice up to that time (largely at the landowners' and royalty owners' insistence) was to have separate mills on each 40- or 80-acre lease to ensure proper royalty distribution. In 1932, Eagle Picher completed a central mill near the southwest corner of the field. The initial capacity, rated at 3,600 tons per day, soon was increased to 5,500 tons and later to 10,000 tons per day; the ultimate capacity was 18,000 tons per day.

By 1940, Eagle Picher dominated production in the field. The 1940s were characterized by increased mechanization of mining equipment. Introduction of slushers in sheet-ground mines in the late 1930s and of track-mounted shovels in the early 1940s did away with the traditional method of hand shoveling ore into steel cans at the working face. In 1946, rubber-tired diesel trucks of 10-ton capacity were perfected for underground haulage. These technological developments contributed greatly to the recovery of lower-grade ores.

Because of depressed metal markets, many operations were cut back or suspended in 1957. By midyear of 1958, all major mining operations were closed. Mining was resumed at a reduced rate in 1960, and the last record of significant production occurred in 1970.

In the Arbuckle Mountains, lead and zinc occur mainly as galena, sphalerite, and smithsonite (zinc carbonate) in Cambrian and Ordovician carbonates of the Arbuckle Group. Most of the significant mines were located along the Washita Valley fault zone on the north flank of the Arbuckle anticline. Approximately 1,500 tons of zinc ore was mined from 1904 to 1914. Most of the significant mining activity was southwest of Davis. Mine shafts were generally less than 100 feet deep, and the ore occurred in veins, sheets, and/or pods. Lead and zinc minerals occur in veins in the granites and in contact zones between igneous rocks in the Wichita Mountains. Most prospects were small and production was limited.

From the early 1800s to about 1920, lead and zinc minerals (galena and sphalerite) were mined in the Ouachita Mountains. The ore minerals were commonly associated with quartz

veins that cross Lower Ordovician and Mississippian shale units. Production probably was limited to only a few tens of tons to a few hundred tons of ore.

Copper

Chalcopyrite occurs locally in veins in the Ouachita and Wichita Mountains. Scattered occurrences of other copper minerals, mainly chalcocite and malachite, occur as encrustations, impregnations, veinlets, and/or small nodules in Permian shales and sandstones in western Oklahoma. Most deposits are small, and most attempts at commercial production have been unsuccessful.

In 1965, Eagle-Picher Industries, Inc., began to mine a thin but extensive copper shale, which contained 1-3% copper and some silver, near Creta, in Jackson County, southwestern Oklahoma. The main ore occurred in a 3-inch- to 1-foot-thick zone in the Flowerpot Shale, and it had an areal extent of more than 15 square miles. Approximately 1.88 million tons of ore was processed by 1975. The mine was closed in 1975 because of lower copper prices and higher production costs.

Iron and Titanium

Small deposits of limonite occur in the Arbuckle Mountains, and they have been mined to a limited extent for making special cements. Numerous thin layers of ironstone nodules, containing 40-45% iron, occur in thick shales in Carter County. In the Wichita Mountains, titaniferous magnetite is associated with gabbro, and small amounts of low-grade hematite were used as paint pigment. Titanium also occurs in ilmenite in alluvial sands around the Wichita Mountains; some of the sands contain 3-7% ilmenite.

Manganese

Small deposits of manganese oxide and manganiferous carbonate occur in the eastern Arbuckle Mountains and eastern Ouachita Mountains. The deposits in the Arbuckle Mountains were worked from the 1890s to the early 1940s. These manganese deposits occur along fault zones and unconformities (Ordovician-Silurian).

Deposits are narrow and generally have limited areal extent.

Uranium

In Oklahoma, uranium is associated with many different rock types and geologic environments. Uranium occurrences in the state include: (1) granitic rocks and their late-stage intrusives, (2) arkosic sediments (weathered granite), (3) organic-rich shales, (4) phosphatic black shales, (5) bituminous-coal beds, (6) local point sources, and (7) stratiform bodies. Uranium enrichments of the point-source type are common and widespread across the state but generally have very limited areal extent. These occurrences formed where mobile, oxygenated, uranium-bearing ground water came in contact with local, subsurface, reducing chemical environments. The reducing chemical environment may have been associated with plant fragments and/or oil fields. In the Cement area of Caddo County, the largest known point source in the state is associated with an oil field. The only reported commercial uranium production in Oklahoma was from Cement, where about 13 tons of carnotite ore, averaging 2.2% U_3O_8 , was mined from the Rush Springs Sandstone in 1956.

CONCLUSION

The utilization of Oklahoma's forest resources would be enhanced by improving the structure of the forest resource. This could be accomplished by conversion from hardwoods to pines on sites currently growing hardwoods but capable of producing adequate growths of pines. This change, in addition to an improvement in the level of growing stock per acre, would provide a significant increase in the quantity and quality of the state's forest resource.

To accomplish these goals, the transfer of information to landowners and potential investors must be improved. While the opportunities for profitable investments in forest management and utilization are not certain, some measures could improve the overall situation. For example, increased emphasis on extension programs for forest landowners, and state government investment incentive programs for the forest industry,

might stimulate improvements in forest resource utilization.

Oklahoma's nonfuel mineral resources have been produced in every one of the state's 77 counties in the past, and currently are produced in 69 of the counties. In 1990, the value of nonfuel mineral production in Oklahoma was about \$260 million per year. Nonfuel mineral resources, which previously have encountered transportation barriers against their export to other regions, have the potential to make a significant contribution to the state's economy if market demand becomes more favorable. Although the number of workers employed in mining, exclusive of oil and gas, is relatively small, expansion of exports could alter the situation. For some minerals, such as iodine, recent industrial investments in western Oklahoma seem to indicate a growing demand.

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— Chapter 10 —
LIST OF ILLUSTRATIONS

Figures

10.1 — Oklahoma forest land by forest type, 1990 _____	161
10.2 — Distribution of land in Oklahoma by major land use, 1990 _____	162
10.3 — Distribution of Oklahoma forest land by ownership type, and timber harvest in Oklahoma, 1952–2030 (projected) _____	164
10.4 — Distribution of eastern Oklahoma forest land by forest type, 1990 _____	165
10.5 — Distribution of forest industry establishments in eastern Oklahoma by type of operation _____	166
10.6 — Distribution of employment and wages and salaries in the Oklahoma forest industry by type of operation, 1990 _____	168

Maps

10.1 — Percent of total land area in forest by county, 1982 _____	163
10.2 — Softwood production by county _____	165
10.3 — Hardwood production by county _____	166
10.4 — Location of wood-using mills, 1984 _____	167
10.5 — Major geologic provinces of Oklahoma _____	169
10.6 — Distribution of principal nonpetroleum mineral resources of Oklahoma _____	171

Tables

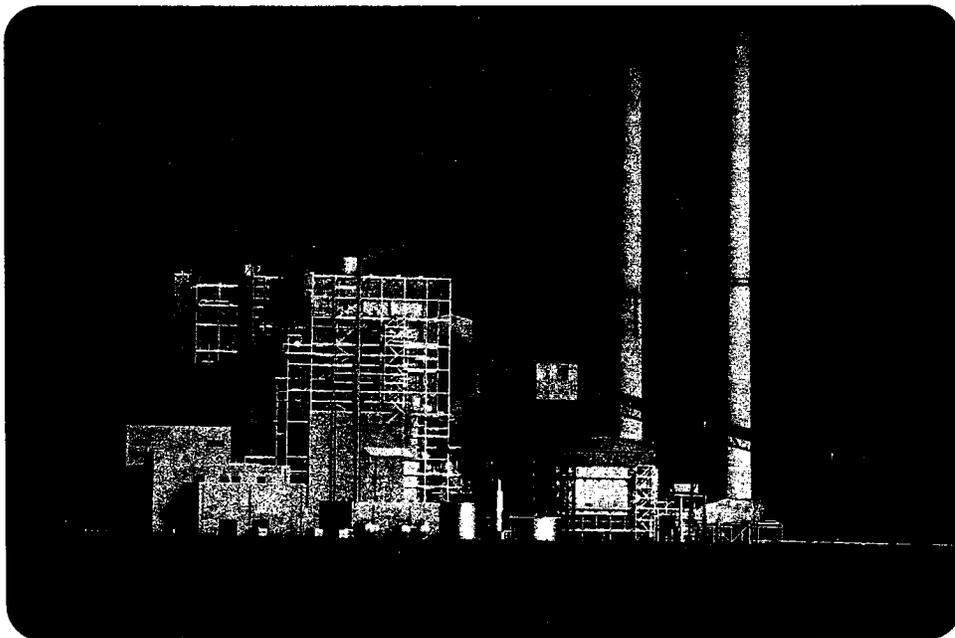
10.1 — Nonfuel mineral production in Oklahoma _____	170
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Oklahoma Resources

Chapter
11

Utilities and Industrial Location

by
Howard W. Motley, Jr.



Contents

Executive Summary _____	179
Introduction _____	179
Importance of Public Utilities _____	180
Interaction Between Utility and Customer _____	180
Quality of Service _____	181
Special Rate Programs _____	181
Overview of the Largest Oklahoma Utilities _____	181
Oklahoma Gas and Electric Co. _____	182
Oklahoma Natural Gas Co. _____	184
Public Service Co. of Oklahoma _____	185
Southwestern Bell Telephone Co. _____	186
National/Regional Comparisons of End User Costs _____	188
Customer Assistance Programs _____	189
Oklahoma Gas and Electric Co. _____	190
Public Service Co. of Oklahoma _____	193
Oklahoma Natural Gas Co. _____	193
Conclusion _____	195
References _____	195
List of Illustrations _____	196

Utilities and Industrial Location

Howard W. Motley, Jr.

Executive Summary.—Oklahoma and its energy industry have played an important role in the nation's economy. To assure a healthy and strong future economy, Oklahoma's industrial and commercial base must be expanded and diversified, and public utility services are key to that effort. Adequate and reasonably priced electricity, natural gas, and telecommunications services, along with continued responsible regulation, will ensure that the public receives the benefits of those services and the resulting industrial growth.

In a 1987 Industrial Development Research Council survey of plant locators and site selectors, utility costs were among the main concerns in choosing a location for a new manufacturing facility. Excellent utility service is a prime drawing card for the State of Oklahoma, which holds an edge in both cost and availability of utility services.

The Oklahoma Corporation Commission regulates electric, gas, and water retail sales in the State of Oklahoma, with the exception of municipally owned utilities and rural water districts. Telecommunication companies within the Commission's jurisdiction bring the total number of regulated utilities to 146. The Commission's principal duty is rate regulation, which encompasses accounting, financing, quality of service, safety, and rules of operations.

Regulated Oklahoma utility prices are competitive and compare favorably to regional states and the nation as a whole. (See section titled "National/Regional Comparisons of End-User Costs"). These national utility cost surveys assert that as of January 1, 1988, Oklahoma City's and Tulsa's industrial electric rates placed in the lowest 16% and 19%, respectively. Further, Oklahoma City's and Tulsa's industrial gas rates, as of December 31, 1987, placed in the lowest-priced 1% in the nationwide survey.

Reliable electric and gas service is essential to most business and industrial operations. The two largest electric utilities in Oklahoma have never had to curtail service because of power shortages and each company has a reliability factor of 99.9%. Due to proper system design and controlled gas reserves, the largest gas utility in Oklahoma has only curtailed deliveries in three of the last 12 years, and the largest annual curtailment during that period was only 0.189% of total system sales.

For an industry interested in expanding or relocating, whose manufacturing process is energy intensive, Oklahoma is a natural choice. The state's central U.S. location, unparalleled vocational education programs, strategic highway systems, and profit-minded tax incentives join forces with abundant and inexpensive energy to make Oklahoma an ideal site for many industries.

INTRODUCTION

Public utilities are distinguished as being a class of business "affected with a deep public interest" and therefore subject to regulation. Actually, many businesses have this characteristic—some of the leading court cases on regulation involved grain warehousing and cotton ginning. Those businesses generally classified as public utilities, however, are further distinguished in that they usually operate as controlled monopolies. As

such, they are obligated to charge fair, nondiscriminatory rates and to render satisfactory service to the entire public on demand. In return, they are generally free from substantial direct competition and are permitted, although not assured of, a fair return on investment. The industries generally classified as public utilities are electric, gas, telephone, and water. However, certain other industries, such as sewage disposal and steam heating, may also be classed as public utilities. The ser-

vices provided by these industries are generally not considered utility services when furnished under private contract or when packaged as a commodity for competitive sale (for example, electricity generated solely for a factory, or bottled gas or water).

Public utilities are often referred to as "natural" monopolies because a controlled monopoly generally is in the public interest. They operate most efficiently as monopolies because concentration within a territory permits

the use of larger and more efficient equipment, with lower average expense per unit of output. Also, the greater diversity of customer demand, generally resulting from service to an entire area, causes a relatively lower combined peak demand, permitting a smaller investment in plant capacity per customer. Direct competition (for example, competing electric companies) would be uneconomical because it would duplicate investment and clutter public property with distribution lines. If allowed to persist, it could lead either to unnecessarily high rates or to insufficient earnings. The latter may be as undesirable to the public as the former, for protection of the investor is necessary to attract capital. Some element of competition does exist—electricity and gas compete with each other and with other fuels, and companies compete for industrial customers—but competition is, overall, relatively limited.

Generally, public utilities are subject to regulation, which becomes a substitute for the economic controls of competition in assuring fair prices and adequate service. Regulation is intended to obtain for the public both the benefits that would be achieved by competition and the efficiency of operation as a monopoly. Public utility regulation as now conceived is the consequence of long years of experimentation and change, developing with the growth and technological advancement in the utility industry and the economy.

Much of the development of the regulatory process has centered in state public service commissions. There were such bodies as early as 1839 in Rhode Island and 1844 in New Hampshire. These early agencies had no rate authority; at that time it was assumed that competition would assure proper rates and adequate service. They have been referred to as "weak" commissions, organized to enforce safety and other statutes, provide statistics and information, and render assistance to legislative bodies. The first two states with commissions endowed with definite and extensive authority, both established in 1907, were Wisconsin and New York.

Most retail gas and electric rates and local telephone rates are now

regulated by state commissions. Intra-state (but not interstate) wholesale rates are also generally regulated by state commissions. When state laws do not provide for regulation by state commissions, local rates are ordinarily regulated or set by municipal bodies.

Although regulatory commissions have many powers and duties, perhaps the principal reason for their existence is the regulation of rates. Many of their other powers are necessary adjuncts of rate regulation, and the extent of commission jurisdiction varies from state to state and among federal agencies. In addition to rates, areas of regulation include accounting, financing, rules of service, and safety.

The basic principles of rate regulation rest upon concepts of fairness and equity, and avoidance of unreasonable discrimination. The utility is entitled to rates that are fair to it, but not to rates that are unfair to its customers. Supreme Court utility-rate decisions have been based upon the constitutional prohibitions against confiscation of private property. They have followed the principle of a fair return on the fair value of the investment used in providing service.

An extremely important characteristic of electric utilities is that they are a "capital-intensive" industry. High plant investment requirements (to replace equipment, add new pollution-control equipment, and meet the continued growth in the industry) impose heavy and frequent financing requirements. Accordingly, it is important that utilities be well regarded in the investment community. The large investment in fixed property causes utilities to operate with relatively high fixed costs, for example, depreciation, property taxes, and interest. Thus, utilities, particularly electric utilities, are affected importantly by the economics of mass production and decreasing incremental cost. The incremental cost of producing additional quantities of energy decreases progressively until growth requires a major plant addition. For this reason, it is desirable to utilize new facilities fully at the earliest possible date.

Utilities are enfranchised by government and have the right of eminent domain. Their property is dedicated to the public service, and in gen-

eral, they must serve all who apply. Plants must be adequate to meet demand at any time, despite seasonal weather and other factors. Utilities usually have the right to use streets and highways and to condemn property for the construction of facilities.

IMPORTANCE OF PUBLIC UTILITIES

Interaction Between Utility and Customer

Utilities are one of the few businesses in which manufacturing industry and primary service industry are in continuing contact. By the very nature of the product, the utility works with the customer company several times each year and, in some cases, several times each month.

The Marketing Department contact with industry can be in the nature of (1) assisting with utility load control, thereby promoting conservation; (2) introducing new rates, such as Time-of-Use Rate and Load Curtailment Rate; (3) thermal heat and cooling programs; (4) energy efficient outdoor lighting; (5) efficient electric food service equipment; and (6) continuing industrial market research. All of these are designed to promote conservation, to provide better service, and to lower the industrial customer's utility bill.

In addition, several times each year, Oklahoma utilities invite prominent business leaders to Industry Appreciation Meetings, where they are thanked for their business. At these meetings, utility executives give economic projections and report on utility trends of interest to the customer. The industry executives are then given an opportunity to comment on their dealings with the utility. Such open dialogue promotes understanding of supplier and customer problems.

The Economic Development Department of most utilities is in periodic contact with industrial customers. In most communities, two existing industry programs that are available are (1) Business Retention and Expansion, and (2) Manufacturers Council.

The Business Retention and Expansion Program contacts all manufacturing facilities in a community to

assess their satisfaction with the area, including the availability of labor, city services, suppliers, transportation, and other items of importance to the manufacturer. The Manufacturers Council is a utility-sponsored project to get business leaders together at least once a quarter. The program may include a speaker on a current industrial topic or may be open discussion between the executives. Both of these existing industry programs let industry know that the utility is genuinely interested and wants to help business to succeed.

Quality of Service

In respect to its gas and electric utilities, Oklahoma is most fortunate in absolute as well as comparative terms. Because the state is the third largest producer of natural gas among the contiguous 48 states, this has meant cheap and abundant supplies for direct gas application in homes and industry. In addition, this fuel has been available for the purpose of firing the generation of electric power systems throughout the state. Gas utility customers have rarely been curtailed because of a shortage, and the cost has been competitive with every state.

Most of Oklahoma's electric customers are served by two relatively large investor-owned electric utilities. For the reasons noted earlier, gas as a boiler fuel to these power generating sources has not been a problem. In addition, the state is in no way dependent upon nuclear power, but has instead relied on coal as an alternative fuel to natural gas. Given the economic and political volatility that has come to be associated with nuclear power throughout the nation, Oklahoma is indeed fortunate to be dependent on two relatively stable fuel sources for electric utility fuel.

Oklahoma customers have also been spared the economic consequences of high electric rates that have accompanied overbuilding or excess generation capacity. This phenomenon has been particularly destructive to industrial activity in many other parts of the country because of high electric rates that usually follow. At the same time, it is worth mentioning that, apart from weather-related

disturbances, Oklahoma has never experienced an extended electrical power interruption.

Nearly all sources of electric power within the state are interconnected and are members of the South-west Power Pool, which is a voluntary organization covering a seven-state area (namely, Oklahoma, Texas, Arkansas, Kansas, Louisiana, Missouri, and New Mexico), formed for the purpose of coordinating the power integrity of this geographic area of the country. This arrangement also has presented an opportunity for shared costs and increased reliability for Oklahoma's utilities. Oklahoma maintains an enviable stature in terms of supply and cost for electric power due to foresighted planning and responsible regulation. This phenomenon is not always found in all parts of the electric utility industry and stands as a credit to Oklahoma's competitive position nationwide.

Special Rate Programs

Oklahoma's electric and gas rates are among the lowest in the nation. The three largest energy utilities, Oklahoma Gas and Electric Co., Oklahoma Natural Gas Co., and Public Service Co. of Oklahoma, serve the majority of Oklahoma's electric and gas consumers.

The rates for electric power remain among the most competitive when compared with all other sources nationwide. In point of fact, current industrial rates offered by the state's two largest investor-owned electric utilities are much lower than the majority of these other sources. These two electric utilities continue to operate well within their required generation reserve margins, and no plans have been announced, nor are any anticipated, which would signal a large cycle of generation station construction. This translates into an extended period of rate or cost stability in the price for a kilowatt-hour of power.

Although electric and gas tariff rates are very competitive in Oklahoma, many Oklahoma utilities have been most innovative in developing a menu of special rate programs. The programs are aimed at specific marketing objectives, which also help in the stabilization of utility costs, as well

as enhancing the state's competitive position. These special rate programs are summarized by utility in the next section.

OVERVIEW OF THE LARGEST OKLAHOMA UTILITIES

This section focuses on the state's four largest utilities: Oklahoma Gas and Electric Co. (OG&E), Oklahoma Natural Gas Co. (ONG), Public Service Co. of Oklahoma (PSO), and Southwestern Bell Telephone Co. (SWBT). The three largest energy utilities—OG&E, ONG, and PSO—serve approximately 73% of Oklahoma's electric consumers and 74% of gas consumers. SWBT serves approximately 82% of Oklahoma's telephone consumers.

Telephone service within the limits of the two largest cities in the state, Oklahoma City and Tulsa, is provided by SWBT. SWBT's territory covers most of the state; however, smaller areas are served by any one of 45 other state-regulated telephone utilities. These territories were established by state statute and can be modified only by order of the Oklahoma Corporation Commission (OCC). In some cases, for example, when a city served by one telephone utility annexes territory served by a second, service may be offered by more than one utility.

Natural gas service within the city limits of Oklahoma City and Tulsa is provided primarily by ONG. In general, communities outside these cities also receive natural gas service from ONG, the state's largest gas distributor. These other areas may also be served by another of the state's 21 state-regulated natural gas utilities, an interstate pipeline, or a municipal gas system. In rural areas of Oklahoma where gas service is not available, other heating sources such as propane or electricity are usually available.

Electric service is provided primarily by OG&E inside the Oklahoma City limits and by PSO inside the Tulsa city limits. Although these two companies are the largest electric distributors in Oklahoma, the state is also served by 31 other electric companies and cooperatives. Like telephone service areas, electric utility service territories were established by state statute and are modified through the OCC. In

some cases electric service may also be available from more than one supplier.

All public utilities operating in Oklahoma are key to the expansion and diversification of Oklahoma's industrial and commercial base. As regulated public utilities, and thus, controlled monopolies, these companies are required to supply adequate and reliable electric, gas, and telecommunication service to the public upon demand, at reasonable prices.

Oklahoma Gas and Electric Co.

General Characteristics and Location

Oklahoma Gas and Electric Co. (OG&E) at 321 N. Harvey, Oklahoma City, Oklahoma 73102, the state's largest supplier of electric power, is five years older than the state itself. Incorporated in 1902, OG&E began with a few hundred customers in Oklahoma City but has now grown to serve about 1.6 million people in a 30,000 square-mile area.

Although OG&E sold the last of its natural gas facilities in 1928, the company retained the "Gas and" portion of its corporate name, because it was felt that the company's reputation and goodwill were so firmly established that it would be unwise to change the name.

OG&E is an investor-owned (NYSE listed) Oklahoma-based corporation. Boiler fuels are coal and natural gas. No nuclear units have been built, and none are planned. OG&E provides retail electric service in 269 cities and towns. It also sells wholesale electricity to seven communities and two rural electric cooperatives. The service area of OG&E is shown in Map 11.1.

OG&E ended 1987 with a total of 634,414 customers. The breakdown by customer class is presented in Table 11.1.

Generating Capacity and Quality of Service

Reliable electric service is not just important, it is essential to the operation of most businesses and industry. OG&E's reliability factor is 99.9%, and the company has never had to curtail service because the power was not available.

Obviously, there have been weather-related outages, but those are held to a minimum because of high-quality construction standards. Additionally, OG&E's successful planning has resulted in adequate reserve capability without being "over built." Excess capacity, of course, usually translates into higher electric rates, and OG&E's customers are not subject to these higher rates.

Existing electricity reserves are adequate until the mid-1990s at expected growth rates, and existing supplies of electricity are adequate for the seven-state Southwest Power Pool area.

In 1986, OG&E acquired ENOGEX, a 3,000-mile gas pipeline system plus four gas processing plants, which transports gas to its 3,258,000 kilowatts (kw) of gas-fired generating plants. Eleven unit coal trains deliver 5,700,000 tons of Wyoming coal to OG&E's 2,515,000 kw of coal-fired generating plants every year, and nearly 400,000 tons of Oklahoma coal is delivered locally by truck. This diversification of fuel supply helps ensure that adequate, economical, and dependable electricity will be available for OG&E's customers through the 1990s and well into the next century.

The explosion of the "electronics age" is creating more and more demands for quality of service. OG&E, historically, has met the needs of its customers and is working to improve its quality of service as new electronic demands are encountered.

OG&E has never had to ask its cus-

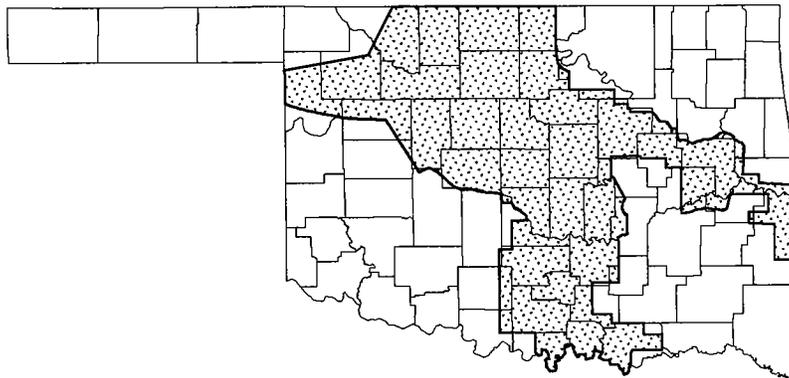
tomers to curtail usage due to shortages of electricity. Plans are made well in advance to assure adequate supplies are available. A history of OG&E's reserves is depicted in Table 11.2.

Special Industrial Rate and Support Programs

OG&E has a professionally staffed Economic Development Department to assist companies in finding and evaluating available space and sites. The department is constantly researching the market and has computerized listings at its fingertips. Space and site possibilities can be narrowed by merely touching a few keys. Complete demographic information on cities throughout OG&E's 30,000-square-mile service area is constantly updated and ready for review.

In October 1988, OG&E opened a world-class Business Resource Center, using touch-sensitive laser-disc technology and computers, which allows business prospects the opportunity to view available buildings and sites throughout Oklahoma. Interested parties can scan the entire state in less than two hours and be able to evaluate available space and sites that are most suited to their needs, making their site-selection easier and less time-consuming. There is no charge for the consultations, literature, or customized site tours provided by OG&E's professional services.

OG&E has several special industrial rate and support programs. The following is a brief summary of selected programs.



Map 11.1 — Service area of Oklahoma Gas and Electric Co. Source: Oklahoma Gas and Electric Co., unpublished data (n.d.).

Table 11.1 Number of OG&E Customers by Rate Class

Rate Class	Number of Customers
Residential	547,525
Commercial	69,742
Industrial	8,078
Public Authority	9,131
Resale	38
Total	634,514

Source: OG&E, unpublished data (n.d.).

Time-of-Use and Curtailable Rates: OG&E offers discounts to industrial or commercial users who maintain a certain amount of flexibility in their energy usage. The time-of-use rate is offered to industrial or commercial users who can reduce their electric consumption for a six-hour period during peak times, from 2:00 p.m. to 8:00 p.m. on weekday afternoons in the summer. Industries such as oil wells have the option of not working during these hours and can take advantage of a lower rate. The company also has a "curtailable rate" for industrial consumers who agree to lower their demand during peak periods when the company experiences a disruption in the supply of electricity that could affect the reliability of service to its customers.

Trade Electricity for Gas Rider (TEGR): In November of 1986, OG&E implemented TEGR, allowing certain large OG&E customers, whose peak demand is 5,000 kw or greater, to supply natural gas to OG&E for the purpose of generating their electricity. In March 1988, peak demand requirement was lowered to 2,500 kw, provided the annual energy use is 15,000,000 kilowatt hours (kwh). This change makes the program available to a greater number of customers. Approximately 80 customers are participating in this program and all have achieved significant savings.

In addition to the cost savings achieved by the large customers, savings have been realized by the small commercial and residential customers through lower fuel costs. These reduced costs, which translate into

lower utility bills, are a result of a shift from higher- to lower-priced fuels used to generate the overall electricity needs of the utility system. The total savings realized since approval is approximately \$38.8 million.

The Power Quality Program: In recent years, the use of sensitive electronic equipment by OG&E's customers has proliferated. The computer boom has resulted in electronic- and microprocessor-based equipment being used in homes and businesses throughout the state. In addition to computers, this includes VCRs, microwave ovens, and alarm clocks in the homes; cash registers, X-ray machines, elevators, and gas pumps in businesses; and process controllers, variable speed motors, and robots in our industries.

The use of this equipment is placing demands on the electric power at the customer's point of use that are well beyond traditional requirements. Impulses, dips, waveform distortions, and momentary outages that once went unnoticed can now be crucial and very costly. Disturbances as short in duration as 1 millisecond can completely disable some of this equipment.

While the electric utility can be the source of these disturbances through power factor correction capacitors, load switching, and loose or damaged hardware, many of the disturbances come from other sources. Some disturbances such as lightning, radio frequency (RF) interference, and disturbance-producing equipment in nearby customer's facilities are conducted through the utility power lines to the customer. Others are generated within the customer's own facility through inadequate wiring, improper grounding, and disturbance-producing equipment. Utility and customer sources of disturbances are separate, but because the electric power distribution systems interconnect, they are not easily differentiated.

Regardless of the source of the power disturbance, customers look to the utility for answers. To meet the needs of the customers for quality electric service, OG&E has begun the Power Quality Program. Through this program, the company will help existing businesses retain their competitive edge by reducing losses resulting

from equipment disruptions and failures induced by power quality disturbances. Additionally, OG&E will further encourage economic development by providing an added value to electric service in Oklahoma.

When a customer is experiencing power quality problems, the company will utilize a teamwork approach with the customer and other concerned parties to locate the source of the disturbance, regardless of its origin, and to determine the appropriate solution. Since the utility power system is the source of some of these disturbances, the company will first check the quality of service provided to the customer and make necessary corrections or repairs. After the electric service to the customer has been determined to be within normal operating specifications, the company will move into the customer's facility to assist in locating the disturbance. The company, along with the customer and an electrician, will inspect the facility wiring and grounding system associated with the sensitive electronic equipment. Sophisticated power monitors will be placed at various locations in the facility to determine the type, intensity, and frequency of the offending disturbances.

Once the disturbance has been identified and its source located, the company will assist the customer in securing the appropriate solution. The solution to the problem could be a corrective action as simple as tightening connections, moving a soft drink machine from one outlet to another, or running a new circuit wire. In some cases, power conditioning equipment such as uninterruptible power supplies (UPS), isolation transformers, transient voltage suppressors, or power line conditioners will be required at the electrical input of the sensitive electronic equipment.

The company has appointed Power Quality Teams in various locations throughout the service area. These teams are being supplied with the necessary measurement equipment and are receiving technical training in locating and solving electronic disturbance problems. This will enable the company to respond to the customer's needs for quality electric service in an electronic age.

Table 11.2 OG&E Electricity Reserves, 1968-87

Year	MW Demand	MW Capacity	Margin	% Reserves	GWH Energy
1968	1,755	2,113	358	16.9	7,700
1969	2,015	2,440	230	9.4	8,850
1970	2,210	2,526	316	12.5	9,876
1971	2,360	2,880	490	17.2	10,726
1972	2,745	3,147	415	13.2	11,977
1973	2,775	3,147	787	25.0	14,295
1974	3,290	3,887	597	15.4	14,956
1975	3,185	4,091	906	22.2	15,118
1976	3,218*	4,347	1,129	26.0	16,093
1977	3,509*	4,101	451	11.0	16,861
1978	3,680*	4,409	729	16.5	18,658
1979	3,510*	4,387	1,276	29.1	19,993
1980	4,098*	5,213	1,115	21.4	21,087
1981	4,261*	5,453	1,192	21.9	21,343
1982	4,288*	5,383	1,095	20.3	20,922
1983	4,533*	5,394	861	15.9	20,989
1984	4,727*	5,923	1,196	20.1	20,570
1985	4,295*	5,578	1,283	23.0	19,544
1986	4,486*	5,627	1,141	20.3	18,400
1987	4,193*	5,845	1,652	28.3	19,699

* Excludes Western Farmers Electric Cooperative wheeling demand figure.

MW = megawatts; GWH = gigawatt hours. Source: OG&E, unpublished data (n.d.).

The largest customers in the OG&E service area represent a wide variety of national and international corporations involved in steel-making, glass products, electronics, gypsum processing, automobile assembly, food products, tire building, and construction materials as depicted in Map 11.2. This diverse customer base has required OG&E to develop a wide variety of services to meet the needs of these customers. From premium quality power to the most advanced electrotechnology expertise available anywhere, OG&E has made a commitment to work in partnership with industry to develop efficient and financially strong companies.

Oklahoma Natural Gas Co.

General Characteristics and Location

Oklahoma Natural Gas Co. (ONG), 100 W. Fifth St., Tulsa, Oklahoma 74103, was incorporated on October 12, 1906, and has grown to serve more than two-thirds of the state's industrial, commercial, and residential users. ONG's service area comprises 261 communities in 57 counties throughout the state (Map 11.3).

In 1952, ONG saw the need to secure long-term gas supplies. It is from this impetus that the company has ac-

quired and maintained one of the largest utility-owned reserve bases in the nation. These reserves and carefully designed transmission systems have afforded ONG independence from interstate suppliers and have enabled ONG's rates to be among the nation's lowest for many years.

In addition to low rates, ONG strives for excellence in service to all types of industrial and commercial consumers. A large portion of ONG's sales are dedicated to oil and agribusiness, but increasing diversification of customers' needs are evident. Varied manufacturing concerns in the state include fertilizer and refinery busi-

nesses, as well as glass plants, paper mills, printing plants, steel mills, brick plants, computer products, tire plants, flooring products, and food processors.

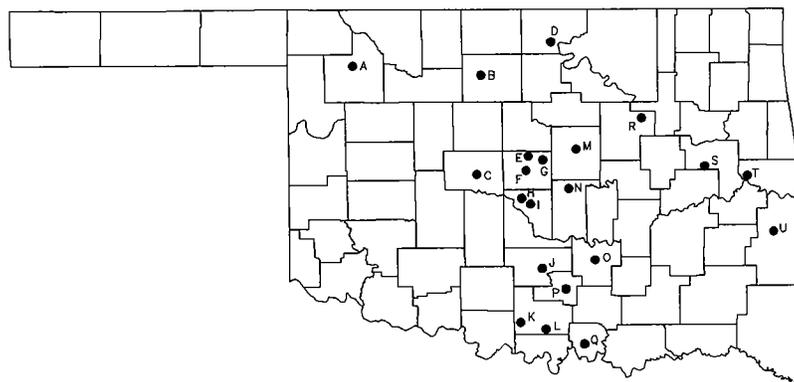
Customers are served based on three basic rates, industrial, commercial, and residential, with a fourth class of customer being wholesale. The breakdown of customers per class as of August 31, 1987 (Table 11.3).

Gas Reserves and Quality of Service

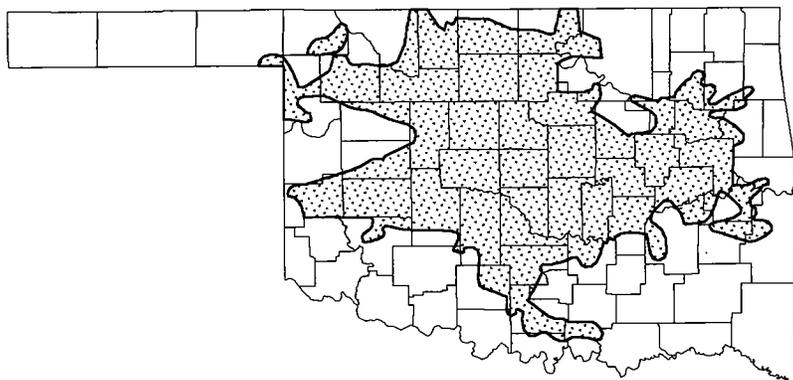
ONG has secured long-term reserves and has built a complex system of more than 15,000 miles of gathering, transmission, and distribution lines ranging from the far northwest to the extreme southeast. This has enabled ONG to provide safe and efficient natural gas with a long history of largely uninterrupted service.

ONG has controlled reserves in excess of 1.8 trillion cubic feet of gas with 124 billion cubic feet of gas in five different underground storage facilities. Conservative estimates of ONG's deliverability set the maximum capacity at slightly over 2 billion cubic feet of gas per day.

In order to preserve service to the state's residential customers, ONG and the Oklahoma Corporation Commission have set forth a curtailment schedule which may be used in case of emergencies. Due to proper design and some good fortune, however, ONG has not been forced to curtail deliveries for several years. The largest curtailment in the history of the company involved only 0.54% of its total system sales, and this occurred



Map 11.2 — Oklahoma Gas and Electric Co. industrial customers. Source: Oklahoma Gas and Electric Co., unpublished data (n.d.).



Map 11.3 — Service area of Oklahoma Natural Gas Co. Source: Oklahoma Natural Gas Co., unpublished data (n.d.).

more than 15 years ago. A complete curtailment history is presented in Table 11.4.

Special Rate Programs

In today's highly competitive marketplace, ONG recognizes the need for business and industry to reduce costs and improve quality and efficiency whenever possible. To help in this effort, ONG and the Oklahoma Corporation Commission have worked together to create and implement special rate programs.

Pipeline Capacity Lease Program: In February 1985, ONG started this program, which reduced the cost of gas for some customers by more than 50 percent. It is intended for customers who use more than 75,000 million cubic feet per year, and stated simply, allows them to purchase gas on the open market and use ONG's pipelines to have it delivered to their facilities. The lease charged by ONG is essentially equal to the margin the company would normally receive had the customer purchased ONG's gas and is, therefore, revenue-neutral to ONG and does not affect cost of service to other customers.

Further, the consumer may purchase gas from ONG at any time, and if the purchased volumes are "paid back" within a set period, the consumer's bill is credited for these volumes. Thus, the large industrial user is able to access spot market supply and price without risking loss of the reliability of supply that is guaranteed by purchase from a gas utility.

Special Industrial Sales Program: In June 1987, this program was initiated by ONG to reduce costs to those industrial customers not eligible to reap the benefits of the PCL program. The Special Industrial Sales Program (SISP) was approved by the Oklahoma Corporation Commission and allows ONG to purchase cheaper gas out of the traditional order of the ratable take system with a resulting reduction in gas cost of approximately \$0.65 per million cubic feet. In July 1988, SISP was modified to allow schools, hospitals, and ONG's PCL and fertilizer manufacturing customers to participate. The fertilizer customers are now allowed to participate in SISP for up to 50% of their capacity for gas consumption. Previously, the fertilizer manufacturers were allocated a special supply of gas outside of the SISP. By approval of these modifications, the OCC has further lowered the cost of gas for residential and small commercial customers as a result of a larger credit from the expanded program.

These programs have proven successful in maintaining ONG's industrial load while helping qualified users to remain profitable. This has, in turn, benefited the economy of the entire state.

Public Service Co. of Oklahoma

General Characteristics and Location

The Public Service Co. of Oklahoma (PSO) at 212 E. Sixth St., Tulsa, Oklahoma 73119, is an Oklahoma cor-

poration that is a wholly owned subsidiary of Central and Southwest Corp., a registered public utility holding company. PSO provides electric service in 55 Oklahoma counties serving 227 cities and towns. In addition, it provides wholesale service to three other communities. The company's current investment in electric property exceeds \$1.6 billion. At the end of 1987, PSO was providing service to 446,492 customers. The breakdown by customer class is presented in Table 11.5.

PSO's service territory is approximately 30,000 square miles and the population of that area exceeds 1,050,000. PSO's service area is represented in Map 11.4.

Generating Capacity and Quality of Service

PSO provides its customers electricity through gas-fired and coal-fired generating facilities located throughout Oklahoma. In 1987, 60% of the energy from PSO facilities utilized natural gas as a fuel source, while 40% was coal-fired. All natural gas consumed by PSO is delivered to its plants by Transok, Inc., a wholly owned subsidiary of Central and Southwest Corporation. Transok, Inc. owns and operates a 2,300-mile gas system. In 1987, both Wyoming and Oklahoma coal were consumed in PSO's two coal-fired generating plants.

PSO is committed to being the lowest-cost electricity producer in the Southwest. The company's highest net system peak occurred in 1986 when the demand reached 3,115,000 kw. The total generating capacity at the end of 1987 equalled 3,859,000 kw; however, 409,000 kw of that capacity have been placed in storage and are unavailable for immediate use. Through the remainder of the 1980s and beyond, all further generating capacity will be owned by the Central and Southwest System. PSO and the three other operating companies will purchase only the amount of capacity needed to maintain reserve margins at an acceptable level. This means that PSO will not have to charge Oklahoma customers the cost of an entire power plant, thus stabilizing elec-

Table 11.3 Number of ONG Customers by Rate Class

Rate Class	Number of Customers
Residential	567,050
Commercial	57,259
Industrial	2,320
Wholesale	37
Total	626,666

Source: ONG, unpublished data (n.d.).

tric rates except for the effect of inflation.

Heavy interconnection with adjacent electric utilities through 45 transmission interconnects, as well as 230,000 volt and 345,000 volt transmission links, with electric systems in Kansas, Texas, Missouri, Arkansas, and Louisiana, give PSO a system reliability of more than 99.9%. The company has years of experience in providing dependable power to continuous processing industries such as refineries, glass plants, zinc smelters, steel furnaces, and paper mills.

Special Industrial Rate and Support Programs

PSO's industrial marketing programs ensure that industrial and manufacturing customers receive an abundant supply of low-priced energy. In this way, the company can continue to provide important benefits to its customers while steadily increasing overall industrial sales. Industrial marketing programs have been supported by training and technical liaisons, presentation materials, computer support, customer meetings, and communications with trade allies.

PSO has several special industrial rate and support programs. The following is a brief summary of selected programs.

Supplemental Energy Sales Program: This program allows industrial customers to purchase supplemental kilowatt hours on an interruptible basis and at a discounted price. Supplemental purchases pertain only to consumption over and above the customer's average daily or weekly energy usage. In certain circumstances,

supplemental purchases can significantly reduce the customer's total kilowatt demand cost.

Industrial Gas/Electricity Rider (IGER) Program: This program helps large commercial and industrial customers improve their competitive position and reduce their operating costs. IGER saves PSO customers millions of dollars annually, and boosts Oklahoma's economic development effort by attracting new industry with low energy prices.

The IGER Program allows industrial and commercial users whose peak annual demand is 5,000 kw or more to purchase natural gas directly from PSO natural gas producers on the spot market, and deliver the gas to PSO generating stations. The savings, often considerable, are passed along to the industrial user in the form of a credit on the fuel use portion of its electric bill. Further, residential customers and commercial/industrial customers, who do not qualify for the program, receive secondary benefits in the form of lower fuel costs, which decrease their monthly utility bill. Total savings to PSO's customers have been approximately \$41.5 million.

PSO was the nation's first utility to offer this type program to industrial consumers. When the program was approved in June 1986, all of the utility's contracts were long term, as they must be so that long-term supply of fuel at power plants and reliability of electricity to consumers can be guaranteed. While spot market prices were high, these long-term contracts were advantageous. However, long-term agreements are no longer so favorable. IGER is a mutually beneficial plan for reducing customers' costs at a time when the company's long-term contract fuel cost is above spot market fuel prices. PSO has also renegotiated some of its contracts and upgraded efficiency at one of its power plants, but the IGER Program has had the most far-reaching effects on the electricity bills of industrial/commercial and residential users.

Energy Engineering: Through this program, PSO offers valuable technical support and economic analysis to key industrial decision-makers. These major businesses are shown how the

specification of electric power equipment can increase productivity, improve product quality, and reduce processing costs. The program is oriented to both new construction and conversion opportunities based on a number of technical and economic feasibility characteristics.

Power Conditioning Program: A small percentage of PSO customers have sensitive electronic equipment that cannot tolerate voltage fluctuations or other service irregularities. A number of options are being studied to determine cost-effective methods that will provide these customers with premium electric service.

A detailed brochure offers customers referral information and possible solutions to power problems. Additionally, PSO will sponsor power conditioning seminars and provide training for employees. PSO also makes available specialized monitoring equipment which may be used at customer locations to help pinpoint power irregularities.

Customer Relations Program: This program brings PSO's executive management together on a one-on-one basis with executives from major industrial customers. Begun in 1986, these meetings allow PSO to express its position while identifying the needs and wants of industrial customers.

The objectives of the program are twofold: to stress to customers that PSO is responsive to their needs; and, to impress upon all PSO employees the critical role "customer satisfaction" plays in PSO's overall corporate success.

Southwestern Bell Telephone Co.

Southwestern Bell Telephone Co. (SWBT), P.O. Box 26707, Oklahoma City, Oklahoma 73126-0707, is the largest of four principal subsidiaries of the Southwestern Bell Corp. (SBC), which maintains its headquarters in St. Louis, Missouri. Three other main SBC subsidiaries are Southwestern Bell Publications, Southwestern Bell Telecom, and Southwestern Bell Mobile Systems.

Since its creation early in the century, SWBT has aggressively de-

Table 11.4 ONG Curtailment, 1964-87

Fiscal	Total Sales (MMcf)	Industrial Sales (MMcf)	Curtailment (MMcf)	Percent of Total Sales	Percent of Industrial Sales
1964	170,760	78,900	6	0.004%	0.008%
1965	179,522	81,700	30	0.017%	0.037%
1966	177,813	82,100	76	0.043%	0.093%
1967	178,682	80,000	0	0.000%	0.000%
1968	190,803	81,600	0	0.000%	0.000%
1969	198,019	84,900	17	0.003%	0.020%
1970	213,083	87,000	360	0.169%	0.414%
1971	221,353	93,300	358	0.162%	0.384%
1972	229,213	97,400	29	0.013%	0.030%
1973	240,257	99,500	1,292	0.538%	1.298%
1974	246,917	107,800	127	0.051%	0.118%
1975	287,577	122,600	7	0.002%	0.006%
1976	307,869	136,900	0	0.000%	0.000%
1977	352,273	152,000	398	0.113%	0.262%
1978	344,710	166,500	0	0.000%	0.000%
1979	335,610	173,800	0	0.000%	0.000%
1980	352,160	179,300	0	0.000%	0.000%
1981	365,054	188,700	0	0.000%	0.000%
1982	306,128	174,300	0	0.000%	0.000%
1983	260,379	140,800	492	0.189%	0.349%
1984	281,847	162,200	0	0.000%	0.000%
1985	247,557	151,100	270	0.109%	0.179%
1986	214,949	131,800	0	0.000%	0.000%
1987	213,684	137,000	0	0.000%	0.000%

Source: ONG, unpublished data (n.d.).

ployed people and technology to keep pace with the needs of its diverse customer base. This priority is particularly evident in the telephone company's Oklahoma division, one of SWBT's five state operations. To accommodate this diversity of needs in 1988, the division employed about 6,000 Oklahomans, who served more than 1.2 million customers in 187 communities. SWBT's Oklahoma service territories are depicted on Map 11.5.

Today's SWBT telecommunications network began several years ago with careful planning and development. Initial concerns about the state-wide network's reliability prompted the company more than 20 years ago to begin placing its cable distribution system underground. The result today is that nearly 85% of the cable that serves local phone customers of SWBT is underground, a natural barrier against the elements.

In addition, all long-distance calls made by SWBT are now either routed by underground cable or via microwave towers. While such improvements make the SWBT system more reliable, other advances are being taken to make sure the network can

meet the high-tech demands of the information age.

In the early 1960s, SWBT's state-wide network began evolving from an analog system, the transmission of voice communications via a continuous electronic signal, to digital technology, which transforms voice and data into electronic information bits. Digital technology means more reliability, less expense, more security, higher transmission speeds, and larger capacity than analog.

Oklahoma became the SWBT leader in placing high-capacity digital microwave long-distance facilities in rural areas, converting rural analog facilities to digital, and replacing some analog switching offices with digital switches. By the early 1980s, digital long-distance switching equipment was introduced in Oklahoma City and Tulsa. The first digital microwave radio system in the SWBT Oklahoma region was installed between Tulsa and Bartlesville, and the first digital central office in SWBT was opened in Sperry.

Today, the SWBT Oklahoma network has 5,725 miles of digital microwave radio channels. Although some

mechanical telephone switching systems remain in use in Oklahoma, digital and analog electronic switching systems serve nearly 80 percent of all SWBT access lines.

As of 1990, SWBT has 61 digital switching offices, and digital trunk facilities serve 95 percent of all SWBT access lines in the state. Coupled with transmission by fiber-optic cable, which is 99.5% error-free, digital technology provides customers with a myriad of options for basic telephone and data-transmission services. Fiber-optic cable can carry voice, data, and video transmissions over hair-thin fibers of glass. Laser light, pulsing at a speed greater than 500 million times per second, can transmit in excess of 8,000 simultaneous conversations on a single pair of fibers.

SWBT first used fiber optics in early 1983 after a fiber cable was placed between south Oklahoma City and the downtown area. The company's first large-scale installation of fiber-optic cable was in 1987, when a cable was placed between Oklahoma City and Ponca City. As of early 1988, SWBT had placed 635 miles of fiber-optic cable in Oklahoma.

With its still-growing digital network, SWBT now provides a variety of high-tech services. The network meets telecommunications needs that range from basic home phone service to complex office systems, thanks to the company's Plexar service. High-speed data transfer, video and facsimile services and electronic mail are available via SWBT's MegaLink and MicroLink Services.

SWBT, through past planning and digital technology, has positioned itself as a leader in the Integrated Services Digital Network (ISDN). ISDN will allow the transmission of voice, data, and images over a single line. Customers will be able to plug their telephone set, data terminal, personal computer, facsimile machine, or even an alarm system into a standard telephone jack. In the home, ISDN will give easier and less-expensive access to mainframe computers and databases for working at home, banking, shopping, and a range of other services.

Of SWBT's access lines in Oklahoma, 77% are equipped to provide

Table 11.5 Number of PSO Customers by Rate Class

Rate Class	Number of Customers
Residential	389,992
Commercial	50,361
Industrial	4,892
Other	1,247
Total	446,492

Source: PSO, unpublished data (n.d.).

equal access or one-plus dialing to long-distance companies. In Oklahoma City, 99.5% of all SWBT customers have equal access. In Tulsa, 98.3% of the customers have equal access.

NATIONAL/REGIONAL COMPARISONS OF END-USER COSTS

Oklahoma utilities' prices are competitive and compare very favorably to states in the region and in the nation as a whole. The illustrations included in this section clearly show the regional competitiveness, while the independent surveys of the Edison Electric Institute and the American Gas Association reaffirm that fact and broaden the comparison to a national level.

The regional study encompasses 12 cities, including Oklahoma City and Tulsa. A comparison of this nature is valuable in developing a brief observation of utility rate levels between selected cities. However, a specific consumer's usage should be obtained and an annual bill calculated to precisely compare utility rates. While the study only reflects Oklahoma City and Tulsa, which are served electricity by Oklahoma Gas and Electric Co. and Public Service Co. of Oklahoma, respectively, and natural gas in both cities is provided by Oklahoma Natural Gas Co., it should be noted that the same utility rates apply in all cities served within Oklahoma by these utility companies, for example, Jet, Kellyville, Fort Gibson, Ringling, Sentinel, and Tishomingo.

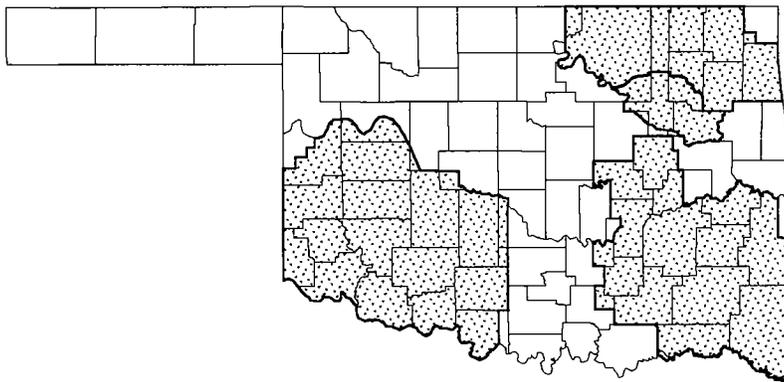
Data used to create Figures 11.1 through 11.4 were computed and compiled by staff of the Oklahoma Corporation Commission's Public Utility Division. Usage levels were

held constant within each customer class and energy type. Every effort was made to standardize such variables as time of use, interruptibility, and on/off peak energy use and demand. Further, special programs such as Oklahoma's IGER and TEGR are not offered in all the cities included in the comparison, therefore, only standard tariff rates were used in the interest of comparability. All applicable rate charges, taxes, franchise fees, and exemptions in effect in each city as of December 31, 1988, are recognized in the calculations. Fuel charges as of December 31, 1988, were used as well, except in instances where this factor was deemed to be so low or high as to be nonrepresentative of typical year-end fuel costs. In these cases, fuel costs from the nearest representative month was used.

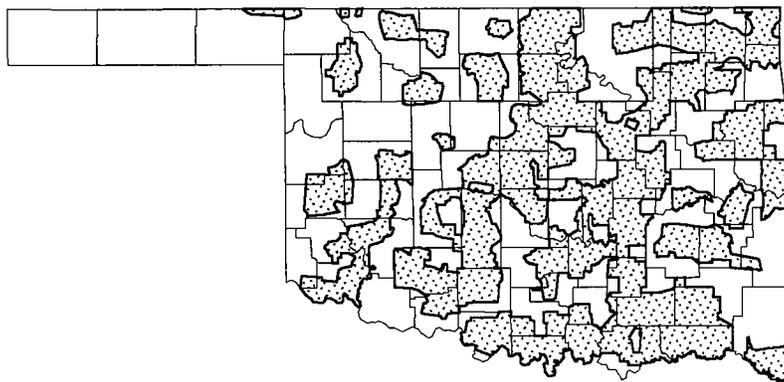
The annual utility bills shown in Figure 11.1, "1989 Regional Industrial

Gas Rate Comparison," are based on an annual usage of 8,943 million cubic feet of natural gas. Oklahoma City's and Tulsa's costs of \$27,343 were the lowest of any regional city included in the comparison. Costs ranged upward to \$42,073 in St. Louis, Missouri, with an average of \$36,481. Oklahoma City and Tulsa were 35% lower than the high and 25% lower than the average.

The calculations in Figure 11.2, "1989 Regional Industrial Electric Rate Comparison," are based on an annual usage of 2,159,800 kwh, with a monthly demand charge based on 780 kw. Costs range from a low of \$124,990 in Oklahoma City, followed by \$126,697 in Tulsa, to a high of \$236,403 in Albuquerque, New Mexico, with an average of \$163,919. As in the industrial gas comparison, consumers in Oklahoma's two major cities pay lower rates than in any of the other regional cities. Compared with the regional



Map 11.4 — Service area of Public Service Co. of Oklahoma. Source: Public Service Co. of Oklahoma, unpublished data (n.d.).



Map 11.5 — Service area of Southwestern Bell Telephone Co., Oklahoma. Source: Southwestern Bell Telephone Co., unpublished data (n.d.).

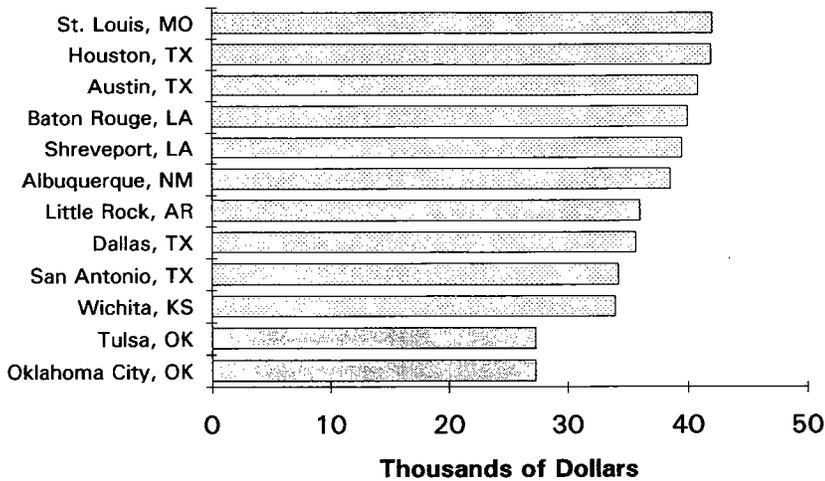


Figure 11.1 — 1989 regional industrial gas rate comparison. Source: Oklahoma Corporation Commission, unpublished data (n.d.).

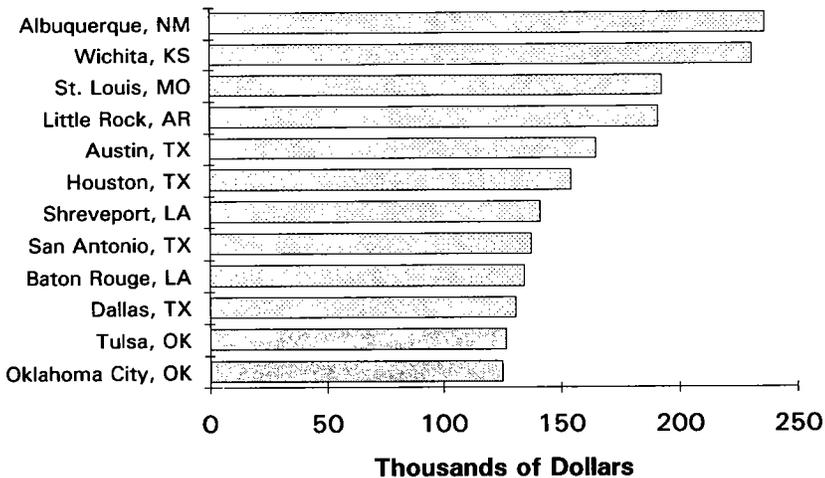


Figure 11.2 — 1989 regional industrial electric rate comparison. Source: Oklahoma Corporation Commission, unpublished data (n.d.).

average, consumers in Tulsa and Oklahoma City save roughly 23% each year.

The calculations in Figure 11.3, "1989 Regional Residential Gas Rate Comparison," assume an annual residential natural gas use of 100.6 million cubic feet. Costs range from lows of \$423.91 and \$427.94 in Oklahoma City and Tulsa, Oklahoma, respectively, to a high of \$563.78 in Shreveport, Louisiana. Oklahoma City and Tulsa were \$80.11 and \$76.08, respectively, under the regional average of \$504.02.

In Figure 11.4, "1989 Regional Residential Electric Rate Comparison," utility bills are based on an annual residential usage of 10,470 kwh. The

costs range from a low of \$639.62 in Austin, Texas, to a high of \$1,092.39 in Wichita, Kansas. Oklahoma City, \$766.45, and Tulsa, \$747.80, fall \$58.07 and \$76.72 below the average of \$824.52, respectively.

Table 11.6 presents typical monthly electric bills and corresponding rankings for residential and industrial consumers, as of January 1, for the years 1981–88. The bills and ranks are based on monthly residential use of 1,000 kwh and monthly industrial use of 1,500,000 kwh with a demand of 5,000 kw. While only the 12 cities chosen for regional comparison are shown on Table 11.6, the EEI survey is

national in scope. The rankings progress from the highest to the lowest bills, with the highest indicated as "1." Of the more than 200 typical bills ranked each year, Oklahoma City's and Tulsa's have consistently ranked among the most reasonable in the nation. In 1988, Oklahoma City's residential bill ranked 142, in the lowest 34%, while Tulsa's rank of 185 placed it in the lowest 14%. In the same year, Oklahoma City's industrial bill ranked 181, in the lowest 16%, and Tulsa's corresponding bill ranked 174, in the lowest 19%.

Table 11.7 contains typical monthly natural gas bills and corresponding ranks for residential and industrial service as of December 31, for the years 1981–1987, for the 12 cities chosen for regional comparison. The information presented in Table 11.7 assumes monthly residential use of 100 therms (10 million cubic feet) and monthly industrial use of 10,000 therms (1,000 million cubic feet). As in the EEI survey, the AGA rankings are national in scope, and a rank of "1" indicates the highest monthly bill reported. Oklahoma City's and Tulsa's residential gas bills have consistently ranked within the lowest 25%. At present, the typical monthly residential natural gas bill ranking of these cities is 113 of 127, placing Oklahoma residential costs in the lowest 12% of the nation. Of the 125 industrial bills reported for 1987, Oklahoma City's and Tulsa's ranking of 124 placed them among the least expensive 1% of all participating cities.

CUSTOMER ASSISTANCE PROGRAMS

The Oklahoma Corporation Commission acknowledges the importance of economic development and the demand by current and prospective large commercial and industrial customers for reasonably priced energy. However, in the decision-making process, all customers are represented and considered, along with possible exposures such as the potential increase in rates to remaining consumers resulting from loss of an industrial customer. Therefore, it is imperative that all facts be weighed in establishing utility rates to be charged to each class of customer.

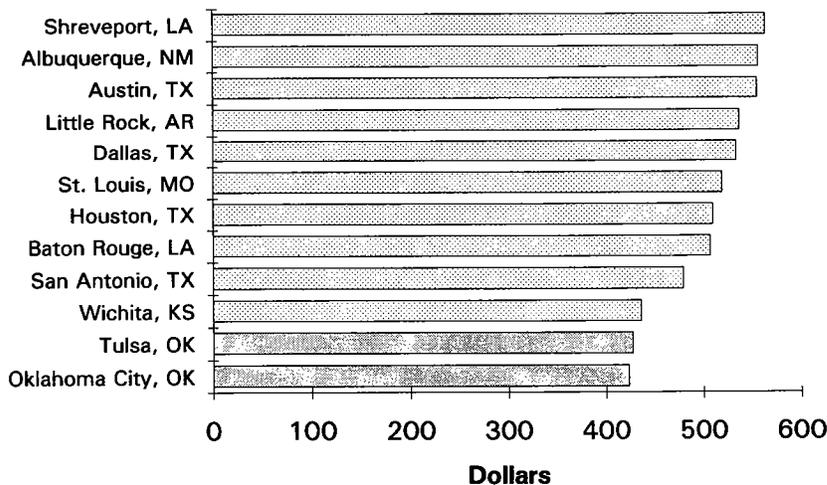


Figure 11.3 — 1989 regional residential gas rate comparison. Source: Oklahoma Corporation Commission, unpublished data (n.d.).

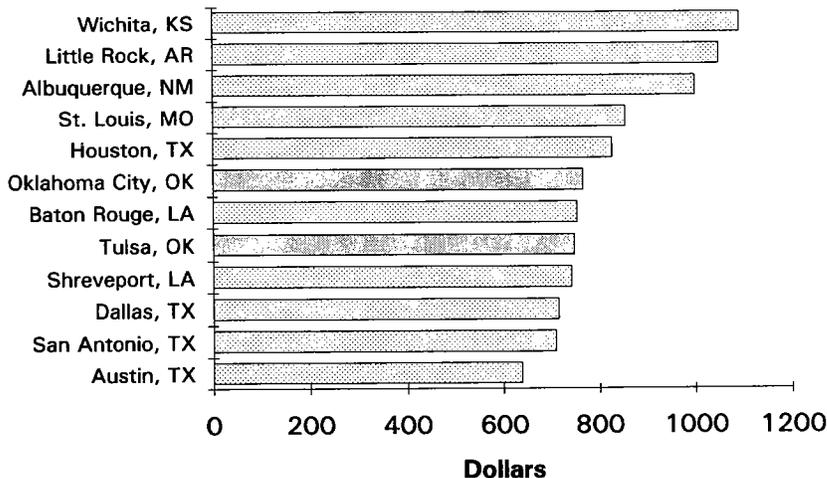


Figure 11.4 — 1989 regional residential electric rate comparison. Source: Oklahoma Corporation Commission, unpublished data (n.d.).

The OCC has fashioned options available for the protection and assistance of elderly/handicapped utility customers in Oklahoma. Additionally, most utility companies voluntarily provide other programs, rates, and information to other residential customers. The following is a list summarizing options, programs, and information offered. Special programs also are offered by individual utility companies; these are listed by company.

Third-Party Notifications

These are offered by utility companies to consumers who wish to have a relative or friend notified should their account become delinquent.

Elderly and Handicapped Coding

This is available to qualified consumers who notify the utility that they wish to be included in the Commission notification. Presence of this code in a customer's account guarantees that the OCC will be notified prior to disconnection for nonpayment. Most utility companies are equipped with telecommunication devices for the deaf and hearing impaired.

Life Threatening Code

This is available to qualified customers who notify the utility that they wish to be included in this program. Customers whose accounts contain a

"Life Threatening" code are given first priority in case of a service outage.

Average Payment Plan

Under this plan the utility company will average bills annually, thereby allowing customers to adequately budget payments and eliminate seasonal variations.

Low User Residential Rates

These are special programs for customers that can limit usage.

Planned Economy and Kilowatt Saver (PEAKS)

This program involves placement of a device on a central air-conditioning system which restricts usage on a limited basis during peak demand occurrences for three months annually, and results in a monthly credit on the customer account during this period.

Energy Audit

This program provides a thorough evaluation of a consumer's residential use of energy. The audit includes recommendations for reducing energy consumption, and provides cost estimates for making the recommended energy efficient improvements.

All electric and gas utilities will provide, upon request, a list of agencies within the community who can often assist in payment of utility bills for the qualifying consumer.

Oklahoma Gas and Electric Co.

OG&E sponsors three major programs that are geared to assist its elderly/handicapped or distressed customers.

Lend-a-Hand

This program assists in the emergency payment of energy bills of all kinds, including electricity, gas, propane, wood, and coal. Funds are donated by customers when they pay their electric bills, and are earmarked for distribution by the Salvation Army, which administers the program. Lend-A-Hand was initiated in February 1986 when OG&E donated \$50,000 in seed money. As of 1989, more than 50,000 customers had donated to the program and about \$200,000 had been distributed.

Table 11.6 Typical Residential and Industrial Monthly Electric Bills and Rankings, January 1, 1981-88

RESIDENTIAL* City	Utility	1988		1987		1986		1985		1984		1983		1982		1981	
		Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank
Albuquerque, NM	Public Service Company of New Mexico	\$100.91	12	\$88.79	30	\$90.27	37	\$79.91	59	\$64.83	123	\$63.64	110	\$83.45	23	\$67.78	37
Austin, TX	City of Austin**	62.93	134	56.05	176	67.94	118	64.76	128	58.20	152	58.59	144	46.21	189	46.12	156
Baton Rouge, LA	Gulf States Utilities Company	60.44	151	62.29	141	64.30	138	63.66	135	65.71	115	61.85	121	59.04	114	47.89	143
Dallas, TX	Texas Utilities Electric Company	78.71	58	78.41	58	86.94	47	74.74	79	74.74	70	66.64	89	63.01	88	47.69	144
Houston, TX	Houston Lighting & Power Company	81.26	48	78.99	56	72.92	87	62.13	137	63.10	133	59.47	140	52.12	161	49.04	136
Little Rock, AR	Arkansas Power & Light Company	61.54	142	62.85	138	66.69	126	56.65	174	55.41	166	52.52	178	48.31	176	40.18	193
Oklahoma City, OK	Oklahoma Gas & Electric Company	63.80	132	59.24	158	62.34	150	55.55	177	50.41	196	51.72	186	--	--	35.58	211
San Antonio, TX	City Public Service**	70.89	95	68.39	114	63.28	143	52.85	185	54.90	170	52.32	179	47.56	183	42.88	177
Shreveport, LA	Southwestern Electric Power Company	53.79	185	60.32	151	63.20	144	58.67	161	44.68	206	51.82	183	39.18	209	45.76	159
St. Louis, MO	Union Electric Company	92.69	29	91.10	22	90.03	38	67.25	118	67.45	101	64.20	106	50.20	170	47.39	146
Tulsa, OK	Public Service Company of Oklahoma																
Wichita, KS	Kansas Gas & Electric Company																
Number of Utilities		214	209	216	220	224	225	220	224	224	224	225	225	233	233	233	231

INDUSTRIAL* City	Utility	1988		1987		1986		1985		1984		1983		1982		1981	
		Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank	Bill	Rank
Albuquerque, NM	Public Service Company of New Mexico	\$141,074	6	\$128,388	8	\$131,004	8	\$115,283	32	\$93,123	64	\$91,333	56	\$121,053	15	\$92,806	30
Austin, TX	City of Austin**	75,119	143	64,811	184	82,646	121	77,770	139	67,930	156	68,515	147	49,950	201	49,815	183
Baton Rouge, LA	Gulf States Utilities Company	67,845	172	71,225	162	74,298	158	73,862	151	81,488	113	75,692	122	71,478	122	54,394	159
Dallas, TX	Texas Utilities Electric Company	72,086	156	71,986	158	87,381	95	92,328	71	92,328	67	80,854	101	77,219	98	57,285	144
Houston, TX	Houston Lighting & Power Company	93,808	71	89,847	75	86,296	102	69,350	165	70,832	146	71,820	138	58,020	180	49,141	197
Little Rock, AR	Arkansas Power & Light Company	65,075	181	68,730	170	74,505	156	64,613	182	64,357	177	64,257	183	56,922	182	48,240	194
Oklahoma City, OK	Oklahoma Gas & Electric Company	85,250	97	78,710	133	83,360	116	75,175	147	67,465	160	69,430	144	--	--	--	--
San Antonio, TX	City Public Service**	90,017	63	89,483	80	79,211	137	66,278	173	64,912	175	83,504	87	54,452	191	48,535	192
Shreveport, LA	Southwestern Electric Power Company	64,076	174	75,050	146	78,357	143	79,073	134	53,409	201	64,131	162	40,599	208	48,868	190
St. Louis, MO	Union Electric Company	110,304	35	115,841	24	113,825	34	85,543	103	85,838	94	80,424	103	66,908	146	62,730	117
Tulsa, OK	Public Service Company of Oklahoma																
Wichita, KS	Kansas Gas & Electric Company																
Number of Utilities		214	209	216	220	224	225	220	224	224	224	225	225	233	233	233	231

*Based on typical residential use of 1,000 kWh per month, and a demand of 5,000 kW.

**Municipal utility.

Source: Edison Electric Institute (n.d.).

Table 11.7 Typical Residential and Industrial Monthly Gas Bills and Rankings, December 31, 1981-87

RESIDENTIAL* City	Utility	1987		1986		1985		1984		1983		1982		1981	
		Bill	Rank	Bill	Rank	Bill	Rank								
Albuquerque, NM	Gas Company of New Mexico	\$45.26	107	\$46.24	108	\$50.83	107	\$58.03	107	\$52.88	95	\$	107	\$	--
Austin, TX	Southern Union Gas Company	--	--	59.00	60	57.00	83	--	--	64.00	56	--	--	--	--
Baton Rouge, LA	Gulf States Utilities Company	47.21	98	45.24	111	49.07	112	--	--	50.83	112	51.76	96	41.58	72
Dallas, TX	Lone Star Gas Company	41.89	117	--	--	53.14	98	58.45	93	54.95	102	59.25	68	49.11	48
Houston, TX	ENTEX	47.18	99	42.69	120	--	--	--	--	--	--	--	--	--	--
Little Rock, AR	Arkansas Louisiana Gas Company	43.27	113	49.15	101	48.53	115	46.57	122	45.77	120	37.78	111	32.90	87
Oklahoma City, OK	Oklahoma Natural Gas Company	--	--	--	--	--	--	--	--	--	--	--	--	--	--
San Antonio, TX	City Public Service**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shreveport, LA	Arkansas Louisiana Gas Company	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Louis, MO	Laclede Gas Company	43.27	113	49.15	101	48.53	115	46.57	122	45.77	120	37.78	111	32.90	87
Tulsa, OK	Oklahoma Natural Gas Company	45.48	106	--	--	43.19	125	37.91	127	35.26	125	32.00	114	25.95	89
Wichita, KS	Kansas Power & Light	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Number of Utilities Ranked			127		127		127		129		129		126		114
*Based on typical residential use of 10 Mcf per month.															
**Municipal utility.															
INDUSTRIAL* City	Utility	1987		1986		1985		1984		1983		1982		1981	
		Bill	Rank	Bill	Rank	Bill	Rank								
Albuquerque, NM	Gas Company of New Mexico	\$3,716	101	\$3,685	107	\$4,310	107	\$5,030	100	\$4,718	104	\$	--	\$	--
Austin, TX	Southern Union Gas Company	--	--	4,868	54	4,886	83	--	--	5,598	61	--	--	--	--
Baton Rouge, LA	Gulf States Utilities Company	3,435	112	3,187	118	3,569	122	--	--	4,215	112	4,436	96	3,707	66
Dallas, TX	Lone Star Gas Company	4,059	82	--	--	5,538	50	5,936	45	6,020	36	5,591	58	4,931	31
Houston, TX	ENTEX	4,073	81	3,624	110	--	--	--	--	--	--	--	--	--	--
Little Rock, AR	Arkansas Louisiana Gas Company	2,838	124	3,767	104	3,709	120	3,793	121	3,718	118	3,273	103	2,819	83
Oklahoma City, OK	Oklahoma Natural Gas Company	--	--	--	--	--	--	--	--	--	--	--	--	--	--
San Antonio, TX	City Public Service**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shreveport, LA	Arkansas Louisiana Gas Company	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Louis, MO	Laclede Gas Company	--	--	--	--	3,709	120	3,793	121	3,718	118	3,273	103	2,819	83
Tulsa, OK	Oklahoma Natural Gas Company	2,838	124	3,767	104	--	--	3,337	122	3,108	120	2,691	105	2,134	84
Wichita, KS	Kansas Power & Light	3,640	105	--	--	--	--	--	--	--	--	--	--	--	--
Number of Utilities Ranked			125		125		123		123		123		121		107
*Based on typical industrial use of 1,000 Mcf per month.															
**Municipal utility.															

Source: American Gas Association (n.d.).

Hand-n-Hand

This program provides assistance to elderly individuals at or just above poverty level in weatherizing and making small repairs to their homes, thereby reducing their energy consumption and electric bills. The work is performed by retired persons hired as contract employees and trained by the utility. The program began in July 1983. As of 1989, 5,081 homes had received weatherization and repair through the program with an average expenditure of \$239 per home. An OG&E survey of these homes indicated a 20% reduction in energy use.

Gatekeeper

OG&E participates in this national program, which trains individuals having regular or day-to-day contact with elderly/handicapped persons to recognize the signals of health and potential crisis situations. All problems detected are referred to a professional or paraprofessional for resolution. OG&E employees report problems to the local Areawide Aging Agency. The program began in April 1987, and as of 1989, more than 500 OG&E employees had been trained as "gatekeepers." The company encourages participation in the program by all interested persons. As of 1989, roughly 250 individuals outside OG&E had been trained by utility employees.

Public Service Co. of Oklahoma

PSO sponsors several programs that assist elderly/handicapped or needy customers in their area.

Light a Life

This program is analogous to OG&E's Lend-A-Hand, and was initiated in July 1986. Seed funds in the amount of \$365,000 were allocated to the program from undistributed Black Fox Station Refunds: \$40,000 for immediate use with the remainder made available in annual increments of \$100,000 for three years. As of 1989, customer donations of more than \$97,000 had been received from 4,633 families. The program is administered by the Salvation Army, and as of 1989, approximately \$217,000 had been distributed.

Project Serve

This is a cooperative effort by PSO and the Tulsa Metropolitan Ministry in which the utility provides training for weatherization of the homes of the elderly and needy in the Tulsa area. The Ministry provides labor and materials. The project began in 1982, and as of 1989, about 300 homes had been weatherized.

Gatekeeper

PSO was Oklahoma's first utility to join the national Gatekeeper Program in February 1987.

Tulsa Weather Coalition

PSO has spearheaded the Tulsa Weather Coalition since 1980, helping individuals in high-risk groups (e.g., those who are ill, elderly, handicapped, very young) to prepare for and respond to prolonged extreme weather conditions by providing the use of fans, air conditioners, and other equipment at no cost. PSO makes its facilities available as collection points for donated equipment. The Weather Coalition administers the program, and PSO employees coordinate repairs and install the equipment.

Oklahoma Natural Gas Co.

ONG sponsors two major problems to assist the elderly/handicapped and needy in its area.

Share the Warmth

Donations received through this program are used to pay residential heating expenses regardless of energy source. Begun in February 1983, this was the first utility-sponsored program of its kind in Oklahoma. To date, \$1.5 million donated by customers (\$1,265,000) and shareholders (\$235,000) have been distributed by the Salvation Army, administrator of the program. This assistance has reached approximately 17,000 families.

On Watch

This program is similar to Gatekeeper. Field employees are trained to recognize the signals of health and potential crisis situations and respond appropriately.

Other programs sponsored or supported by ONG include "Adopt a

School," in which employees volunteer to serve, for example, as tutors, teachers' aides, staff of Learning Centers, and party sponsors in public schools in the Oklahoma City and Tulsa metropolitan areas. Through the "Loaned Executive Program," an executive of ONG is "loaned" to United Way for a period of time, up to three weeks thus far. This individual serves as a temporary staff member and representative of United Way during ONG office hours. ONG employees provide cold stress training sessions to the public through the "Hypothermia Program." These sessions serve to increase the public's awareness of the problem, which primarily affects the elderly, the very young, and the ill, and give information on prevention and treatment.

Rural Electric Cooperatives

According to surveys, the average age of customers of Oklahoma's Electric Cooperatives (Coops) is between 50 and 60 years of age, and the average income of these consumers falls substantially below that of the general population of the state. To handle the special needs of their customers, Coops offer the Good Neighbor Program, which consists of a variety of subprograms dealing with specific problems that are frequently encountered.

Home Energy Audit

This program offers free assessments of weatherization needs to any customer who wants to participate. The majority of these audits have been performed for the elderly or those with relatively low incomes. The audits were developed by OSU Staff in 1981, and have been performed at more than 5,000 residential sites.

Coop Discounts

These are available for the purchase of hot water heaters and heat pumps to replace those that are old or inoperative. The Heat Pump Rebate Program became available in 1986 to all customers. Two Coops sell the equipment; the remainder of the work is done through contractors. The customer purchases a heat pump and has it installed. A trained employee of the Coop then inspects the site on behalf

Table 11.8 Addresses and Telephone Numbers of Electric Coops in Oklahoma

1) Alfalfa Electric Coop. P.O. Box 39 Cherokee, OK 73728-0039 (405) 596-2712	2) Caddo Electric Coop. P.O. Box 70 Binger, OK 73009-0070 (405) 656-2322
3) Canadian Valley Electric Coop. P.O. Box 751 Seminole, OK 74818-0751 (405) 372-2884	4) Central Rural Electric Coop. P.O. Box 1809 Stillwater, OK 74076-1809 (405) 326-6486
5) Choctaw Electric Coop. P.O. Box 758 Hugo, OK 74743-0758 (405) 326-6486	6) Cimarron Electric Coop. P.O. Box 299 Kingfisher, OK 73750-0299 (405) 375-4121
7) Cookson Hills Electric Coop. P.O. Box 260 Stigler, OK 74462-0280 (918) 967-4614	8) Cotton Electric Coop. 226 N. Broadway Walters, OK 73572 (405) 875-3351
9) East Central Oklahoma Electric Coop. P.O. Box 1178 Okmulgee, OK 74447-1178 (918) 756-0833	10) Harmon Electric Association P.O. Box 393 Hollis, OK 73550-0393 (405) 688-3342
11) Indian Electric Coop. P.O. Box 49 Cleveland, OK 74020-0049 (918) 358-2514	13) Kay Electric Coop. P.O. Box 607 Blackwell, OK 74631-0607 (405) 363-1260
14) Kiamichi Electric Coop. P.O. Box 340 Wilburton, OK 74578-0340 (918) 465-2338	15) Kiwash Electric Coop. P.O. Box 100 Cordell, OK 73632-0100 (405) 832-3361
16) Lake Region Electric Coop. P.O. Box 127 Hulbert, OK 74441-0127 (918) 772-2526	17) NE Oklahoma Electric Coop. P.O. Box 948 Vinita, OK 74301-0948 (918) 256-6405
18) Northfork Electric Coop. P.O. Box 400 Sayre, OK 73662-0400 (405) 928-3366	19) Northwest Electric Coop. P.O. Box 188 Woodward, OK 73802-0188 (405) 256-7425
20) Oklahoma Electric Coop. P.O. Box 1208 Norman, OK 73070-1208 (405) 321-2024	21) People's Electric Coop. P.O. Box 429 Ada, OK 74821-0429 (405) 332-3031
22) Red River Valley Rural Electric Association P.O. Box 220 Marietta, OK 73448-0220 (405) 276-3364	23) Rural Electric Coop. P.O. Box 609 Lindsay, OK 73052-0609 (405) 756-3104
24) Southeastern Electric Coop. P.O. Box 1370 Durant, OK 74702-1370 (405) 924-2170	25) Southwest Rural Electric Association P.O. Box 310 Tipton, OK 73570-0310 (405) 667-5281
26) Tri-County Electric Coop. P.O. Box 7 Hooker, OK 73945-0880 (405) 652-2418	27) Verdigris Valley Electric Coop. P.O. Box 219 Collinsville, OK 74021-0219 (918) 371-2587

Note: Numbers correspond to those shown on Map 11.8.

of the consumer to ensure that a high-quality job has been performed. When the job is approved or all problems are corrected, the Coop rebates \$300 to the consumer. The 19 Coops supplied by Western Farmers Electric Cooperative (WFEC) share the cost of the rebate equally with WFEC, \$150 each. Rebates to customers of the remaining seven Oklahoma-based Coops are funded by their supplier, KAMO. As of 1989, customers had received a total of \$1,172,955 in combined rebate checks.

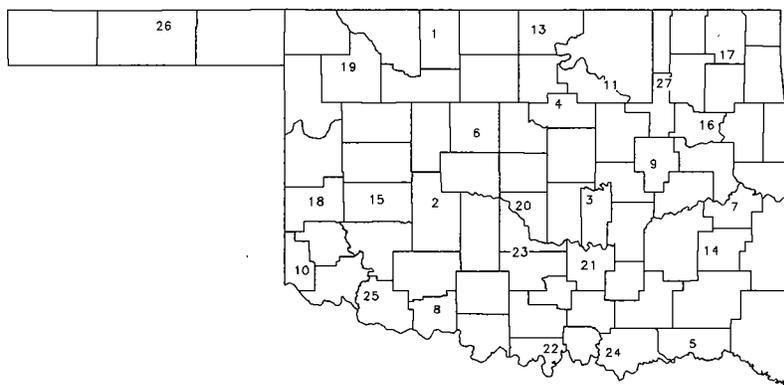
Water heaters range in price from around \$125 upward. Oklahoma's Coops make this equipment available at a very reduced cost, then rebate \$100 of that reduced cost. Five Coops simply give water heaters to customers, replacing old, inefficient, or dysfunctional equipment.

Energy Resources Conservation Loan

This program frequently works in conjunction with the Home Energy Audit Program and Coops Discounts. Funds are available to low income families through the Coops with the assistance of the Rural Electrification Association. The usual maximum amount loaned is \$5,000 at 5% interest for a period of up to seven years. These loans are used to pay for such energy improvements as caulking and weather stripping, heat pumps, water heaters, insulation, and storm doors and windows. Payments are typically small, \$10–\$15, and are added to the customer's utility bill for convenience.

Good Neighbor Watch

This is sponsored by all 26 Coops headquartered in Oklahoma. Field employees receive training to recognize crisis and potential crisis situations and respond appropriately, either by applying CPR or first aid treatment, or reporting the situation to the



Map 11.6 — Location of Oklahoma-based Rural Electric Cooperatives. Source: Rural Electric Cooperatives, unpublished data (n.d.).

local Coop's office where the call is referred to the proper professionals or paraprofessionals for resolution. To make reporting more simple, many field employees are equipped with walkie-talkies that notify the Coop when a specific code is pressed.

Finally, the Coops make centrally located bulletin boards and staff available in their offices for the purpose of sifting and spreading job information, since the unemployment rate is much higher than average in many of their territories. Some coops also offer occasional job seminars with the cooperation of the Oklahoma Employment Security Commission.

Map 11.6 depicts the Oklahoma-based Rural Electric Cooperatives. The utilities' addresses and telephone numbers are provided in Table 11.8.

CONCLUSION

Economic development in Oklahoma is greatly affected by the availability and cost of utility services. Attracting new industries, as well as retraining and expanding existing industries is vital. The Oklahoma Corporation Commission is dedicated to working with energy-intensive industries to ensure the lowest energy cost possible. Special industrial programs

and rates have been implemented and studies are continuing on various types of programs designed to enhance economic development of the state.

The field of public utility regulation faces many challenges in our changing economy and technology. Regulators must heed precedents and established procedures, but they must also recognize the need for changing ideas, methods, and rules to encounter present and future conditions. Effective and continued regulation of public utilities is paramount to the success of Oklahoma's economic endeavors. Innovative rate regulation is aggressively embraced by the Oklahoma Corporation Commission in an attempt to benefit all classes of customers receiving utility service.

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— Chapter 11 —
LIST OF ILLUSTRATIONS

Figures

11.1 — 1989 regional industrial gas rate comparison _____	189
11.2 — 1989 regional industrial electric rate comparison _____	189
11.3 — 1989 regional residential gas rate comparison _____	190
11.4 — 1989 regional residential electric rate comparison _____	190

Maps

11.1 — Service area of Oklahoma Gas and Electric Co. _____	182
11.2 — Oklahoma Gas and Electric Co. industrial customers _____	184
11.3 — Service area of Oklahoma Natural Gas Co. _____	185
11.4 — Service area of Public Service Co. of Oklahoma _____	188
11.5 — Service area of Southwestern Bell Telephone Co., Oklahoma _____	188
11.6 — Location of Oklahoma-based Rural Electric Cooperatives _____	195

Tables

11.1 — Number of OG&E customers by rate class _____	183
11.2 — OG&E electricity reserves, 1968–1987 _____	184
11.3 — Number of ONG customers by rate class _____	186
11.4 — ONG curtailment, 1964–1987 _____	187
11.5 — Number of PSO customers by rate class _____	188
11.6 — Typical residential and industrial monthly electric bills and rankings, January 1, 1981–1988 _____	191
11.7 — Typical residential and industrial monthly gas bills and rankings, December 31, 1981–1988 _____	192
11.8 — Addresses and telephone numbers of utilities in Oklahoma _____	194

Oklahoma Resources

Chapter
12

Environmental Regulation

by

Henry Eisenhart,
Ellen Odle Bussert,

and

R. Fenton Rood



Contents

Executive Summary _____	199
Introduction _____	200
Environmental Policies _____	200
Air Quality _____	201
Air Pollution _____	201
Air Quality Legislation _____	201
Air Quality in Oklahoma _____	201
Water Quality _____	204
Water Pollution _____	204
Water Quality in Oklahoma _____	205
Municipal Waste Water _____	206
Hazardous Waste Disposal _____	206
Hazardous Waste Pollution _____	206
History of Hazardous Waste Legislation in Oklahoma _____	207
Hazardous Waste Management _____	209
Solid Waste _____	210
Solid Waste Overview _____	210
Litter _____	210
Solid Waste Legislation _____	211
Solid Waste Management _____	211
Radioactive Waste _____	211
Conclusion _____	212
References _____	212
List of Illustrations _____	214

Environmental Regulation

Henry Eisenhart, Ellen Odle Bussert, and R. Fenton Rood

Executive Summary.—Historically, Oklahoma is a populous state. Jurisdiction for environmental regulation reflected that philosophy and was spread among many state agencies. The Oklahoma Legislature consolidated the state's approach to environmental protection by creating the Oklahoma Department of Environmental Quality (DEQ) on July 1, 1993. The law charged the agency with the mission of being responsive to environmental concerns of industry and the public, to improve the manner in which citizen complaints are tracked and resolved, and to gain state delegation of federal programs. The DEQ is Oklahoma's regulatory authority for air quality, water quality, radiation, and waste management.

Oklahoma's environmental legislative history parallels that of the federal government. The Oklahoma Clean Air Act was adopted in 1971, beginning a program of air monitoring and the development of a regulatory structure. The act has been amended numerous times since to keep pace with federal changes. The most recent changes were passed in 1992.

The DEQ operates a comprehensive network of air sampling sites throughout the state. Data are collected for carbon monoxide, nitrogen oxide, sulphur dioxide, particulates, ozone and lead. These data demonstrate that most of Oklahoma possesses superior air quality, and that industrial and municipal air pollution is declining.

Water is officially recognized as one of Oklahoma's most precious resources. The first state legislature after statehood, in 1907, created a State Board of Health and charged the commissioner with inspecting all public facilities for sanitary conditions and to advise state and local governments in all hygienic matters. In 1917, the legislature placed the control of all public water supply and sewer systems under the State Board of Health. In 1977, Oklahoma received national attention as the first state to qualify for primary enforcement responsibility of drinking water standards set by the 1974 federal Safe Drinking Water Act. Today, the DEQ's State Environmental Laboratory (formally operated by the Oklahoma State Department of Health) operates more than 100 monitoring stations on lakes and streams across the state. Municipal and industrial discharges are carefully regulated to ensure that the water quality standards for each stream are met.

Oklahoma state government expanded into the field of solid waste management with the passage of the Oklahoma solid Waste Management Act in 1970. This created a regulatory structure through a permitting system for disposal sites, along with authority for compliance monitoring and enforcement.

The Solid Waste Management Act has been amended repeatedly to reflect changing federal requirements. While the statute strongly encourages source reduction and recycling, there is no reduction goal or mandate. Oklahoma has a number of major industries who use recycled materials as their primary feedstocks. More than 4,000 people are employed remanufacturing a variety of paper, glass, steel, HDPE plastics, and aluminum products.

Oklahoma's regulatory control over hazardous waste began with the passage of the controlled (Hazardous) Industrial Waste Act of 1976. This legislation predated original federal requirements, and has been amended continually to reflect the evolution of hazardous waste management. The DEQ regulates hazardous waste generators, transporters, treaters, recyclers and disposers. Pollution prevention is one of the top priorities of the DEQ. The Customer Assistance Division of the DEQ is set up to help businesses and industries reduce the volume and toxicity of their wastes. A voluntary pollution prevention program, Target '98, was created in 1993 to encourage Oklahoma industries to work together to reduce 15 chemicals they all produced as a byproduct of their manufacturing processes by 50% before the year 1998. This program was so successful that by the end of 1995, participating companies only produced 16 million pounds per year from the 32 million pound baseline.

INTRODUCTION

At one time, the name "Oklahoma" conjured up images of a dust bowl, wind erosion, stark plains, a desolate landscape, and western migration. Today, Oklahoma has a new image—one of progress, economic stability, pride in governance, and a sense of being in control of the environment.

Keys to this progress have been science and technology, new industry, expanding international relationships, and preservation and enhancement of the physical landscape and its importance in providing a basis for high quality of life indicators. With progress comes an abundance of desirable development, but there is always a price to pay for a burgeoning society. This price is the gross utilization of nonrenewable resources and waste disposal problems.

Industrial byproducts must be handled and disposed of properly to avoid pollution problems. Government, civic, and business leaders today are forced to balance economic development and environmental protection to ensure a good quality of life in the future. As a result, these decision makers must also lead the way in adopting environmental policies and programs that reflect a realistic understanding of both the positive and negative ramifications and results of economic development.

The term "ecosystem" is a good description of one of the most important ideas to emerge in recent decades. The idea is that humans live in a resource system that is virtually closed, a natural environment with essentially fixed dimensions in terms of mass energy and assimilative-regenerative capacity. Whatever has been and will be produced, consumed, and ultimately discarded within this resource system is still here, in one form or another.

With that in mind, the state is taking steps to properly manage its natural resources. Policies and programs are being established to help achieve that goal.

ENVIRONMENTAL POLICIES

Developing strong conservation policies has been an important goal for the nation since the beginning of

this century. The federal government is responsible for crafting most of the regulatory framework that governs the quality of air, land-use, water, and waste disposal. States must meet federal regulatory standards, but have the option to operate more stringent programs. One state's laws may be more strict than those of other states, which creates many challenges when regulating natural resources that are regional in nature.

Conservation has always been an issue in America. The original colonists regularly enforced farming and hunting regulations in order to protect the land from overuse and wildlife from decimation. As the development of the West progressed in the late 19th and early 20th centuries, soil, minerals, and timber were exploited at an alarming rate and conservation policies regarding the protection of the quantity of resources became very important. National policy in the 1930s and 1940s continued to focus on limiting development, encouraging nonuse, and setting aside public lands for future generations.

With conservation as a central theme, national parks were established and some of America's most beautiful scenic areas and natural phenomena were protected from exploitation. Regulation of public lands was practiced, prohibiting the abuse or use of certain tracts of land except for specific activities, such as grazing or controlled farming.

Soil conservation measures were enacted in the 1930s, primarily because of the poor farming practices in Oklahoma, Kansas, and Texas during this period that contributed significantly to the Great Dust Bowl. This was a time when intense heat and deficient rainfall resulted in one of the worst droughts of record for the state of Oklahoma. Farmers and ranchers lost everything: The corn crop failed; sorghum and cane planted early were burned beyond recovery; cotton deteriorated rapidly; stock waste became exhausted over much of the state; and pastures declined rapidly. The Oklahoma Legislature responded to this crisis by creating the Oklahoma Conservation Commission to help landowners eradicate the problems of erosion from wind and water in the state.

Concurrently, however, coal mining and oil and gas exploration were being encouraged, along with lumbering and agriculture. These practices brought about new concerns because developers in these industries were, for the most part, not interested in returning mining or timber sites to their original condition, nor were they overly concerned with the degradation that occurred at drilling sites. Although the Oklahoma Legislature created state agencies such as the Department of Agriculture, Department of Mines and the Corporation Commission to regulate these industries, no emphasis was placed on environmental protection.

In recent years, the original mission of these regulatory agencies has been changed by the Legislature to better protect the environment. One example is the Oklahoma Department of Mines, whose mission in 1986 was expanded to include developing programs to minimize environmental impact on land, air, and water quality. The Oklahoma Corporation Commission now has an Environmental Division that is dealing with pollution problems caused by the oil and gas industry.

Historically, Oklahoma's regulatory structure for environmental protection has been fragmented among several state agencies. In the 1970s, extensive legislative interim studies were conducted to determine the best possible way to streamline environmental programs. Many bills were sponsored over the years, but it was not until the 1992 legislative session that the "Oklahoma Environmental Quality Act" was passed and signed by the Governor. This law names 10 state agencies that have environmental regulatory authority. The state environmental agencies include the Department of Environmental Quality, Oklahoma Water Resources Board, Oklahoma Corporation Commission, State Department of Agriculture, Oklahoma Conservation Commission, Department of Wildlife Conservation, Department of Mines, Department of Public Safety, Department of Labor, and the Department of Civil Emergency Management.

The act also created a new agency, the Department of Environmental

Quality (DEQ), to house programs governing water quality, air quality, solid waste management, hazardous waste management, and customer assistance. The DEQ is dedicated to providing quality service to the people of Oklahoma through comprehensive environmental protection and management programs. These programs are designed to assist the people of the state in sustaining a clean, sound environment and preserving and enhancing our natural surroundings where Oklahomans, today and tomorrow, may prosper and enjoy life. The DEQ will accomplish its mission through regulatory and nonregulatory means to achieve a balance that sacrifices neither economic growth nor environmental protection.

To address the problem of obtaining dual state and federal National Pollutant Discharge Elimination System (NPDES) permits, language was added to the Environmental Quality Act that authorized the DEQ to issue such permits to industries seeking discharge permits. The transfer of agency powers and duties occurred on July 1, 1993.

The Environmental Quality Board governs the DEQ. The board is made up of 13 individuals appointed by the Governor, with expertise in such areas as oil and gas, agriculture, water, waste management, and local government. A new component to the board is that three members are to represent environmental organizations. The board is responsible for: (1) hiring the Executive Director of the DEQ; (2) serving as the rulemaking authority for the DEQ; and (3) acting as the appellate body for complaints within the jurisdiction of the DEQ. Advisory councils in the areas of air, water, solid waste management, radiation management, and hazardous waste management and laboratory services were established by the act for the purpose of recommending rules to the Environmental Quality Board.

The DEQ created a Customer Service Division, which was unique at that time in state government. This is a nonregulatory division that helps industry, government and the public with environmental services such as permitting, understanding regulations, and pollution prevention tech-

niques. It also operates a Small Business Assistance program that is dedicated to helping this audience understand and comply with the myriad of environmental laws as well as acting as an advocate for them.

To meet the challenge of addressing environmental concerns, the Environmental Complaints and Local Services Division was established. This division is responsible for receiving environmental complaints from residents of Oklahoma. Complaints are received in the 39 field offices and by the environmental complaints hotline, which operates 24 hour per day, seven days per week.

AIR QUALITY Air Pollution

Since the industrial revolution, urban dwellers have endured air pollution in one form or another. Early industry created intolerable levels of smoke from factories that persisted well into the middle of the 20th century in most industrialized countries. In the U.S., pressure from citizens brought about new measures for the monitoring and control of smoke pollution; however, the nature of air pollution was to become much more complex. Technology brought with it a great deal of energy production and new industrial and manufacturing processes that have contributed significantly to polluting the air.

One of the greatest causes of air pollution is car exhaust. This, coupled with emissions from other vehicles, is the greatest source of carbon monoxide, hydrocarbons, and nitrogen oxides. Power-generating stations contribute the majority of sulphur oxides, while industry in general contributes the most particulates to the atmosphere.

Air pollution is, for the most part, a phenomenon of urban living and increases proportionately with the size and density of the urban population. Certain climatic factors also contribute to the severity of air pollution. Oklahoma, because of its susceptibility to constant southerly and northerly breezes and its relatively flat topography, does not have many days annually when air pollution becomes serious. However, as metropolitan areas increase in size and density, the po-

tential for air pollution problems is very real.

AIR QUALITY LEGISLATION

The Clean Air Act, last amended in 1990, provides the national framework for efforts to protect air quality. Congress first enacted legislation dealing with air pollution 32 years ago; however, this legislation was a mere authorization of federal research and financial assistance. It was not until 1963 that Congress began to legislate substantive control regulations. The 1963 Clean Air Act was modeled after the existing Clean Water Act. This act provided authority to engage in research and development, to establish technical and financial assistance programs and, through a complicated fact-finding process, to abate air pollution.

The Clean Air Act was amended in 1965 to authorize establishment of emission standards for automobiles, and again in 1970 to mandate the prevention of significant deterioration of air quality programs. In 1977 it was amended to address nonattainment areas. The most recent amendments to the act were passed by Congress in 1990. One of the most notable sections of the act prohibits individuals from knowingly venting ozone-depleting compounds used as refrigerants. It also requires the U.S. Environmental Protection Agency (EPA) to develop regulations that limit emissions of ozone-depleting compounds during their use and disposal to the "lowest achievable level" and that "maximize recycling" (See Table 12.1 for a sample of the research topics mandated by the act).

The Clean Air Act enabled the federal government to establish health and welfare ambient standards for air pollutants to achieve and maintain clean air. States are required to develop plans to assure the standards are attained and maintained. Under the act, the federal government also regulates emissions from automobiles, new facilities, and hazardous air pollutants. Table 12.2 shows air pollutants measured by the EPA.

Air Quality in Oklahoma

The development of the Oklahoma Clean Air Act generally followed the

Table 12.1 -- Federal Environmental Legislation

AIR AND RADIATION	
Legislative mandate:	Clean Air Act
Research Topics:	Lung disease and cancer Sensitive population groups Indoor air and health risks Measurement of hazardous pollutants Crop and forest damage Emission controls for volatile organic compounds (VOC) and nitrogen oxides (NO _x) Coal combustion pollution control Health effects of non-ionizing radiation
TOXIC SUBSTANCES AND PESTICIDES	
Legislative mandate:	Toxic Substances Control Act; Federal Insecticide, Fungicide and Rodenticide Act; Federal Food, Drug and Cosmetic Act
Research Topics:	Estimation of exposure and toxic effects in humans and other species Chemical structure and environmental activity Control of genetically engineered organisms Engineering research and discharges
HAZARDOUS WASTES	
Legislative mandate:	Resources Conservation and Recovery Act; Federal Water Pollution Control Act; Comprehensive Environmental Response, Compensation, and Liability Act
Research Topics:	Securing landfills and surface impoundments Disposal, incineration and other treatment methods Control of volatile organic compounds Field monitoring
ACID RAIN	
Legislative mandate:	Energy Security Act; Clean Air Act (pending)
Research Topics:	Emission sources and deposition Acidic loadings and concomitant effects Mitigation, including liming of lakes Trends in acidic deposition
WATER QUALITY	
Legislative mandate:	Clean Water Act; Marine Protection, Research and Sanctuaries Act
Research Topics:	Support for water quality standards Regulation of ocean disposal Short-term biologic toxicity tests Reduction in cost of sludge disposal Cost-effective water treatment systems
DRINKING WATER	
Legislative mandate:	Safe Drinking Water Act
Research Topics:	Distribution systems and concomitant effects on health, costs and compliance Disinfection byproducts Infectious disease transmittal Human exposure to chemicals
ENERGY	
Legislative mandate:	Clean Air Act; Clean Water Act; Safe Drinking Water Act; Resource Conservation and Recovery Act; Toxic Substances Control Act; National Environmental Policy Act
Research Topics:	Reduction in emission control costs Identification of synthetic fuel pollutants Health risks of synthetic fuel pollutants Boiler conditions and pollutant-related reactions

Source: EPA Journal (1984).

development of the Federal Clean Air Act. The state's first act was a 1955 version that merely authorized the Oklahoma State Department of Health to study the problem. The Oklahoma

Clean Air Act was amended in 1963 and again in 1967. The 1967 act, with amendments in 1992, established the framework under which the state currently operates. The Oklahoma Qual-

ity Codes, enacted by the Legislature in the 1992 session, authorized the DEQ to implement the state and federal Clean Air Act.

The Air Quality Division of the

Table 12.2 -- Atmospheric Pollutants Measured by the Environmental Protection Agency, 1984

Elements	Radicals	Others	Gases
Antimony	Ammonium	Aeroallergens	Carbon monoxide
Arsenic	Fluoride	Asbestos	Methane
Barium	Nitrate	Radioactivity	Nitric oxide
Beryllium	Sulfate	Benzene-soluble organic compounds	Nitrogen dioxide
Bismuth		Benzo[a]pyrene	Pesticides
Boron		Pesticides	Reactive hydrocarbons
Cadmium		Respirable particulates	Sulfur dioxide
Chromium		Total suspended particulates	Total hydrocarbons
Cobalt			Total oxidants
Copper			
Iron			
Lead			
Manganese			
Mercury			
Molybdenum			
Nickel			
Selenium			
Tin			
Titanium			
Vanadium			
Zinc			

Source: EPA Journal (1984).

DEQ is responsible for protecting Oklahoma's air quality. As a part of implementing the Clean Air Act, the DEQ adopts rules, promotes compliance efforts, enforces rules, and develops pollution prevention strategies to reduce emissions and improve air quality.

An EPA-approved State Implementation Plan (SIP) provides strategies and procedures for the daily operations of the DEQ Air Quality Division. This SIP is reviewed and amended as necessary. It includes rules and strategies developed at the state level for implementing the various federal air quality programs. To date, DEQ has acquired all delegation of available EPA air quality programs.

The Air Quality Council serves as the initial rulemaking body for the Air Quality Division of the DEQ. Through the Oklahoma Clean Air Act, the Governor appoints to the Air Quality Council nine citizens who represent the following disciplines: engineering, higher education, transportation, local government, general industry, agriculture, petroleum industry, electric industry, and the general public. The Council holds public hearings, reviews complaints, and provides expertise about various air quality issues. All air quality rules and regula-

tions must first be reviewed and approved by the Air Quality Council before being recommended to the Environmental Quality Board. Once approved by the Board, the rules proceed to the State Legislature and then to the Governor for final approval.

The 1992 amendments to the Oklahoma Clean Air Act established the authority necessary to implement the federal mandates and to preclude federal intervention and sanction. The new requirements established by the amendments authorized the DEQ to develop an operating permit system for federally defined major pollution sources, establish a public review process for permits, and establish a fee system for those major air pollution sources.

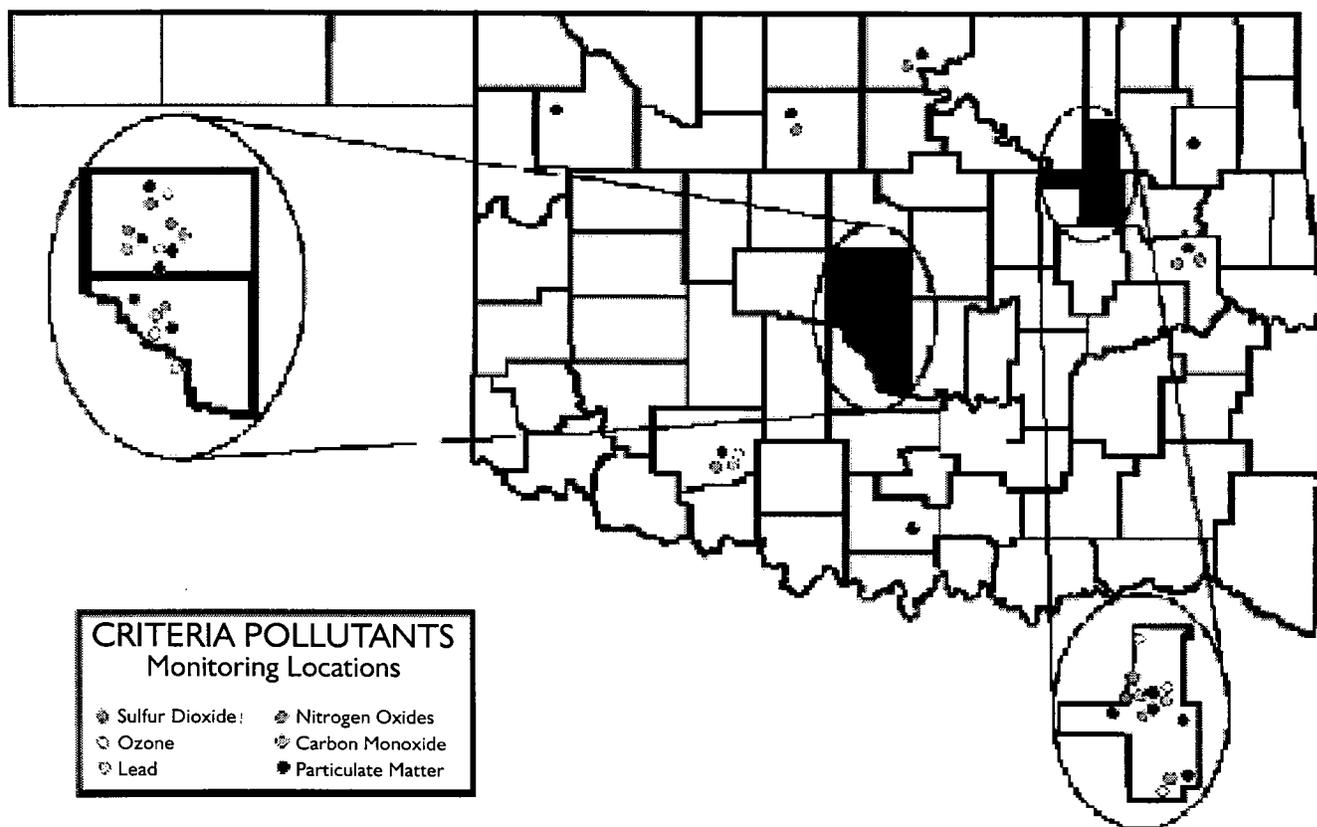
A Small Business Technical Assistance Program is also mandated by the act, and includes the components of a Small Business Assistance Panel and a Small Business Ombudsman. Further, the amendments simplified and clarified the administrative appeal process for the DEQ orders; revised the statutory qualifications of the Air Quality Division Director, and enhanced the DEQ's enforcement authority by authorizing the use of field citations with penalties for noncomplying sources and established crimi-

nal penalties for violation of the act and permitting requirements. Finally, the amendments deleted tax credit provisions no longer enforced and revised other obsolete language in the act.

Oklahoma's air quality standards are controlled in part by a vigorous permitting and monitoring program. (See Map 12.1 for locations of the DEQ's sampling sites.) A network of monitoring stations routinely measures concentrations of the criteria air pollutants in the ambient air. The Oklahoma air quality monitoring network consists of 48 monitors located at 31 sites throughout the state. Monitors are placed in counties containing significant air pollution sources. All ambient air monitoring stations in the state are equipped with EPA-approved instruments that are maintained and calibrated by qualified DEQ personnel. Data from the network provide an overall view of the state's air quality and are used in the development of statewide control strategies. Likewise, these data are an integral component for measuring the success of national pollution-control standards.

Owners and/or operators of businesses that are potential contributors to polluted air or discharge must obtain state authorization before construction or modification of their industry. The purpose of the construction permit is to assure that the business can comply with the state and federal regulations. After construction, the owner and/or operator must secure a permit to operate. This review is to determine compliance with all state and federal emission limitations. Again, depending on size, type, and location, there may be a requirement to test and determine the actual emission from the new source.

The state also has adopted the National Ambient Air Quality Standards (NAAQS) for the six criteria pollutants, which are sulfur dioxide, particulate matter, carbon monoxide, photochemical oxidants (ozone), non-methane hydrocarbons, nitrogen dioxide (NO₂), and lead (Pb). The Clean Air Act requires DEQ to review the public health standards for the criteria pollutants every five years. Results from the 1997 scientific review indicate the need to revise and tighten



Map 12.1 — Locations of air sampling sites. Source: Oklahoma Department of Environmental Quality.

these standards for particulate matter and ozone. The EPA signed these updated standards July 16, 1997.

To ensure these standards are attained and maintained, the Air Quality Division of the DEQ operates an air monitoring network. The network consists of 39 monitoring sites in counties throughout the state that contain significant air pollution sources. Each site measures one or more of the pollutants that are subject to the National Ambient Air Quality Standards. Additional sites may be added with the implementation of new standards for particulate matter and ozone.

Since 1970, air quality in Oklahoma has improved tremendously. Many of these improvements are the result of pollution control programs instituted by EPA, state and local agencies and industry. Since the passage of the Oklahoma Clean Air Act, the DEQ has joined in a committed effort with federal agencies, industry, and a concerned public to find solutions to

maintain clean air in the state. Innovative and more cost-effective methods and common sense strategies are actively being sought to further reduce air pollution emissions and improve air quality.

WATER QUALITY

Water Pollution

In the United States, the effort at abatement of water pollution is directed toward the following areas: (1) domestic sewage; (2) infectious agents; (3) plant nutrients, particularly nitrogen and phosphorous; (4) organic chemicals, insecticides, pesticides, fertilizers and detergents; (5) other mineral and chemical substances from industrial, mining, and agricultural operations; (6) sediments from land erosion; (7) radioactive substances; and (8) heat. Table 12.3 shows common sources of water pollution.

Environmental concerns regarding water pollution are a very high priority with most state and local govern-

ment agencies. Historically, waterborne diseases and toxins have had a significant impact on entire communities. Today, with the growth of U.S. industries and recurring "oil spill" or "chemical spill" incidents in major waters, everyone is aware of the potential danger of water pollution from both a health and an aesthetic viewpoint. In addition, the American public has become much more interested in conservation issues, is much more recreationally oriented, and continues to value water as one of the most precious resources.

Industry is by far the principal contributor of water pollution. Industry discharges three to four times the amount of oxygen-demanding wastes as municipal sewage systems and, unfortunately, many of these wastes are toxic. Traditionally, the industries that have been the major polluters are paper, organic chemicals, and petroleum. Scientists also believe that waste heat is a major source of water pollu-

Table 12.3 -- Principal Wastes and Environmental Water Pollutants

Municipal Waste	Industrial Waste	Agricultural Waste	Others
Solids:	Spent acids	Slaughterhouse products	Mining waste
Household wastes	Caustic solutions	Animal waste	Quarry waste
Commercial wastes	Chemical solvents	Fertilizers	Sewer sludge
Litter	Poisons	Pesticides	Construction demolition waste
Liquids:	Flammable liquids	Food processing waste	Medical, surgical and veterinary waste
Sewer effluent	Explosives		Radioactive waste
Commercial solvents	Liquids containing heavy metal ions		Abandoned vehicles, tires, consumer goods
	Drilling mud		Litter
	Salt brine		

Sources: EPA (n.d.) and Oklahoma State Department of Health (n.d.).

tion. Waste heat, or thermal pollution, is caused by power industries, which use tremendous amounts of water in the cooling process, then return it to natural water sources (Table 12.4).

The petroleum industry, with which Oklahoma has a particularly strong economic interest, has received criticism nationwide for its continual fouling of beaches and coastal areas near refining ports and for reoccurring spills and leakage. These cause grave environmental damage to wildlife and recreation areas, and are difficult and expensive to clean up. Also, petroleum products, particularly crude oil, are not water-soluble; therefore, from an aesthetic standpoint the pollution is readily visible and often inconvenient. A positive factor, however, is that oil spills can be easily located and technology is progressing to aid in a safe and effective means of dealing with these periodic environmental disasters.

Oklahoma's concerns stem from the disposal of industrial petroleum wastes, including spent acids, drilling fluids, emulsifiers, and salt water into injection wells that are designated liquid waste disposal sites licensed and regulated by the Oklahoma Corporation Commission. These injection wells would be located in areas and in geologic strata that will prevent seepage of liquid waste materials and the consequent contamination of ground water.

Water Quality in Oklahoma

Oklahomans appreciate water as one of the state's most precious natu-

ral resources. Since 1917, some of the earliest programs of the State Department of Health (now the DEQ) have been aimed at protecting public health through safe drinking water. The DEQ has continued to ensure a high quality of water for Oklahoma. Most of the state's 2,384 public water sources comply with state and federal drinking water standards for organic and inorganic chemicals and radiological quality. In 1977, Oklahoma received national attention as the first state to qualify for primary enforcement of standards set by the 1974 federal Safe Drinking Water Act. State government has paid particular attention to the abatement of water pollutants and improving waste-water treatment facilities and has begun a vigorous program for monitoring major groundwater sources throughout the state (Map 12.2). The State Revolving Fund (SRF) public water construction loan program was created to aid public water supplies. These funds are available as of September 1997.

The Federal Water Pollution Control Act and the subsequent amendments evolving into the Clean Water Act have primarily guided the direction of municipal waste-water disposal. The national goals of clean and safe surface water and ground water have been adopted by Oklahoma to enhance the environmental health of our citizens.

As early as 1965, the State Department of Health recognized the need for adequate treatment of municipal waste water. The Board of Health

adopted the following water pollution control policy statement on December 12, 1965:

Consistent with the programming made in the development of the waters of the state of Oklahoma and the increasing use of such waters for municipal, industrial, and agricultural supplies as well as navigation, recreation and wildlife, and other beneficial purposes, and in order to protect the waters of the state against the encroachment of pollution, the State Board of Health adopts the following statements as supplementary to existing Health Department policy:

1. That all wastes discharged to the waters of the state receive the equivalent of secondary treatment prior to being discharged, and that action be taken by the State Department of Health to secure the orderly achievement of this objective for all wastes under its jurisdiction.

2. That the State Department of Health continue to work with municipalities and other local, state, and federal agencies to secure better operation of waste treatment facilities and to encourage, where indicated, joint municipal and joint municipal-industrial projects for compatible wastes with the objectives of effecting more comprehensive basin planning and increased economy in meeting the higher costs of better treatment procedures which will be required in the future.

3. That the State Department of Health continue to support research in advanced waste treatment methods and in the reuse of water for all purposes, with particular emphasis on the value of waste water for irrigation.

These programs now are operated by the DEQ.

With the passage of the Clean Water Act (Public Law 92-500) and subsequent regulations adopted by the EPA, states were required to develop water quality standards to protect beneficial uses of streams. Standards were developed and adopted by the Oklahoma Water Resources Board for Oklahoma's rivers and streams. The DEQ, in conjunction with the Council of Governments representing larger metropolitan areas, has developed wasteload allocations for each discharger of sanitary waste in the state.

Table 12.4 -- Use of Cooling Water by U.S. Industry

Industry	Cooling Water Intake (billions of gallons)	Percent of Total
Electrical power	40,680	81.3
Primary metals	3,387	6.8
Chemical and allied products	3,120	6.2
Petroleum and allied products	1,212	2.4
Paper and allied products	607	1.2
Food and kindred products	392	0.8
Machinery	164	0.3
Rubber and plastics	128	0.3
Transportation equipment	102	0.2
All others	273	0.5
Total	50,065	100.0

Source: Advanced Waste Treatment Program, EPA (n.d.).

Oklahoma's geography and geology play a role in determining water quality. (See Map 12.3 for an illustration of the state's major geological provinces). Oklahoma's terrain ranges from flat semiarid areas of 16–20 inches per year of rainfall in the Panhandle to mountainous terrain in the eastern third of the state with as much as 56 inches annual rainfall, producing several scenic streams containing very high quality water. The flat low rainfall areas with their sluggish or intermittent streams and the high quality streams in the higher rainfall areas have dictated waste treatment procedures and contributed to determining modern waste management technology.

Wasteload data is gathered and then converted into organic and hydraulic limits and included as a condition of a permit issued jointly by the State Department of Health and the EPA, which is developing regulations to control toxic substance discharge and sludge disposal requirements. The DEQ took over sole regulating authority after receiving National Pollutant Discharge System (NPDES) delegation on November 19, 1996.

The protection of the beneficial uses of Oklahoma's waters will be a specific goal regarding municipal

waste water. The issuance and enforcement of discharge permits by the state will intensify communities' desire to provide adequate and progressive waste-water treatment services for domestic and commercial demands.

Water quality assessment in Oklahoma is primarily operated by the DEQ, the Oklahoma Water Resources Board, the Oklahoma Conservation Commission, and the U.S. Geological Survey (USGS). The programs utilized in water quality assessment are the basic water monitoring plans, the high flow monitoring program, and the USGS monitoring program. The basic water monitoring plan is operated by the DEQ and is carried out through the collection and assessment of surface water quality data and also includes toxic monitoring of streams. The high flow program assesses non-point contributions during high flow events throughout Oklahoma annually. The USGS operates a water quality monitoring program that gathers data for flow rates, gauging stations, overall water quality, and sedimentation levels (suspension and settled).

During the past several years, numerous studies of specific areas have been conducted by various agencies. These studies have focused on Tar Creek, the Illinois River system and tributaries, and a variety of surface water lakes. Toxic monitoring surveys are performed to measure and evaluate the level of toxic heavy metals and organic compounds in fish tissue. The accumulation of toxins in fish tissue serves as an effective indicator of long term pollution. Although the vast majority of Oklahoma's lakes and waterways sampled have tested out below levels of concern, several reservoirs have residues that exceed DEQ standards.

MUNICIPAL WASTE WATER

State statutes require that a permit be obtained from the Water Quality Division of the DEQ prior to construction of any part of a sanitary sewer system. Plans and specifications for new construction are submitted for review to the Construction Unit of the Water Quality Division of the DEQ. Upon determining that the plans for the proposed project meets design standards adopted by the Environ-

mental Quality Board, a permit is prepared and is then issued to the applicant.

Pretreatment of industrial waste discharged to a Public Owned Treatment Works (POTW) is the responsibility of the discharger and is regulated by municipal ordinances. Currently, the pretreatment program is administered in Oklahoma by the EPA. A state permit is issued to all discharging sanitary waste treatment facilities in the state. A single permit allows more uniformity in enforcement between the DEQ and the EPA.

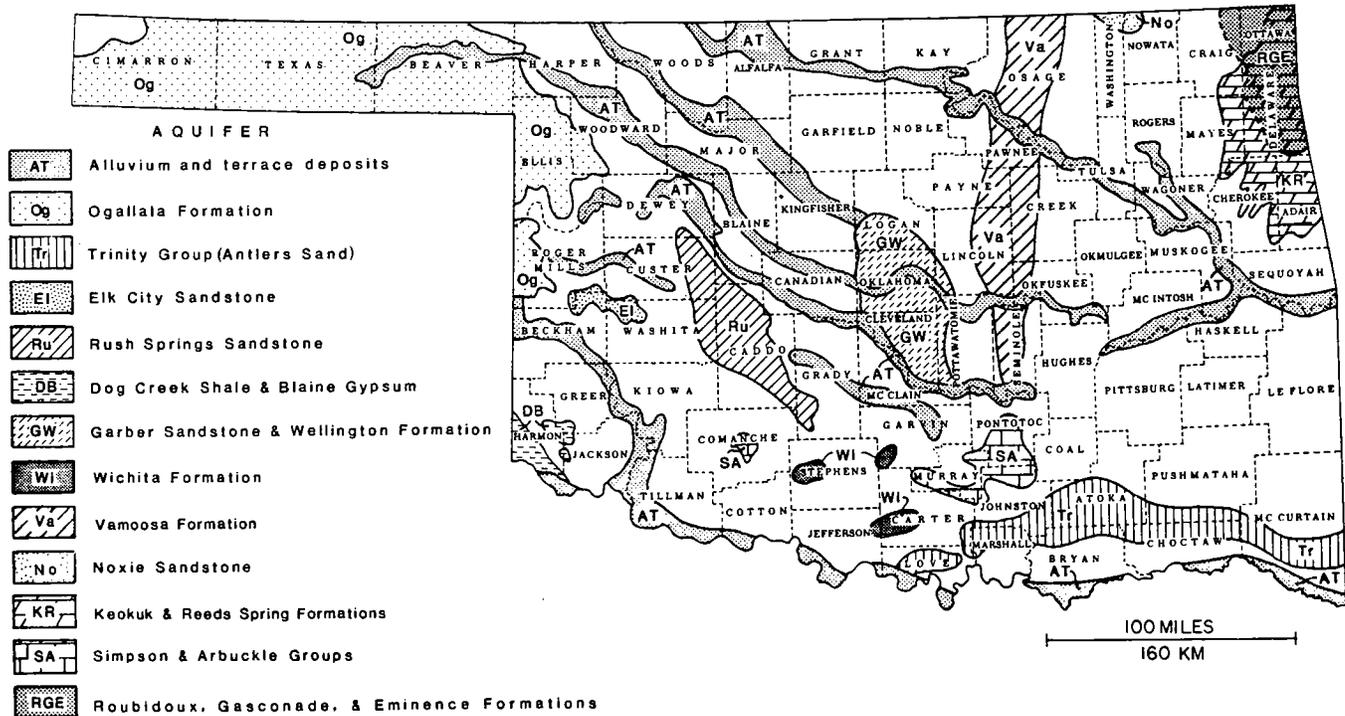
Technology that can produce an equal or better quality effluent at reduced cost is promoted by both the state and federal governments. The construction grants program provided for a 10% increase in grants for innovative waste-water projects. Title VI of the 1987 Amendments to the Federal Clean Water Act changed the grant program into a revolving loan fund.

The State Revolving Fund (SRF) waste-water construction loan program was created for the construction of publicly owned waste-water treatment facilities. The SRF was designed to replace the EPA's construction grants program. The cities of Tulsa, Muskogee, Dewey, Beaver, Guymon, Marietta, and Nicoma Park were the first Oklahoma communities to take advantage of the low-interest loan program. As of July 1997, 57 SRF waste-water construction loans, totaling nearly \$219 million, have been approved. Of these loans, 54 have been closed, with nearly \$211 million collected.

HAZARDOUS WASTE DISPOSAL Hazardous Waste Pollution

Oklahoma's economy has traditionally been based on oil and agriculture. Due to the absence of a large industrial sector, Oklahoma has been spared the legacy of hazardous waste problems encountered in the historically industrialized regions of the country. Many of the problem sites that do exist stem from old oil refineries and metal smelters.

Nationally, EPA's Superfund program (Comprehensive Response, Compensation, and Liability Act of 1980 [CERCLA]) is designed to correct his-



Map 12.2 — Major sources of ground water in Oklahoma. Source: Johnson and others, 1980.

torical hazardous waste mistakes. The EPA identifies the worst sites in the nation and places them on a "National Priorities List" (NPL). Ten Oklahoma sites have been placed on the NPL: Compass Industries in Tulsa; Double Eagle Refinery Company in Oklahoma City; Fourth Street Abandoned Refinery, Oklahoma City; Hardage/Criner in McClain County; Mosley Road Sanitary Landfill in Oklahoma City; Oklahoma Refining Company in Cyril; Sand Springs Petrochemical Company in Sand Springs; Tar Creek in Ottawa County, Tenth Street Dump in Oklahoma City; and Tinker Air Force Base in Oklahoma County.

The State of Oklahoma and the EPA are in the process of cleaning up these sites. Clean-up has been completed at Fourth Street Refinery, Sand Springs Petrochemical Company and Tenth Street Dump.

HISTORY OF HAZARDOUS WASTE LEGISLATION IN OKLAHOMA

Hazardous waste was first officially recognized in the Oklahoma Solid Waste Act of 1970. While the term itself was not specifically defined, the statute did include hazardous waste as an element of the defini-

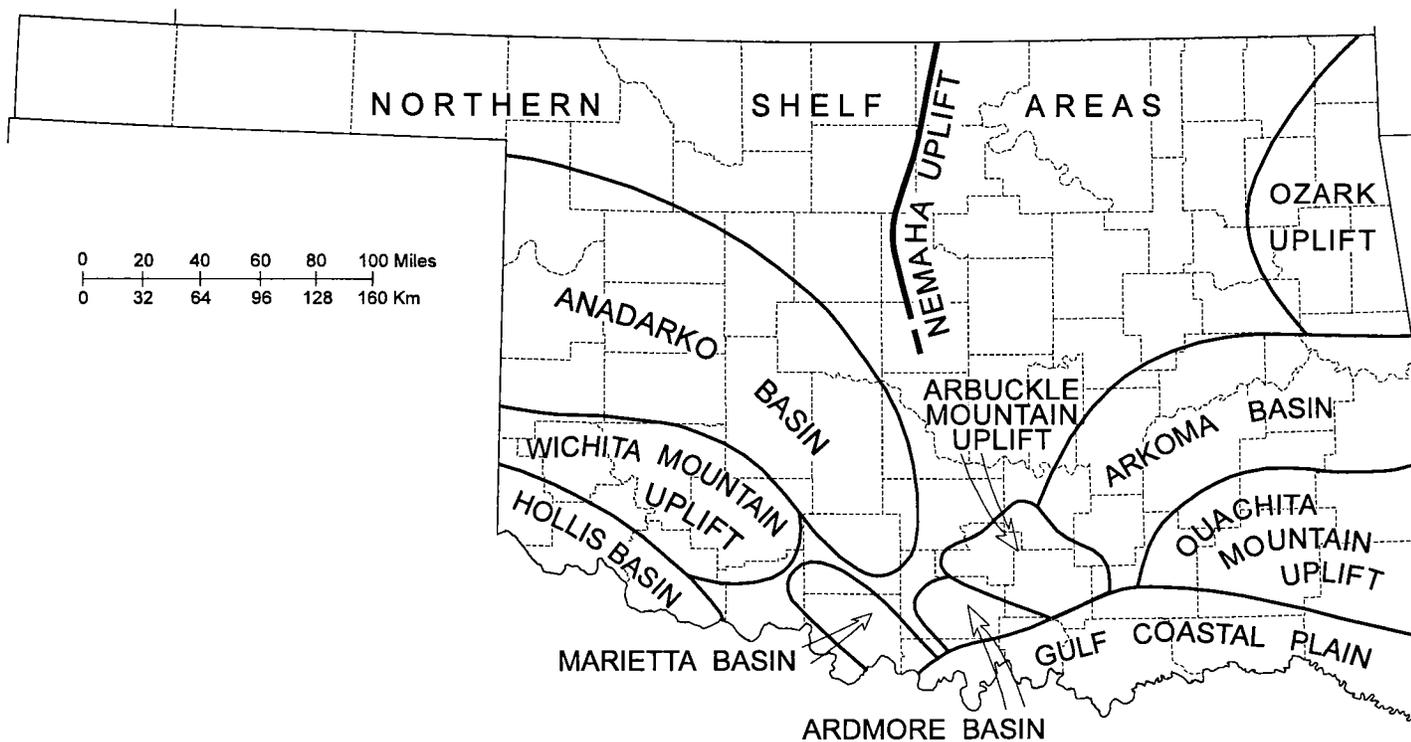
tion of solid waste. Other state laws at the time established separate regulatory structures for liquid industrial wastes and wastes produced through the exploration and production of oil and gas. It should be noted that liquid industrial wastes were at that time regulated by the Oklahoma Water Resources Board, which had statutory jurisdiction over industrial waste underground injection wells and industrial discharges to surface waters. The Oklahoma Corporation Commission had jurisdiction over underground injection wells used by the oil and gas industry and has input in determining potential sites for the underground disposal of industrial waste.

The first rules to deal with hazardous wastes were promulgated in 1971, under the Oklahoma Solid Waste Act. They dealt primarily with the permitting of what are now called land disposal sites—landfills, impoundments, and land-treatment. In that era, landfills were used for both garbage and hazardous waste. Table 12.5 presents the costs of these methods of hazardous waste disposal at that time. There was no statutory jurisdiction to regulate the storage of hazardous wastes in any way; rules dealing with genera-

tors, transporters, and reporting requirements were minimal.

Under this first set of rules, a landfill/impoundment hazardous waste facility was permitted in 1972 to Royal N. Hardage in McClain County. This facility appeared to meet the criteria of the day, and was the only permitted hazardous waste landfill in Oklahoma. Significant controversy developed, not over the site itself, but over the fact that the site was accepting waste from out-of-state generators. While the chemical dump seemed to meet the technical standards of the day, the scientific and regulatory aspects of the field of hazardous waste management quickly evolved beyond the capabilities of Hardage. He closed the site in 1980, and it was among the first Oklahoma sites added to the NPL.

During the early 1970s, a number of entrepreneurs attempted to establish other hazardous waste landfills. These efforts aroused extensive public protests and attracted the attention of state policy makers. Additionally, there was a growing awareness that the government had neither a comprehensive regulatory program nor the manpower needed to attempt to regulate these companies.



Map 12.3 — Major geological provinces of Oklahoma. Source: Johnson and others, 1980.

In 1974, the Oklahoma Legislature convened its first special committee to study the problem of hazardous waste management. The committee's work resulted in the passage of the first comprehensive legislation aimed at hazardous waste, the Oklahoma Controlled Industrial Waste Disposal Act, in 1976. Since this bill predated the federal Resource Conservation and Recovery Act (RCRA), it contained a number of unique features:

1) "Controlled industrial waste" was used in lieu of the now common term "hazardous waste";

2) In addition to regulation of the generation, transportation, and disposal of hazardous waste, the law also required generators to obtain approval of a "disposal plan" prior to shipping any hazardous waste for disposal;

3) A comprehensive process for permitting hazardous waste disposal sites was established to include public participation;

4) Injection wells for hazardous waste were brought into the regulatory structure; and

5) A manifest and reporting system was created.

The first rules to implement the act were adopted by the Board of Health in June 1977. These rules were revised in 1979, based mostly on needs experienced during implementation. During this same time period, there were several efforts to establish additional facilities, all of which generated public controversy and opposition. Hazardous waste is now regulated by the DEQ.

An important element of Oklahoma's modern hazardous waste infrastructure was added with the creation of the Lone Mountain facility near Waynoka in 1979. Developed by a major industrial waste management company, this surface disposal site has consistently employed state-of-the-art environmental management techniques. Its separate containment cells are constructed with a series of three synthetic (high density polyethylene) liners over three or more feet of recompacted clay. Leachate collection systems remove and treat any liquid that accumulates in a cell.

The Oklahoma Controlled Industrial Waste Disposal Act created national attention because of its "reciprocity" clause. This provision prohibited the importation of hazardous waste except from states with which Oklahoma had formal agreements. Such agreements were required to be signed by the governors of the two states, and stipulated that industries in each state could ship hazardous waste to either state for disposal. The disposal industry protested that the requirement for reciprocity violated the Interstate Commerce Clause of the U.S. Constitution, and the law was ultimately struck down by the Tenth Circuit Court of Appeals.

The national passage of RCRA in 1976 launched a process of sophisticated evolution that touched every aspect of hazardous waste management. As EPA promulgated the national standards, Oklahoma responded with appropriate changes in both state law and regulations.

The controversies that swirled around proposals in the early 1980s

Table 12.5 -- Costs of Alternative Methods of Hazardous Waste Disposal

Method	Costs (\$ per metric ton)
Landfill	
Drums	168-240
Bulk	55-83
Land Treatment	
Incineration	5-24
Clean high-Btu liquids	13-53
Liquids in general	55-237
Solids & highly toxic wastes	395-791
Chemical treatment	
Acid-based neutralization	21-92
Cyanide & heavy metals	66-791
Resource recovery	
Deep-well injection	
Oily waste water	16-40
Toxic rinse water	132-264
Transportation	0.15 per metric ton-mile

Source: Jorgensen (1981).

for new hazardous waste disposal sites helped stimulate a demand for public participation in the hazardous waste management process. In 1981, amendments to the Oklahoma Controlled Industrial Waste Disposal Act created the Oklahoma Hazardous Waste Management Advisory Council. This nine-member board was charged with reviewing and recommending rules to be adopted in Oklahoma's hazardous waste management program. By law, council members represented specific interest groups such as agriculture, industry, environmental groups, waste industry, engineering, geology, and the general public. In addition to serving as a sounding board, the council assists in rule development.

Oklahoma has long recognized that the best way to manage hazardous waste is to eliminate it, reduce it, or recycle it. In 1987, the Legislature passed the Recycling, Reuse, and Ultimate Destruction Incentive Act. This provided Oklahoma industries with a 20% tax credit for the purchase and installation of equipment for the recycling, reuse, or ultimate destruction of

hazardous waste. The tax credit may be taken only one time for each unit installed and must be taken within three years of the date of installation and initial use of the unit.

Oklahoma's synergism with national hazardous waste standards was reflected in amendments in 1992 which replaced the term "controlled industrial waste" with the universally accepted term "hazardous waste." This change was incorporated throughout the statute as well as the rules.

The concept of state reciprocity arose again in 1992 with a new statutory provision addressing state hazardous waste fees. Oklahoma developed a schedule of state fees to be levied for hazardous waste disposal activities. For waste imported from outside the state, the fee was to be the same as that in the originating state unless it was lower than Oklahoma's. This provision was challenged and ultimately ruled unconstitutional. As a result, the fees are assessed uniformly, irrespective of the state in which the waste originated.

Also, in 1992, the Hazardous Waste Management Act was modernized to include hazardous waste reduction as a major element of the state's hazardous waste program. The law set a goal of reducing hazardous waste by 25% by 1996. Through Oklahoma's Target '98 program, this goal was achieved.

Hazardous Waste Management

The current hazardous waste management program is administered by the DEQ. This program has experienced continued growth from 1980 to present, as the regulations have become more stringent. Regulatory activities are funded through state hazardous waste fees of \$9.00 per ton for the treatment, storage, or disposal of hazardous waste, or \$4.00 per ton if the waste is recycled.

Hazardous waste treatment, storage, and disposal facilities must obtain construction and operating permits from the DEQ. The permitting process includes significant opportunities for public participation. The applicant must formally notify affected property owners (within one mile of the proposed site) and give them an opportunity to review an emergency

plan. The emergency plan must minimize the hazards to property owners from emergencies and releases.

The general public is notified of permit actions through advertisements in two newspapers. Copies of the permit applications are made available in a number of locations, including a repository near the proposed site. As the application is reviewed, the public has several opportunities for public meetings and hearings to provide input to the DEQ.

Transportation planning is incorporated into hazardous waste management through the county commissioners. The commissioners in the county of the proposed facility and adjacent counties are required to review the classification and status of roads and bridges to be used to access the site. The applicant must obtain a certification from the commissioners that the roads and bridges are adequate.

The Oklahoma Hazardous Waste Management Act contains extensive exclusionary siting criteria for hazardous waste facilities designed to safeguard Oklahoma's water resources. The statute prohibits hazardous waste treatment, storage, or disposal facilities over the principal ground-water bedrock aquifers of their recharge areas as mapped by the Oklahoma Geological Survey. It also prohibits the construction of such facilities within the 100-year flood plain. For injection wells, the statute forbids their location anywhere that they may have an adverse or unpredictable effect on an existing injection well or oil or gas well.

The statute places a high priority on drinking water supplies, prohibiting hazardous waste facilities within one quarter mile of any public or private drinking water well. It also prohibits the injection of hazardous waste into or above an underground source of fresh water. Hazardous waste off-site disposal facilities are further restricted from locating within one mile of any public school, educational institution, nursing home, hospital, or public park.

The most prominent trend in hazardous waste management is for generators to eliminate, greatly reduce, or recycle their hazardous waste. Since the late 1970s, Oklahoma's hazardous

waste officials have provided technical assistance to support recycling and waste minimization. These efforts were highlighted in 1986 with the creation of a formal Industrial Waste Elimination Program. It is now known as the DEQ's Pollution Prevention Program.

Staff from the Pollution Prevention Program continually creates opportunities for small- and medium-sized businesses and industries to learn about the economic benefits of eliminating waste. Activities ranging from regional workshops to on-site waste audits have helped Oklahoma industries reduce their waste and become more cost competitive. The state is committed to furthering its pollution prevention initiatives and to assisting businesses and industry in achieving waste reduction.

SOLID WASTE

Solid Waste Overview

Oklahoma does not have a long history of industrial development. One benefit of the state's agrarian tradition is the relative lack of environmental problems from mismanaged waste. For example, only two of Oklahoma's Superfund sites are old municipal solid waste landfills.

Current landfills provide high quality environmental protection and have abundant capacity. Solid waste management, therefore, has not become a crisis. A statewide county solid waste planning process has documented that collection services are available to virtually every Oklahoma family. Unfortunately, the planning also identified illegal dumping as one of the state's most significant environmental challenges. In response, many Oklahoma counties have developed special "trash cop" enforcement programs. A trash cop is a full-time peace officer whose sole duty is to prevent illegal dumping.

Composting programs are encouraged by the DEQ as a viable source reduction option for communities. In order to protect ground water, the state requires municipal composting facilities to obtain an operating permit. The City of Norman, in central Oklahoma, was the first municipality to begin a city-wide compost program in 1991. Several other communities

are in the process of starting municipal yard-waste composting programs. Other communities sponsor "don't bag it" programs that encourage citizens to leave their grass clippings on the lawn instead of bagging them.

Law does not mandate recycling programs. However, many communities in Oklahoma have developed them. Methods of collection include curbside programs, buy-back centers, and drop-off centers. In northeast Oklahoma, the City of Owasso operates the state's first municipally owned recycling center. In operation since May of 1988, the center serves a population of about 30,000. This center is unique in that it buys newspaper, glass, aluminum, computer paper, used auto batteries, and used oil. It accepts other waste as a service to the community. The City of Tulsa initiated a successful "recycling depot" system providing seven locations across the metro area for citizens to drop off their recyclable materials.

Recycling is a major industry in Oklahoma. Another important way in which the state is addressing solid waste management is by developing markets for recycled goods. Oklahoma is home to more than 20 industries that use recyclables in their manufacturing processes. Some of the major commodities recycled in-state are glass, office paper, corrugated cardboard, and high-density polyethylene plastic.

LITTER

A portion of the solid waste that is generated in Oklahoma each day finds its way to interstate highway systems, city and county roads, recreation areas, parks, playgrounds, and public areas. Through many unique, effective programs, Oklahoma is attempting to educate the public about the cost and health hazards of casual littering, as well as the unattractiveness of litter.

Governor G.B.A. Robertson was one of the first elected officials to attempt to combat the litter problem. He proclaimed the week of April 4, 1921 to be "Clean Up Week" and did "earnestly recommend that Oklahomans observe the week by a general clean-up and the removal of all rubbish, trash, and waste matter from the premises."

In recent years, one of the most successful antilitter efforts has been the "Don't Lay That Trash On Oklahoma" campaign. Begun in 1988 by First Lady Shirley Bellmon, this was a statewide public awareness campaign aired on the radio and television that encouraged citizens to dispose of litter properly. Bright yellow trash cans placed along the roadside in convenient locations gave citizens an option for disposing of litter. Continuing the theme, but changing the name, Governor Frank Keating began the "Keep Our Land Grand" campaign. Actual litter surveys have documented the positive effect of this effort.

In conjunction with the first media campaign, an Adopt-A-Highway program was established that organized volunteers to clean-up the right-of-ways on state highways and interstates. Approximately 3,000 miles are being cleaned by volunteers four times a year. The Oklahoma Department of Transportation saved \$76,000 in highway clean-up activities as a direct result of the program. A spin-off of the Adopt-A-Highway program is the Adopt-A-County Road program.

In addition to cleaning up litter, the Oklahoma Department of Transportation operates a beautification program. Wildflower plots have been planted along the highways to improve the appearance. From 1988 to 1992, 350 acres of wildflowers have been planted. Not only does this activity discourage littering, it defers mowing until later in the summer. Reduced mowing saves the taxpayers money and conserves energy. Another significant effort of the beautification program was organizing volunteers to plant 3,500 trees along state highways in 1990.

Another program that is gaining popularity in Oklahoma is the "green box" program. The name green box comes from the eight-cubic-yard box that is used to contain trash. This program is designed to provide convenient trash receptacles for rural citizens who have to dispose of their own waste. Otherwise, most of this waste ends up in bar-ditches, fields, and streams. The green boxes are placed in several locations around the county. Delaware County, in eastern Oklahoma, was the first county to imple-

ment this program. Their program began in 1987. The green box system has had positive results, providing citizens with access to proper waste disposal and keeping the roadside and streams clean. McCurtain County duplicated the program in 1992, and is also experiencing tremendous success. Other counties are working to implement this program.

Solid Waste Legislation

The Oklahoma State Legislature passed the Oklahoma Solid Waste Management Act in 1970. This created a permitting program for solid waste disposal sites, and authorized the promulgation of regulations. Over the years, the statute and regulations have been modified to comply with the requirements of the federal Resource Conservation and Recovery Act (RCRA).

In 1990, the Oklahoma Legislature recognized the growing public concern over the environmental and social problems created by careless garbage disposal by passing two major amendments to the Oklahoma Solid Waste Management Act to increase the activities in the state regulatory program.

To fund these increased responsibilities in the state program, the Legislature created a state solid waste fee of \$1.50 per ton on out-of-state waste and 25¢ per month for customers who were billed for garbage services by a public entity. The fee supported the regulatory program as well as solid waste planning, technical assistance, public education, and the promotion of waste reduction and recycling.

In 1991, Oklahoma became the first state in the region to develop a comprehensive program to manage waste tires. The "Oklahoma Waste Tire Recycling Act" levied a recycling fee on the sale of new tires. The act established a waste tire recycling fee of \$1 per tire for passenger cars and light trucks. The fee is assessed to the consumer at the time of purchase. This fee funded the collection, processing and recycling of waste tires. The act was amended during the 1992 session to improve the program.

In 1992, the Oklahoma Solid Waste Management Act was amended with a "bad actor" provision. This requires

applicants for solid waste permits and other people affiliated with them to disclose their compliance status with environmental laws, both within and outside of the state. Current noncompliance may be the basis for denying the permit. At the same time, the statute was also amended to make the financial assurance and postclosure care provisions consistent with federal requirements.

In 1995, the Solid Waste Management Act was amended again to change the state solid waste fee. Landfill operators were required to install scales, and charge a state fee of \$1.50 per ton for all waste disposed.

Major amendments to the Solid Waste Management Act were made again during the 1992 legislative session. One of the most significant amendments was the "bad record" provision. This provision requires applicants and persons affiliated with the applicant to provide disclosure information regarding their compliance history with the law. The intent of this provision is to keep criminal elements or firms with a proven poor compliance record with major regulatory violations from obtaining a solid waste permit.

Solid Waste Management

Oklahoma is served by 41 landfills that accept municipal solid waste. Approximately one third of those facilities are publicly owned. There is one major solid waste combustor owned by the Tulsa Authority for the Recovery of Energy. This facility recovers heat from the combustion and provides steam to an adjacent oil refinery.

Solid waste disposal is regulated by the Oklahoma Department of Environmental Quality. The agency operates a permitting and inspection program for disposal sites, facilitates local solid waste planning, and conducts activities to promote source reduction, recycling and public education.

All applicants are encouraged to contact the DEQ to arrange a conference with a permit assistance team before they submit a permit. The purpose of this service is to provide the applicant with technical information and legal requirements of their proposed operation before they begin.

Additional technical assistance is available on request. Applicants must prepare engineering reports that provide data on the physical resources of the proposed site and detailed designs of the proposed disposal process.

The permitting process concentrates on the technical issues associated with the environmental protection features of the proposed facility. There are a number of opportunities for public participation ranging from informal meetings, to the filing of comments, to formal public hearings.

Radioactive Waste

Historically, significant quantities of low-level radioactive waste (LAW) have been generated since the 1940s. This waste is generated from a variety of sources, including government and industrial research, nuclear power reactors, medical services, and manufacturing processes. Table 12.6 shows a breakdown of the number of commercial nuclear reactors around the world.

The annual volume of LAW disposed at commercial disposal sites increased steadily until 1980. From 1981 to 1985, the volume decreased to approximately 2,600,000 cubic feet annually. In 1986, the volume dropped to 1,804,000 cubic feet. The closure of three LAW disposal sites between 1975 and 1978 increased the disposal burden of the remaining sites located at Barnwell, South Carolina; Beatty, Nevada; and Richland, Washington.

In 1980, acting upon concerns stated by the governors of the disposal-site states, Congress passed the Low-Level Radioactive Waste Policy Act, making disposal of commercially generated LAW a responsibility of each state and encouraging the states to form interstate compacts to manage and dispose of LAW on a regional basis. The act provided that any compact region approved by Congress could restrict the use of its LAW disposal facility to the member states of the compact after January 1, 1986.

By 1984, the concern that no new regional LAW disposal facilities would be operating by the end of 1985 initiated discussions in Congress on new LAW legislation. In 1985, Congress passed the Low-Level Radioactive

Table 12.6 -- Nuclear Power Generation in Different Countries, 1984

Country	Number of Commercial Reactors	Number of Canceled Reactors	Nuclear Energy as Percentage of Total Electricity Generated
Argentina	2	0	10.0
Austria	0	1	0.0
Belgium	6	0	45.0
Brazil	1	0	2.0
Bulgaria	4	0	29.0
Canada	10	0	11.0
CSSR	3	0	no data
DDR	5	0	12.0
Finland	4	0	40.0
France	32	0	48.0
FRG	15	0	17.0
Hungary	1	0	no data
India	4	0	3.0
Italy	3	0	4.0
Japan	24	0	19.0
Pakistan	2	0	0.2
Puerto Rico	0	1	0.0
South Korea	3	2	13.0
Spain	7	0	9.0
Sweden	10	0	40.0
Switzerland	4	0	28.0
The Netherlands	1	3	5.0
Taiwan	4	0	40.0
UK	37	0	16.0
USA	82	107	13.0
USSR	40	0	7.0
Yugoslavia	1	0	no data

Source: Time (1984).

Waste Policy Amendments Act, which extended out-of-region access to the existing disposal sites through 1992. Like the 1980 Act, the Amendments Act of 1985 declares disposal of commercial LAW to be a state responsibility. It continues to encourage formation of interstate LAW management compacts. The Amendments Act, however, also requires states and compact regions without operating disposal sites to meet specific milestones and deadlines, leading to the operation of new regional disposal facilities by January 1, 1993. To date, Congress has ratified seven interstate compacts comprising 37 states.

Following the passage of the 1980 Act, negotiations were begun with Oklahoma's neighboring states on the development of a compact region and draft compact language. After numerous meetings, such draft language was agreed to and submitted to the legislatures of Nebraska, Kansas, Oklahoma, Arkansas, and Louisiana. Ultimately, the Central Interstate LAW Compact was adopted by

these five states. Other states originally involved chose to go their own way.

The compact provided for a governing Commission, made up of one member from each of the five states. In addition to handling necessary administrative and procedural matters, the Compact Commission has selected a host state (Nebraska) through a method that involved two separate studies of the compact region to determine potential sites. The Commission has also selected a contractor, U.S. Ecology, Inc. to develop, build, and operate the disposal facility.

Traditionally, Oklahoma has generated very small amounts of LAW on an annual basis. Since Oklahoma has no nuclear reactors used for electricity generation, it is likely that this trend will continue in the future. For the same reason (no reactors), Oklahoma generates no civilian high-level radioactive waste. As of January 1, 1988, the actions taken by the Compact Commission have met all the deadlines imposed by the 1985 LAW Act. It

is anticipated that the Ecology site in Nebraska should be open to receive waste in the future.

CONCLUSION

Oklahoma is at the forefront in adopting federal legislation and initiating state and local legislation that has affected positively the state's physical and environmental resources. Through a series of government regulations and a conscientious monitoring program, Oklahoma's air and water quality is being supervised and protected, yet the state's industrial base is growing as well. Oklahoma's air quality is excellent, water resources are plentiful and well managed, and the mechanisms are in place to continue to protect Oklahoma's precious natural resources while encourage demographic and economic growth statewide.

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— Chapter 12 —
LIST OF ILLUSTRATIONS

Maps

12.1 —Locations of air sampling sites _____	204
12.2 — Major sources of ground water in Oklahoma _____	207
12.3 — Major geological provinces of Oklahoma _____	208

Tables

12.1 —Federal environmental legislation _____	202
12.2 — Atmospheric pollutants measured by the EPA, 1984 _____	203
12.3 — Principal wastes and environmental water pollutants _____	205
12.4 — Use of cooling water by U.S. industry _____	206
12.5 — Costs of alternative methods of hazardous waste disposal _____	209
12.6 — Nuclear power generation in different countries, 1984 _____	212

Oklahoma Resources

Chapter

13

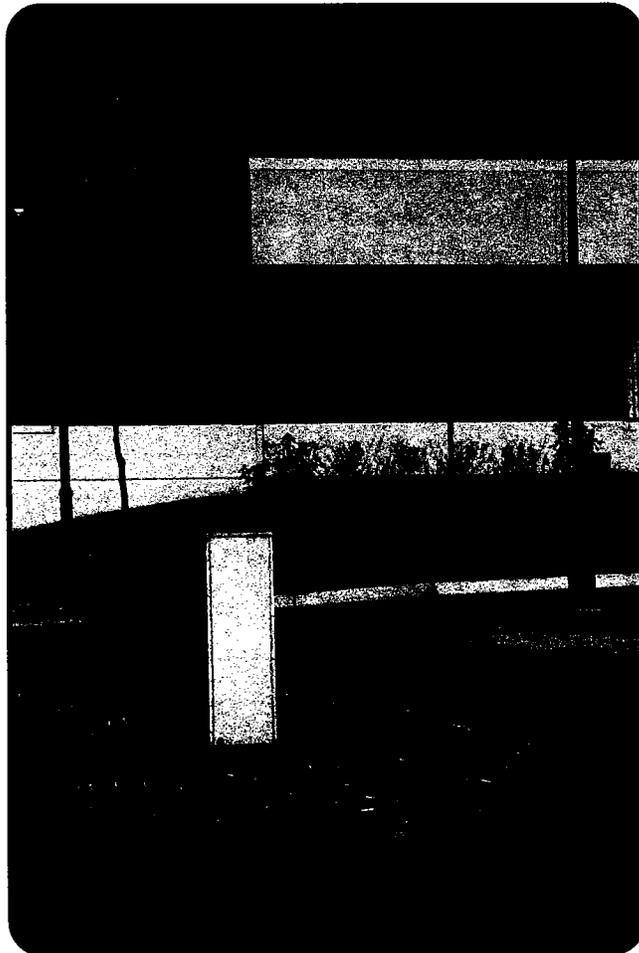
The Finance Industries
and Taxes

by

Herbert O. Giles

with assistance from

Binita Sinha



Contents

Executive Summary	217
Introduction	218
History	218
Regulation	218
Oklahoma's Finance Industry	219
Oklahoma's Commercial Banks	219
State and National Banks in Oklahoma	220
Branching, Bank Holding, and Multibank Holding Companies	220
Oklahoma's Need for Financial Products	221
Excess Credit	223
Agricultural Finance Industry	223
Thrift and Real Estate Financing	224
Savings and Loan Associations	224
Mortgage Banking Companies	225
Consumer Credit	225
Credit Unions	225
Industrial Financing	226
Doing Business in Oklahoma	226
Gross Production Taxes	226
Retail Sales and Use Tax	227
Property Taxes and Assessment Practices	227
Inventories	227
An Overview of Oklahoma Taxes	227
Tax Advantages	227
Business Taxes	227
Workers' Compensation	228
A Guide to Oklahoma Taxes	228
Individuals	228
Corporate and Business Taxes	228
Conclusion	228
References	229
List of Illustrations	230

The Finance Industries and Taxes

Herbert O. Giles
with assistance from Binita Sinha

Executive Summary.—The financial industry in Oklahoma has undergone rapid changes brought about by the needs of consumers and the changing abilities of the financial institutions and the economic infrastructure upon which they rest. Initially, Oklahoma's economy was based on agriculture and the distribution industries. As the oil and gas industry assumed a prominent role, financial institutions became more concentrated near the sources of need. The concentration of government institutions and employment also created needs for more financial institutions. These changes caused the distribution of financial institutions to become less even, and more concentrated in urban administrative centers, especially Oklahoma City and Tulsa, though other clusters have developed to serve specialized regional needs.

The biggest changes in the history of Oklahoma's financial institutions came about in the 1980s, when many of Oklahoma's largest banking institutions were left with nonperforming loans. Other historic changes included a deregulation act that put all depository institutions on more or less the same footing, changes in Oklahoma's ban on branching, and interstate ownership by multibank holding company operations. Laws now allow regional banking systems to be created with the proper reciprocal state laws.

Oklahoma's savings and loan associations (SLAs), now called thrift institutions, were particularly hard hit in the 1980s. The SLAs had large loan portfolios of low-interest long-term mortgages, and inflationary pressures in the 1970s put many SLAs in a position of having deposits exceed assets. The mortgage banking industry, concentrated in the Oklahoma City and Tulsa areas, has enjoyed financial soundness although it has also suffered because of the decline in the real estate market.

The consumer finance industry is well-developed in Oklahoma. Large amounts of personal credit continue to be provided by this sector. Credit unions are associated with professional organizations such as teachers, or special separate groups such as labor unions and large corporations. Nearly 100 Oklahoma communities have created public trusts that can issue revenue bonds for industrial development. Additionally, a majority of Oklahoma's counties and municipalities have voted approval of general obligation tax-supported bonds for industrial development.

Oklahoma has a stable fiscal plan requiring all agencies to operate on a balanced budget. Taxes are diversified and require a minimum of change from year to year. Oklahoma has demonstrated a readiness to change its tax laws when such change would result in better conditions for business and the general public.

Individual and corporate income tax provides the largest amount of revenue to the state. Sales tax is the second largest provider of revenue to the state. Municipalities and counties may also levy sales taxes with the approval of the voters. Ad valorem taxes are assessed on property uniformly throughout the state. About two-thirds of the property tax revenue supports local schools; the other revenue supports cities, counties, vo-tech schools and community colleges. The state does not receive any property tax revenue. The gross production tax on oil and gas provides about 20% of the state's revenue. There are an additional 50 taxes, but most provide relatively small amounts. Other significant taxes relate to vehicles, motor fuels, cigarettes and tobacco, alcoholic beverages, franchises, and estates.

INTRODUCTION

Needs for money and credit evolve with the needs of consumers, producing changes in financial institutions. Change has been a major characteristic of financial institutions in Oklahoma. Oklahoma is part of the economic-monetary system of the United States, which in turn is part of the world system. The principal role of Oklahoma's financial institutions has been to provide the financial services needed by the state's industries and consumers. The structure of finance and taxation has changed with the needs of Oklahoma to offer new monetary and financial products.

History

Early in the financial structuring of Oklahoma, the dominant industry was agriculture and the dominant governmental philosophy was rural independence. Conscious decisions were made to have a unit-banking system for the protection of the small farmer and small business. The taxation system was based principally on land ownership, and county government was the dominant governing entity. As growth and prosperity demanded more geographically dispersed transactions and interactions, larger organizations with concomitant operations of larger economies of scale appeared on the Oklahoma landscape.

The agricultural industries could usually find the needed services, supplies, equipment, and financing at the county level. As markets became larger, local marketing organizations had to become more sophisticated. The farmer's cooperative system became a sophisticated marketing system for Oklahoma's farming industry. With such a system the agricultural industry could remain manageable on a county or multicounty basis and still provide interstate and international distribution of goods and services; additionally, the farmer's cooperatives could provide credit for their members through the Farm Credit System.

The petroleum industry proved to be the other branch of Oklahoma's basic economy. This industry was geographically specific and consequently created cities and financial

service centers wherever an oil or gas field was found.

The opening of the unassigned lands strengthened the importance of Oklahoma City, making it the financial center of Oklahoma. Oklahoma City was a principal center of distribution long before statehood. It served the many Indian reservations within the central and western portions of the state. When the state capital was moved to Oklahoma City it would have seemed impossible for another city within the state to take lead as the financial capital.

The discovery of oil and natural gas in northeastern Oklahoma created opportunities for other cities to become great financial centers. Tulsa not only became a rival of Oklahoma City for the financial center of Oklahoma, it became the Oil Capital of the World. Tulsa held that title until the early 1960s. Other Oklahoma cities that became distinguished for oil and gas are Bartlesville, Ardmore, Ponca City, Seminole, Duncan, Enid, and Cushing.

Several cities have become specialized in several economic areas. Those cities which have become distinctive because of specialization in marketing and distributive industries are McAlester, Muskogee, Shawnee, Ada, Woodward, Lawton, Altus, and Guymon. Wherever economic diversity is found, financial strength is also found. Some notable examples are university locations, military installations, livestock markets, and grain markets. These specialized places have populations of consumers who demand a wide array of financial services, such as commercial banking, savings and loans, mortgage banking, consumer loans, pawn shops, credit unions, investment securities brokers, Department of Agriculture financial services, Farm Credit System services, and insurance companies. A glance at the many maps in this chapter gives the reader insight into areas of intense consumer demand. The heavy clustering of banks and other financial firms is a sure indicator of intense demand for financial products. Industrial and commercial demand for financial services is quite varied and is dependent on the growth strategies of the particular firm.

Commercial establishments throughout Oklahoma have many different needs for financial services include credit needs, noncredit financial services, venture capital, capital raising services, insurance, and investment services. Typically, the larger the organization, the more services are purchased from out-of-state organizations. Oklahoma's public corporations and firms conducting interstate and international business find it advantageous to maintain accounts with banks that have access to the firms' markets and money investment markets.

Regulation

The banking and finance industry may be the most important support system for the general public, government, and profit and nonprofit organizations alike. Given this great importance there is little wonder why there is so much regulation and oversight of the industry. Moreover, the complexity of the industry does not allow easy inspection or surveillance by the persons or organizations that deposit, loan, or invest funds in banks or other financial institutions. The general public, corporate executives, business owners, bankers, legislators, and financial regulators all play a part in developing the financial industry regulation systems. As a consequence, the financial industry is responsive to many different demands for financial products and services.

The most basic reason for regulation of depository institutions is protection of the depositors. With banks, savings and loan institutions, credit unions, and others that accept deposits, the customers assume the role of creditor and become linked with the fortunes of the institutions. This is vastly different from other retail businesses where customers simply pay for goods or services and never become the firm's creditor. Customers of banks and other depository institutions have had more difficulty protecting their interests than creditors and investors of other types of businesses.

The next section focuses on changes in the law, bank branching, multibank holding companies, interstate banking, agricultural credit sys-

tems, thrift institutions, mortgage banking, consumer credit, and industrial financing. The chapter ends with a look at Oklahoma's taxes.

OKLAHOMA'S FINANCE INDUSTRY

It is difficult to imagine how important a financial institution is to a place or region until financial devastation of momentous proportions slams the area. The demise of Penn Square National Bank occurred in 1982. In the next decade, 113 banks and more than 50% of the savings and loan associations (SLAs) were declared insolvent. Moreover, several credit unions were closed, and some insurance companies failed.

Fortunately, Oklahoma commercial bankers, savings and loan bankers, mortgage bankers, and other credit and noncredit financial service organizations have ended a decade of turbulence and are positioning their organizations to seize every opportunity to continue building Oklahoma. Many lending institutions have restructured the capital and assets parts of their balance sheet. In many cases, additional capital was invested to provide the proper cushion to assure deposit protection in the event of loan losses.

The financial turbulence of the 1980s was largely due to the rise and fall of the petroleum industry and the adjustment of Oklahoma's agricultural industry to changing world markets and government programs. Spurred by the energy shortages of the 1960s and the 1970s, the oil industry demanded prodigious amounts of capital to develop new sources of oil and gas. When the world market was flooded with excess oil supplies, many petroleum exploration and development organizations found there was no demand for their operations and were forced to pull out of the market, leaving many financial institutions with nonperforming loans.

Oklahoma's agricultural industries were caught in a complex situation created by uncertain world markets controlled by state departments, treaties, international politics, and confusing short-term agricultural support programs. Moreover, the agricultural

industry had to contend with the ever-present risks of weather and pests. A result of Oklahoma's agricultural industry's adjustments to the market changes was nonperforming loans for the financial institutions involved with the agricultural industry.

Another part of the turbulence was caused by the increased competition between banks, savings and loan associations, credit unions, and other financial institutions. Prior to the 1980s, the distinction between these institutions was clear. Banks, for the most part, provided checking accounts and short-term loans; thrifts provided savings accounts and long-term mortgage loans; and credit unions provided consumer loans. The Monetary Control Act of 1980 empowered all depository institutions to compete on more or less the same footing.

All depository institutions were placed under the same restrictions with respect to keeping reserves with the Federal Reserve Bank. The savings and loan associations were allowed to provide checking accounts, make larger mortgage loans, and make commercial and personal loans (certain limitations were placed on such loans).

Another important factor in the turbulence within the banking and financial service industry is electronic technology. The increased use of electronic fund transfer has greatly increased the efficiency of financial firms, but the infrastructure for the rapid dispersal of funds and information is expensive to purchase and maintain, and requires highly competent personnel. Smaller firms are at a disadvantage with respect to both technological hardware and highly trained personnel.

OKLAHOMA'S COMMERCIAL BANKS

Oklahoma's banks continually shift banking structure philosophies to respond to consumer needs. The shifts can be painful for some banking firms, but the results are better banking products for Oklahoma's consumers and industries. The structural shifts and changes in Oklahoma's commercial banks are the result of many parties all wanting to provide good banking services to their customers.

Over the years, Oklahoma banking rules disallowed bank holding companies, multibank holding companies, branch banking, and interstate ownership and management of in-state banks. The rapid evolution of bank organizational structure and product strategies in Oklahoma is typical of several other states that had economies dominated by agriculture. Such structure was reflected as the "law of the land," both literally and figuratively, because of the adoption of the McFadden Act more than 50 years ago. This act reinforced the powers of the states to limit branch banking. The Douglas Amendment of 1956 left the states in control of their banking industry. It also, however, enabled national banks to enlarge their operations by allowing bank holding companies to operate on an interstate basis, when the states in which the banks were located permitted such practices.

In the 1980s state laws changed to allow full-service banking across state lines and interstate banking. Of particular interest to Oklahoma banking has been the creation of laws allowing interstate banking. The first such law, passed in 1986, allowed troubled institutions to be purchased by a banking holding company headquartered in another state. June 1987 saw the Oklahoma Banking Bill signed into law, which allowed in-state banks to conduct interstate banking within states that have a reciprocal law. The concept of reciprocity of banking laws has received a great deal of attention and discussion. A favorite point of discussion is the creation of regional banking systems, which would arise from contiguous states enacting reciprocal interstate banking laws. A system that would connect the oil economy states was proposed at a 1984 meeting of the Oklahoma Bankers Association. Regional banking agreements could enhance the lending capacity of a region; however, there is also a fear that local deposits may not be loaned locally and thus some areas may slip into a depressed economy.

Two of the main players in changing the state banking scene are national organizations—the Federal Reserve Bank and the Department of the Treasury (and its Comptroller of the

Currency). These organizations, along with federal agencies and legislative committees, are bringing the whole financial industry to a position that allows economic growth without harmful side effects such as inflation or business failures. At the state level, the State Banking Department is responsible for enforcing the laws that affect banking. The same department is responsible for the rules governing all depository institutions and trust companies.

State and National Banks in Oklahoma

Typically, banks are ranked by asset size, but the size of deposit amounts show how local depositors are supporting their depository institutions and give a picture of the wealth of the area and the depositors' sense of security about the banks. Most rural counties have deposits ranging from less than \$10 million to less than \$40 million. Medium and large depository institutions tend to be located in the areas of oil production, urban centers along the interstate highways, and the two large metropolitan areas, Oklahoma and Tulsa. These banks are involved with all types of consumer and commercial lending, trust services, noncredit services, correspondent banking, and diversified financial services. The number and location of financial institutions relate directly to the size and location of commercial and industrial activity and its supporting population (Map 13.1).

Branching, Bank Holding, and Multibank Holding Companies

The banking laws of Oklahoma rank as some of the strictest in the nation, and those concerning branching are particularly restrictive. Under the Bank Holding Company Act of 1956, the Comptroller of the Currency, with the consent of the Federal Reserve Bank, could allow national banks to buy and operate other banks. The multibank holding company structure allowed those banks within unit-banking states to gain ownership of other banks and thus broaden their market area and stand ready to receive more deposits. Banking leadership was divided on the support of the law. In those states that allowed branching, the aggressive banks usually supported enactment of a single-bank holding company; in unit bank states, expansion-minded banks supported the multibank organization form. A great many states took steps to impede the effects of the legislation.

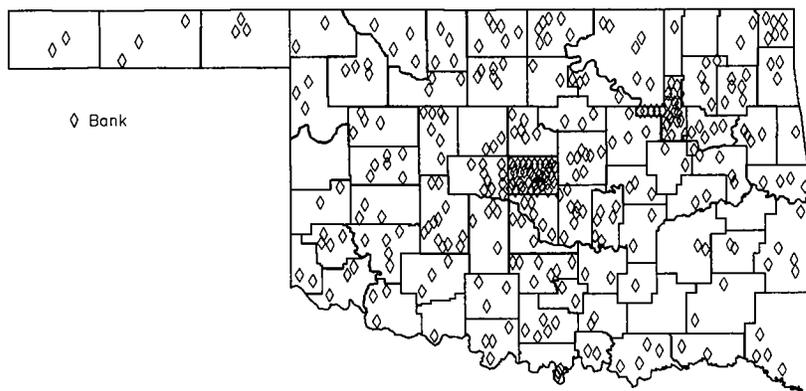
In 1957, the Oklahoma Legislature stopped the First National Bank of Oklahoma City from buying a smaller bank in Idabel. Oklahoma at that time enacted a law that prohibited multibank holding company activities. The law, however, did allow a single bank holding company that could own one bank and operate other affiliated businesses. Such other businesses could be credit life insurance, real estate management, and certain other non-banking businesses. During the 1960s and 1970s several Oklahoma bank holding companies were organized.

Branching is a principal variable in the strategic growth of banking firms. While many Oklahoma banks pressed for branching to be allowed, the legislature held fast to the unit-banking laws. Some liberalization did take place in the 1960s with the passage of 1965 legislation allowing drive-in banking at a detached site, and in 1967 with passage of the Consumer Banking Electronic Facility Act which allowed Automatic Teller Machines (ATMs).

Full-service branching was allowed in the mid-1980s. In 1983 the legislature approved branching on a limited basis. The law allowed a bank to have a main bank and two branches, with one or both branches within the same city, or within 25 miles of the main bank, provided that the branches were not in a city or town that had a bank. An equally important law was enacted that year: the authorization of multibank holding companies. This law provided for Oklahoma single-bank holding companies or multibank holding companies only to operate within Oklahoma; the law specifically prohibited out-of-state bank holding companies to have control of in-state banks. Oklahoma's multibank holding companies were empowered to buy those banks that were designed as failed or failing. By these mergers and acquisitions the financial viability of Oklahoma's banking, industrial, and agricultural industries was preserved.

By the end of 1985, 22 Oklahoma banks were closed. Regulators were predicting that many more banks would be declared insolvent and would be closed. By July 4, 1987, another 30 banks were closed, bringing the total since July 5, 1982, to 52 bank closings. Wayne Osborne, the deputy state banking commissioner, stated he thought there would have been fewer bank closings had branch banking been in place sooner.

A common question arising in the minds of many banking customers centered on the ability and the integrity of the management of the failed institutions. According to John Shelly, president of Equity Bank for Savings F.A., Oklahoma City, the quality and integrity question is a legacy to this day for the bankers managing Oklahoma's assets.



Map 13.1 — Distribution of banks in Oklahoma with deposits \$50 million and above. Source: Sheshunoff and Co. (1992b).

Interstate banking received attention by the legislature in 1985, 1986, and 1987. In 1985 Oklahoma clarified how an out-of-state bank holding company could acquire an in-state bank. The law that changed the course of banking in Oklahoma, however, came the next year.

The most important portion of the 1986 bank law amendment allowed failed or failing banks to be purchased by out-of-state multibank holding companies. This new law placed some limitations on the out-of-state multibank holding companies: in-state banks would be given preferential treatment in the bid procedure for the purchase of a troubled bank, and the out-of-state multibank holding company could not create a branch for one year.

The branching laws were changed substantially in 1986. One amendment changed the distance limitation to 50 miles for the establishment of de novo branches. Another change enacted in 1986 allowed branching under special conditions. When a banking regulatory organization declared a bank insolvent or its deposits unsafe, those regulatory organizations were allowed to invite healthy banks to buy the good assets of the troubled banks, including all its branches. When this occurred, the acquired bank became a branch of the acquiring bank and a new system of across-county-line banking was sometimes created. With this change there were few limitations on the number of branches or their locations when such branches became part of a banking organization because of certain extraordinary conditions. Usually, the acquiring banks made the formerly insolvent banks a better place to do business because of advanced electronic technologies. Whereas convenient location is important to consumer lending, banking services to midsized and large businesses is not greatly influenced by convenient locations. According to Kenneth Brown, Executive Vice President of Liberty National Bank and Trust Company, N.A., Oklahoma City, electronic transfer of information and funds have made every place conveniently located.

July 1, 1987, found the banking laws amended once again, this time allowing the outright purchase of an-

other bank by an in-state or an out-of-state bank holding company. This change eliminated the bid preference for in-state banks. This legislation once again changed the branching law: now banks can have branches in any counties but the branch in another county cannot be a de novo bank for that county.

The 1987 law also introduced the concept of reciprocal state laws for allowing interstate bank ownership. Oklahoma bank holding companies are now allowed to carry on full service banking business in another state if that state specifically has laws allowing the Oklahoma bank to operate in that state and Oklahoma has the requisite law for that state. The Federal Reserve Bank determines when the states have proper reciprocal laws.

The results of the new laws appear to be positive as the rate of bank closure has dropped sharply since 1988 (Table 13.1). Map 13.2 illustrates the extent of multibank holding companies formed in Oklahoma. In most cases where there are across-county-line branching systems, there have been bank mergers or takeovers caused by troubled banking operations. The most intense activity has been in the central and eastern portions of the state. As expected, the most banking, branching, and multibanking activities take place in the most populous counties.

Oklahoma's Need for Financial Products

The banking system in Oklahoma has always played an important role in both household-personal banking and commercial-industrial banking. Long before the Monetary Control Act of 1980 changed the scope of services that could be provided by depository institutions, the ways households and businesses conducted their "banking" had already changed.

For household credit needs, a large number of organizations provided the needed facilities. Paramount in the consumer finance field were Household Finance and Transamerica Financial Corporation. Retail stores also provided huge amounts of credit, with popular stores such as Sears and J. C. Penney at the forefront of the big players. Mortgage companies pro-

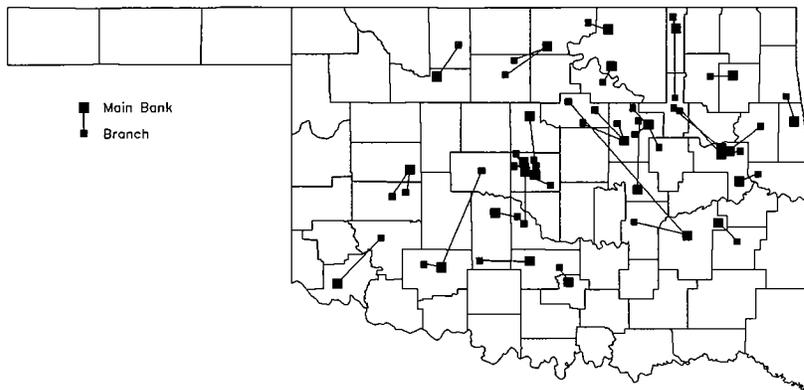
Table 13.1 Bank Closures in Oklahoma Since 1988

Year	Number of Banks Closed
1988	23
1989	12
1990	2
1991	1

Sources: Center for Economic Management and Research, *Statistical Abstract of Oklahoma, 1991*; Sheshunoff and Co. (1992a).

vided credit facilities for purchase of homes and other real estate. Farmers' cooperatives and the U.S. Department of Agriculture provided a full slate of credit products for rural families and agriculture business and industry. Pawn shops have been an important source of credit for a substantial segment of the Oklahoma market. Insurance company policy loans and insurance company real estate loans make a multi-million dollar market in Oklahoma. As large as the consumer credit and mortgage credit industry is, there are relatively few giant players but a myriad of smaller credit providers. Banking with depository institutions is necessary because by law only these institutions can provide checking account services. It is through the system of checking account payments that almost all the money transactions take place.

On the consumer finance side, most credit transactions are small and relatively simple. On the commercial-industrial side, the transactions are usually relatively large, complex, and involve costly risks on the part of the creditors. The play between lender and borrower, including the reduction of risk on the lender's part and the reduction of loan costs by the borrowers, has created a fast moving, ever changing and exciting industry. Oklahoma banks and the state's commercial firms once understood their interdependency. As the firms became larger and needed better cash management services, better capital raising services, and better credit facilities, the Oklahoma banks were pressed to compete with out-of-state banking firms. The home-grown relationships of bankers and commercial firms had to be revised because of economic growth and the economies



Map 13.2 — Distribution of multibank holding companies. Source: Center for Economic Management and Research (1991).

of scale provided by a system of nationwide correspondent banking ties. The relationship bankers want is to position the bank in the company's inner circle, resulting in more transactions and the achievement of an acceptable return on investment. The commercial firms, however, see their banking relationship differently—it hinges on the firm's need for credit. A principal difference between the consumer credit side of banking and the commercial-industrial side is that in business, the name of the game is money, and when the firm is out of money it is out of the game. The commercial-industrial banking customer is looking for ways to keep and make more of their money resources. The bank, therefore, must go to extraordinary lengths to keep pace with the world marketplace and provide the banking products that will keep their customers in business.

The markets that kept Oklahoma out of the clutches of economic upheaval that gripped the "rust belt" and "frost belt" collapsed in the early 1980s and the Oklahoma economy went down. The solution to the problem was simple—more money and better management. With the hundreds of petroleum companies and other industrial firms demanding greater amounts of credit, local banks of all sizes found it necessary to spread the loans among several banks. The sheer volume of loans, as well as loan size, forced many banking firms to install expensive loan tracking hardware and software. Moreover, prudent banking manage-

ment saw the need to invest in more specialized personnel capable of evaluating complex markets, properties, high-tech industries, and service firms.

The larger a commercial-industrial firm, the more banks it has. Firms in the \$5–\$19 million sales category use about two banks; firms in the \$20–\$50 million category use about three banks. Going from \$50 million to \$5 billion of sales revenue, the number of banks used rise steadily and top out at about 20 banks. Those firms which need credit use more banks than nonborrowers; firms in the financial industry use more banks than utilities. The distribution industry average is about 11 banks, and the personal business service industry average is about 14 banks. The extent to which a firm is involved in interstate and international business causes the number of banks used to change. In Oklahoma, those firms requiring frequent access to capital markets, international markets, and interstate markets will likely choose to have their principal banks located where they have the best market advantage. Most, if not all, of Oklahoma's large petroleum, manufacturing, agricultural, and distribution firms have main banks with money center banks or regional banks.

Bankers must stand ready to deliver a wide offering of bank products and services. Banks must serve the consumer with small, short-term credit facilities to help with household management. Banks must also provide checking and savings accounts and savings investment products. A

bank's product line for commercial establishments has to be much larger. Here is a list of products available from those banks found in a listing of the top 500 banks in America: confirmed lines of credit, unconfirmed lines of credit, international credit, short-term Eurodollars or Eurocurrency loans, securitized loans, domestic credit facilities, guarantee or standby letter of credit, merger and acquisition loans, project financing, loans for recapitalization, receivables purchase agreements, international multi-currency loans, revolving underwriting facilities, and note issuance facilities.

Additionally, banks can furnish a wide variety of cash management products and services: automated retail lockbox, automated wholesale lockbox, automated concentration service—depository transfer check, automated concentration service—Automated Clearing House, automated short-term money market investments, retail lockbox, wholesale lockbox, corporate cash letter, zero-balance collection account, depository transfer checks, coupon and security collection, domestic wire transfer, international wire transfer, full account or partial account reconciliation, computerized cash balance and transaction reporting (daily), payroll preparation, remote disbursement account, controlled disbursement account, zero balance account, Automated Clearing House disbursement, direct deposit of employee payroll, and payable through drafts. New cash management products for solving cash problems or achieving high earnings with a firm's cash are being created continuously.

Still other banking services offered to commercial and industrial firms fall in the area of investment banking. Under the Glass-Steagal Act, commercial banks do not have the opportunity to venture into this field. Also offered are: public offering of common stock, Eurobond issues, public offering of bonds, pollution control bonds, industrial revenue financing, floating-rate notes, issuing dealer for a firm's commercial paper, private placement of long-term or short-term debt, Euro-note issues, Eurocommercial paper, currency swaps, repurchase of common stocks, divestiture, valuation studies, corporate restructure advise, ex-

pert testimony, and mortgage-backed securities. The list of products also includes: trade services, foreign exchange, working capital loans, loan caps, forward rate deals, and corporate trusts, including master trusts for pension funds, and other company assets. After studying the product list, it must be obvious that such a line of products can only be offered by banks of substantial size, and that only commercial firms of substantial size will need many of the products.

Excess Credit

The creation of credit is a complex system regulated principally by the Federal Reserve Bank System. Basically, the banks receive deposits and promise the depositor safekeeping of the funds. The bank then loans those funds to creditworthy persons or businesses.

The Federal Reserve Bank requires that a small but specific percentage of the deposits be held at the Federal Reserve Bank. The percentage varies from 12% of demand deposits to 3% of time deposits. The rules become more complex as other regulatory agencies lay on other restrictions. One such restriction is that before the gross loanable deposits are calculated, all government funds on deposits must be subtracted out. In addition, the Federal Deposit Insurance Corporation may require management to set aside additional capital in the form of loan loss reserves. These requirements make it difficult for anyone outside the bank to know with certainty the amount of loanable funds a particular bank has at a particular time. An old "rule-of-thumb" that still is used is as follows: total deposits, less public funds, multiplied by 75%, equals the deposits available to be loaned. When these funds are not loaned but are invested in other ways the loanable deposits are termed "excess credit." Map 13.3 illustrates the distribution of excess credit in Oklahoma banks.

In the calculations for this presentation, only the top 250 Oklahoma banks were included. The formula used was: excess credit equals 75% (deposits less public funds), less the present loan amount.

The capability to produce large credit facilities is one of the strongest

arguments for the creation of more branching, multibank affiliation, and interstate banking. The complexities of a diversified economy demands greater varieties of financial products and service. Those banks that offer large credit facilities, sophisticated cash management, and specialized financial services can do the best job of helping their customers grow.

AGRICULTURAL FINANCE INDUSTRY

There are three main institutional suppliers of capital for the agricultural industry. The local commercial bank has historically been the main contact for the farmer. This credit source has been supplemented and in many cases replaced by either the U.S. Department of Agriculture (USDA) or by the Farm Credit System, or both.

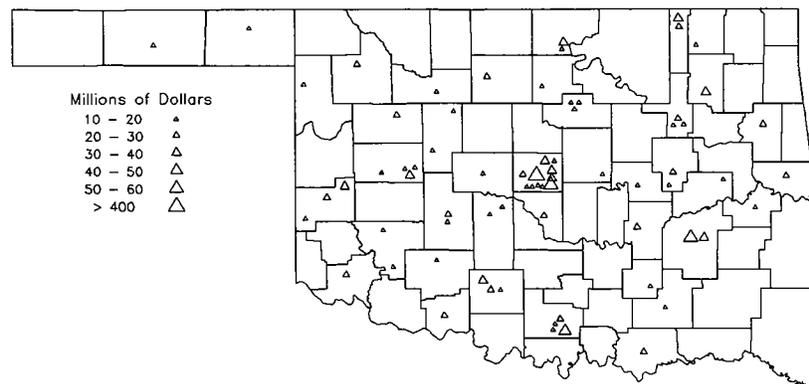
The agricultural need for credit is vividly geographic. Western Oklahoma is clearly dominated by agriculture and the downturn in product exports has hurt the economies of many of the western counties heavily reliant upon trade. Most of these counties had farm operators who took advantage of the liberal loans offered by the money-swollen Farm Credit System. The law allowed the system banks to make loans equal to 85% of the appraised value of the farm land offered as collateral (rather than the old rule of 65%). With the downturn in farm commodity prices and declining exports, the production farm land became less valuable, leading to the Land Banks' reappraisal of the value of the collateral. As the Farm Credit

System called for hefty payments to align the loan with the new appraised value, many farmers found that their operation was land rich but cash poor (see Map 13.4 for a representation of agricultural loans outstanding in 1991).

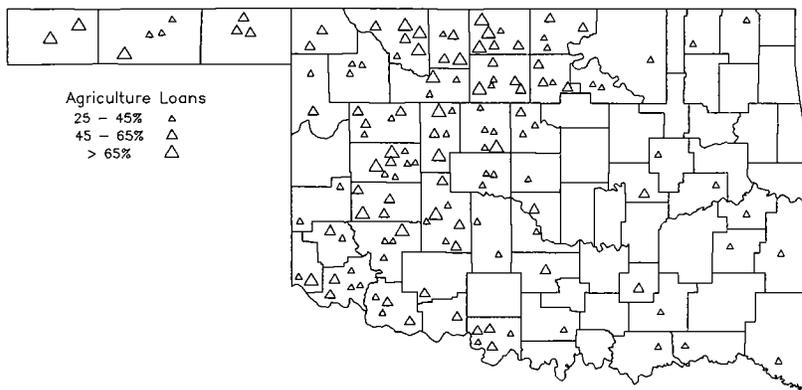
The USDA has dozens of loan programs based on the value of the crop in production with repayment due upon the harvesting and marketing of the crop. The USDA has other longer-term loans at attractive interest rates, and a program to buy certain excess commodity production. Today, the farmer has little choice but to be a part of the Farm Credit System, or one or more of the USDA programs.

The local commercial bankers have many opportunities to do big business with the farm industry, and Oklahoma has a good many agricultural banks, mostly in the western portion of the state. Unfortunately, the largest number of bank failures have come from agricultural banks (by Federal Reserve definition, banks with 25% or more of their assets in agricultural loans).

The Farm Credit System has alerted Congress that the economic shifts to low inflation and low interest rates have resulted in numerous farm loans being called and a large number of loan foreclosures, which threatens to put the Farm Credit System itself in default on its bond payments. Although the Farm Credit System does not have "agency status" and therefore its bonds are not backed with the full faith and credit of the Federal Government, Wall Street has treated



Map 13.3 — Distribution of excess credit in Oklahoma banks. Source: Computed from Sheshunoff and Co (1992a,b).



Map 13.4 — Distribution of agricultural loans outstanding in 1991. Source: Computed from Sheshunoff and Co. (1992b).

the System's bonds as though they were agency bonds. A consequence of all this is the Farm Credit System is in need of a "bail out." The interesting question is how it will be changed in order for the System to continue to do its job. It appears that Congress knows something has to be done but at this time there is little agreement on what should be done.

One intriguing concept is the creation of a "Farmer Mac" or an "Aggie Mae" which would provide a secondary market structure for agriculture loans similar to the secondary markets created by Fannie Mae and its spin-offs, Freddie Mac and Ginnie Mae. Private lenders want a secondary market for farm real estate loans because it would enable them to diversify their risk by pooling loans of varying geographic location and commodity type. The House has proposed a government corporation called the Farm Credit System Temporary Assistance Corporation to carry out a program of financial and technical assistance to system institutions in financial difficulties and to ensure that borrower's stock in such institutions can be retired at face value. The proposal would also require a program of loan restructuring.

The restructuring proposal would require all federal land banks, production credit associations, and the Temporary Assistance Corporation to restructure nonaccrual and high-risk loans if it would cost less than foreclosing on the loan and liquidating collateral. The restructuring would include rescheduling, reamortization,

renewal, deferral of principal or interest, monetary concessions, or any other action that would make it likely that the farm operation of the borrower could become financially viable. This restructuring requirement would be extended to the Farm Credit System of the Farmer's Home Administration.

THRIFT AND REAL ESTATE FINANCING

Savings and Loan Associations

Oklahoma's savings and loan industry has followed its counterparts in the rest of the nation. With the creation of the Federal Home Loan Bank Act of 1932, Oklahoma's savings and loans associations (SLAs) prospered under management of the Federal Home Loan Bank Board (FHLBB), the principal arm through which Congress provided home ownership for American families. Congress allowed the FHLBB to receive preferential interest rates paid to depositors and interest rates charged through mortgage facilities.

In the mid-1960s, the SLAs saw interest rates starting to rise; short-term rates rose more rapidly than long-term rates. Most of the SLAs' assets were in long-term fixed rate mortgages. Moreover, the mortgages were at rates at the mid-single digit level. As the 1960s and the 1970s saw interest rates zoom to double digits, SLAs found themselves in a position of paying rapidly rising passbook rates just to retain the money they had. Commercial banks began issuing certificates of deposit and were competing aggressively for consumer deposits.

Also, government agencies issued securities that were more attractive to SLA depositors than they had previously been, and depositors were becoming more interest-rate conscious.

The Interest Rate Adjustment Act of 1966 restricted passbook accounts to a ceiling of 4.75% and 5.25% for certificates of deposits. The ceiling proved effective except when there were interest rate pressures on the economy, at which times the ceiling created the problem of disintermediation (the withdrawal of money on deposit at financial institutions). The system responded by offering Money Market Certificates (MMCs) at a minimum of \$10,000 denominations at 25 basis points above the most recent six-month treasury bill auction rate. Other investment products were created for the system, but the pressure of inflation on the fixed-rate mortgage product could not be abated.

Although Congress kept trying to provide the needed laws, the U.S. Court of Appeals finally put pressure on Congress to resolve the problems. The result was the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980. A key feature of the Act was a six-year phase-out of deposit rate ceilings. Another feature in the law that affected SLAs included the authority to: offer Negotiable Order of Withdrawal (NOW) accounts; engage in credit card activities; invest up to 20% of assets in consumer loans, commercial, and corporate debt securities; offer trust services; issue mutual capital certificates; and make first and second mortgage loans without regard to size or geographic restrictions.

The Oklahoma SLAs suffered in the 1980s because of the deflation pressures felt throughout the state. Many of the drastic disturbances noted in the commercial banking industry had a ripple effect on the SLAs. A large outflow migration caused by the depressed oil and gas industry left the SLAs with inflated portfolios, nonperforming loans, and disintermediation.

The Federal Savings and Loan Insurance Corporation (FSLIC) exercised a regulatory authority similar to the FDIC. As a regulatory body, it had the responsibility to assure the safe-

keeping of the depositor's funds. It could direct the management of SLAs to provide a cushion of safety for their depositors. In the early 1980s many SLAs in Oklahoma and other energy states were technically insolvent.

On August 10, 1987, President Reagan signed the Competitive Equality Banking Act of 1987. This Act created new borrowing authority for the FSLIC to use the money to reimburse depositors as bankrupt thrifts closed down. The Act was especially important to Oklahoma because it specifically took into account tolerance of an institution's low net worth if that institution was located in a depressed economy where the land market values became substantially lower than they had been a few years before, but whose underlying collateral was income-producing and whose debt-servicing schedule could be maintained. Additionally, the Act allowed weakened thrifts to continue to operate if their conditions stemmed primarily from the depressed economy in their region and if they maintained a net worth of at least 0.05% (the previous law required a 3% net worth).

Generally, Oklahoma thrifts suffered from large volumes of nonearning assets—mostly in the form of repossessed real estate collateral—that had undermined SLA economics and produced large operating and net losses. The proposed solution offered by the FHLBB was to use forbearance with those institutions that had business plans that mapped a clear road to stability and profitability. Additionally, the FHLBB was to act as the merger or acquisition agent for healthy expansion-minded in-state or multi-state financial institutions. Another alternative that the FHLBB was to consider was closing the SLA, the most costly solution because of the burden placed on the FSLIC as well as the economic well-being of the community.

Other plans to strengthen the SLAs included actions to recapitalize through private capital infusion or by changing the mutual association to a stock company.

Under the SLAs' structure in the early 1980s, it appeared that those institutions with the largest and strongest network of branches would have

the greatest chance of servicing the home buyer market and thus accomplish the mission of savings and loan associations. Even though the near-term forecast clearly was for the SLAs to remain the primary provider of home mortgage loans, DIDCA had opened the door for aggressive management to enter other financial product fields. As financial products needed change and as management, Congress, state legislatures, and regulatory bodies responded to the consumer's need for new products, the SLAs were to enter a new, more prosperous era.

Oklahoma's branching of SLAs had provided much-needed depository services and mortgage loan products to every part of the state. Most of the SLAs tended to be concentrated in specific geographic regions which allowed a degree of specialization and ease of supervision that helped eliminate problems the industry had experienced.

Multiple branch strategies was one way for Oklahoma SLAs to gear up to take a larger share of the consumer credit market. Locating near consumers not only allowed the SLAs to become part of communities (promoting economic growth as well as social well-being), it provided the SLAs more convenient access to depositors and borrowers. The savings and loan industry became a very consumer-oriented institution.

In 1989 the Financial Reform Recovery and Enforcement Act (FIRREA) was passed, which abolished the FSLIC and replaced it with the Savings Association Insurance Fund (SAIF) under the control of the FDIC. The FDIC was granted additional authority to manage the Bank Insurance Fund (BIF), which is the insurance entity for funds deposited at banks. Additionally, FIRREA created the Office of Thrift Supervision (OTS), which was empowered to establish the regulations that govern the operation of thrift institutions, formerly called Savings and Loan Associations (SLA).

Mortgage Banking Companies

The mortgage banking system in Oklahoma is like the mortgage banking business in most other states: the bankers simply arrange for money to

be available for the purchase of residential real estate. The money sources are varied but usually are tied closely to large financial institutions, including banks and insurance companies.

The mortgage banking firms in Oklahoma are highly concentrated in the two principal metropolitan areas (Map 13.5). About one-fourth of the mortgage banks in Oklahoma are out-of-state branch operations. Usually the branch operations are owned by firms principally involved with banking, insurance, or some other aspect of finance. These branches are used by the institutions to place loanable funds in well-secured facilities. The branch or its home office usually retains a fee for servicing the loan.

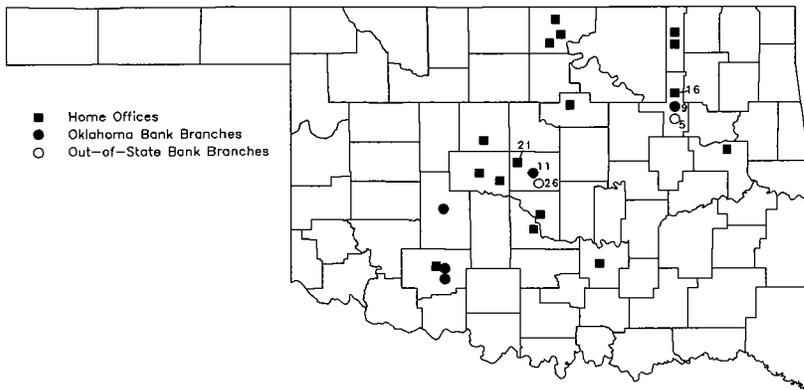
CONSUMER CREDIT

Consumer credit is regulated by the State of Oklahoma Department of Consumer Credit. Every enterprise offering credit for any reason comes under the regulatory powers of this department. There are literally thousands of consumer credit suppliers ranging from the local dentist who allows patients to pay the dental fee in installments, to the giant credit suppliers such as Sears, Transamerica Corporation, and MasterCard. All suppliers of consumer credit must submit an annual report of their consumer credit activities to the Department of Consumer Credit. Typically, however, only the larger suppliers submit the report.

Credit Unions

Credit unions in Oklahoma can be chartered under the federal or state rules. Most Oklahoma credit unions are members of the National Association of Credit Unions and have deposits insured by that association's deposit insurance system.

Credit unions are cooperatives whereby the savings of members are loaned to other members as consumer loans; liabilities are similar to those of mutual savings organizations. The capital requirements are relatively small in comparison to banks or savings and loan associations. The principal requirements for the creation of a credit union includes a lengthy application designating the market segment to be served by the union and a



Map 13.5 — Distribution of mortgage banking firms in Oklahoma. Source: Center for Economic Management and Research (1991).

list of at least 500 depositors. The names and backgrounds of the organizers must be approved by the State Board of Credit Unions.

Credit unions are now allowed to provide "share drafts" which operate like demand deposit checking accounts and are cleared through the same systems as used by banks and SLAs. Credit unions are also able to provide variable rate mortgages and safety deposit boxes. These services place the credit unions in direct competition with thrift institutions and commercial banks.

Credit unions are connected with preexisting organizations. Tinker Credit Union is the largest credit union in Oklahoma; others are connected with several different oil companies, large manufacturing companies, and professional organizations. Most credit unions in Oklahoma are found in the two metropolitan counties (Map 13.6).

INDUSTRIAL FINANCING

In addition to private financing for commercial projects there are a number of government-supported financing systems. Some of the most popular are: industrial revenue bonds; limited tax, general-obligation industrial bonds; Oklahoma Industrial Finance Authority facilities; local industrial foundations; and federal agencies, including the Small Business Administration, the Bureau of Indian Affairs, the Department of Housing and Urban Development, and the Farmers Home Administration.

Nearly 100 communities in Oklahoma have established public trusts

that can issue bonds for commercial industrial purposes. The beneficiary of the obligation must be a county, city, or the state. Additionally, nearly all Oklahoma communities have voted to approve general-obligation tax-supported bonds for industrial development. The Oklahoma Industrial Finance Authority may loan as much as 25% of the cost of land and buildings to be secured by a first or second mortgage. These loans are made through local industrial trusts.

The local industrial foundations are usually groups of private citizens operating with privately subscribed funds for the purpose of offering assistance to industrial projects. There is a resurgence of interest in private venture capital groups; Tulsa has two full-time venture capital companies and Oklahoma City has one.

Doing Business in Oklahoma

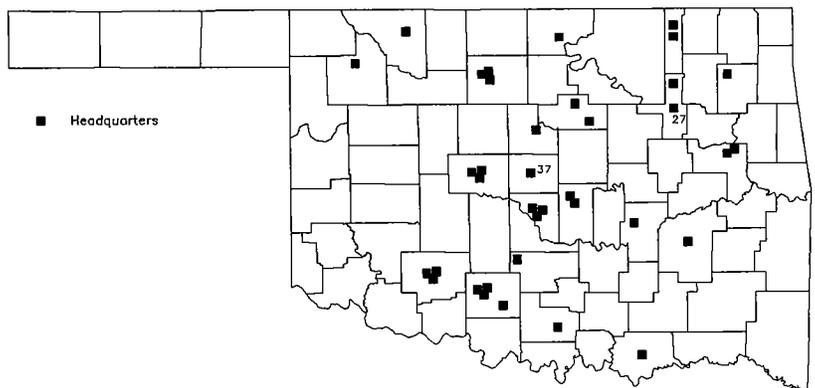
The challenge and opportunities for Oklahoma today and for the re-

mainder of this century are to create a diversified economy not dependent on industries that rely solely on products traded on the commodities exchanges. This interesting challenge comes as an opportunity to all resident persons and corporations and those searching for a good place to grow a corporation. Because of Oklahoma's favorable government attitude, both state and local, there are no present tax laws that cannot be negotiated for change when the change will mean a better place to live and grow a business.

There are several industrial exemptions on motor fuels, including: all aviation fuel, except 8¢ per gallon; fuels used in aircraft engines operated on test stands or for training, testing, or research; specially prepared commercial and industrial solvents, cleaners, and raw petroleum materials or petrochemical intermediates when used or sold for use in the production and manufacture of plastics and many other materials or chemicals; and gasoline used in agriculture, except 6.92¢ per gallon. Additionally, non-highway uses of diesel, LPG, and other special fuels are exempted from motor fuel taxes.

Gross Production Taxes

The gross value of oil, casinghead gas, natural gas, and other minerals form the base of the gross production tax. This tax is assessed in lieu of ad valorem taxes. The rates are 7% on the gross value of oil, casinghead gas, natural gas, and other minerals, and 0.75% on asphalt and mineral ores. Additionally, a "petroleum excise tax"



Map 13.6 — Distribution of credit unions in Oklahoma. Source: Center for Economic Management and Research (1991).

of 0.085% is levied on the gross value of natural gas, casinghead gas, and oil production to pay for administration of state conservation laws. A "conservation excise tax" is also levied on natural gas and casinghead gas at the rate of 7% per 1,000 cubic feet, less 7% of the gross value. The conservation excise tax is not to exceed one-third of the gross value of the commodities.

The gross production tax and other petroleum-related taxes furnish about 20% of Oklahoma's \$3.034 billion budget. Few states are fortunate enough to have such a tax. Most states must depend heavily on other lines of business and industry to carry such a corresponding tax portion.

Retail Sales and Use Tax

The state levies a 4.5% tax on retail sales and the same rate on items purchased out-of-state but used in state (use tax). The use tax is calculated on the price of the item purchased (there are numerous manufacturing exemptions from this tax).

Municipalities may levy an additional tax when approved by a vote of the people; counties also may levy a sales tax. The sales tax is based on the gross proceeds or gross receipts of sales of tangible personal property and enumerated services to consumers or users. In 1997, sales tax levies varied from 6.0% to 8.5% in most towns and cities of the state.

Property Taxes and Assessment Practices

About two-thirds of the property taxes are used for the support of local schools, with lesser portions going to county governments, cities, vocational and technical schools, junior colleges, health departments, libraries, and emergency medical services. There is no ad valorem tax for state purposes.

Oklahoma imposes a uniform assessment practice. The procedures involve an estimation of the fair market value, application of a uniform assessment percentage, and the application of the total mill levy applicable to county, school district, and city to determine the tax amount. The percentage of assessment which a county assessor may select and apply to all real property in the county must be at least 9% and not more than 15%. All

real property is to be revalued at least once every five years. Certain mill levies are mandatory according to the State Constitution, while optional levies are voted by the people of the county, city, or school district. In 1984 the state mill rate averaged 81.10 mills.

Inventories

In 1968 the State Constitution was amended with the adoption of the Freeport Amendment. The amendment established exemptions for business and industry from tax assessments on wares and merchandise that come into Oklahoma from outside the state and leave the state within nine months. Additionally, all consigned goods coming into the state and then forwarded out-of-state are considered part of interstate commerce and are not subjected to Oklahoma's property taxes.

AN OVERVIEW OF OKLAHOMA TAXES

Each year the legislature awaits the revenue estimate from the Board of Equalization before finalizing Oklahoma's \$3+ billion budget. The legislature has shown restraint and great concern over Oklahoma taxes. The prevailing stance of the state leadership is a willingness to consider reforming or adjusting any tax rate or base. Tax changes and their implementation come to full-time venture capital companies slowly, to the credit of the elected officials. The businesses and individuals doing business or residing in this state can have confidence that few changes will come about that will cause them to readjust their long-run strategies for developing a thriving life here.

Tax Advantages

Since the early 1940s, the State of Oklahoma has operated within a balanced budget. This constitutional constraint assures stability of state finances and controls indebtedness. Most tax revenues are produced from personal income tax and sales tax; gross production and severance taxes also contribute large portions. Corporate taxes, business taxes, and real estate taxes provide relatively small portions of state tax resources. The net

effect is that corporations are not excessively burdened with Oklahoma's infrastructure upkeep. Another advantage is a law keeping corporate income tax rate increases to 2% per year. This limitation has become a safeguard only, because the corporate income tax has been increased only once since 1947.

In 1968, the Freeport Amendment to the constitution allowed businesses to bring property to the state and to hold it for as long as nine months without it being subject to Oklahoma tax. A similar law allows property consigned to an Oklahoma consignee to be tax-free for 90 days.

The constitution was amended in 1985 to allow a five-year ad valorem tax exemption for organizations engaged in research and development. This law, coupled with other local and federal benefits, makes Oklahoma an attractive place for organizations creating and improving products and services.

The rich land of Oklahoma has provided much of the world with oil and natural gas. The taxes on these commodities have aided Oklahomans and Oklahoma businesses by reducing the tax burden on manufacturing and other businesses. Gross production taxes and severance taxes produce 15–25% of Oklahoma's tax revenue. These taxes are levied in place of ad valorem taxes.

Personal income tax is the single largest tax-revenue-producing vehicle, yet Oklahoma in the early 1980s had one of the lowest state and local per capita tax burdens in the nation. Individual income tax is figured on the federal gross adjusted income with tax brackets ranging from 0.5% to 6%.

Business Taxes

Business taxes include corporate income tax, sales tax, county property tax, unemployment compensation tax, organization fees, state income tax, licensing fees, and varying county and local taxes and fees. Property taxes in Oklahoma are among the lowest in the nation, averaging less than 1% of the value of the property. Currently the tax is figured using a percent of the property's fair cash value multiplied by a limited tax rate. Rural prop-

erty is assessed at 9% of its cash value while urban property is assessed at 15% of the estimated cash value. The tax rate also varies by urban or rural location. Figure 13.1 illustrates the extent of revenues produced by the major tax sources.

Workers' Compensation

As of June 1988, Workers' Compensation received an average 8% drop in costs. This places Oklahoma fifth-lowest in the eight-state region, which includes Arkansas, Colorado, Kansas, Louisiana, Missouri, New Mexico, and Texas.

A GUIDE TO OKLAHOMA TAXES

Individuals

Retail Sales and Use Tax

The state levies a 4.5% tax on retail sales and on use (placed on items purchased out-of-state but used in-state, e.g., mail order catalog items). Municipalities may levy additional taxes when approved by the vote of the people. The sales tax is based on the gross proceeds or gross receipts of sales of tangible personal property and enumerated services to consumers or users.

Individual Income Tax

Wages earned by Oklahoma residents and other income from property owned or business done in Oklahoma are subject to state income tax. The tax is figured from the Gross Adjusted Income of the federal tax computa-

tion. Adjustments for dependents, child care, energy conservation, and other special deductions are used to arrive at the individual's state taxable income.

Two tax rates are applicable: one deducting the federal income taxes paid and the other not deducting the federal tax. The rates range from 1% to 6% when not deducting the federal tax paid, and from 1% to 11% when deducting the federal income tax paid (the median effective tax rate for married individuals deducting the federal tax paid is 5%).

Property Tax

Another tax affecting individuals who own property is the ad valorem tax. About two-thirds of the ad valorem taxes are used for the support of local schools, with lesser portions going to county governments, cities, vocational and technical schools, junior colleges, health departments, libraries, and emergency medical services. No ad valorem taxes are used for state purposes.

Estate Tax

When the estate passes to a surviving spouse, there is no estate tax due to State of Oklahoma except on the credit from the federal government which would be payable to the state. Lineal heirs have a \$175,000 exemption, thereafter the rates begin at 0.05% for the first \$10,000 and graduate to 10% for estates worth more than \$10 million. There are no exemptions for col-

lateral heirs; their rates start at 1% for the first \$10,000 and graduate to 15% for estates worth more than \$1 million.

Vehicle Excise Tax

The initial registration of a new vehicle will invoke a tax levy of 3.25% of the suggested retail price. Thereafter, annually, or upon the purchase of a used automobile the tax is based on 65% of the previous year's tax.

Vans and pickups in excess of 8,000 pounds may be registered as commercial, if used in a business. Farm trucks are registered for \$30 annually, regardless of size.

Boat and Motor Tax

When boats and motors are registered for the first time or upon transfer of ownership, the tax levy is 3.25% of the manufacturer's suggested retail price, plus \$1 for each \$100 above the list price of \$150.

Manufactured Homes

When the home is new, a tag must be purchased from a tag agent and excise tax must be paid. Each year thereafter, the owner must list the home with the County Assessor for ad valorem taxation.

Corporate and Business Taxes

Table 13.2 shows the principal taxes for which business and industry are liable.

CONCLUSION

Oklahoma has marshalled a great many resources to lead itself out of a depressed economy to one ready to build a better place for Oklahomans to live. During the 1980s many of the state's financial institutions were reorganized, merged, bought, sold, or liquidated under the supervision of government authorities. The financial industry has positioned itself to supply, either directly or indirectly, the capital needed for Oklahoma's diverse businesses.

To shed light on the present state and future prospect of financial industry in Oklahoma, three prominent banking executives were interviewed. The bankers who graciously gave their thoughts were: Mr. Kenneth Brown, executive vice president, Liberty National Bank and Trust Com-

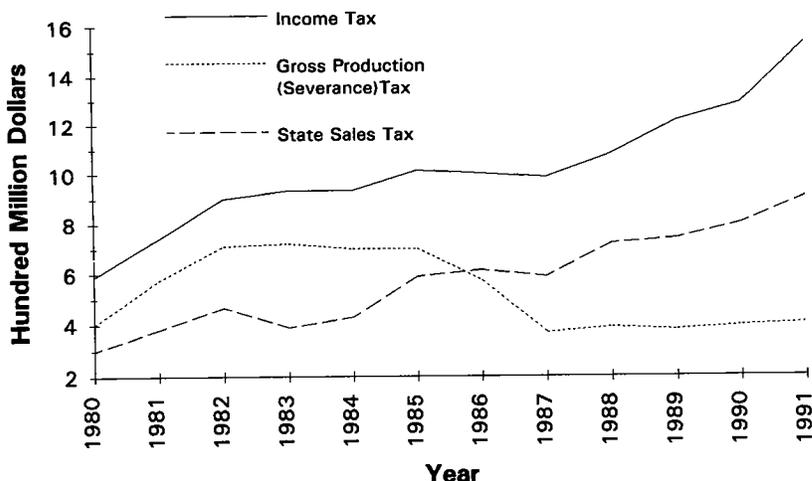


Figure 13.1 — Revenue growth from major tax sources. Source: Oklahoma Tax Commission (1991).

Table 13.2 -- Corporate and Business Taxes

Tax	Base	Rate	Exemptions
Corporate income	Business done within Oklahoma	Flat 6%	None
Annual corporate franchise	Capital allocated in Oklahoma	\$1.25 per \$1,000; Minimum = \$10, Maximum = \$20,000	Capital loans for less than 3 years
Annual franchise registration	For all domestic corporations	\$40.00 per year	None
Motor fuels	Gasoline, LPG Diesel	\$0.16 per gallon \$0.13 per gallon	Agriculture, aviation, solvents, cleaners, manufacturing processes
Sales and use	Gross receipts from the sale or use of personal property	4.5% by Oklahoma; up to 2% by counties; limited use tax by cities	Machinery and equipment, personal property bought for the purpose of production, office supplies, manufactured items sold to out-of-state producers
Property taxes	Real property and some personal property	Approximately 1% of market value	Goods entering Oklahoma and leaving within nine months; cash, receivables, annuities, stocks and bonds; manufacturing or research and development firms for the first five years
Textile mill gross production tax (in lieu of annual property tax)	Gross property products made from cotton, and other fibers	10% gross value of production	Levied in lieu of mill
Gross production	Gross value of oil, gas, and other minerals Asphalt and other minerals	7% 0.75%	Tax not to exceed 1/3 gross value of natural or casinghead gas
Petroleum excise tax	Gross value of natural gas, casinghead gas and oil	95% of gross value of production	None
Unemployment compensation (Title 85)	Mandatory where total payroll exceeds \$10,000 annually or \$100,000 for agricultural or horticultural workers	Rates vary	Self-insured (court approval required)

Source: Oklahoma Department of Commerce (1996).

pany N.A., Oklahoma City; Mr. Tracy Kelly, chairman of the board and CEO of American National Bank, Bristow, Oklahoma; and Mr. John Shelly, president, Equity Bank for Savings F.A., Oklahoma City.

Each banking executive was interviewed separately, using the same set of questions regarding the impact of the changed financial landscape of Oklahoma. Each provided insights from his special vantage point. Yet, there was a commonality of optimism, concern, conviction, and confidence that the banking management in place throughout Oklahoma today has the wherewithal to restore long-term health to Oklahoma's financial infrastructure and restore the spirit of confidence that banks and saving institutions will be safe guardians of the community's wealth and be part-and-parcel of a city or town. With high quality financial systems in place and numerous private and public eco-

nomics development programs, the future can only be termed exciting.

Editor's Note: As described in this chapter, changes were necessary for banks and other financial institutions in Oklahoma after the collapse of oil prices due to the global oil surpluses of the 1980s. Consolidations, reorganizations, and business failures led to new lending standards and policies. Progressively healthy financial conditions began to prevail, leading to robust capital formation and economic growth in the 1990s.

Financial trends that emerged during the period after 1992 have included greater flexibility for out-of-state institutions to enter the Oklahoma markets through continued consolidation of corporate entities. The trend has culminated in the emergence of banking systems serving the entire national market as reflected in the 1998 merger of Nations Bank and

Bank of America. Economies of large-scale banking, plus the ability to establish two branch banks from an existing location, have provided the benefits of larger institutions to Oklahoma consumers.

Small accounts and loans have emerged as a separate market, maintaining the health of local banks and allowing charters for new institutions to meet the demand for traditional, personalized services. Branch banks have moved into retail sites such as malls and super stores. Credit unions have prospered with the demand for custom services and small transactions. The longer prospect, awaiting federal legislation, may allow banks to evolve as comprehensive financial-management institutions with expanded roles in insurance, securities, and financial management, all delivered, in part, through new data-management technologies.

—Gary L. Thompson

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— Chapter 13 —

LIST OF ILLUSTRATIONS

Figure

13.1 — Revenue growth from major tax sources _____ 228

Maps

13.1 — Distribution of banks in Oklahoma with deposits \$50 million and above _____ 220

13.2 — Distribution of multibank holding companies _____ 222

13.3 — Distribution of excess credit in Oklahoma banks _____ 223

13.4 — Distribution of agricultural loans outstanding in 1991 _____ 224

13.5 — Distribution of mortgage banking firms in Oklahoma _____ 226

13.6 — Distribution of credit unions in Oklahoma _____ 226

Tables

13.1 — Bank closures in Oklahoma since 1988 _____ 221

13.2 — Corporate and business taxes _____ 229

Oklahoma Resources

Chapter

14

The Fine Arts

by

Roger Rideout and Nat Eek



Contents

Executive Summary	233
Introduction: Development of the Fine Arts in Oklahoma (1889–1990)	233
Native American Arts	233
Ethnic Bases in the Arts	234
Growth of Types in Arts	234
Historic Status of the Arts in Oklahoma	235
Inventory and Assessment of Current Conditions	235
Arts Support Organizations	235
Visual Arts	236
Dance	237
Drama	243
Music	243
Fine Arts	243
General	244
Impact of Past and Current Decisions and Policy-Making	244
Early Arts Policies	244
The National Endowments	244
Oklahoma Arts Council	244
State and Local Tax Support Programs	245
Changing Tastes in the Fine Arts	245
Current Statewide Arts Policies	245
The Economic Impact of the Arts	246
Future Trends in the Fine Arts in Oklahoma	247
Conclusion	247
References	248
List of Illustrations	248

The Fine Arts

Roger Rideout and Nat Eek

Executive Summary.—Oklahoma benefits from its cultural diversity in many ways. One of the most notable is in the area of fine arts, where numerous cultures, histories, and ethnicities come together in a manner that is unique. From the beginning of its history, Oklahoma has encouraged artistic expression, whether in the form of dance, visual art, theatre, music, or cinema. In early days, this occurred spontaneously and informally, as settlers and tribal nations held dances, concerts, performances, and fairs. Later, as the federal and state governments became more involved in preserving Oklahoma's unique heritage, funding was available to both preserve and support local artists.

The art of Oklahoma has always had a populist orientation; federal programs such as the WPA during the 1930s further strengthened that characteristic. In recent years, more formally organized professional arts associations have received support and appreciation in the urban areas of Tulsa and Oklahoma City. Museums have expanded, and fine arts education opportunities have proliferated, despite the national trend of funding cuts. Furthermore, on a more informal level, independent, participatory, community-based arts activities continue to flourish and stimulate local economies, as crafts fairs, arts festivals, dance clinics, music camps, pow-wows, and community theatres attract increasing numbers of participants. The economic impact of fine arts has been significant on both the community and state level. State and local tax-support programs provide needed capital and operating funds for fine arts activities, while corporate and individual support help maintain an active level of involvement. The arts provide not only employment and satisfaction to individuals in the state, but they stimulate tourism and interstate commerce. The economic impact is significant in terms of tax revenues as well. Arts events and organizations generated more than \$200 million dollars per year in state and local taxes and other resources. The outlook for the arts in Oklahoma is very favorable.

INTRODUCTION:

Development of the Fine Arts in Oklahoma (1889–1996)

Oklahoma is not a single culture, but a combination of cultures. A. M. Gibson states that

[P]eople came to Oklahoma from all directions, from varying circumstances, and brought with them a conglomeration of social, political, economic, and religious traditions....

Gaston Litton writes:

[P]eople from practically every state in the Union were represented in the multitudes who gathered on the border of the Indian Territory in the first weeks of April 1889. The novelty of the situation, in which a vast tract of land amounting to nearly 2 million acres would be opened to settlement on a first-come, first-

served basis, attracted people from all walks of life.

With this land run on April 22, 1889, Oklahoma became an instant "territory," and much of its life changed overnight. Since legitimate communities could now spring up in a day, the fastest way to accomplish this was by bringing supplies from elsewhere.

A town that started with tents found them replaced by wood storefronts and clapboard homes put together with lumber brought in from Texas or Kansas. While some native trees, no matter how spindly or short, were pressed into service, life's necessities and comforts were imported rather than indigenous.

Native American Arts

This need for importation was certainly true of the fine arts. Nothing

existed except what people brought with them. The Native American arts were not really considered fine arts by the new settlers, as most of them had little experience or understanding of such indigenous artistry.

Oklahoma's Native Americans had forms of painting, basketry, beadwork, carving, music, and dancing. Much of what we consider high-quality craft was evidenced in their ceremonial and dress clothing and ornaments, their implements of worship and ceremony, and in some household and living utensils. Now that we have had sufficient historic perspective, many of these objects have achieved true artistic value and attained the status of a real art. The excavations at the Spiro mounds have given us excellent examples of true artistry in simple utilitarian design.

Native Americans used painting primarily for historical recording, utilizing materials that were often fragile and imperfect. It took us almost a half century before we began conscientiously to preserve, understand, and appreciate the unique qualities of Native American art. Now Native American art is one of the fine arts for which Oklahoma is best known.

Native American music breaks into two types: that which is totally indigenous and that which has been influenced by Christian missionaries. According to Litton,

[A]together too little is known about the vast field of Indian music, which was brought to Oklahoma by the many tribes when they took up their residence here one by one.

The Federal Music Project of the WPA studied this music, but, Litton says, even recordings lack "much of the atmosphere and the meaning which can come only to those witnessing the production of the music.

On the borderline of this original, indigenous music is another body of music in the Indian tongues, which reflects the acculturation stimulated by the long contact which many of the Indian tribes had with the Christian missionaries.

Neither of these forms has had any significant influence on the direction of western music. Program music with a specific Native American motif, such as western "cowboy and Indian" film scores, may use Indian tomtom rhythms and simulated chanting, but this is more an Anglo version of Native American music than authentic reproduction of such music. To help us understand and preserve the musical aspect of Native American heritage, the talents of trained musicologists and historians are needed.

Ethnic Bases in the Arts

Gibson writes:

[A]side from military forces, missionaries, and traders, the first large-scale immigration of non-Indian settlers to Oklahoma after the Civil War occurred during the mining boom in the Choctaw Nation in the 1870s. Descendants of these Italian, Slav, Greek, Welsh, Polish, and Russian miners still reside in the old Choctaw Nation and increase the

richness of Oklahoma's ethnic community. Add to these the scattered German and Czech settlements, many still practicing their Old World customs and holding colorful festivals, and one can readily sense the variety of Oklahoma's cultural elements."

Each of these groups who immigrated into Indian Territory, along with 1889 homesteaders from Mexico, England, Scotland, Ireland, Poland, France, and Canada, brought their backgrounds and experience in the arts with them.

Blacks first entered Indian Territory as slaves, and many Native Americans were slave holders. After the Civil War there was a steady migration of free blacks to the area, who over the years contributed significantly to the presentation of the arts.

Most of the art that these first settlers brought in was small and portable due to the limits of transport, but still reflected the national and cultural origins of their owners. Paintings were wrapped and stowed in the bottoms of trunks in wagons, and were usually family portraits of documentary and sentimental value. Etchings and prints were popular and could be rolled and stored. Photographs, usually portraits, were expensive, but important in maintaining family roots. The family photographic portrait album became almost as important as the family Bible in chronicling a family's history and background.

According to Litton, once settlers were established in an area, dugouts and sod houses served as gathering places for pie suppers, country dances, and socials, which were attended by young people throughout the area.

When a community had some kind of central meeting place, art forms that involved group participation became more prevalent. Litton states that the square dance, the singing school, and the play-party gave pioneer families musical outlets. These settlers brought dance to their new communities in the form of square and round dancing, the waltzes of the popular scene, and the ethnic polkas and schottisches. There were no dance troupes.

Music was undoubtedly the most indigenous and omnipresent fine art form. Anyone could sing, and the

early churches had constant use for vocal music. Hymns were a unifying factor, and even nonchurchgoers knew many of them. Upright pianos and small portable foot-pedal pump organs provided accompaniments. Litton adds:

[T]he overnight settlement of western Oklahoma brought a new kind of music not previously known in the Indian Territory. These were the cowboy ballads—lonely, nasal, and plaintive; and the fiddlin' rhythms of the farmers.

Instruments like zithers, violins, trumpets, mandolins, and banjos could be easily carried and were capable of providing an unaccompanied melody for listening enjoyment. Ensembles consisted of choruses, quartets, duos, trios, and bands of mixed instruments, depending upon who could play what. Instruments could also accompany the singing voice. Apparently someone of talent could usually be found. Also, at this time of cultural isolation local talent was recognized, encouraged, and supported, whether black, red, or white.

Theatre was undoubtedly the second most popular form of the fine arts. Part of everyone's educational training was elocution: the memorization and delivery of poems, speeches, lectures, and readings. Also, in a frontier rural society people had to rely on themselves for their entertainment. Consequently everyone was expected to have some natural talent which had at least been honed slightly for public presentation and approval. One's children all were expected to be able to provide instant entertainment at a social visit.

People were familiar with the Bible and the classics, primarily Shakespeare, and small thespian societies quickly became community theatres. Small romantic pieces, farces, and monologues were extremely popular.

Growth of Types in Arts

Litton writes:

Bands were formed in almost all of the towns of any size. They soon made the Sunday afternoon concert in the public square an established custom.

As soon as a community was large enough to be settled, an opera house

or performance hall was built, many times on the second floor of a store building in the center of town, and touring performers and companies quickly established routes to bring entertainment to the new settlers. Just 11 years after the land run, the turn of the century was greeted with a wide variety of available fine arts events throughout the territory.

He adds:

The appearance of the gilt-decorated opera houses in the fast-growing towns brought a beginning of classical music to Oklahoma. Among the more memorable of these theatres were the Overholser Opera House located in Oklahoma City; the Franing Opera House in Norman; and the Busby Opera House in McAlester, which was regarded as the finest between Dallas and Kansas City.

Once a town had a suitable auditorium soloists and artists with national reputations performed as part of lyceum and chautauqua series. These annual offerings boasted a variety of entertainment for the frontier which is unrivaled to this day.

Historic Status of the Arts in Oklahoma

Litton states that "public school music got its start with the advent of statehood and perfection of the school curriculum. Provision was made for the office of a music teacher or supervisor." The other art forms soon followed with classes and teachers in the visual arts and drama. To this day, dance continues primarily in the physical education curriculum, and then primarily for women.

In Oklahoma, dance has always been held in great respect, partly due to the acceptance of the importance of these early physical education classes, but also from our Native American heritage, where dance was an important and totally acceptable social and ceremonial expression of life. Most importantly, dance was a respectable and highly regarded form of artistic expression for men as well as for women.

The important thing to realize is that the arts were all a part of the public school curriculum on a variety of levels. The arts meant culture, and the

isolation of early frontier life made the settlers want the pleasures of the fine arts for their families and friends, and especially their children.

INVENTORY AND ASSESSMENT OF CURRENT CONDITIONS

All the major forms of the fine arts are currently well represented in Oklahoma—especially those of the visual arts, and the performing arts of dance, drama, and music. There also are museums and a variety of cultural societies that encourage the continuance, growth, and development of the fine arts.

The arts in the United States now are considered an important and integral part of any local scene. This has not always been the case, and much of this recognition is a result of arts groups banding together to promote their collective values, chambers of commerce promotions which recognize the commercial and financial return of the arts, and governmental bodies that realize how the arts provide leisure activities, benefit the welfare of their constituencies, and raise the quality of life in their communities.

Part of our current cultural conflict is related to how we wish our state to be represented in the eyes of the public. Gibson states:

Champions of the cowboys and Indians image. . . maintain that state business and political leaders have been too apologetic for the state's western characteristics and that the attempt to erase this vital feature of the Oklahoma heritage could prove harmful to one of the state's key industries, that of tourism.

On the other hand, a total concentration on our western heritage suggests that we only have an "indigenous" culture, a pastiche of "cowboy and Indian" with no real basis for a quality heritage in the arts. Nothing could be further from the truth. What seems to be emerging in Oklahoma since the 1960s is a dual culture: a healthy respect and support for the western aspects of our culture, while at the same time a continuing exploration and support of a general contemporary culture which is both national and international in scope.

Many times Oklahomans are more familiar with what is going on in the

arts scene on the east and west coasts than the coastal residents are of our contemporary scene. In addition, well-trained and talented Oklahomans continued to enhance the arts on a national level in dance, film, television, music, and theatre. Some of our most popular current performers have Oklahoma training and Oklahoma roots.

According to Gibson,

Oklahoma's cultural diversity has generated a vigorous response in the fine arts and humanities, ranging from community theatres and art galleries to writers' clubs and ballet companies. . . Growth in the number of private teachers of voice, piano, and instrumental music reflects the interest in Oklahomans in providing fine arts opportunities for their youth.

While the arts have always been with us, they did not achieve this kind of recognition in this country until after World War II. Probably one of the greatest positive influences was that of the creation of the National Endowment for the Arts in 1965, which by its very existence at last showed that the arts were a valid concern of the federal government and deserved federal financial support.

Oklahoma took advantage of this federal legislation and established its own state council to support the arts and the humanities. According to Gibson,

[D]uring the 1960s a quickening interest was shown in Oklahoma's aesthetic heritage, and it has continued throughout the 1970s. A tangible manifestation of this was the creation in 1965 of the Oklahoma Arts and Humanities Council.

Arts Support Organizations

Oklahoma is fortunate to have several strong and active advocacy groups that promote the arts both in government and in the community. One of the most important group organizations is the Assembly of Community Arts Councils of Oklahoma. With a membership of more than 37 arts councils in 40 cities, it covers the state from Alva to Tulsa, Duncan to Ponca City. The assembly provides technical assistance and training, research and referral, and helps advo-

cate worthy arts programs and projects while sharing valuable information and management expertise.

The Alliance for Arts Education is a component of the John F. Kennedy Center for the Performing Arts in Washington, D.C., and has membership throughout the country. Through the Oklahoma chapter, 14 organizational members and many individual members help promote quality arts education programs throughout the state.

The Mid-America Arts Alliance, based in Kansas City, Missouri, is a six-state arts consortium of Arkansas, Kansas, Missouri, Nebraska, Oklahoma, and Texas. This Alliance provides financial and technical assistance to Oklahoma presenters of visual arts exhibits, dance, music, and drama programs. Individual Oklahoma sponsors contract through the MAAA for subsidized arts events to present in their communities. MAAA funding sources are the National Endowment for the Arts, state arts agencies, foundations, corporations and private donors.

In 1986, statewide arts and humanities organizations formed the Oklahoma Cultural Coalition in order to address issues of public and private support for cultural institutions, programs, and activities. The 11 participating organizations represent all the arts and humanities, education, historical societies, and tourism and recreation throughout the state.

In 1987, the Oklahoma Legislative Arts Caucus was formed under the cochairmanship of Representative Glen Johnson, Okemah, and Senator Enoch Kelly Haney, Seminole. Sen. Haney is an accomplished Native American artist in his own right. The caucus acts as a legislative support group for arts and arts education programs designated by legislation and made possible with matching funds from the Oklahoma Arts Council to schools and non-profit organizations. It currently has more than 60 legislators involved.

Visual Arts

Museums

The Oklahoma Museums Association services all the museums and historical societies in the state with a

membership of more than 51. Within the state of Oklahoma, the museums of art are the greatest purveyors of the visual arts. All the major museums have both permanent collections of valuable works as well as an annual listing of rotating and new exhibits. Three of them are accredited by the American Association of Museums.

Below are listed some of the most important and active museums of art in the state.

Thomas Gilcrease Museum, Tulsa: This museum, which concentrates on the Westward Movement, North American development, and Native American art and artifacts, boasts a permanent collection of 10,000 works of art, 50,000 Native American artifacts, and 90,000 rare books and documents.

Museum of Art, University of Oklahoma, Norman: Extensively remodeled in 1986, this museum has an excellent collection of 20th-century American works, a unique selection of Native American paintings, plus unusual changing exhibits of regional and international artists.

Oklahoma City Art Museum, Oklahoma City: Is the result of a merger in 1989 of the Oklahoma Art Center, with its primarily 20th-century American Collection, and the Oklahoma Museum of Art, whose focus had been European 19th-century works. Presently the Museum houses a collection of 3,500 works of art, primarily paintings, works on paper, and sculptures. The permanent collection has flourished over the past half century through gifts from the WPA, the Oklahoma Art League, the Art Renaissance Club, and countless private donors.

Philbrook Art Center, Tulsa: This museum houses the Kress Collection of Italian Renaissance art, plus many excellent 19th- and 20th-century English and American works. Also included are some Native American art, Chinese jades, and African sculpture.

Woolaroc Museum, Bartlesville: Operated by the Frank Phillips Foundation, the museum features exhibits of

the cultural development of man in the New World, and a rich private collection of western and Native American art.

Goddard Center, Ardmore: This local art center provides classes, meetings, performances and concerts, and houses a good contemporary collection in the visual arts plus western works by Charles Russell, Albert Bierstadt, and William Robinson Leigh, all of which are supplemented by touring exhibits.

National Cowboy Hall of Fame, Oklahoma City: Established as a monument to those who pioneered the west, this museum contains an impressive collection of western art works by Charles W. Russell, Frederic Remington, Thomas Moran, and James Earle Fraser, plus the John Wayne Collection of remarkable kachina figures.

Mabee-Gerrer Museum of Art, Shawnee: On St. Gregory's College campus, the museum, named for Father Gregory Gerrer—a pioneer artist-collector of taste, houses a small but well-chosen collection of 19th- and 20th-century European and American artists, plus many artifacts from Mid-east and European civilizations.

Oklahoma also has many other local historical museums about the state that help preserve the frontier tradition of the early arts in such forms as memorabilia, instruments, and photographs.

Galleries: The many exhibits of these museums are augmented by showings in private galleries throughout the state. There are many in Oklahoma's largest cities, and while the majority of them focus on "western art," almost all showcase work of good quality by local artists. "Western art" is defined as visually realistic art primarily based on cowboy and Native American themes. Because of this state's western location, this kind of art has always been of great interest and demand.

Gibson states:

A sign of cultural advance is a sustained, involved interest in art, and many Oklahomans have produced and collected art. In early times, the

Sooner State's natural beauty and varied human groups attracted world-famous painters... such as George Catlin and Frederic Remington. In modern times, certain Oklahomans have used their wealth from oil to patronize the arts, such as Ernest W. Marland of Ponca City, Thomas Gilcrease of Tulsa, and Frank Phillips of Bartlesville."

Private galleries and artists' cooperatives augment the active Oklahoma scene in the visual arts. The most recent Oklahoma Cultural Resource Directory from the State Arts Council listed 39 galleries in Oklahoma City, 23 in Tulsa, and another 65 statewide, and this was only a partial listing!

Art Festivals: Art festivals supplement museum and gallery exhibits with annual local showings of arts and crafts that are available for purchase. These run from a weekend to an entire week, and feature booth displays by both local and regional artists (usually screened by a qualified selection committee), food booths, and various performing acts. These are all designed to bring together people of all ages and backgrounds to help celebrate the arts, and to encourage the spectators to take some art home with them to become part of a personal collection. Notable examples are Oklahoma City's annual Festival of the Arts held in April, Tulsa's Mayfest, Norman's May Fair held the first week in May, and the Southwest Festival of the Arts in Weatherford in September.

The Oklahoma City Festival is ranked as one of the top 10 outdoor festivals in the nation, and in 1988 drew more than 750,000 visitors to its colorful display and performance tents. For one week, this festival celebrates the arts with a unique mix of high quality arts and crafts for viewing and buying, food booths of great variety, demonstrations in the arts, and free arts performances.

A new arrival on the festival scene is Red Earth. Devoted to Native American arts and displays, the first festival was held in June 1987 in Oklahoma City with more than 100 Indian nations gathering. More than 50,000 attended the first festival, and there were juried fine arts and dance com-

petitions during the three-day event, as well as a variety of other Native American activities. Like all good Native American public events, Red Earth demonstrated joy and pride in native heritage while allowing the outsiders to watch and occasionally participate in this ethnic celebration.

Another interesting artistic mix is the Medieval Fair, sponsored by the University of Oklahoma each April. The fair offers a variety of arts and crafts along with performances and spectator events, all with the flavor and logic of the Middle Ages. The three-day annual event now attracts crowds of more than 100,000 persons.

Many of the art fairs and festivals in Oklahoma are annual events and are held about the same time each year. Table 14.1 gives the dates of some of the festivals that took place in 1997.

Arts Training: The United States is unique in that much of our training in the arts is now handled on the high school, college, and university level, rather than within the European-style conservatory. In order to support this kind of training program, performances, exhibitions, concerts, and recitals are essential to provide the students with a training outlet for their talents, which at the same time gives valid arts experiences to the community.

Education can be one of the great preservers as well as promoters of the fine arts. For example, Gibson states that "the most notable development in the Oklahoma art world was the school of Indian artists developed by Oscar Jacobson at the University of Oklahoma. He encouraged the Indian students to use indigenous themes and a simple form derived from the Indians' historical style in pictorial art. Jacobson's school produced more than 30 native artists from 10 different tribes. Among his famous students were five young Kiowas, Stephen Mopope, Monroe Tsa-to-Ke, James Auchiah, Jack Hokeah, and Spencer Asah, who came to the campus in 1928." These well-known Native American artists are now referred to as "the Kiowa Five."

With this training as the beginning of a heritage, Native American painters are now accepted the world over.

At one time Santa Fe and Taos were the primary centers of Native American art. Now there are many Oklahoma Native American artists whose work is sold locally, and whose reputations draw art dealers to the state.

There are more than 100 visual arts programs in the Oklahoma public schools, and each of these have periodic exhibitions of their students' work. Sponsored by the Oklahoma Arts in Education Association, the annual Oklahoma Young Talent Exhibit shows the best works of high school students entered from around the entire state, and the exhibit travels to several cities during the year.

Dance

Ballet Heritage

Of historic distinction is the fact that Oklahoma had five Native American ballerinas of international reputation all at one time—Maria Tallchief (Chicago), Marjorie Tallchief (Boca Raton, Florida), Yvonne Chouteau (Oklahoma City), Rosella Hightower (Cannes, France), and Moscelyn Larkin (Tulsa). After their major performing careers, all of them continued to contribute to the international and national ballet scene as managers, choreographers, and teachers of ballet in companies, studios, and universities. A major mural titled "Flight of Spirit," by Chickasaw artist Mike Larsen, was dedicated at the State Capitol on November 17, 1991. The mural honors the Indian ballerinas, all five of whom were present for the dedication ceremony.

Ballet Companies

There are two professional ballet companies in the state that offer seasons of performances. These are the Tulsa Ballet Theatre and Ballet Oklahoma (Oklahoma City). The Tulsa Ballet has toured nationally to critical acclaim. They have been brought to prominence by the late Roman Jasinski and Moscelyn Larkin (one of our Native American ballerinas). Both companies tour regionally through the Oklahoma Arts Council's touring program and MAAA.

Local Companies

The Bartlesville Civic Ballet is also active, and the University of Okla-

Table 14.1 -- Oklahoma Arts Festivals, 1997

<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>	<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>
Feb. 1-2	NATIONAL CRAFT FAIR State Fairgrounds, Oklahoma City	crafts	April 5-6	SPRING ARTS & CRAFTS FESTIVAL Turner Falls Park, Davis	crafts
Feb. 1-2	RED EARTH WINTER EXPO Kirkpatrick Air, Space & Science Museum, Oklahoma City	fine art, crafts, dance, music, storytelling, folk arts	April 6-10	ART UNDER THE OAKS JUDGED EXHIBITION & SALE Five Civilized Tribes Museum, Muskogee	crafts
Feb. 7-9	AN AFFAIR OF THE HEART State Fairgrounds, Oklahoma City	fine art, craft, folk arts	April 10-12	TONKAWA REDBUD FESTIVAL Northern OK College—Performing Arts Center Tonkawa	music
Feb. 8	CHOCOLATE FESTIVAL Commons Restaurant—OCCE, University of Oklahoma, Norman	chocolate art	April 11-13	MEDIEVAL FAIR Brandt Park Duck Pond, Norman	fine arts, crafts, photography, dance, music, theater
Feb. 8-9	WINTERFEST Kirkpatrick Air, Space & Science Museum, Oklahoma City	fine art, crafts, photography, dance, music, folk arts	April 11-12	RURAL AMERICA Downtown Cordell	fine art, crafts, quilt show, chili contest
Feb. 21-22	TULSA INDIAN ART FESTIVAL Expo Square—Upper Level, Tulsa	fine art	April 11-12	SPRING MARKET Stillwater Municipal Airport, Stillwater	crafts
Feb. 28— March 2	CHILDREN'S MEDICAL CENTER ARTS & CRAFTS FESTIVAL Expo Square—Exhibit 1 Bldg., Tulsa	fine art, crafts, photography	April 12-13	ART UNDER THE OAKS INDIAN MARKET Five Civilized Tribes Museum, Muskogee	fine art, crafts, dance, folk arts
March 4-22	PIECEFUL MEMORIES ANNUAL QUILT SHOW Seminole Nation Museum Art Gallery, Wewoka	fine art, fine crafts, folk arts	April 12-30	CIMARRON TERRITORY CELEBRATION Fairgrounds & various locations, Beaver	fine arts, crafts, music
March 8	UNION HIGH SCHOOL PTSA ARTS & CRAFTS FAIR Union High School, Tulsa	fine art, crafts	April 17-20	KEEPER OF THE PLAINS CELEBRATION Convention Hall, Enid	fine art, dance
March 9-31	STUDENT ART SHOW Five Civilized Tribes Museum, Muskogee	fine art	April 18-19	SPIRIT OF THE SOUTHERN PLAINS (Native American Festival) Comanche County Fairgrounds—Expo Center, Lawton	fine arts, crafts, photography, dance, music, folk arts
March 13-16	OCTAFEST '97: STATE FESTIVAL OF PLAYS Oklahoma State University—Vivia Locke Theater, Stillwater	theater	April 22-27	FESTIVAL OF THE ARTS Festival Plaza/Myriad Gardens Oklahoma City	fine art, crafts, dance, folk arts, photography, opera, theater
March 15	SPIRO MOUNDS FAMILY KITE FLITE DAY Spiro Mounds Archaeological Park, Spiro	crafts, kite art	April 26-27	NATIONAL CRAFT FAIR Fairgrounds, Tulsa	crafts
March 20-22	HEAVENLY TREASURER'S Clarion/Comfort Inn Hotel 4345 N. Lincoln, Oklahoma City	fine art	May 1-3	MOUNTAIN WINDSONG FESTIVAL OF BOOKS & AUTHORS Hwy 62 South, Tahlequah	books
March 21-22	CELEBRATION OF BOOKS Rogers University—T.C.T. Campus, Tulsa	literary, folk arts	May 2-4	ARTS FOR ALL FESTIVAL Shepler Plaza—4th & Gore Blvd., Lawton	fine art, fine crafts, photography, dance, music, opera, theater
March 21-22	SCOTTISH HERITAGE FESTIVAL Joe Barnes Regional Park, Midwest City	crafts, photography, dance, music, theatre, folk arts, pipe band comp.	May 2-4	SPRING ARTS & CRAFTS SHOW Community Cntr.—E. Reno & Midwest Blvd., Midwest City	crafts
March 22-23	GARLAND ARTS & CRAFTS SHOW Expo Center—Independence & 177, Shawnee	crafts	May 3	CORDELL ART IN THE PARK Downtown Square, Cordell	fine art, crafts, photography
March 23	FESTIVAL OF SPIRITUALS First Christian Church—220 S. Webster, Norman	music			
March 29	CREATIVE CRAFT FESTIVAL Cleveland County Fairgrounds, Norman	crafts, stained glass, pottery			

Table 14.1 -- continued

Date	Festival	Disciplines	Date	Festival	Disciplines
May 3-4	GROVEFEST Downtown & Civic Center, Grove	fine art, crafts, car show, music	June 1-22	INVITATIONAL EXHIBIT: ROBERT ANNESLEY & MIKE DANIEL Five Civilized Tribes Museum, Muskogee	fine art
May 3	PRAGUE KOLACHE FESTIVAL Prague City Park, Prague	fine arts, crafts, photography	June 4-8	CHAUTAQUA: PRIME TIMES, SCOUNDREL TIMES, POSTWAR AMERICA U.C.T./Rogers College Campus, Tulsa	music, theater, humanities
May 3	TACO SALE Cleveland County Fairgrounds, Norman	crafts, music	June 5-31	TWILIGHT CONCERTS Joe Barnes Regional Park, Midwest City	music
May 6-13	SPRING ART SHOW Gallery & Art Center, Holdenville	fine art, photography	June 5-8	NEW GENRE FESTIVAL Boston & Brady, Tulsa	fine art, dance, music, theater
May 9-10	STILWELL STRAWBERRY FESTIVAL ARTS & CRAFTS Third & Oak, Stilwell	fine art, crafts, photography	June 5-7	SUMMERFEST Hwy 51 & 69 (1 block east), Wagoner	crafts, music
May 10	FOUNDERS DAY Main Street, Lindsay	crafts, music, rodeo	June 7-8	CHISHOLM TRAIL FESTIVAL Garth Brooks Blvd. & Vandament, Yukon	crafts, dance, music, theater, (living history)
May 10	MAYFAIR ARTS FESTIVAL Reaves Park, Norman	fine art, crafts, photography, pottery, jewelry	June 7	NESCATUNGA ARTS FESTIVAL Downtown Square, Alva	fine arts, crafts
May 10	OKLA-HOE-DOWN Joe B. Barnes Regional Park, Midwest City	fine art, crafts, music	June 7	WATERMELON PATCH ARTS & CRAFTS FESTIVAL Fairgrounds, Woodward	crafts
May 16-17	BOILING SPRINGS BLUEGRASS FESTIVAL Boiling Springs State Park, Woodward	crafts, folk arts, music (blue- grass)	June 10-29	GILBERT & SULLIVAN OPERETTA FESTIVAL Chapman Hall—Kendall Hall, Tulsa	opera
May 16-18	CLAREMORE STATE POW WOW Rogers State College Campus, Claremore	crafts, dance	June 10-14	KIAMICHI OWA CHITO ART SHOW Forest Heritage Center—Beavers Bend Park, Broken Bow	fine art
May 16-18	MANY STRONG & BEAUTIFUL NATIVE WOMEN Hwy 62 South, Tahlequah	fine art, crafts, traditional art (by Native American women)	June 13-21	OK MOZART FESTIVAL Community Center, Bartlesville	fine art, music, opera
May 17	ARTS ON THE SQUARE Kiowa County Courthouse Square, Hobart	fine art, crafts, photography, pottery, sculpture	June 13-15	RED EARTH NATIVE AMERICAN CULTURAL FESTIVAL Myriad Convention Center & Plaza, Oklahoma City	fine arts, crafts, photography, Native American art, dance, music, story- telling
May 24-26	CHEROKEE SQUARE ARTS & CRAFTS FESTIVAL Downtown—Cherokee Square, Tahlequah	fine art, crafts	June 13-14	SULPHUR DAYS CELEBRATION Chickasaw National Recreation Area, Sulphur	fine arts, crafts, photography, dance, music, theater, folk arts
May 24-26	PASEO ARTS FESTIVAL NW 30 & Dewey, Oklahoma City	fine art, photography	June 14-29	OKLAHOMA SUMMER ARTS INSTITUTE Quartz Mountain Arts & Conference Center, Lone Wolf	fine art, photography, writing, dance, music, theater
May 25-26	EDMOND BLUES IN THE NIGHT & JAZZ FESTIVAL Hafer Park—9th & Bryant, Edmond	fine art, crafts, music	June 19-22	JUNETEENTH HERITAGE FESTIVAL ON GREENWOOD Greenwood Cultural Center, Tulsa	fine art, crafts, music
May 30- June 1	MAGNOLIA FESTIVAL Citywide, Durant	crafts, photogra- phy, dance, music, theater, folk arts, parade	June 21-22	BAH-KHO-JE 201 E. Main Street, Coyle	fine art, crafts, dance, music (all Native Ameri- can), folk arts
May 30- June 1	PIONEER DAYS Main Street, Oologah	crafts, parade	June 21	JENKS COUNTRY FAIR Main Street, Jenks	crafts, dance, music
May 31- June 1	NATIONAL CRAFT FAIR Fairgrounds, Tulsa	crafts	June 21	SPRING ARTS FESTIVAL Garfield County Courthouse Lawn, Enid	fine art
May 31- June 1	RENDEZVOUS '97 Gilcrease Museum, Tulsa	fine art, crafts, dance, music, theater (living history), folk arts			

Table 14.1 --continued

<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>	<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>
June 26–29	JAZZ IN JUNE Brookhaven Village, Andrews Park & Sooner Theater, Norman	music (jazz)	Aug. 7–10	CELEBRATION OF QUILTS: QUILTS IN BLOOM Clarion Hotel—4445 N. Lincoln Blvd., Oklahoma City	quilts
June 26–28	OKLAHOMA SHAKESPEAREAN FESTIVAL Southeastern OK State University, Durant	theater	Aug. 8–16	BOK/WILLIAMS JAZZ ON GREENWOOD Greenwood & Archer, Tulsa	music
June 26–28	FAIRVIEW SHOW OF THE ARTS Major County Fair Building, Fairview	fine arts, crafts, photography	Aug. 9	RUSH SPRINGS WATERMELON FESTIVAL Jeff Davis City Park, Rush Springs	fine art, crafts (handmade), dance, music
June 29–31	COMPETITIVE ART SHOW Five Civilized Tribes Museum, Muskogee	fine art	Aug. 22–23	FIESTA de COLORES St. Thomas More Church, Tulsa	fine art, crafts, dance, music
July 4	4TH OF JULY FAMILY FUN FESTIVAL Eldon Lyon Park—7400 NW 36, Bethany	crafts, photogra- phy, music, car show	Aug. 29– Sept. 1	MOUNTAIN WINDSONG HOLIDAY ARTS EVENT Hwy 62 South, Tahlequah	fine art, crafts, photography, music
July 4	4TH OF JULY FESTIVAL Pennington Creek Park, Tishomingo	crafts	Aug. 30– Sept. 1	ARTS FESTIVAL OKLAHOMA Oklahoma City Community College, Oklahoma City	fine arts, crafts, dance, music
July 4	4th OF JULY CELEBRATION Red Bud Park, Marlow	crafts, music	Aug. 30– Sept. 1	CHEROKEE HOMECOMING Cherokee Heritage Center, Tahlequah	fine arts, crafts, music
July 4–5	HOLIDAY IN THE PARK ARTS & CRAFTS SHOW Chandler Park—Multi-Purpose Center, Purcell	crafts	Sept. 3–6	CHEROKEE STRIP DAYS CELEBRATION Garfield County Courthouse Lawn, Enid	crafts, music
July 4–5	LIBERTYFEST Rogers Point Park, Catoosa	crafts, dance, music, folk arts, chili cook-off	Sept. 4–6	BLUEGRASS & CHILI FESTIVAL Williams Center Green/Main Mall, Tulsa	crafts (SW Native American), dance, music, folk arts
July 4	NORMAN DAY Reaves Park, Norman	crafts	Sept. 4–7	CLEVELAND COUNTY FREE FAIR Cleveland County Fairgrounds, Norman	crafts
July 17–20	AMERICAN MUSIC FESTIVAL Simmons Center, Duncan	music	Sept. 5–6	PUMPKIN FESTIVAL OF THE ARTS Caddo County Courthouse Lawn, Anadarko	fine arts, crafts, photography, sculpture
July 17–19	CAMERON UNIVERSITY SUMMER OPERA FESTIVAL Cameron University Theater, Lawton	opera	Sept. 7–30	OKLAHOMA ART WORKSHOPS NATIONAL JURIED EXHIBITION 6953 South 66 E. Avenue, Tulsa	fine art
July 18–20	HEART OF TULSA Expo Square—Fairgrounds, Tulsa	fine art, crafts, photography, jewelry, antiques, clothing	Sept. 12–14	INDIAN SUMMER FESTIVAL '97 Bartlesville Community Ctr., Bartlesville	fine art, crafts, sculpture, dance, music, folk arts, traditional dress
July 18–19	MIDSUMMER NIGHTS' FAIR Lions Park, Norman	fine art, crafts, photography, dance, music, opera, folk arts	Sept. 13	CHEROKEE STRIP ARTS & CRAFTS FESTIVAL Courthouse Park—east side, Perry	fine art, crafts, photography, folk arts
July 26–27	DEEP DEUCE JAZZ FESTIVAL NE 2nd & Walnut Street, Oklahoma City	music, crafts, folk arts	Sept. 13–14	GARLAND ARTS & CRAFTS SHOW Expo Center—Independence & 17, Shawnee	arts & crafts
Aug. 1–2	BELL POW WOW Bell Pow Wow Grounds, Stilwell	fine art, crafts, photography, dance, music (Native American)	Sept. 13	OKRAFEST! Downtown, Checotah	crafts
Aug. 1–2	SAPULPA FEST Downtown—Dewey Street, Sapulpa	crafts, dance, music	Sept. 19–20	DESIGNS OF AUTUMN Main Street, Miami	fine art, pho- tography, dance, music, opera, theater, folk arts

Table 14.1 -- continued

<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>	<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>
Sept. 19–21	FALL FESTIVAL OF THE ARTS Civic Center, Elk City	fine art, crafts, dance, music, theater, children's fun fair	Oct. 4	CREATIVE CRAFT FESTIVAL Cleveland County Fairgrounds, Norman	crafts
Sept. 19–20	FORT SILL–CHIRICAHUA–WARM SPRINGS–APACHE CELEBRATION Fort Sill Apache Tribal Complex, Apache	crafts, dance	Oct. 4	DOWNTOWN SHAWNEE'S FALL ARTS & JAZZ FESTIVAL Main Street, Shawnee	fine art, dance, music, theater, folk arts, jazz-related poetry
Sept. 20	ARTS 'N ACTION Country Courthouse & Airport, Frederick	fine art, crafts, dance, music, car show, aviation fly-in	Oct. 4–5	FALL ARTS & CRAFTS FESTIVAL Turner Falls Park, Davis	crafts
Sept. 20	BILLINGS WHEAT COUNTRY FESTIVAL Community Bldg & Main Street, Billings	crafts, dance, music	Oct. 4–31	SPIRIT OF OKLAHOMA MASTER ART SHOW Five Civilized Tribes Museum, Muskogee	fine art
Sept. 20–21	FALL FESTIVAL OF THE ARTS Community Civic Center, Elk City	fine art, crafts	Oct. 4–5	TAYLORSVILLE COUNTRY FAIR Rural Payne County (between Perkins & Stillwater), Perkins	crafts, music, pioneer living skills
Sept. 20	HISPANIC HERITAGE CELEBRATION Government Springs Park, Enid	dance (Spanish)	Oct. 5	ART IN THE PARK Andrews Park (corner of Daws & Front), Norman	fine art, dance, music, theater
Sept. 20	OUTLAW DAYS Red Bud Park, Marlow	crafts, music, parade, poetry contest (cowboy & cowgirl)	Oct. 5	FALLFEST Simmons Center, Duncan	fine art, crafts, dance, music, folk arts
Sept. 20–21	PONCA CITY FINE ARTS FESTIVAL Ponca City Art Center—819 E. Central, Ponca City	fine art, photography	Oct. 7–14	FALL ART SHOW HSPS Gallery & Art Center—118 N. Broadway, Holdenville	fine art, photography
Sept. 26–28	COMANCHE NATION FAIR Camp Eagle (old Craterville Park) Ft. Sill Res., Cache	fine art, crafts, photography, dance, music, theater	Oct. 9–12	OKLAHOMA INTERNATIONAL BLUEGRASS FESTIVAL Citywide, Guthrie	crafts, music
Sept. 26–27	HARVEST MOON STORYTELLING FESTIVAL Cherokee Heritage Center (Friday), Tahlequah; Murrell Home (Saturday), Tahlequah	music, storytelling	Oct. 11	COLONY'S 4TH ANNUAL GOOBERFEST John Kauger Memorial Park—downtown Colony	fine art, crafts, photography, music, folk art
Sept. 26–28	INTERNATIONAL FESTIVAL Library Plaza—4th & B, Lawton	fine arts, crafts, photography, dance, music, folk arts	Oct. 11	CORDELL PUMPKIN FESTIVAL Cordell Square, Cordell	crafts, dance, music
Sept. 27–Oct. 4	CHICKASAW FESTIVAL & ANNUAL MEETING various locations, Tishomingo	fine arts, crafts, dance	Oct. 11	FESTIVAL IN THE PARK Memorial Park, Cushing	fine art, photography
Sept. 27	HOOK -N- COOKOFF Powderhorn Park, Langley	crafts, dance, music, culinary	Oct. 11	GLOBAL OKLAHOMA—A FESTIVAL OF CULTURES Rose State College, Midwest City	dance, music, theater
Sept. 27	INDIAN SUMMER ARTS FESTIVAL Courthouse Square—downtown, Chandler	fine art, crafts, dance, music	Oct. 11–12	GRAPES OF WRATH FESTIVAL Sallisaw City Park & Rodeo Grounds, Sallisaw	crafts, photography, music, folk art
Oct. 3–4	WATONGA CHEESE FESTIVAL Downtown & fairgrounds, Watonga	fine art, crafts, music, photography	Oct. 11	HOMINY ARTS & CRAFTS SHOW Horace Mann Elementary School, Hominy	crafts
Oct. 4	ART IN THE PARK Chickasaw National Recreation Area, Sulphur	fine art, crafts, photography, dance, music, folk arts, theater	Oct. 18–19	CATOOSA FALL FESTIVAL Corner of Cherokee & Antry Drive, Catoosa	crafts, dance, music
			Oct. 18	FALL PRAGUE ART GUILD QUILT SHOW High School Community Center, Prague	fine arts, crafts
			Oct. 18–19	MANNFORD ARTS & CRAFTS FESTIVAL Mannford Elementary & High Schools, Mannford	folk art (hand-crafted items only)

Table 14.1 -- continued

<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>	<u>Date</u>	<u>Festival</u>	<u>Disciplines</u>
Oct. 24-26	AN AFFAIR OF THE HEART State Fairgrounds, Oklahoma City	fine art, crafts, folk arts	Nov. 8	HONEY FESTIVAL High School Gym, Erick	fine art, crafts, music
Oct. 25-26	FALL FEST '97 Blinn Memorial Park, Tonkawa	crafts	Nov. 8-9	SANTA'S WORKSHOP CHRISTMAS GIFT SHOW & SALE Grove Civic Center, Grove	fine art, crafts
Oct. 25	INTER-TRIBAL FALL DANCE Cleveland County Fairgrounds, Norman	fine art, crafts, silent auction	Nov. 14-15	CARTER COUNTY ARTS & CRAFTS FESTIVAL & FOOD FAIR Hardy Murphy Coliseum, Ardmore	crafts
Oct. 25- Nov. 15	SEMINOLE SIGNATURES Seminole Nation Museum, Wewoka	fine art	Nov. 15-16	FAMILY ARTS & CRAFTS SHOW National Guard Armory, Perry	fine art, crafts, photography
Oct. 25	SORGHUM DAY FESTIVAL Main Street & Wewoka Avenue, Wewoka	fine art, crafts, photography, dance, music, folk arts	Nov. 20-22	HOLIDAY OPEN HOUSE Downtown, Jenks	crafts, music, trolley rides
Oct. 31- Nov. 1	FALL FESTIVAL '97 Fairgrounds, Duncan	fine art, crafts (handmade only)	Nov. 22-23	GARLAND ART & CRAFT SHOW Expo Center, Shawnee	arts & crafts
Oct. 31- Nov. 2	TULSA ARTS & CRAFTS FALL FESTIVAL Expo Center—Expo Square, Tulsa	fine art, crafts, photography	Nov. 23- Jan. 12	CHRISTMAS GALLERY Firehouse Art Center, Norman	fine art, crafts, folk arts
Nov. 1-2	CREATIVE CRAFT FESTIVAL Cleveland County Fairgrounds, Norman	crafts	Nov. 28-31	COLONY COUNTRY CHRISTMAS SHOW John Kauger Memorial Park—down- town Colony	music
Nov. 1	HARVEST MISSIONS FESTIVAL Westport Mennonite Brethren Church, Collinsville	crafts, music	Nov. 28-29	CREATIVE CRAFT FESTIVAL Cleveland County Fairgrounds, Norman	crafts
Nov. 1-2	NATIONAL CRAFT FAIR State Fairgrounds, Oklahoma City	crafts	Nov. 29-31	CELEBRATING THE HOLIDAYS CHRISTMAS SHOW Five Civilized Tribes Museum, Muskogee	fine art, crafts
Nov. 1-2	SOUTHEASTERN OKLAHOMA ARTS & CRAFTS SHOW J. I. Stipe Recreation Center, McAlester	fine art, crafts	Dec. 4-6	SHAWNEE CHRISTMAS CELEBRATION Downtown, Shawnee	dance, music, theater
Nov. 2-3	HEAVENER ARTS & CRAFTS FESTIVAL Heavener High School, Heavener	fine arts, crafts	Dec. 4-6	WONDERS OF WINTER ANTIQUES, ARTS & CRAFTS SHOW Grady County Fairgrounds— Hwy 62, Chickasha	crafts (hand- made), antiques
Nov. 7-9	BEAVERS BEND FOLK FESTIVAL & CRAFTS SHOW Beavers Bend Resort Park, Forest Heritage Center, Broken Bow	crafts, folk music, folk arts	Dec. 5-7	FALL ARTS & CRAFTS SHOW Midwest City Community Center, Midwest City	crafts
Nov. 7	FALL FESTIVAL Payne County Expo Center, Stillwater	crafts	Dec. 6-7	CHRISTMAS FAIR Firehouse Art Center—444 S. Flood, Norman	fine art, crafts, photography, folk arts
Nov. 7	ILLINOIS RIVER ARTS & CRAFTS FESTIVAL University Center, Tahlequah	arts & crafts	Dec. 7	HOLIDAY CRAFT BAZAAR Farm & Home Building—2nd & Van Buren, Purcell	crafts
Nov. 7-8	JENKS TEDDY BEAR CONVENTION Jenks Central Campus—205 E. B Street, Jenks	fine art, crafts, photography, collectible teddy bears	Dec. 13	CREATIVE CRAFT FESTIVAL Cleveland County Fairgrounds, Norman	crafts
Nov. 7-8	VETERANS DAY POW WOW N.E.O. College—Multipurpose Arena, Miami	crafts (Native American), dance	Dec. 20	1998 NATIVE AMERICAN ART CALENDAR SIGNING Tribes Gallery—307 E. Main, Norman	calendar artwork & signing
Nov. 8	FALL FESTIVAL ARTS & CRAFTS SHOW Hoover Building, Enid	fine art			

homa Department of Dance with its Oklahoma Festival Ballet presents annual programs of high quality.

Miguel Terekhov and Yvonne Chouteau (another of our Native American ballerinas) created and developed the ballet program in the University.

The Prairie Dance Theatre from Oklahoma City tours extensively both within and outside the state, and presents dance performances and workshops under the artists-in-schools program.

Drama

Professional Companies

Theatre is not as strong now as it was 20 years ago in Oklahoma. However, there are still several permanent theatre groups extant. The best known are: Theatre Tulsa, the summer Lyric Theatre (Oklahoma City), the Pollard Theatre (Guthrie), Jewel Box Theatre (Oklahoma City), Theatre North (Tulsa), Town and Gown Theatre (Stillwater), and the Lawton Community Theatre, to name a few. More than 20 theatres, amateur and professional, produce a full season each year.

Community Theatres

Founded in 1969, the Oklahoma Community Theatre Association (OCTA) focuses on the cultural richness in theatres about the state. There are more than 70 such theatres statewide; more than 60 are OCTA members. All are actively producing plays this year for live audiences and many have children's theatre production programs for school children. OCTA sponsors a festival of plays produced by its membership and has annual conferences. Ongoing programs include playwriting competitions, a lending library, production and technical consultations and a resource exchange for members. OCTA also provides adult continuing education scholarships to members, which is one of its largest budgeted programs, second only to the consultant and initiative grants program.

Outdoor Drama

Of the annual presentations of outdoor dramas the best known is "Trail of Tears," presented each sum-

mer for two months in the Tsa-La-Gi Theatre, Cherokee Heritage Center, Tahlequah. This depicts the history of the Cherokee Tribe in its trek from North Carolina to Indian Territory in Oklahoma in the 19th century. In Tulsa each summer, Discoveryland! Outdoor Theatre presents Rodgers and Hammerstein's musical *Oklahoma!*

Shakespeare Festivals

There are two summer semiprofessional Shakespeare festivals which have begun to develop state followings: Shakespeare-in-the-Park in Edmond, which presents several of the Bard's works outdoors each summer, and the Oklahoma Shakespearean Festival at Durant on the campus of Southeastern Oklahoma State University, which features plays of Shakespeare, children's theatre, and a Renaissance Faire annually in July.

Educational Theatre

Undoubtedly the richest theatre resources are in the drama programs of Oklahoma's colleges and universities. For example, the School of Drama at the University of Oklahoma offers high-quality performances of classic plays, musicals, operas (jointly with the School of Music), and experimental and original plays as part of their regular season to audiences of more than 20,000 persons.

Other seasons of notable dramatic fare are provided by Oklahoma State University, Southwestern Oklahoma State University, University of Tulsa, University of Central Oklahoma, Cameron University, Lawton, and Oklahoma City University. Almost all the state colleges and universities offer either seasons or occasional dramatic performances and teach courses in theatre.

Music

Professional Symphonies

One of the great classic strengths of the state is its possession of two fine professional symphonies: the Oklahoma City Philharmonic (successor to the Oklahoma Symphony Orchestra) and the Tulsa Philharmonic. Both have full-length seasons and provide programs of both classic and semiclassical works with internationally known performers as soloists. Both orchestras

tour through the Oklahoma Touring Program of the Oklahoma Arts Council and the Tulsa Philharmonic tours with Mid-America Arts Alliance regional touring program.

Semiprofessional Music Organizations

Oklahoma is also fortunate to have additional municipal orchestras that draw musicians from their own communities, such as the Bartlesville Symphony, the Enid-Phillips Symphony, and the Lawton Philharmonic, all of which provide regular programming. The Oklahoma Youth Orchestra, the Oklahoma Youth Symphony, and the Tulsa Youth Orchestra give talented students of high school age opportunities to perform classical music before state audiences during the school year.

Opera Companies

The Tulsa Opera has an annual season of three operas of high quality, which gives the state its only continuing professional opera company. The Lyric Theatre (Oklahoma City) each summer mounts a semiprofessional season of five popular musicals, and is now well past its 20th year. The Cimarron Circuit Opera Company of Norman continues to provide touring opera performances of great variety to communities throughout the state.

Music Festivals

The annual summer OK Mozart International Festival in Bartlesville has brought in musicians to develop programs of national acclaim. During one week they play a great variety of orchestral, chamber, and solo music of Mozart, many times rediscovering seldom-played works of major interest. Other 18th-century composers are also featured.

The Tri-State Music Festival sponsored by Phillips University in Enid each May for one week has a long and honorable history of showcasing high-quality music talents throughout the state and region.

Fine Arts

Oklahoma Arts Institute

Of particular importance to the growth of the arts in the state of Oklahoma is the private nonprofit organi-

zation known as the Oklahoma Arts Institute. Founded in 1977 by the State Arts Council and with administrative offices based in Oklahoma City, it began by providing an annual summer institute for talented high school students in the fine arts (The Oklahoma Summer Arts Institute).

For two weeks each June, 200 students, ages 14–18, converge on Quartz Mountain State Park (see below) for classes and performances and exhibits in all the fine arts. Classes are taught by major artists in each field. This institute is unique in that all the students are exposed to a variety of the arts, not just their own specialty. Since its founding the Oklahoma Arts Institute has expanded its program to include continuing education institutes for adults in September and October (the Oklahoma Fall Arts Institutes), touring exhibits, publications, and films.

Quartz Mountain Arts and Conference Center

The Summer and Fall programs of the Oklahoma Arts Institute are held at Quartz Mountain State Park (near Altus), which now is in the process of a \$16 million building program to add new facilities to the lodge area which will turn the entire park into a year-long arts and conference center for conferences, seminars, and workshops, open to all interested organizations and private individuals.

The State Department of Tourism and Recreation, the Oklahoma Arts Council and the State Department of Education as well as the private sector have been instrumental in making this possible. Corporate support has been significant from Phillips Petroleum, Conoco, Southwestern Bell Telephone, The Sarkeys Foundation, The Noble Foundation, The Kerr Foundation and others.

General

Ultimately one cannot overlook the importance of the educational and community arts programs that contribute a wide variety of exhibits and performing arts to their various municipalities. In many ways these are the organizations that personalize the arts, and make their presence a necessary part of community life.

IMPACT OF PAST AND CURRENT DECISIONS AND POLICY-MAKING

Early Arts Policies

Prior to the enactment of the federal legislation creating the National Endowment for the Arts and the National Endowment for the Humanities, there was little Oklahoma legislation that consistently benefitted the fine arts for any period of time. While there were always special legislative appropriations each year that supported local festivals and in some cases museums, these did not create long-term fine arts support and interest.

Federal Arts Project

One cannot overlook, however, the importance of the WPA Federal Arts Project during the 1930s, and the assistance it provided the arts in Oklahoma during the time of the great drought. The Federal Writers Project, with its excellent manuals on state history and touring, the painting of murals and other visual arts in our civic and municipal buildings, the creation of federal painting collections that supported major artists and which in turn became part of state collections, all were significant in the growth, development, and support of fine arts in the state. The Civic Center Music Hall in Oklahoma City and the founding of the Oklahoma City Symphony were WPA projects.

Federal Theatre Project

In Oklahoma the Federal Theatre Project concentrated its efforts on puppetry performances in the migrant worker camps. Tragically, no trace of that work remains today, unless it is hidden in some federal storage warehouse in the nation's capital.

Unfortunately, the political witch-hunting that caused the demise of the Federal Theatre Project left a stain on the minds of the general public which suggested that any federal support of the arts was politically radical and unwise. The arts would be better to survive in the open marketplace.

The National Endowments

In 1965 Governor Henry Bellmon established the Oklahoma Arts and

Humanities Council. This was prompted by the federal government's enactment of a bill in 1965 that had created the National Endowment for the Arts and the National Endowment for the Humanities. For the first time since the Federal Theatre Project of the 1930s, our country was willing to consider federal financial support of the arts. In Washington, D.C., one of the early decisions made by these new agencies was to create national councils for the arts and for the humanities, which would provide monies to the individual states if they would in turn create state and local arts and humanities councils.

Oklahoma Arts Council

Governor Henry Bellmon created the state agency in 1965, making Oklahoma eligible for federal funding. In 1971 the single council became the State Arts Council of Oklahoma, with a Humanities Task Force under its auspices. In 1972, the Task Force separated and formed the Oklahoma Humanities Committee with a budget of \$150,000. In 1983, its name was changed to the Oklahoma Foundation for the Humanities. As an independent, nonprofit organization, the Foundation provides grants to help other organizations produce and present humanities programs and offers programs and program services throughout the state. Headed by Anita May, Executive Director, by 1987–88 its budget rose to approximately \$600,000 in grants from the National Endowment for the Humanities and from private donors.

In 1996 the name of the State Arts Council of Oklahoma was changed through an act of the state legislature to the Oklahoma Arts Council. This council is composed of 15 members appointed by the governor and confirmed by the State Senate. According to Betty Price, the executive director of the Oklahoma Arts Council since 1983, the Council's primary responsibility is to encourage and stimulate all forms of artistic endeavor in Oklahoma.

The current Oklahoma Arts Council is funded by a combination of federal funding from the National Endowment and annual state appropriations by the Oklahoma legislature. In 1965 the Oklahoma Arts and Human-

ties Council had funds totaling more than \$15,000, which primarily went for office support. For fiscal year 1992, the Council's budget from the state legislature was at its highest level of appropriated funds, \$3,457,572.

State and Local Tax Support Programs

What the endowments began in 1965, the public and private sector has continued. The federal government by its funding indicated that support of the arts was worthy of the national tax dollar, and through the National Endowment for the Arts and its many studies, we began to realize what economic effect arts dollars could have on communities and the state in which they existed.

In the 1987 Economic Impact Study by Dr. A. Ray Grimes for the State Arts Council, several important statements were made about the arts in Oklahoma. First, in 1987 more than 4 million people attended arts events in Oklahoma, which is more than the entire population of the state.

The ripple effect is defined as monies generated by events that in turn create and develop the need for other supportive goods and services. For example, those coming to town to attend a local concert find themselves buying meals, gasoline, and perhaps even staying the night at a local motel. According to Dr. Grimes, more than \$216 million "was generated in the Oklahoma economy through the ripple effect stimulated by arts activities."

Of particular interest during the last five years of economic readjustment is the growth of tax revenues generated by nonprofit arts organizations. In 1980 the amount was \$2.18 million; in 1987 it was \$5.98 million, an increase of 174%. The ripple effect during that time is almost as impressive. In 1980 it was \$111.9 million; in 1987, \$216.4 million, an increase of 93%.

Of vital importance to people living in Oklahoma is the effect of the arts on individual employment. In 1987, 1,636 people were employed full and part time by various arts organizations. In addition, 4,301 jobs were created as a result of expenditures by the arts industry, patrons, and visiting artists. No matter how you look at it,

this means an improvement in the Oklahoma quality of life.

Quality of the arts in any community makes it a more desirable place to live. According to the State Arts Council, the excellence of the Tulsa Ballet Theatre, as well as other Tulsa arts organizations, were specifically noted by State Farm Insurance and Kimberly-Clark when they chose to locate their companies in Tulsa. Another example is that of Lawton, selected by Goodyear for a major plant site, with the final decision based on the fact that it had a symphony orchestra.

Of particular importance in the last 20 years is the use of an occupant or hotel-motel tax to provide additional municipal revenues to support tourism and recreation. This tax is automatically assessed to each individual using nightly lodging within the city as he or she pays the hotel or motel bill.

In Oklahoma City, this tax is used entirely by the local Chamber of Commerce to promote tourism. In Norman, the tax supports the local Chamber of Commerce promotional programs, the city park development program, and the Arts and Humanities Council projects. As more cities enact this kind of legislation, the arts will receive more support from those coming briefly to a city, yet who enjoy the artistic and aesthetic benefits of that city.

Changing Tastes in the Fine Arts

Attendance has greatly increased at museums and galleries, is holding its own in the movie and video area, and is declining in the following order among the other performing arts—down in dance, symphonic and pop concerts, theatre, and finally opera. Opera saw the greatest loss of audience attendance.

Audiences are fickle; in many ways their tastes and interests are constantly changing as the arts adjust to that audience demand. In terms of statistical popularity, what the 1960s were to theatre, the 1970s were to dance, the 1980s were to opera and musical theatre. It is difficult to predict what the next direction of public taste will be, but this constant variation is healthy!

The arts will always reflect the society of their time, and consequently they must change as society changes. If they did not, there would be no growth or experimentation. We would still be painting cathedral ceilings instead of abstract nonrepresentational emotions and combining media on canvas.

Current Statewide Arts Policies

Certain statewide policies help guarantee the health of the arts in Oklahoma, and it is important that these policies be continued to give the focus and support necessary for survival.

1) Financial support of the Oklahoma Arts Council and its projects are now part of the annual legislative appropriation bills.

2) Many individual cities and towns have their own arts and humanities councils, working with the Assembly of Community Arts Councils and the Oklahoma Arts Council.

3) The Governor's Annual Arts Awards were established in 1976 by the Oklahoma Arts and Humanities Council during the administration of Gov. David Boren. The annual event, held in the Great Rotunda of the State Capitol, recognizes those individuals and groups throughout the state who have contributed significantly to the arts in Oklahoma.

4) Some cities have hotel-motel or occupancy taxes whose revenues directly support arts and recreation programs in the cities levying them.

In addition, there are certain policies and approaches that can be instituted by both the state and the local municipalities to help promote the growth and development of the arts in Oklahoma.

1) The legislature must continue and increase its support of the Oklahoma Arts Council. It is equally important for it to begin to support the Oklahoma Foundation for the Humanities.

2) The Oklahoma Arts Council and the Assembly of Community Arts Councils must continue actively supporting the creation of arts and humanities councils in cities and towns throughout the state.

3) Media coverage of the Governor's Arts Awards must be increased so people are informed of the quality and quantity of arts programs throughout

the state. This is especially true in the smaller towns. They need and deserve this recognition.

4) All chambers of commerce should form links with their local arts organizations for mutual support and assistance, and the local arts scene should always be part of any city or town promotion for new business and industry. At the same time, arts organizations should always join their local chambers of commerce and be active in their projects.

5) Arts groups should be conscious of the State Department of Tourism and Recreation's projects and activities, and should assist wherever possible, even suggesting mutually beneficial projects.

6) Arts groups should keep their local legislators conscious of their activities and projects, and encourage their personal attendance whenever possible and appropriate.

7) State legislation in capital improvements should always include a percentage of the total cost for art, similar to the federal guidelines. This will ensure that new buildings will always have an aesthetic environment. Business and industry should be encouraged to do likewise.

8) Efforts should be made to provide tax support for the arts in each community. In many ways a hotel-motel tax is a good source of such revenue. However, a few enlightened communities provide direct tax monies to support the arts by underwriting municipal performance spaces, festivals, museums, and art centers.

9) The State Department of Education should actively seek implementation of arts programs in the public schools on the primary and secondary level, utilizing the 1988 National Endowment for the Arts document "Towards Civilization." Local school boards should join in this goal.

The Economic Impact of the Arts

The State of Oklahoma does not have an economic impact model for the arts. Individual umbrella organizations that represent arts disciplines have developed their own. Yet, each model involves different criteria, which complicates efforts to generate any total assessment.

For example, the Oklahoma Historical Society borrows a model from the National Parks Service to estimate the economic impact of their 13 member museums and 14 historic sites. In this model, average daily expenditures are computed for each person attending a museum or historic site. The averages are provided by the chamber of commerce in the community where the museum or historic site is located. The total average expenditure is multiplied by an indirect or induced sales estimate ($\times 1.75$) and combined with similar estimates for tax revenue generated and sales to tourists. For the 1995 fiscal year, this model indicates that \$39.6 million was generated from the 536,000 tourists who visited museums and historic sites.

The Oklahoma Libraries Association, which collates the use and expenditures for its 108 public and institutional library members, records that in the '93-'94 fiscal year nearly \$39 million was spent serving more than 10 million customer transactions.

The Oklahoma Community Theater Association (OCTA) counts the physical assets of its 60+ members along with actual budgets. OCTA's multipliers for direct or induced sales range from 3.00 to 18.00. Total budgets for fiscal year 1995 were \$30 million with more than \$200 million in physical assets (buildings, equipment, etc.). Using the most conservative multiplier, OCTA claims nearly \$54 million in revenues generated throughout the state as a result of the 450,000 persons who attended OCTA member productions.

Equally, many organizations within the state are omitted in models assessing the arts, yet they offer educational and enrichment opportunities to citizens. The Omniplex Museum in Oklahoma City, the Tulsa and Oklahoma City zoos, the educational outreach programs of various halls of fame, for example, are all efforts that greatly enrich the aesthetic life of Oklahoma citizens.

In 1987 the State Arts Council of Oklahoma (SACO) commissioned Dr. A. Ray Grimes to develop an economic impact study of the arts. His findings indicated that in 1987 alone the varying arts events and organizations

- were attended by more than 4 million visitors;
- generated almost \$6 million in state and local taxes;
- generated \$216 million in revenues for the state.

A 1980 estimate of these variables listed tax revenues at just over \$2 million and that arts organizations generated \$112 million in revenue. Grimes analysis indicates that between 1980 and 1987 arts activities in Oklahoma experienced an increase of 174% in taxes for the state and a 93% increase in revenues generated.

In 1992, SACO again commissioned an impact study. The Center for Economic and Management Research (CEMR) at the University of Oklahoma undertook an assessment of the nonprofit arts organizations within the state, meaning that music stores, art supply houses, costume shops, private teachers, and other for-profit arts businesses were excluded from the survey. The impact variables in the 1992 study were different from those used in the 1987 study, but the researchers concluded that nonprofit arts events and organizations:

- generated \$227.9 million;
- spent \$42 million;
- attracted 4.49 million persons to arts events;
- supported 4,798 jobs;
- generated \$74.7 million in personal income;
- received 652,000 hours of volunteer time.

Among the report's incidental findings were indications that attendance at arts events greatly exceeded attendance at major sports events in the state. Also, the arts impact on Oklahoma is increasing at rates greater than the general economy. Expenditures by arts organizations were compared to 1987 figures and the researchers concluded that arts-related growth between 1987 and 1992 was at 41% while personal income during that same period increased only 25%. The 1992 study looked at admission fees, sales by arts organizations, and related consumer spending among 335 arts organizations in the state. According to this study, 125 arts and crafts fairs and festivals were held and more than 5,500 performances were

given in all forms of artistic expression. 5,900 visiting artists came to Oklahoma through sponsorship of the nonprofit organizations or festivals. Government grants to the arts topped \$7 million while memberships and private grants came in at \$16.8 million.

SACO's two formal impact studies indicate that the arts are thriving economic concerns in Oklahoma. Attendance at arts events and monies generated exceed growth in other segments of the economy. The number of arts organizations and events increases each year as does base financial support throughout the state. Impressive though these figures are, they do not tell the whole story. The strength and influence of the arts extends beyond individual events and the persons and organizations that sponsor them. The arts thrive in local firehouses, bank lobbies, shopping malls, civic centers, school auditoriums, parks, and county fairs, where citizens meet to display their works, present plays and concerts, and express their creative energies for the benefit of their fellow citizens.

The arts thrive each time a child reads a book, a senior citizen takes an art class, a school tours a historic site, a teenager buys another CD, or a Native American dons a headdress to dance the history of his or her tribe. The arts are pervasive, intrusive, and inextricably bound to our daily lives and to our efforts to define ourselves as individuals and as members of a time and place.

Therefore, models that claim to project the impact of the arts by economic criteria alone are inherently flawed. The true purpose of the arts, of festivals, museums, performances, etc. is to preserve, celebrate, and educate citizens in the cultural heritages that Oklahomans share. Since the outcome will always be a creative experience, an enlivened spirit, and a richer life, the outcome cannot be quantified precisely. The quality of life that Oklahomans experience is influenced by the arts' presence in their communities, in their state, and in their personal lives. One cannot measure that impact only in economic terms.

Future Trends in the Fine Arts in Oklahoma

It is hard to predict what economic, social, and political impact the arts will have in the future. Based on current trends for the past 25 years, however, it is possible to make the following conjectures:

1) The fine arts will continue to be a vital part of the U.S. quality of life and will probably increase as more free time is available to our populace.

2) The concept of federal and state financial support of the arts has been not only accepted but now is expected.

3) Federal and state support and creation of new "arts in education" programs will grow, which in turn will create an audience demand as these generations enter the mainstream job market.

4) Popularity in the forms of the arts will continue to shift and change, and it will be difficult to predict what the new forms and interests of the future will be; however, a) electronic discoveries and inventions will continue to effect changes in the arts; b) videotape and other new electronic techniques will consume more and more of the performance market; c) television with its techniques and use of electronic equipment will become our primary source of information and entertainment; d) electronic reproduction will seriously effect production of live music in concert to the point that concerts may become combinations of live talent and recorded sound; e) the visual arts market will continue to be a major source of economic activity and investment; and f) the performing arts will become more and more regionally focused, with much of the initial creativity moving out of large urban centers like New York City and Los Angeles.

5) At times of general political stability the arts tend to be conservative, while at times of instability, they tend to be innovative and experimental.

6) Rich nations have great art, while poor nations tend to have great religions. While religious art is some of the world's greatest, it is primarily funded and nurtured by private patrons. Ultimately it is the knowledgeable individual collector/patron who supports the arts best, and is willing to accept the newest directions in the

arts. In the U.S., however, the corporate patron has become a major support system in the latter half of the 20th century.

7) The U.S. is now the center of the contemporary art world, while London continues as the center of the historic art world. The U.S. continues to be the major international influence in the visual arts, dance, and music.

8) Oklahoma will continue to share in this richness as it trains artists and audiences of the future through its higher educational programs, and as its state and municipal legislatures continue their positive support of the arts.

9) Oklahoma is richest in its support of the arts because of a positive attitude of the people which says that the arts are important to our state quality of life, and deserve not only our attention but our financial assistance, corporate as well as individual.

CONCLUSION

One of Oklahoma's great strengths is its people. While our heritage is diverse, the individual human isolation in the early years of statehood made us both self-reliant as well as warm and friendly as inhabitants of the state.

Litton writes:

[T]he load of the settlers was lightened considerably by neighborliness, which was an unfailing characteristic of the pioneers. Helpfulness was second nature to the settlers. Formerly, they had been strangers from remote states; now they were drawn together in this new land by their common interests and hardships. Borrowing became an accepted part of the settler's code.

This very neighborliness and friendliness makes us support the arts out of a personal need as well as a feeling that it is good for all of us. It is something we want to share, that we feel must be a part of our lives. We are willing to support challenge and experimentation in the arts. We seldom say it can't be done. We are willing to stand by with a positive attitude and see if it can. It is up to us to make sure that the arts live up to their promise. At the moment in Oklahoma the arts continue to be fine!

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— Chapter 14 —

LIST OF ILLUSTRATIONS

Table

14.1 — Oklahoma arts festivals, 1997 _____ 238

Oklahoma Resources

Chapter
15

The Cities and the Land

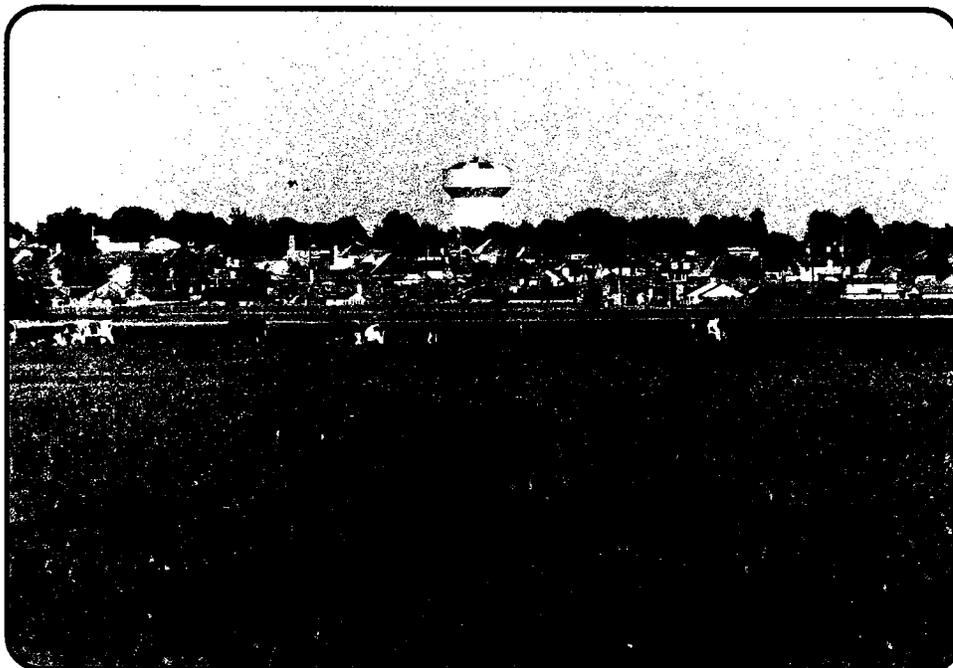
by

Gary L. Thompson,

Michael E. Lewis,

and

Binita Sinha



Contents

Executive Summary _____	251
Introduction _____	251
From Rural Small Towns to Urban Metropolises _____	252
The Contemporary Setting _____	252
The Transition from a Rural Agrarian to an Urban Industrial Society _____	252
Urban Restructuring: 1920–60 _____	253
Increasing Stability and Diversification: 1960–90 _____	253
Contemporary Urban Functions and Spheres of Influence _____	254
Urban Service Areas _____	254
Oklahoma Urban Hierarchy _____	255
Specialized Economic Functions of Oklahoma Cities _____	256
Tulsa and Oklahoma City—Oklahoma’s Major Urban Cores _____	257
Diversified Regional Centers _____	259
Oklahoma’s Most Specialized Cities _____	261
Other Regional Multipurpose Service Centers _____	262
Conclusion _____	262
References _____	262
List of Illustrations _____	264

The Cities and the Land

Gary L. Thompson, Michael E. Lewis,
and Binita Sinha

Executive Summary. — Oklahoma is an urban state with nearly 40% of its population living within the two major metropolitan areas—Tulsa and Oklahoma City. The urbanization of the state took place in a very short period of time relative to other western states. From an early landscape of widely scattered rural farms, the state boomed into the modern era largely as a result of rapid and dynamic changes in the energy industry. The transformation of agriculture due to mechanization, drought, farm consolidation, market prices, and economies of large-scale production increased the urban manufacturing population as farm people left rural areas for the cities.

In functional terms, Oklahoma's cities tend toward diversity rather than specialization. Manufacturing, transportation services, finance, insurance, and real estate are all represented, in addition to oil and gas and agricultural service and processing industries. Government employment, both federal and state, is also a major component of Oklahoma's urban economic base.

Tulsa, Oklahoma City, and Lawton define a northeast-to-southwest urbanized corridor within the state. Tulsa functions primarily as a manufacturing and corporate center for a number of industries, including petroleum, for which it is best known. Oklahoma City provides a range of economic functions and services, with public administration and government forming a major component of its economic base. Oklahoma City also serves as a regional retail, wholesale, and financial center for a large market area that extends west of the city to the Panhandle.

The future appears bright for the new cities of Oklahoma. The movement of hard-working, trained, and well-educated people from all parts of the state and the nation into Oklahoma's cities has created a mix of ideas, skills, and leadership that will carry the state forward into the next century. The results have been population expansion and a resurgence of optimism as the state has participated in the growth of the Sunbelt. The population, income, and general prosperity of Oklahoma cities have increased. The people of the state have grown more confident in their future, and are justifiably proud of the quality of life in Oklahoma's cities.

INTRODUCTION

Oklahoma is home to some of the fastest-growing cities in the region. Overall, the state's population grew 18.2% between 1970 and 1980. The U.S. Census Bureau estimated that between 1980 and 1985, the population increased an additional 9%, from 3,025,487 to 3,297,952 residents. After 1985 growth slowed and some out-migration occurred due to the downturn in economic conditions. The contraction was overcome by natural population growth and a stabilizing economy during the late 1980s. In 1990, the state population registered an increase of 35.10% over that of

1960. Most of the urban growth and development of the 1970s remains evident in the large metropolitan regions centered around Oklahoma City and Tulsa. The state's fourth largest city, Lawton, experienced a very rapid and positive economic recovery based on new manufacturing facilities, while Norman became the third largest city in the state.

Growth and diversity continue to characterize the major cities of Oklahoma. As centers of large commercial market regions, they form a dynamic network of social, cultural, and economic linkages that underpin economic life in the Sooner State. This

chapter provides an assessment of how this network of urban places developed, the basic contemporary functions served by the cities of the state, and a description of the special characteristics and attributes of some of the largest urban areas in Oklahoma.

Oklahoma's cities serve as focal points for the marketing and distribution of goods and services within the state and the nation. Newspaper circulation provides a way of measuring the market areas served by Oklahoma's cities. A general hierarchy of metropolitan market centers can be identified, with Oklahoma City and Tulsa each occupying primary posi-

tions, followed by smaller regional market centers such as Enid, Lawton, and Muskogee.

A functional economic classification of Oklahoma cities will further illustrate both the diverse character and specialization among Oklahoma's cities. Contrary to popular views, most Oklahoma cities are neither energy-dependent nor agriculture-dependent. A broad mix of industries and service functions brings diversification and stability to many Oklahoma towns and cities.

Cities are not only places of work, but places where people live. The living environment of Oklahoma's cities will be investigated here, and the distinct character and cultural heritage of the major cities of the state will be described and documented.

FROM RURAL SMALL TOWNS TO URBAN METROPOLISES

The Contemporary Setting

Contemporary Oklahoma has both urban and rural characteristics, but in simple terms of population the state is primarily urban, with most of the population living within the metropolitan centers along an axis from Lawton in the southwest, through Oklahoma City, to Tulsa in the northeast. Two counties, Tulsa and Oklahoma, contain nearly 40% of the total population. Additional population is concentrated along the peripherals of the urban corridor (Map 15.1). Satellite cities and other developments extend as far as 60 miles from the two

metropolitan centers, creating large fields of commuting and urban-oriented economic activities within the urban corridor.

Significant portions of Oklahoma retain a rural character. Some of these areas have experienced a revival of economic growth and development similar to that in the urban areas. This development is complex in character but largely resulted from changes in Oklahoma's economic structure, including the dispersal of small-scale manufacturing plants. Improvements in communications, transportation, and service infrastructure in the smaller towns of Oklahoma have made much of this rural renaissance possible. Regional service centers have grown to play significant social and economic roles in the rural regions of western and southeastern Oklahoma. As these trends continue, past distinctions between rural and urban lifestyles have become subtle and the opportunities for combining the best of both worlds are increasing.

The Transition from a Rural Agrarian to an Urban Industrial Society

Oklahoma has not always been an urban state, even though some towns in the western half of the state sprang into existence in a matter of days. Much of the state followed the pattern common in other areas of the Midcontinent: early agricultural settlement gave way to increasing urbanization and diversification in larger cities. A

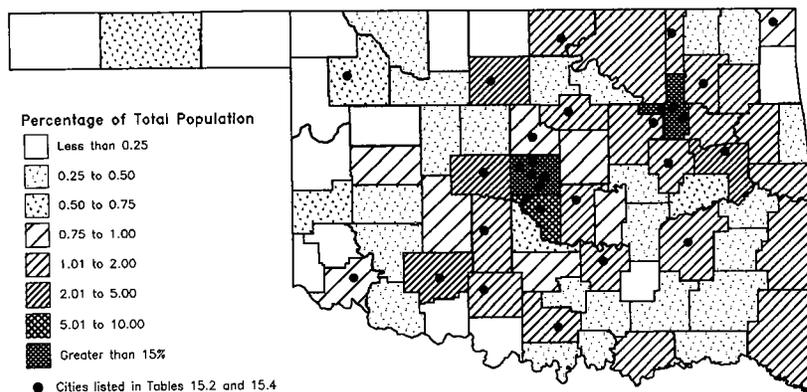
significant difference in the case of Oklahoma was the speed of its evolution from a commodities-based economy to one focused on manufacturing, government, and commerce. This section briefly reviews the urbanization process from rural small towns to the dominance of urban metropolitan centers.

From the time of statehood in 1907 until the census of 1920 the population of Oklahoma grew steadily in nearly all regions. Many new arrivals established farms as a result of land runs and lotteries. Others purchased land from the federal government or leased land from the Five Civilized Tribes, which consisted of the Cherokee, Choctaw, Chickasaw, Creek, and Seminole Indian Nations. These tribes had been farming and ranching in eastern Oklahoma since the early 1830s. Members of several Plains Indian tribes occupied lands in western Oklahoma.

Following the Civil War, southerners began moving into the eastern and southern fringes of the present day state in increasing numbers. Following the lead of the Indian population, they tended to establish small cotton and corn farms in the river valleys and creek bottoms of the Indian lands. Other settlers set up informal villages and trading centers along the military roads and rail lines which crossed the forested uplands and open prairies of the Indian Nations.

Midwestern grain and livestock farmers were attracted to the prairies of the Cherokee Nation in northern and central Oklahoma. Settlers scattered widely over the land in typical midwestern fashion, establishing wheat farms and cattle ranches in the west, and corn, cotton, and mixed livestock farms in the east.

The wide dispersion of settlers earlier in Oklahoma's history contrasts with the present pattern of more concentrated settlement. In all but the most mountainous areas of the state a farmhouse occupied nearly every quarter section, a school stood every three to six miles, and hundreds of small towns and villages were a short wagon drive apart. These small towns provided the basic services and supplies needed to operate a farm. It was a highly decentralized and locally ori-



Map 15.1—Percentage of total population by county, 1990. Source: U.S. Bureau of the Census (1990), as reported by the Oklahoma Department of Commerce, Oklahoma State Data Center, Population of Oklahoma Cities, 1990.

ented pattern, with county seats serving as the focal points of government, trade, and services.

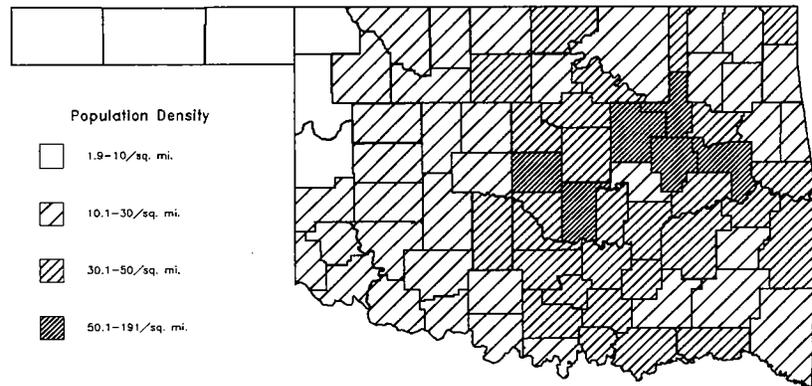
The early uniformity of population distribution can be seen in the census of 1910, when the density of population was 23.9 persons per square mile throughout the state. Just six counties were settled by fewer than 10 people per square mile and only Oklahoma, Tulsa, Muskogee, and Pottawatomie Counties reported a population density greater than 50 persons per square mile.

The discovery and development of Oklahoma's oil and gas resources began to attract large numbers of people to various fields of the Oklahoma "oil patch" in the central and northeastern portions of the state. Development of these energy resources first stimulated the growth of Tulsa, and later, Oklahoma City. By 1920 the population density of the state reflected oil and gas development and the rapid urbanization of northeastern Oklahoma (Map 15.2).

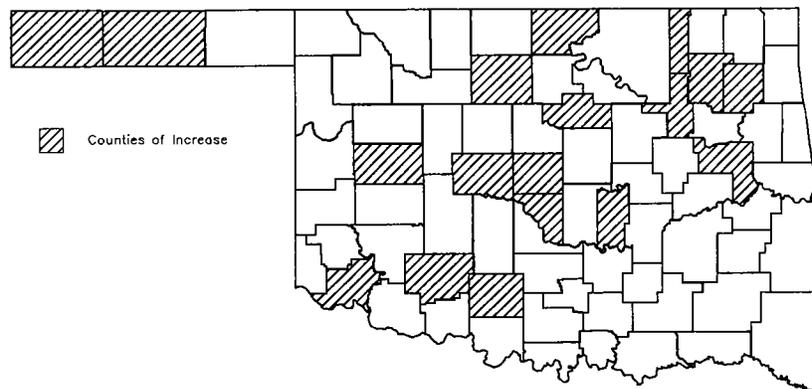
Urban Restructuring: 1920–60

A significant transition in the character, structure, and function of Oklahoma's cities and towns took place between 1920 and 1960. When it was complete, the population patterns of Oklahoma had changed dramatically. The general trend during much of this period involved a redistribution and adjustment of the state's population and economic base from the widely dispersed, locally oriented agricultural or oil-field landscape of the early years to an urban hierarchy based on a diversified mix of services, manufacturing industries, and government employment. A diagonal axis of urban growth from southwest to northeast began to emerge (Map 15.3).

The Great Depression of the 1930s shook the entire nation, but Oklahoma in particular became synonymous with rural poverty, drought, and migration in the popular literature and news media of the day. A significant period of recovery began as government employment and agricultural prices increased immediately following the Second World War. The image of a state plagued by "hard times" was revived again in the early 1950s as farmers on the Southern



Map 15.2—Population density by county, 1920. Computed from data in *The Oklahoma Almanac, 1993–94* (1993).



Map 15.3—Population increase by county, 1920–1960. Computed from data in *The Oklahoma Almanac, 1993–94* (1993).

Plains suffered from another severe drought. By 1960, the population in many Oklahoma counties had decreased because environmental factors, along with increasing agricultural mechanization, and farm enlargement, made survival on small farms difficult.

The oil industry, like agriculture, experienced advances in technology. Better equipment and more mobile drilling rigs moved into common usage. As the rural road system improved, drilling materials could be transported more quickly and easily from distribution centers without the need for local sources of supply. As a result of these changes the many small towns serving the oil fields were consolidated into larger urban centers, and oil-field workers commuted to their jobs at the well site from homes in towns and cities throughout the state.

Much was written about the migration from rural Oklahoma between 1930 and 1960. Many accounts emphasized the movement of tenant farmers to distant regions, particularly the Pacific Coast. Most people who changed residences did not leave the state, but simply moved away from a farm or oil field to a larger town or city where they took jobs in a rapidly diversifying urban economy. Oklahoma's cities became the growth poles of this transition period.

Increasing Stability and Diversification: 1960–90

Between 1960 and 1990 the emergence of a substantial manufacturing industry and the increasing influence of the government and professional services sector of the economy brought a general measure of stability and diversification to Oklahoma's cities. In rural eastern Oklahoma, high birth

rates and the search for a pleasant place to retire were among a variety of factors that brought a resurgence of population growth.

The early stage of the trend towards diversification and stability was given a significant boost during the 1950s with the expansion of several major defense facilities in Oklahoma. One of these, the Oklahoma City Air Materiel Area, subsequently known as Tinker Air Force Base, employed 23,650 personnel and had an annual payroll of \$84 million during the early 1950s.

Manufacturing growth was stimulated by a variety of factors. A surplus labor supply resulting from modernization and mechanization of agriculture and energy production provided a natural opportunity for the location of manufacturing plants. Improvements in the state's transportation infrastructure further stimulated the development of manufacturing by making rapid access to national and world markets possible. Federal investment in transportation included construction of an interstate highway corridor between the Great Lakes and the Pacific Coast via Oklahoma, an inland waterway port at Tulsa, and international airports at Tulsa and Oklahoma City.

By 1980 manufacturing had become the largest contributor to the state's gross economic product. Machinery, electronic equipment, textiles, glass, and fabricated metals are just some of the industries that have diversified Oklahoma's economy and helped to make it a prominent urban industrial state.

Initially, most manufacturing plants concentrated development in the Tulsa and Oklahoma City metropolitan centers. Only 14 of Oklahoma's counties produced 80% of the goods manufactured in the state in 1972. Nearly all of these counties were clustered along the southwest-northeast axis of Oklahoma's urban growth corridor between Lawton and Tulsa.

More recently, new industries have increasingly chosen to locate in smaller towns and cities, particularly those in the northeastern section of the state where a high rate of natural increase has produced a large labor pool. This population surge in north-

eastern cities and towns has been enhanced by increased recreational and retirement area development associated with the construction of large freshwater lakes in the scenic Ozark uplands.

The greatest growth has occurred in Oklahoma's metropolitan statistical areas (Map 15.4). Much of this development has been the result of migration. A majority of new metropolitan residents have moved from rural areas within Oklahoma, but sizable numbers of new residents have come to Oklahoma from other regions (Table 15.1). Between 1980 and 1988, the population of Canadian County increased by 30.6%, of which 63.40% was an increase due to netmigration. Similarly, Cleveland County recorded an increase of 22.7% during the same period, 56.39% through netmigration. In McClain County, 64.86 percent of the total increase in population during 1980 and 1988 was due to immigration. Some of the other counties where immigration contributed significantly to the increase in population during 1980-90 are McIntosh, Marshall, Wagoner, Sequoyah, and Rogers. This mixture of new people from a variety of backgrounds and experiences has created a favorable business climate for growth and innovation.

CONTEMPORARY URBAN FUNCTIONS AND SPHERES OF INFLUENCE

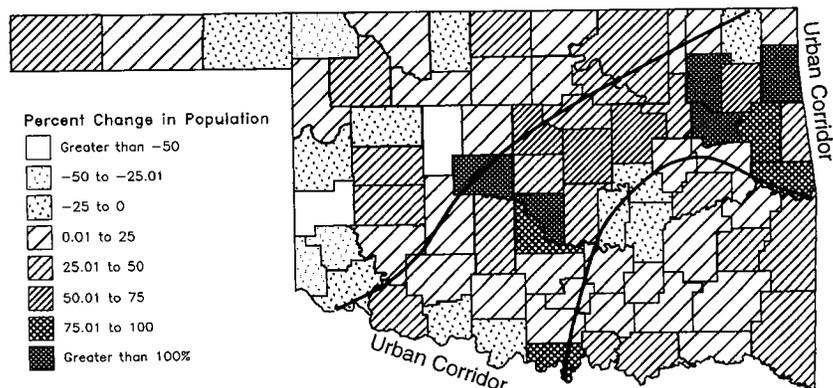
The economic functions provided by Oklahoma's cities extend well beyond their physical boundaries. The

spheres of influence of Tulsa and Oklahoma City, for example, reach out to regional service centers and rural markets within and beyond the state. Measuring the extent of these market areas is not an exact science. Trade area boundaries vary according to the economic function that defines the sphere of influence. One of the most reliable indicators, newspaper circulation, will be used in this chapter to identify the market areas of some of Oklahoma's major cities. This will be followed by an analysis of the economic specialization of 30 Oklahoma cities based on categories of employment.

Urban Service Areas

Newspaper circulation serves the dual purpose of indicating both informational and advertising functions. The market areas of the major cities of Oklahoma are mapped in terms of a regional analysis of newspaper circulation (Map 15.5).

Oklahoma City and Tulsa are clearly the leaders of Oklahoma's urban hierarchy. Based on the circulation of the *Daily Oklahoman* and *Sunday Oklahoman*, published in Oklahoma City, and the *Tulsa World* and the former *Tulsa Tribune*, the two cities dominate all sections of the state, surpassing the circulation area of any other regional center. The circulation of the *Oklahoman* spreads westward and southeastward across the state, reaching as far as Morton County, Kansas, and Ochiltree County, Texas, in the Panhandle region. To the northeast, the



Map 15.4—Percent change in county population, 1960-90. Computed from data in *The Oklahoma Almanac, 1993-94* (1993).

Table 15.1 Immigrants, Outmigrants, and Net Migration into Oklahoma, 1987-90

Year	Immigrants (By region of origin) (in 000's)					Outmigrants (By region of destination) (in 000's)					Net Migration
	Total	NE	MW	S	W	Total	NE	MW	S	W	
1987-88	33	4	23	-	6	26	4	6	-	16	7
1988-89	87	2	53	-	32	75	5	15	-	55	12
1989-90	52	2	25	-	25	66	-	39	-	27	-14
NE - Northeast		MW - Midwest			S - South		W - West				

Source: U.S. Department of Commerce (1990b).

market area of the *Oklahoman* is preempted, and the *Tulsa World* predominates. There is considerable overlap, however, in the circulation of the two newspapers along a broad transitional band arching from Kansas to Arkansas about midway between the two cities.

Enid and Lawton have large market areas in the northwest and southwest, respectively, and illustrate the regional influence of cities in the second tier of Oklahoma's market hierarchy. Enid is the principal business and service center of Oklahoma's prime wheat lands, while Lawton serves a diverse rural area primarily devoted to agriculture, oil and gas production, and government employment. Another city in this tier, Muskogee, is the market center for a diverse rural population along the Arkansas River Valley and the Ozark Uplands in eastern Oklahoma. Satellite cities such as Norman and Edmond, near Oklahoma City, and Broken Arrow, near Tulsa, generally have newspapers that are more locally oriented, with smaller circulation areas, because of the dominant influence of neighboring metropolitan area newspapers.

At the third tier of the market hierarchy are the business and service centers of Oklahoma's most prosperous small towns and rural areas, with newspaper circulations greater than 5,000 and populations of less than 40,000 residents. The newspapers represented range from the *Guymon Herald* and the *Idabel Gazette* at opposite corners of the state, to the *Shawnee News Star*, which serves households in central Oklahoma. Most of these newspapers serve as information and ad-

vertising outlets for their immediate areas. In many of these communities it is not unusual for a household to receive both the local newspaper and the major newspaper of either Tulsa or Oklahoma City.

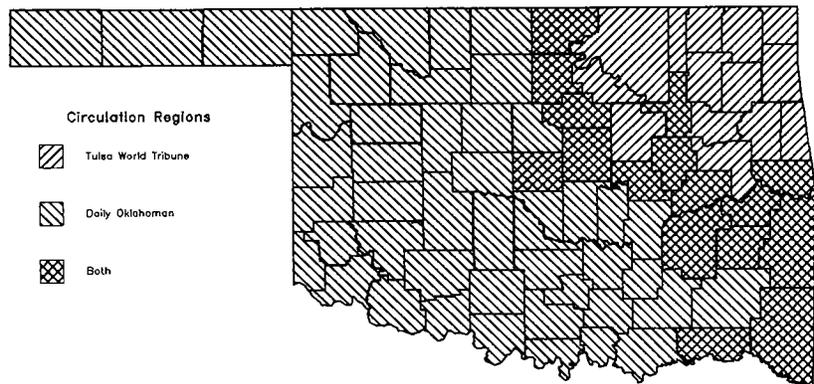
A fundamental trend that accompanies the process of urbanization is geographical expansion of trade areas and the economic dominance of large cities. Trade areas are dynamic, expanding and contracting with population change. Using newspaper circulation as a primary indicator of trade areas, it is clear that Oklahoma City has a slightly more extensive trade area than Tulsa, as might be predicted from the populations of the two cities. This pattern, however, underestimates the size of Tulsa's trade area because many western Oklahoma counties are very lightly populated. The Tulsa newspaper also has significant circulation in many Arkansas, Missouri, and Kansas counties.

Below the level of the two metropolitan centers, it is clear that Enid, Lawton, and Muskogee represent significant regional centers with trade areas covering significant areas. Slightly smaller regional centers include McAlester, Ada, Ardmore, Woodward, Miami, and Ponca City. Below this level, most counties are commercially centered on a single county seat. In considering Oklahoma urban regions, it is necessary to recognize that highly specialized urban economies may have market regions which are larger than their populations suggest. The markets for cities such as Bartlesville, the headquarters city of Phillips Petroleum, or Duncan, the home of Halliburton (oil well services), are found far outside Oklahoma in the world's petroleum production regions.

Another consideration in Oklahoma's network of urban places is the existence of Fort Smith, Arkansas, near Oklahoma's eastern border. The labor shed for this city extends into Oklahoma's Adair, Sequoyah, and Le Flore Counties and it exerts a significant influence in the commerce of these border counties.

Oklahoma Urban Hierarchy

Cities provide goods and services based on the population of their market regions. Most first-order places serve a collection of families engaged in primary economic activities such as agriculture or mining. Larger, second-order places—in most cases county seats—serve a number of smaller



Map 15.5—Regional market areas of newspaper circulation, 1984–85. Source: American Newspaper Markets, Inc. (1985).

towns with more specialized goods and services. Finally, regional service centers serve a number of county seats and rural service center. Although there is much variation in size of towns and cities, many first-order places have a population of about 500, second-order county seats about 10,000, and regional service centers, 50,000 people. Manufacturing, tourism, government employment, or transportation arteries may cause great differences in city size.

Oklahoma's urban system is very clearly organized below the levels of the two dominant metropolitan centers, Oklahoma City and Tulsa. Patterns of the regional system are easily recognized in most of the state.

Enid, a prosperous regional service center for a large market region oriented to wheat, cattle, and oil and gas production, serves the northwestern quadrant. Within Enid's market region Woodward has shown strong growth, particularly during the period of active oil exploration. Woodward now serves as a subregional center in the Enid market area. Guymon, in the Panhandle, lies in the domain of Amarillo, Texas, for some economic functions. Despite the distance, ties to Oklahoma City remain strong for Panhandle counties.

Lawton serves the entire southwestern area of the state, a role which it has assumed through rapid population growth in recent years. Lawton has captured business from cities that were once in the commercial shadow of Wichita Falls, Texas. Commercial air travel, a regional newspaper, television broadcasting, and wholesaling are central functions of such a regional service center. The city of Duncan, once a rival center, now looks to Lawton for high-order goods and services.

Ardmore, in frontier days the dominant city of southern Oklahoma, continues to serve as a regional service center for the Arbuckle Mountains and several southern counties. Norman, principally a center of government employment and commuters for Oklahoma City, has established itself as a regional service center for several counties to the south. This recent development has occurred as a result of new commercial activity that

competes directly with Oklahoma City.

Ada continues a strong commercial role in Pontotoc and surrounding counties. In southeastern Oklahoma, the small city of McAlester plays a role as the principal regional service center for the Kiamichi Mountain area. Its small population somewhat understates the importance of the city in the regional economy of the southeast. Its strong financial institutions give a better indication.

Muskogee, once the regional center of the northeast, has seen its market area diminish with the encroachment of Tulsa and Fort Smith, Arkansas. It still retains a significant commercial role in the Arkansas Valley area. Northeastern Oklahoma is heavily influenced by the close proximity of Tulsa, though Miami serves the far corner region. Ponca City, in the north, has an important regional role but it lies at the borders of the market regions of Tulsa, Oklahoma City, Enid, and Wichita, Kansas.

Specialized Economic Functions of Oklahoma Cities

Oklahoma cities provide a wide variety of goods and services to their respective market areas, both urban and rural. As in the case of market areas, a wide number of methods have been developed for classifying the types of economic functions that cities provide to their respective service areas. One method developed by Nelson relies on readily available data and measures the degree of specialization or diversification for each city by using employment in basic industrial groups. Applying this method to 30 Oklahoma cities reveals the widely diverse economic character of the state, as well as the special functions served by individual cities.

Thirty Oklahoma cities with populations greater than 10,000 in 1985 were selected for analysis (Table 15.2). Eleven employment groups reported by the U.S. Bureau of the Census were then chosen to represent the broad spectrum of goods and services provided by urban places (Table 15.3). The categories chosen for analysis were: (1) agriculture, including horticultural workers, grain elevator and storage workers, and animal caretak-

Table 15.2 Oklahoma Cities with More Than 10,000 Residents in 1985 and Their Population in 1990

City	Population	
	1985	1990
Ada	16,917	15,820
Altus	23,786	21,910
Ardmore	24,845	23,079
Bartlesville	35,708	34,256
Broken Arrow	46,972	58,043
Chickasha	17,020	14,988
Claremore	14,374	13,280
Del City	27,050	23,928
Duncan	23,226	21,732
Edmond	46,162	52,315
Enid	52,502	45,309
El Reno	17,223	15,414
Guthrie	12,136	10,518
Lawton	85,629	80,561
McAlester	18,418	16,370
Miami	14,189	13,142
Midwest City	53,385	52,267
Moore	40,289	40,318
Muskogee	42,792	37,708
Norman	75,350	80,071
Oklahoma City	432,812	444,719
Okmulgee	16,190	13,441
Ponca City	28,616	26,359
Sand Springs	14,358	15,346
Sapulpa	17,518	18,074
Shawnee	27,932	26,017
Stillwater	38,044	36,676
The Village	11,983	10,353
Tulsa	374,535	367,302
Woodward	15,318	12,340

Source: U.S. Department of Commerce (1990b).

ers; (2) mining, principally oil and gas extraction, but also including significant employment in sand and gravel operations, gypsum mining, and coal mining; (3) construction and building trades; (4) manufacturing; (5) employment in transportation, communications, and public utilities; (6) wholesale trade; (7) retail trade; (8) banking, insurance, real estate, and other financial services; (9) businesses engaged in repair and other personal services, including automobile repair, private household services, entertainment, and recreation; (10) professional services, including medical, legal, and education professionals; and (11) public administration professions, limited to regular government functions, meaning the legislative, judicial, administrative, civil service, and regulatory activities of government.

Once the functions were identified, employment data for each city were

Table 15.3 Economic Activities in Oklahoma by Percent of Employed Persons Within 11 Major Industrial Categories

Industry	Average of 30 Cities (%)	Standard Deviation (n=30)
Agriculture	1.283	0.8748
Mining	4.987	5.614
Construction	6.434	1.215
Manufacturing	16.702	6.562
Transportation, communications, and public utilities	6.612	1.765
Wholesale trade	4.163	1.486
Retail trade	17.990	2.486
Banking, insurance, real estate and other finance	5.677	1.565
Business, repair and other personal services	7.659	1.304
Professional services	21.537	6.631
Public administration	7.044	4.485

Source: U.S. Department of Commerce (1990b).

tabulated and the average and standard deviation from the average employment for all 30 cities were calculated (Table 15.4). The calculations were made on a percentage basis to control for differences in the size of the labor force among the 30 cities. Based on this classification method, professional services, retail trade, and manufacturing are the major functions performed by Oklahoma cities in terms of total employment. The functions that vary most widely among the 30 cities are professional services, manufacturing, and mining.

The number of standard deviations above or below average are noted by the numbers one, two, or three in a city's classification code. For example, cities that were between zero and one standard deviation above average for a given service function were considered to be specialized in that particular service or industry.

Tulsa and Oklahoma City—Oklahoma's Major Urban Cores

Oklahoma City is not only the largest city in Oklahoma, with 958,839 residents in its greater metropolitan area

and 444,719 in the city proper in 1990, but also a remarkably diversified urban center. Oklahoma City is the state's capital and center of government administration, as well as a center of transportation, financial services, wholesale trade, and a wide variety of business, repair, and entertainment services. The presence of significant government and mining sectors gives it a diversified economic base.

Oklahoma City is a very important marketing center for livestock and a major processing/distribution center for livestock, grains, and cottonseed oil. Oklahoma City functions as transportation hub, not only for agricultural commodities, but also the wholesaling and jobbing of a wide variety of commodities and products sold throughout the state and region. Regional and national aviation, trucking, and rail transportation all use Oklahoma City as a distribution and warehousing center.

Aviation in particular has become not only an economic function, but a private interest of many residents of the Oklahoma City area. The number of private pilots and general aviation airports in the area is far above the national average. Both civilian and military aviation-related payrolls provide income for thousands of people in the metropolitan area.

The Oklahoma City Air Logistics Center, located at Tinker Air Force Base in the southeast section of the city, provides an air logistics and aircraft repair service for the U.S. Air Force's worldwide installations and aircraft fleet. It is the largest single employer in the state, with some 25,000 civilian and military personnel on its payroll.

Across the city from Tinker Air Base, the Will Rogers World Airport and the Mike Monroney Aeronautical Center have kept Oklahoma at the forefront of the jet age. Associated with the aeronautical center is the Federal Aviation Administration's national research center and records warehouse for all U.S. pilots. The center's permanent staff employs around 3,300 people plus some 14,000 students who come for training in air traffic control.

Agriculture and petroleum-related industries and financial services for a majority of the surrounding area of

the state and region are also centered in Oklahoma City. Most of the state's largest banks have their main offices in the renovated downtown district.

Personal services are another major function provided by Oklahoma City. The downtown district, where a number of the largest hotels and convention centers in the state are located, offers a major portion of the city's above-average employment in the personal service industry. Business consulting and a variety of repair and supply services, from automobiles to electronic equipment, form another major segment of the city's personal service role. The Hertz Corp. has a national reservation center located in Oklahoma City.

Entertainment and amusement parks also contribute to the city's service function. Oklahoma City is the site of a number of nationally recognized cultural and arts facilities, including the National Cowboy Hall of Fame, as well as a regional amusement park playground, with several local theme parks. The Remington Park Thoroughbred race track is rapidly establishing itself as one of the nation's highest-quality facilities. It anchors a collection of recreation facilities in the northeast quadrant. The Oklahoma City Zoo adjacent to Remington Park has been compared to the best in the country. Also nearby are museums such as the Cowboy Hall of Fame, the Firefighters Museum, the Softball Hall of Fame, and the 45th Infantry Division Museum, plus a growing collection of associated restaurants and motels. These facilities are functionally linked together to form the basis of a major cluster of recreation and entertainment.

In addition to being the largest city in the state, Oklahoma City is one of the largest cities in the country in terms of physical land area. Its incorporated area covers 621 square miles, primarily as a result of a series of annexations in the early 1960s. In the process of spreading its incorporated boundaries over a wide area, several cities became surrounded by Oklahoma City. The Village, Edmond, Del City, and Midwest City are four examples included in this analysis because their populations exceed 10,000 people. The Village is an incorporated

Table 15.4 A Functional Classification of Oklahoma Cities

City	Population (1985)	Classification ¹
Ada	16,917	D ² (R, ProS, PerS, F, AG)
Altus	23,786	R3, AG2, PA1
Ardmore	24,845	D (M, T, R, W, F, PerS)
Bartlesville	35,708	Mi3, M, PerS
Broken Arrow	46,972	W2, F1, T1, C, M
Chickasha	17,020	AG1, M1, Mi, ProS
Claremore	14,374	C1, T1, PerS, F, AG
Del City	27,050	PA2, T, PerS, R
Duncan	23,226	Mi2, M1
Edmond	46,162	F1, W1, ProS, C, Mi
Enid	52,502	T1, W, R, Mi, AG, C, PerS, ProS, C
El Reno	17,223	AG2, T2, C1, PA, R
Guthrie	12,136	AG1, C, ProS, PA
Lawton	85,629	R2, AG1, C1, PerS1, PA
McAlester	18,418	PA1, PerS1, W, F
Miami	14,189	M1, R, AG, ProS
Midwest City	53,385	PA2, T
Moore	40,289	T1, F1, W, PA, C
Muskogee	42,792	D (W, C, M, ProS, T, PA)
Norman	75,350	ProS2, R, PA
Oklahoma City	432,812	PerS1, F1, W, T, PA
Okmulgee	16,190	ProS1, R, AG, C
Ponca City	28,616	M1, C, PerS
Sand Springs	14,358	M2, F1, C, W, T
Sapulpa	17,518	M1, T, W
Shawnee	27,932	C1, PA, F, ProS, R
Stillwater	38,044	ProS3, AG1, R
The Village	11,983	F2, W2, PerS1, R, ProS
Tulsa	374,535	W1, PerS1, T1, M
Woodward	15,318	Mi3, C1, R1

¹ Functional Classification Key

Agriculture	AG
Mining	Mi
Construction	C
Manufacturing	M
Transportation, communications, public utilities	T
Wholesale trade	W
Retail trade	R
Finance, insurance, real estate	F
Personal services	PerS
Professional services	ProS
Public administration	PA

² D = Diversified city. Numbers associated with classification symbols indicate the number of standard deviations above the average for the 30 cities included in the analysis.

Source: Computed by G.L. Thompson and M.E. Lewis.

wholesale and financial district completely surrounded by Oklahoma City. Edmond is one of the fastest growing residential communities in the state, as well as the location of a number of wholesale, financial, and professional services of its own. Del City and Midwest City were both developed by private developers in response to the location of the Oklahoma City Air Logistics Center. Their major role has been to provide housing and shopping facilities in support of the Air Center.

One aspect of Oklahoma City's manufacturing economy often goes unnoticed. The assembly of computer components is of considerable significance. The large Western Electric plant is one of the regions largest points of employment with over 5,000 employees. Hitachi, Xerox, and other firms place Oklahoma City on many maps of "high-tech" industrial centers. A support system of vocational and technical institutes provide a well-trained work force for most levels of electronics production.

Oklahoma City has one of the lowest intensities of land use of all U.S. cities. Beyond the ring of suburban cities, an extensive belt of rural acreage surrounds the metropolitan core. As a functional urban system, Oklahoma City and environs extend over a geographical area that approaches 5,000 square miles. This massive urban field encompasses almost 1 million people within commuting distance of the core, making it an urban region of greater magnitude than commonly recognized. It looks to the west, serving a large sector of the southern plains. In this role, it resembles Minneapolis, Omaha, Kansas City, and Dallas/Fort Worth. Perhaps the dominant characteristic of the central Oklahoma urban agglomeration—low population density—has prevented it from being as well-recognized as older, more compact cities.

Tulsa, Oklahoma's second major metropolitan center, lies 100 miles northeast of Oklahoma City and forms the second pole within the urban axis of the state. With a population of 367,302 within the city itself, and 708,954 residents in its greater metropolitan area in 1990, it is a close rival to Oklahoma City as the most populous metropolitan center of the state.

While Oklahoma City stands out as the center of public administration and finance for the state, Tulsa and surrounding cities specialize in manufacturing employment. Oklahoma City has manufacturing industries, but employment in those industries is not above the state average, as it is in the case of the Tulsa metropolitan area.

Another conspicuous difference in the two cities is the lack of federal government employment in the Tulsa area as compared to Oklahoma City. While the aircraft industry is well-represented in Tulsa, no large concentration of federal employment is found in the metropolitan area.

Tulsa's historical development was significantly different from that of Oklahoma City. Rather than being born suddenly during a land run, Tulsa experienced a period of gradual growth and development. The recorded history of Tulsa dates back to 1836 when Achee Yahola, a Creek Indian chief, built a village on the present site of Tulsa following the removal of

his people from Alabama over the Trail of Tears.

Late in the 19th century Tulsa was a cattle-trading and railroad way station. In 1905, oil was discovered just south of the city, setting off a rush to the Glenpool area and an explosion of petroleum development and industrialization. As a result of the establishment of corporate headquarters for a number of petrochemical industries, Tulsa earned the title "Oil Capital of the World." The city's population more than tripled between 1910 and 1920, and then nearly doubled during the 1920s. Oil refining and oil-related financial and administrative services are still a major part of Tulsa's employment base, and several major oil companies continue to maintain regional headquarters in Tulsa.

Great strides in developing the Tulsa transportation infrastructure have enhanced economic development as well. Tulsa's economy took on an added dimension when the McClellan-Kerr Arkansas River Navigation System was completed in the early 1970s, making Tulsa the nation's westernmost inland port city. The nearby Port of Catoosa makes Tulsa a major shipping and receiving point for goods and materials transported by rail, truck, or river barge. High bulk, low unit-value products such as grains and heavy construction materials are important commodities on the system. Additional transportation improvements, most in the form of belt-line freeways around the city, and a direct turnpike linking Oklahoma City, helped spark middle-income residential development and industrial expansion in the area south and east of the downtown business district.

The city of Tulsa and its surrounding municipalities have invested heavily in manufacturing and construction industries in an effort to make use of recent improvements in transportation and to bring greater diversity to the region. Aviation and petroleum-related manufacturing and refining are currently the two dominant industries in the Tulsa metropolitan area. The city is the site of an international airport as well as several plants that manufacture aircraft and aerospace components and avionics equipment. Tulsa is also the location

of several large regional offices of a variety of corporate employers. Much of the growth in employment in these nonpetrochemical industries took place within the past 20 years.

Tulsa is somewhat unusual among large urban centers in that much of the manufacturing industry of the metropolitan area takes place in industrial towns and cities surrounding Tulsa, while residential development has been encouraged and maintained by a strong city planning infrastructure within the city itself. Instead of a flight to the suburbs, Tulsa has maintained healthy and vibrant residential areas that have drawn people into the city. Commuters traveling to manufacturing jobs in the Tulsa region are likely to be traveling from within the Tulsa city limits to jobs in surrounding industrial towns, a pattern the opposite of most cities.

Tulsa is noted for the high quality of urban life centered around one of the premier residential areas in North America—South Tulsa. This large area of stately homes has experienced stability and maturation rather than flight and decay. With its well-regarded art museums, its new University Center for Higher Education, and its Arkansas Riverfront Park Development, Tulsa is characterized by a high degree of civic pride and commitment to maintaining a high quality urban environment.

Tulsa has only one sizable bedroom community—Broken Arrow. Other surrounding cities are manufacturing centers that are relatively autonomous. Sand Springs and Sapulpa are probably the best examples of industrial towns on the outskirts of Tulsa. More than 35 manufacturing industries are located in Sand Springs, making a range of products from glassware and bakery goods to fabricated steel.

Diversified Regional Centers

Nine cities meet the criteria for classification as diversified cities. They range in size from Oklahoma City to Ada and Claremore, two of the smaller local service centers. Oklahoma City has already been discussed. Each of the smaller diversified regional cities will be briefly discussed in this section.

Ada

Ada was named for an early store owner's daughter, and grew from a post office and general store in the Chickasaw Nation to become the county seat of Pontotoc County at the time Oklahoma became a state in 1907. Ada is now the regional service and educational center of a primarily nonmetropolitan, south-central economic area of the state.

A total of 40 manufacturing plants employ more than 1,500 people in Ada. The two largest employers, a glass plant and a cement plant, make use of nearby supplies of glass sand, limestone, and natural gas. Aside from manufacturing, Ada's principal functions center on retail trade, professional and personal services, including real estate and finance, and the sale and production of high-grade beef cattle.

Ardmore

Ardmore originated in 1887 as the principal rail outlet for the agricultural products of the Chickasaw Nation. Following the establishment of the town as an agricultural marketing center, oil was discovered when a wildcat well first struck what became known as the Healdton oil field.

The petroleum industry became the basis for further industrial expansion and diversification in Ardmore, and today the city is the location of several manufacturing plants. Most of these plants are small in scale, employing fewer than 125 people. Several larger manufacturing plants, however, have been established in the area. The Uniroyal Tire Co. employs some 1,700 people in making automobile tires, and Georgia-Pacific employs 125 people in the manufacture of asphalt roofing products. Other important local products include ice cream, men's clothing, and construction materials.

Ardmore still retains much of its character as a large rural service center. The retail and financial services of the city reach a large number of people living on small rural acreage in the surrounding rolling prairies and woodlands. As in many parts of rural Oklahoma, many of these rural residents combine city jobs and supplemental sources of income with small-

scale farms and livestock operations. Ardmore is a significant center of the petroleum industry. It has contributed its wealth through several foundations to the social progress of the state and has realized significant capital investment in its own urban infrastructure. The downtown core has been reshaped in recent years by high quality new construction. The city has distinctively prospered in recent years.

Claremore

Claremore is perhaps best known as the home town of Will Rogers, the most popular American humorist. It is the seat of Rogers County and is located adjacent to the Will Rogers Turnpike, 29 miles northeast of Tulsa. Construction and transportation services are major functions of Claremore. Several enterprises specialize in the production of prefabricated log homes. This type of home construction is popular for building on recreational property scattered among the many public parks and lakes in the nearby Ozark Mountains. The city also provides a variety of repair and maintenance services for the oil industry, and is a meat processing center for livestock produced on the nearby Cherokee prairies. It is progressively affected by proximity to its large neighbor, Tulsa, and is the site of a new state university.

Enid

Enid exhibits the most broadly diversified economy of the 30 cities considered in this analysis. Transportation, agriculture, petroleum, construction, wholesale and retail trade, and personal and professional services are all above the average for the 30 cities. Only transportation stands out as being a significant specialization.

The long-term strength and stability of Enid's economy is suggested by the fact that the city has recorded a population increase in each census since 1910. In 1980 Enid's population surpassed the 50,000 mark, making it the center of Oklahoma's fourth-largest metropolitan statistical area. In 1990, the Enid metropolitan statistical area had a total population of 56,753.

The importance of transportation in Enid's economy is largely the result of its role as a railroad and grain ship-

ping center. Enid originally sprang into existence in a matter of hours with the opening of the Cherokee Outlet in 1893. The town was platted just south of the Rock Island railroad lines. Today the lines of three major railroads intersect at Enid. These railroads have lines hauling freight in 10 different directions from the Enid switchyard. The grain elevators and other storage facilities associated with the railroad lines make Enid the nation's third largest wheat storage point.

Both agriculture and oil are important in Enid's rural support base. Garfield County, of which Enid is the county seat, is in the heart of Oklahoma's prime wheat lands, producing high quality, hard red winter wheat for use in yeast breads and hard rolls. Much of Enid's wheat finds its way into national and world markets by rail to Houston and over water via the Tulsa Port of Catoosa, which is linked to the Lower Mississippi River system and the Port of New Orleans.

Petroleum was first located in 1917 in the nearby Garber Pool east of the city, which has been continuously producing oil since that time. West of Enid, the Ringwood Field was discovered in 1946 and is still producing large quantities of crude oil and natural gas. Champlin Petroleum Co. operates one of the state's largest oil refineries in Enid in association with these fields.

Education and vocational training are additional functions served by Enid for much of northwestern Oklahoma. Phillips University is a fully accredited liberal arts institution with an enrollment of 1,400 students. Two nursing schools and schools of medical and X-ray technology, and a vocational training school are located in Enid.

Vance Air Force Base, located three miles south of Enid, is a small installation primarily devoted to jet fighter pilot training. The small base continued to contribute about \$10 million dollars annually to Enid's trade channels in the early 1990s.

A stable and prosperous economic base has allowed Enid to develop and enjoy a high-quality community life. The city is noted for one of the best city libraries in the state, excellent parks and recreational facilities, and

several well-maintained museums depicting the early settlement and development of the Cherokee Outlet region. This city represents one of the most stable urban economies of the American plains.

Moore

Moore, primarily a residential community to the south of Oklahoma City, retains a number of functions of its own. Recent rapid growth in residential housing construction has contributed to a large number of people engaged in the real estate and construction industries.

Transportation and trade services have been important to Moore since its establishment along the Santa Fe rail line during the Oklahoma Land Run of 1889. Transportation, communications, and utilities continue to be a major role served by the city. Moore is also the home of a significant number of personnel employed at nearby Tinker Air Force Base. It has been the site of explosive urban growth.

Muskogee

Muskogee is an Indian name for the Creek Indians. Following the Civil War the city became the site of the Union Agency, acting as the administrative center between the federal government and the Five Civilized Tribes. As such it was the dominant city in Oklahoma's early development. The city has a long and colorful history as an Indian capital, a cattle trail supply center, an oil boom town, and a railroad town. Muskogee is currently a commercial, medical, and transportation center.

Muskogee has played a major role in the development of the McClellan-Kerr Arkansas River Navigation System. It is credited with being the site of the first port city in Oklahoma and acted as a proving ground for port development techniques at other sites along the waterway.

The professional service sector of Muskogee's functional position within southeastern Oklahoma is dominated by the provision of health services. Medical facilities in Muskogee include a large Veterans Administration hospital, Muskogee General Hospital, a City-Council Health Clinic, and several well-staffed modern nursing homes.

Construction and manufacturing industries are also well-represented in Muskogee. The construction of a large coal-burning electric generating plant, coupled with the Port of Muskogee, has attracted a variety of industries to the local area. Sand and gravel, glass containers, tire and tube materials, metal alloys, machine tools, air conditioning equipment, jams and fruit preserves, and bread are all produced in the area.

Muskogee's historical position in the Indian Nation makes it a cultural and social center for a large rural area. This aspect of Muskogee's heritage has been cultivated in a number of well-known city parks and gardens. Honor Heights Park, on the western edge of the city, is comprised of 114 acres of horticultural gardens in a natural setting. Each April the park's Azalea Festival attracts more than 600,000 visitors to Muskogee.

Shawnee

Shawnee is the county seat of Pottawatomie County and a retail and professional service center. The city is a short drive by freeway from Oklahoma City and combines a rural atmosphere with the amenities of the nearby urban center. Public administration employment is primarily associated with a significant number of Shawnee residents commuting to civil service jobs at the U.S. Air Force's Tinker Field complex.

But Shawnee is more than a residential satellite of Oklahoma City. Higher education is a major professional service provided to the state by Shawnee's two private colleges, Oklahoma Baptist University and St. Gregory's Junior College. Each has contributed greatly to the cultural and economic development of the city.

Construction services and financial services in Shawnee are associated with its proximity to Oklahoma City and to historical ties with petroleum development in central Oklahoma.

Oklahoma's Most Specialized Cities

Eight specialized cities each had three or fewer categories between zero and one standard deviation above average, and one category at least two

standard deviations above average (see Table 15.3). Specialized cities in Oklahoma cover a wide variety of industries, ranging from primary extractive industries such as agriculture or oil and gas field development, to highly service-oriented industries, such as education or public administration.

Altus

Altus has been the retail trade center of the prime agricultural lands in the southwestern corner of Oklahoma since 1891. As early as 1900 Altus had four grocery stores, five general stores, a drug store, a bank, a hotel, two newspapers, and a number of other businesses. The functional role of the city as a retail trade and supply center for surrounding farms was maintained by construction of a railroad early in its history.

The drought of the 1930s brought tremendous pressures for change in agricultural practices all across the Southern Great Plains. The response of Altus farmers to the drought hazard was to push for development of an irrigation project. Development began with a dam across the North Fork of the Red River that formed Altus-Lugert Lake. Approximately 70,000 acres of cotton, wheat, and feed crops are irrigated each year with water from the reservoir. In addition to surface water, the ground-water resource of the area has also been tapped. Irrigation has served in some degree to insulate Altus from wide fluctuations in dry farming yields and maintain the city's function as a farm supply and retail trade center.

Altus is also the site of an Air Force installation that houses the world's largest aircraft—the C-5A Galaxy cargo transport plane—as well as units of the Mobile Communications and Strategic Air Command.

Bartlesville and Ponca City

Bartlesville and Ponca City share the distinction of being the founding cities of two major petrochemical companies. Ponca City grew up around the oil and gas development business of Ernest Marland, which subsequently came under the control of the Continental Oil Co. (Conoco). Bartlesville is the international head-

quarters city for the Phillips Petroleum Co., first started by the Phillips brothers in 1917 on Osage and Cherokee Indian lands in northeastern Oklahoma. Major oil-field equipment services companies are also headquartered in Bartlesville.

Duncan

Duncan was initially an agricultural service center, and still retains significant ties to agricultural services and linkages. But with increasing economies of scale within agriculture, and shifts to more extensive livestock ranching operations, the number of rural farm residents in Duncan's market area declined. Declines in the rural farm population coincided with major oil field developments nearby, and oil- and gas-related services soon replaced agriculture as the leader in industrial employment in Duncan. Duncan is the headquarters for Halliburton Services, a company with worldwide interests in servicing and monitoring oil and gas field equipment.

Midwest City and Del City

Midwest City and Del City both specialize in public administration employment as a result of their proximity to the Tinker Air Force Base complex. Construction of the Tinker facility began in 1941 and grew to include a major logistical and aircraft maintenance and repair facility. The Tinker complex is the state's largest single employer, with a total workforce approaching 25,000, including some 12,000 civil service personnel.

Norman and Stillwater

Norman and Stillwater are the homes of Oklahoma's two major universities. The University of Oklahoma, with an enrollment averaging around 20,000 students, is in Norman, and Oklahoma State University, with some 18,000 students, is in Stillwater. Stillwater is the most highly specialized of the two cities. In addition to the functions provided by the presence of a large agricultural college in the city, Stillwater serves as a retail trade and agricultural service center for a large rural portion of north-central Oklahoma.

Norman, approaching 100,000 people, serves as a retail trade and gov-

ernment training center as well as the home of the largest university in the state. The U.S. Postal Service operates a postal training and servicing center in Norman. A sizeable group of Norman residents employed in public administration also commute to jobs with federal and state government agencies in Oklahoma City. Two recently constructed manufacturing plants, one producing vitamin supplements and the other computer disk drives, as well as a regional shopping mall, add a measure of diversity to Norman's economic base. The city has experienced explosive population growth in the 1990s.

Woodward

Woodward is another example of an Oklahoma city that began as an agricultural supply and service center, and was subsequently transformed into an oil and gas field service center. The city is subordinate to Enid in terms of some agricultural service and marketing functions. Agriculture is still an important part of Woodward's economy, however, and to the west and northwest, Woodward has preempted a sizeable portion of Enid's agricultural market area, particularly livestock feeding and hauling services.

The most recent period of growth in the Woodward area has been related largely to recent expansions in energy exploration and extraction in the Anadarko basin in western Oklahoma and the Panhandle. In terms of oil- and gas-field services, equipment repair, and well-drilling employment, Woodward has become the major center of western Oklahoma, subordinate only to Oklahoma City. In addition to oil-field services, a number of both large and small oil and gas production and distribution companies have established corporate offices in Woodward.

Regional Multipurpose Service Center—Lawton

Lawton is a significant regional center that is above average in a variety of functions, including retail trade, agriculture, personal services, construction, and public administration employment. Lawton is the regional center of southwestern Oklahoma, with a population exceeding 80,561 people in 1990.

Retail trade has been enhanced by a renovation and renewal of the central business district following a 10-year construction project that invested \$21.5 million in capital improvements to 115 acres in the heart of downtown Lawton. The project included construction of a 442,000-square-foot enclosed downtown shopping mall. The enclosed mall features a major department store at one end and a smaller department store at the other end. Additional shopping centers and malls are located on the margins of the urban area and along the H. E. Bailey Turnpike on the east side of the city. The Bailey Turnpike places Lawton within an hour-and-a-half drive of downtown Oklahoma City.

A major military installation also enhances Lawton's economic base. Fort Sill is the headquarters of the U.S. Army Field Artillery and home of the Artillery Center and School. The military reservation associated with the post covers 95,000 acres, providing a training ground for some 20,000 men and women serving in the United States Armed Forces.

In addition to Fort Sill, Lawton has also benefited from its proximity to the Wichita Mountains Wildlife Refuge. Each year more than a million visitors are attracted to the unique natural landscapes preserved in the large refuge, which was one of the earliest established to protect and perpetuate the last remaining herds of American bison.

CONCLUSION

Oklahoma was initially a rural state comprised mostly of small farms in the east and large cattle ranches in the west. The state passed through a rapid period of urbanization and industrialization following a period of change in agricultural structure that left fewer people on small rural farms. Most of the shift in Oklahoma's population occurred within the state, as rural farm people migrated to nearby towns and cities. Today, Oklahoma is primarily an urban state, with the majority of its residents employed within an urbanized corridor stretching from northeast to southwest along the major transportation arteries between Tulsa and Oklahoma City. Regional urban centers are located in

Enid, Lawton, Woodward, and McAlester.

In terms of the functions they serve, Oklahoma has more diversified cities than it does highly specialized cities. Manufacturing employs more people in the cities of the state than does agriculture or petroleum extraction. Government employment is also a major part of the state's economic landscape. The more highly specialized cities focus on oil and gas, agriculture, and government employment.

Given the broad milieu of functions and services provided by Oklahoma's cities, the future appears bright for both the cities and the rural areas dependent on them. Oklahomans have weathered the storms of the past, coped with adversity, and adjusted to changing conditions, until today the state is a far different place from what it was when the first farmers swarmed over the land in the rush to establish homes. The Oklahoma of today is beginning to enjoy more balanced and consistent economic development due in large measure to the influence of the cities on the land.

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— Chapter 15 —
LIST OF ILLUSTRATIONS

Maps

15.1 — Percentage of total population by county, 1990 _____	252
15.2 — County population density, 1920 _____	253
15.3 — Population increase by county, 1920-60 _____	253
15.4 — Percent change in county population, 1960-90 _____	254
15.5 — Regional market areas of newspaper circulation, 1984-85 _____	255

Tables

15.1 — Immigrants, outmigrants, and net migration into Oklahoma, 1987-90 _____	255
15.2 — Oklahoma cities with more than 10,000 residents in 1985 and their population in 1990 _____	256
15.3 — Economic activities in Oklahoma by percent of employed persons within 11 major industrial categories _____	257
15.4 — A functional classification of Oklahoma cities _____	258

From Resources to Resourcefulness

Gary L. Thompson

With resources, people create a world where they may experience the passages of life and the fulfillments of the human spirit. The ability to envision and develop resources is the key to satisfaction and accomplishment, and through the course of its first century, Oklahoma has enjoyed the benefits of each.

The most valuable resource has been the vitality of a committed population, who used the prairies, the rich earth, the coal and oil, stone, lead, zinc, and timber to build a new state on the southern plains. The materials of the land were transformed into houses and cities, highways, schools, colleges and universities, dams, enterprises, hospitals, and churches.

The enthusiasm for harvesting the bounty of the natural world led quickly toward an economy dominated by commodity production, leaving the state exposed to cycles of the weather and the marketplace. Wealth was created, particularly from the petroleum and natural gas industries, within which a complex institutional structure of labor, management, capital, technology, and scientific research emerged. The flow of wealth from these mineral resources underpinned the state's economy during times when agriculture faced challenging dilemmas of drought, surpluses, and soil depletion. The oil and gas fields provided the loci for two great metropolitan centers, and smaller poles of urban growth throughout the state.

Large portions of the state in the western and central plains have enjoyed a favorable juxtaposition of excellent agricultural soils plus oil and gas production. Irrigation has offset the erratic rainfall regime of the Pan-

handle and other areas of western Oklahoma.

Some southern and eastern counties were less fortunate in the endowment of soil and oil. Local economies in these regions have developed on the basis of specialized agriculture—irrigated cotton, poultry, horticulture, nursery and greenhouse crops. Timber production has assumed a significant role in the southeast. Economic development has occurred in the tourism, second-home, and retirement housing developments around the large reservoirs of these regions, where forests, lakes, hills, and mountains have proven a valuable and enduring resource base.

With rapid urbanization, Oklahoma has experienced the same rural population adjustments as the nation at large. Small towns have struggled to maintain vitality. Many have successfully marshalled their resources through a partial redefinition of their economic roles. Main streets have been refurbished and buildings preserved to become a new source of pride and a renewed setting for commerce. Some communities have encouraged local investment in small service and manufacturing enterprises. Small plants requiring innovative design and entrepreneurial management skills have appeared in small communities throughout the state. Many have thrived as hometowns for commuters who earn livelihoods in nearby growth centers.

Overall, the population of the state has grown along a wide central axis that connects the economic centers of Texas with the Midwest.

Oklahoma City has become a more significant center of electronic and computer components manufacturing

than is nationally recognized, while Tulsa continues in ways largely associated with management, aircraft technology, and service industries. The development and management of oil and gas resources allowed both cities to build important infrastructural bases that have supported their transition toward diversified economic growth. Both enjoy strategic locations in the continental economy and both have emerged as metropolitan centers with dynamic edge cities at their geographical margins.

In the southwest, economic growth in the Lawton-Duncan area has grown on a variegated economic base, which includes federal employment, high-tech petroleum technologies, large manufacturing plants, and agriculture.

The recovery of Oklahoma's economy from the legacies of the commodity boom cycle of the 1970s has been slow but progressive. Oklahomans have considerable personal experience in accepting downturns in commodity prices and production. A remarkable degree of tenacity and self-reliance has developed as a result. In the face of widespread financial chaos in the 1980s, Oklahoma has chosen new directions that are less dependent on the exploitation of material resources. In the 1990s, there is less emphasis on the harvesting and gathering of consumable commodities and more emphasis on developing the human resources of the state. During a time of economic distress, infrastructural investments have been made in schools, highways, basic research facilities, medical care networks, and eleemosynary systems. Oklahomans have drawn from experience the lesson that resources are defined more

by historical circumstance and need than by geology and climate. Resource development will be influenced more by individual responses to economic trends, state goals, and

investments than by marketplace demands of the moment. Success in the emergent global economy follows the decision to encourage resourcefulness and new economic

specializations. Oklahoma is beginning to mold the outlines of its own destiny and to enjoy the benefit of a location central to national economic growth.