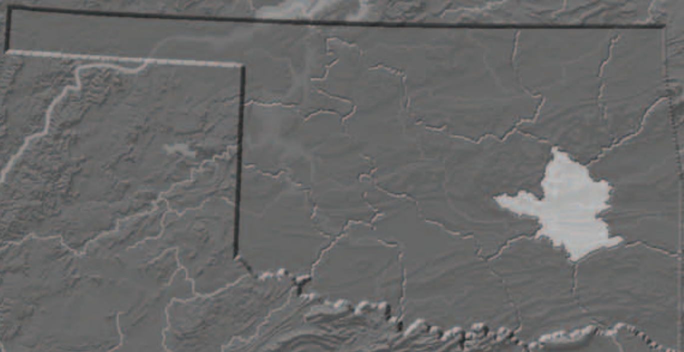
Oklahoma Comprehensive Water Plan

OCWP

Eufaula
Watershed Planning Region Report

Version 1.1



Oklahoma Water Resources Board

The objective of the Oklahoma Comprehensive Water Plan is to ensure a dependable water supply for all Oklahomans through integrated and coordinated water resources planning by providing the information necessary for water providers, policy-makers, and end users to make informed decisions concerning the use and management of Oklahoma's water resources.

This study, managed and executed by the Oklahoma Water Resources Board under its authority to update the Oklahoma Comprehensive Water Plan, was funded jointly through monies generously provided by the Oklahoma State Legislature and the federal government through cooperative agreements with the U.S. Army Corps of Engineers and Bureau of Reclamation.

Oklahoma Comprehensive Water Plan

OCWP

The online version of this 2012 OCWP Watershed Planning Region Report (Version 1.1) includes figures that have been updated since distribution of the original printed version. Revisions herein primarily pertain to the seasonality (i.e., the percent of total annual demand distributed by month) of Crop Irrigation demand. While the annual water demand remains unchanged, the timing and magnitude of projected gaps and depletions have been modified in some basins. The online version may also include other additional or updated data and information since the original version was printed.

Cover photo: Red clover at Lake Eufaula dam, courtesy Lake Eufaula Association.

Oklahoma Comprehensive Water Plan

Eufaula Watershed Planning Region

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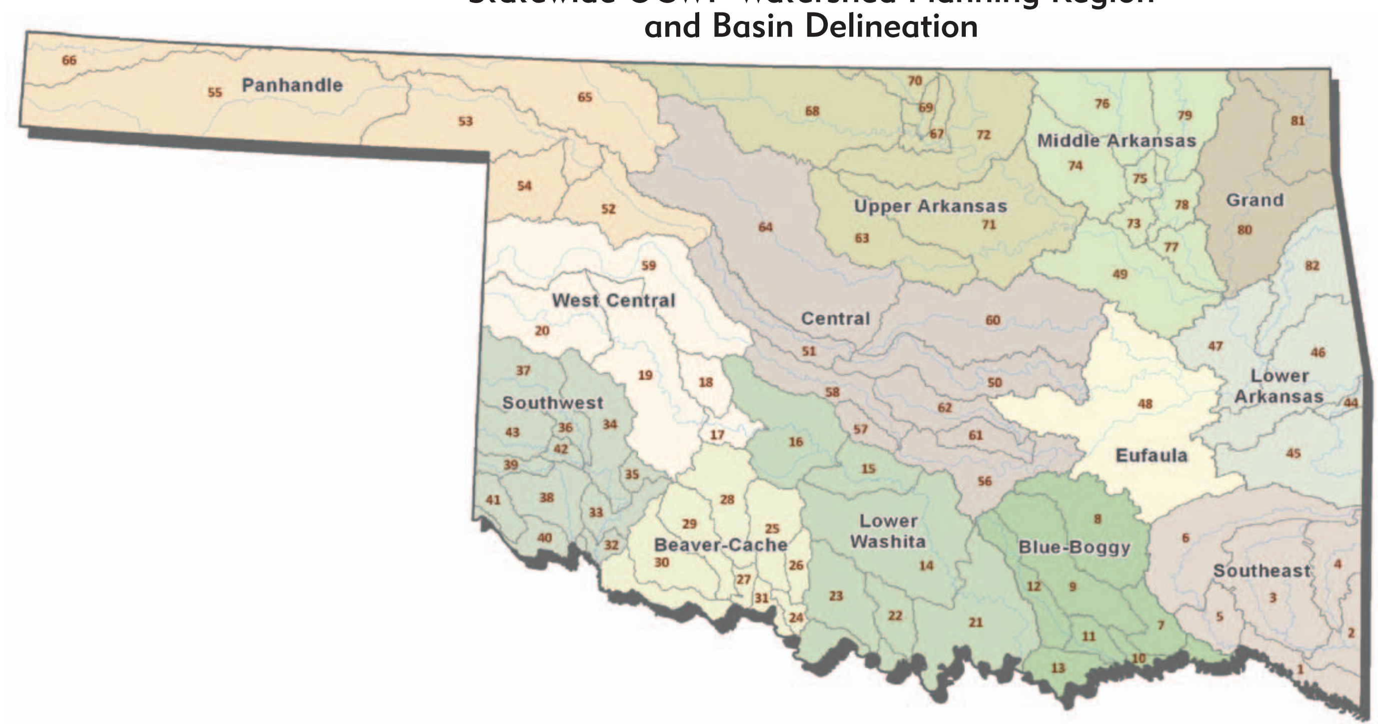


Introduction

The Oklahoma Comprehensive Water Plan (OCWP) was originally developed in 1980 and last updated in 1995. With the specific objective of establishing a reliable supply of water for state users throughout at least the next 50 years, the current update represents the most ambitious and intensive water planning effort ever undertaken by the state. The *2012 OCWP Update* is guided by two ultimate goals:

1. Provide safe and dependable water supply for all Oklahomans while improving the economy and protecting the environment.

2. Provide information so that water providers, policy makers, and water users can make informed decisions concerning the use and management of Oklahoma's water resources.

In accordance with the goals, the *2012 OCWP Update* has been developed under an innovative parallel-path approach: inclusive and dynamic public participation to build sound water policy complemented by detailed technical evaluations.

Also unique to this update are studies conducted according to specific geographic boundaries (watersheds) rather than political boundaries (counties). This new strategy involved dividing the state into 82 surface water basins for water supply availability analysis (see the OCWP *Physical Water Supply Availability Report*). Existing watershed boundaries were revised to include a United States Geological Survey (USGS) stream gage at or near the basin outlet (downstream boundary), where practical. To facilitate consideration of regional supply challenges and potential solutions, basins were aggregated into 13 distinct Watershed Planning Regions.

The primary factors in the determination of reliable future water supplies are physical supplies, water rights, water quality, and infrastructure. Gaps and depletions occur when demand exceeds supply, and can be attributed to physical supply, water rights, infrastructure, or water quality constraints.

This Watershed Planning Region report, one of 13 such documents prepared for the *2012 OCWP Update*, presents elements of technical studies pertinent to the Eufaula Region. Each regional report presents information from both a regional and multiple basin perspective, including water supply/demand analysis results, forecasted water supply shortages, potential supply solutions and alternatives, and supporting technical information.

As a key foundation of OCWP technical work, a computer-based analysis tool, "Oklahoma H2O," was created to compare projected demands with physical supplies for each basin to identify areas of potential water shortages.

Integral to the development of these reports was the Oklahoma H2O tool, a sophisticated database and geographic information system (GIS) based analysis tool created to compare projected water demand to physical supplies in each of the 82 OCWP basins statewide. Recognizing that water planning is not a static process but rather a dynamic one, this versatile tool can be updated over time as new supply and demand data become available, and can be used to evaluate a variety of "what-if" scenarios at the basin level, such as a change in supply sources, demand, new reservoirs, and various other policy management scenarios.

Primary inputs to the model include demand projections for each decade through 2060, founded on widely-accepted methods and peer review of inputs and results by state and federal agency staff, industry representatives, and stakeholder groups for each demand sector. Surface water supply data for each of the 82 basins is based on 58 years of publicly-available daily streamflow gage data collected by the USGS. Groundwater resources were characterized using previously-developed assessments of groundwater aquifer storage and recharge rates.

Additional and supporting information gathered during development of the *2012 OCWP Update* is provided in the *OCWP Executive Report* and various OCWP supplemental reports. Assessments of statewide physical water availability and potential shortages are further documented in the OCWP *Physical Water Supply Availability Report*. Statewide water demand projection methods and results are detailed in the OCWP *Water Demand Forecast Report*. Permitting availability was evaluated based on the OWRB's administrative protocol and documented in the OCWP *Water Supply Permit Availability Report*. All supporting documentation can be found on the OWRB's website.

Regional Overview

The Eufaula Watershed Planning Region includes one basin (Basin 48). The region includes portions of the Central Lowland and Ouachita physiography provinces, encompassing 3,223 square miles in east-central Oklahoma, covering portions of Okmulgee, Okfuskee, Hughes, Seminole, McIntosh, Haskell, and Pittsburg Counties.

The region's terrain ranges from the hills and ridges of the Northern Cross Timbers in the north, transitioning southward to the diverse plains, terraces, and wooded hills of the Arkansas Valley, then to the Fourche Mountains at the far southern border. The region's climate is mild with annual mean temperatures varying from 59°F to 63 °F. Annual evaporation varies from 50 to 58 inches, and average precipitation varies from 42 to 50 inches per year.

The largest cities in the region include McAlester (2010 population, 18,431), Okmulgee (12,882), Seminole (6,855), and Henryetta (6,183). The greatest demand is from Municipal and Industrial water use.

By 2060, this region is projected to have a total demand of 55,630 acre-feet per year (AFY), an increase of approximately 14,800 AFY (36%) from 2010.

Eufaula Regional Summary

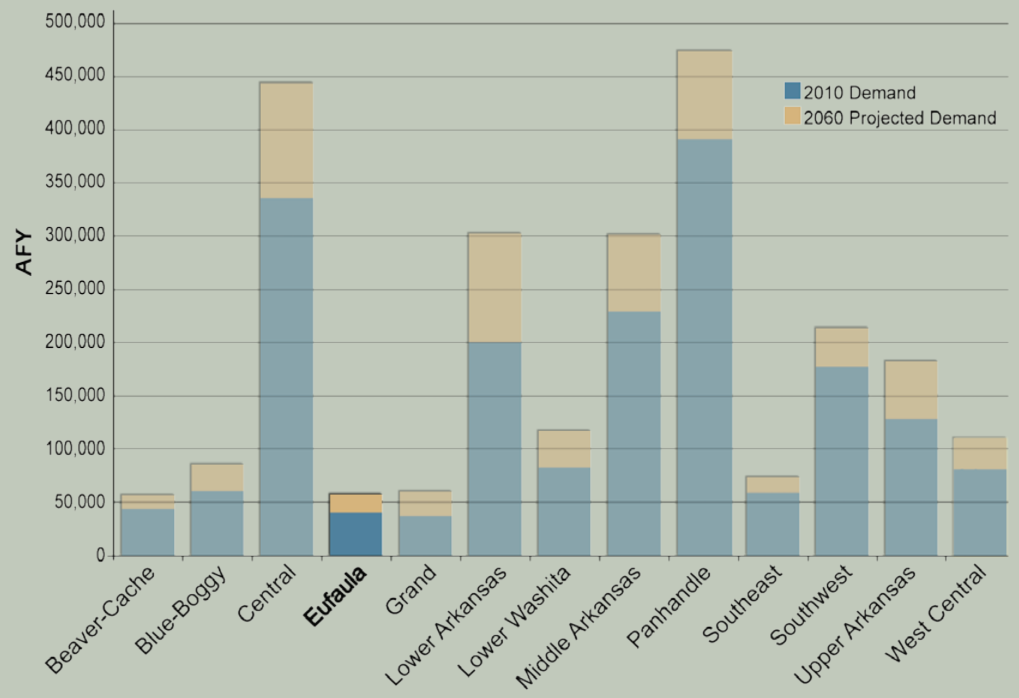
Synopsis

- The Eufaula Watershed Planning Region relies primarily on surface water supplies (including reservoirs), and to a lesser extent, alluvial and bedrock groundwater.
- It is anticipated that water users in the region will continue to rely on these sources to meet future demand.
- By 2020, alluvial and bedrock groundwater storage depletions may lead to higher pumping costs, a need for deeper wells, and potential changes to well yields and/or water quality.
- To reduce the risk of adverse impacts on water supplies, it is recommended that storage depletions be decreased where economically feasible.
- Additional conservation could reduce or eliminate alluvial and bedrock groundwater storage depletions.
- Reservoir storage could be used as an alternative to mitigate alluvial or bedrock groundwater storage depletions.

Eufaula Region Demand Summary

Current Water Demand:	40,850 acre-feet/year (2% of state total)
Largest Demand Sector:	Municipal & Industrial (51% of regional total)
Current Supply Sources:	88% SW 4% Alluvial GW 8% Bedrock GW
Projected Demand (2060):	55,640 acre-feet/year
Growth (2010-2060):	14,790 acre-feet/year (36%)

Current and Projected Regional Water Demand



The Eufaula Region accounts for 2% of the state's total water demand. About 51% of the 2010 demand is in the Municipal and Industrial demand sector. Oil and Gas (25%) is the second-largest demand sector.

Water Resources and Limitations

Surface Water

Surface water supplies, including reservoirs, are used to meet 88% of the Eufaula Region's demand. The region is supplied by two major streams: the Canadian River and North Canadian River. The rivers and creeks in the region can have periods of low to no flow due to seasonal and long-term trends in precipitation. Large reservoirs have been built on several rivers and their tributaries to provide public water supply, flood control, recreation, and other purposes. Eufaula Lake, constructed by the U.S. Army Corps of Engineers in 1964, is the lone major reservoir in the region. Large municipal lakes include McAlester, Dripping Springs, Henryetta, Okmulgee, Talawanda #2, Weleetka, and Wewoka. Sportsman is also a significant lake in the region but is not used for municipal water supply.

Relative to other regions in the state, surface water quality is considered good, several water bodies have been identified as impaired for Agricultural use (Crop Irrigation demand sector) and Public and Private Water Supply (Municipal and Industrial sector). The availability of permits is not expected to limit the development of surface water supplies for in-basin use through 2060.

Alluvial Groundwater

Alluvial groundwater is used to meet 4% of the demand in the region. The majority of currently permitted alluvial groundwater withdrawals in the region are from the Canadian River and North Canadian River aquifers. Domestic users do not require permits and may be obtaining supplies from major and minor alluvial aquifers throughout the region to meet their needs. If alluvial groundwater continues to supply a similar portion of demand in the future, storage depletions from these aquifers are likely to occur. The availability of permits is not expected to constrain the use of alluvial groundwater supplies to meet local demand through 2060.

Bedrock Groundwater

Bedrock groundwater is used to meet 8% of the demand in the region. Currently permitted and projected withdrawals are primarily from minor bedrock aquifers. The Vamoosa-Ada aquifer has more than 1.6 million AF of storage in the region and receives 4,000 AFY of recharge, but only underlies about 3% of the region. If bedrock groundwater continues to supply a similar portion of demand in the future, storage depletions from the Vamoosa-Ada or minor aquifers are likely to occur. However, the availability of permits is not expected to constrain the use of bedrock groundwater supplies to meet local demand through 2060.

Water Supply Limitations

Eufaula Region

Water Supply Limitations

Surface water limitations are determined based on physical availability, water supply availability for new permits, and water quality. Groundwater limitations are determined based on the total size and rate of storage depletions in major aquifers. Groundwater permits are not expected to constrain the use of groundwater through 2060; insufficient statewide groundwater quality data are available to compare basins based on groundwater quality. Basins with the most significant water supply challenges statewide are indicated by a red box. The remaining basins with surface water gaps or groundwater storage depletions are considered to have potential limitations (yellow). Basins without gaps and storage depletions are considered to have minimal limitations (green). Detailed explanations of each basin's supplies are provided in individual basin summaries and supporting data and analysis.

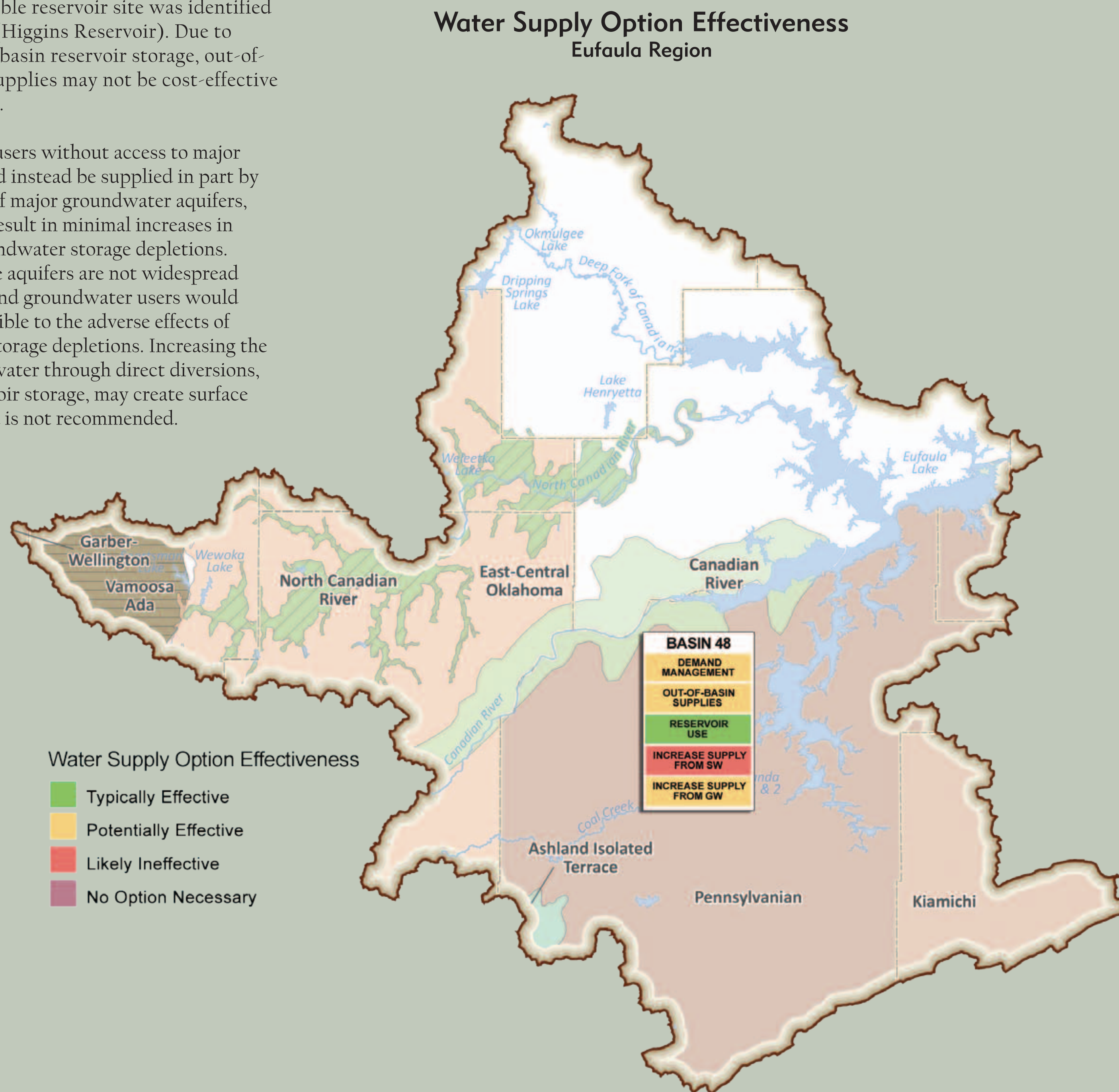
Water Supply Options

To quantify physical surface water gaps and groundwater storage depletions through 2060, use of local supplies was assumed to continue in the current (2010) proportions. Lake Eufaula and other lakes in the basin are capable of providing dependable water supplies to existing users, and with new infrastructure and reallocation of storage, could be used to meet all of Basin 48's future surface water demand during periods of low streamflow. However, these reservoirs are fully allocated. Alluvial and bedrock groundwater storage depletions may occur starting in 2020. The development of additional reservoir supplies and groundwater supplies, where accessible, should be considered short- to long-term water supply options.

Moderately expanded water conservation activities, primarily from increased conservation by public water suppliers and from increased crop irrigation efficiency, could reduce groundwater storage depletions. Further reductions could occur from substantially expanded conservation activities. These measures would require a shift from crops with high water demand (such as corn for grain and forage crops) to low water demand crops, such as sorghum for grain or wheat for grain, along with increased irrigation efficiency and increased public water supplier conservation. Temporary drought management activities may not be necessary since aquifer storage could continue to provide supplies during droughts.

New reservoir storage could increase the dependability of available surface water supplies and mitigate alluvial groundwater storage depletions in the basin. Major reservoirs in the Eufaula Region do not have unpermitted yield but are expected to meet substantial future demand from existing permit holders. Out-of-basin sources could provide additional supplies to mitigate the region's gaps and groundwater storage depletions. The OCWP *Reservoir Viability Study* included an evaluation of the potential for reservoirs throughout the state; one potentially-viable reservoir site was identified in this region (Higgins Reservoir). Due to substantial in-basin reservoir storage, out-of-basin/region supplies may not be cost-effective for many users.

Surface water users without access to major reservoirs could instead be supplied in part by increased use of major groundwater aquifers, which would result in minimal increases in projected groundwater storage depletions. However, these aquifers are not widespread in the region, and groundwater users would still be susceptible to the adverse effects of groundwater storage depletions. Increasing the use of surface water through direct diversions, without reservoir storage, may create surface water gaps and is not recommended.



Effectiveness of water supply options in the Eufaula Region. This evaluation was based upon results of physical water supply availability analysis, existing infrastructure, and other basin-specific factors.

Water Supply

Physical Water Availability

Surface Water Resources

Surface water has historically been the primary source of supply used to meet demand in the Eufaula Region. The two major streams in the region are the Canadian and North Canadian Rivers. The Canadian River generally has abundant flows but has historically experienced prolonged periods of both above- and below-average streamflow.

The Canadian River flows for 34 miles through Basin 48 in the Eufaula Region before entering Lake Eufaula. Major tributaries in the region include Fish Creek (134 miles long in the region), Coal Creek (55 miles long), and the North Canadian River (55 miles long). The North Canadian enters Lake Eufaula in its northern reaches and joins the Canadian near the Town of Eufaula.

Existing reservoirs in the region increase the dependability of surface water supply for many public water systems and other users. The region is named for its major lake, Eufaula Lake, which was constructed by the U.S. Army Corps of Engineers in 1964 for flood control, water supply, navigation, and hydropower purposes (since modified to include recreation). The lake, located on the Canadian River in Basin 48, has a dependable water supply yield of 56,000 AFY. Other significant municipal water supply lakes include McAlester Lake, built on Bull Creek in 1930 by the City of McAlester; Dripping Springs Lake, built in 1976 by the City of Okmulgee; and Okmulgee Lake, built in 1928 by City of Okmulgee. Smaller water supply lakes in the region include Henryetta, Talawanda #2, Weleetka, and Wewoka. In addition, the City of Seminole operates Sportsman Lake, which does not sustain a water supply yield. There are many other small Natural Resources Conservation Service (NRCS), municipal, and privately owned lakes in the region that provide water for public water supply, agricultural water supply, flood control, and recreation.

Significant reservoirs in the Eufaula Region have little or no unpermitted yield, but are expected to meet future demand from existing permit holders. Existing water rights should be considered when planning to meet additional future demand from existing reservoirs. Improved reservoir operations, water right reductions, or reallocation of assigned storage from one use to another could potentially provide additional flexibility to meet future water needs.

As important sources of surface water in Oklahoma, reservoirs and lakes help provide dependable water supply storage, especially when streams and rivers experience periods of low seasonal flow or drought.

Reservoirs
Eufaula Region

Reservoir Name	Primary Basin Number	Reservoir Owner/Operator	Year Built	Purpose[1]	Normal Pool Storage	Water Supply		Irrigation		Water Quality		Permitted Withdrawals[2]	Remaining Water Supply Yield to be Permitted
						Storage	Yield	Storage	Yield	Storage	Yield		
					AF	AF	AFY	AF	AFY	AF	AFY	AFY	AFY
Dripping Springs	48	City of Okmulgee	1976	WS, FC, R	16,200	---	7,214	0	0	0	0	7,800	0
Eufaula	48	USACE	1964	FC, WS, HP, N, R	2,314,600	56,000	56,000	0	0	0	0	63,096	0
Henryetta	48	City of Henryetta	1928	WS, R	6,660	---	---	---	---	---	---	3,727	---
McAlester	48	City of McAlester	1930	WS, R	13,398	16,900	9,200	0	0	0	0	16,000	0
Okmulgee	48	City of Okmulgee	1928	WS, R	14,170	---	---	---	---	---	---	4,434	---
Sportsman	48	City of Seminole	1958	FC, R	5,349	---	---	---	---	---	---	3,000	---
Talawanda #2	48	City of McAlester	1924	WS, R	2,750	---	---	---	---	---	---	3,000	---
Weleetka	48	City of Weleetka	1923	WS, R	385	---	---	---	---	---	---	233	---
Wewoka	48	City of Wewoka	1925	WS, R	3,301	---	---	---	---	---	---	957	---

No known information is annotated as "---"

1 Purpose refers to the use(s) for reservoir storage as authorized by the funding entity or dam owner(s) at the time of construction.
WS=Water Supply, R=Recreation, HP=Hydroelectric Power, IR=Irrigation, WQ=Water Quality, FW=Fish & Wildlife, FC=Flood Control, LF=Low Flow Regulation, N=Navigation, C=Conservation, CW=Cooling Water

2 Some permitted withdrawals at Lake Eufaula include water from the hydroelectric power pool.

Surface Water Resources
Eufaula Region

Reservoirs may serve multiple purposes, such as water supply, irrigation, recreation, hydropower generation, and flood control. Reservoirs designed for multiple purposes typically possess a specific volume of water storage assigned for each purpose.

Water Supply Availability Analysis

For OCWP physical water supply availability analysis, water supplies were divided into three categories: surface water, alluvial aquifers, and bedrock aquifers. Physically available surface water refers to water currently in streams, rivers, lakes, and reservoirs.

The range of historical surface water availability, including droughts, is well-represented in the Oklahoma H2O tool by 58 years of monthly streamflow data (1950 to 2007) recorded by the U.S. Geological Survey (USGS). Therefore, measured streamflow, which reflects current natural and human created conditions (runoff, diversions and use of water, and impoundments and reservoirs), is used to represent the physical water that may be available to meet projected demand.

The estimated average and minimum annual streamflow in 2060 were determined based on historic surface water flow measurements and projected baseline 2060 demand (see Water Demand section). The amount of streamflow in 2060 may vary from basin-level values, due to local variations in demands and local availability of supply sources. The estimated surface water supplies include changes in historical streamflow due to increased upstream demand, return flows, and increases in out-of-basin supplies from existing infrastructure. Permitting, water quality, infrastructure, non-consumptive demand, and potential climate change implications are considered in separate OCWP analyses. Past reservoir operations are reflected and accounted for in the measured historical streamflow downstream of a reservoir. For this analysis, streamflow was adjusted to reflect interstate compact provisions in accordance with existing administrative protocol.

The amount of water a reservoir can provide from storage is referred to as its yield. The yield is considered the maximum amount of water a reservoir can dependably supply during critical drought periods. The unused yield of existing reservoirs was considered for this analysis. Future potential reservoir storage was considered as a water supply option.

Groundwater supplies are quantified by the amount of water that an aquifer holds ("stored" water) and the rate of aquifer recharge. In Oklahoma, recharge to aquifers is generally from precipitation that falls on the aquifer and percolates to the water table. In some cases, where the altitude of the water table is below the altitude of the stream-water surface, surface water can seep into the aquifer.

For this analysis, alluvial aquifers are defined as aquifers comprised of river alluvium and terrace deposits, occurring along rivers and streams and consisting of unconsolidated deposits of sand, silt, and clay. Alluvial aquifers are generally thinner (less than 200 feet thick) than bedrock aquifers, feature shallow water tables, and are exposed at the land surface, where precipitation can readily percolate to the water table. Alluvial aquifers are considered to be more hydrologically connected with streams than are bedrock aquifers and are therefore treated separately.

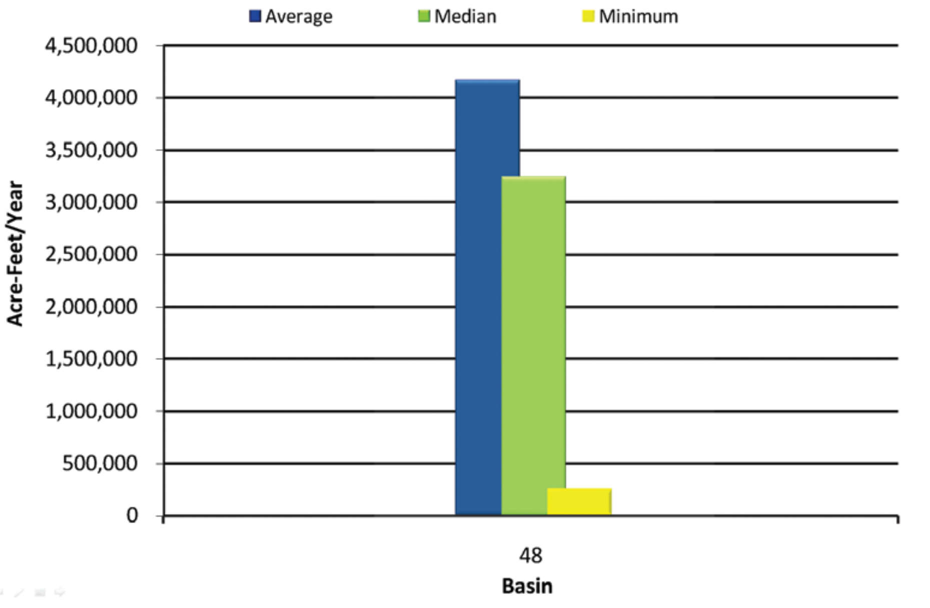
Bedrock aquifers consist of consolidated (solid) or partially consolidated rocks, such as sandstone, limestone, dolomite, and gypsum. Most bedrock aquifers in Oklahoma are exposed at land surface either entirely or in part. Recharge from precipitation is limited in areas where bedrock aquifers are not exposed.

For both alluvial and bedrock aquifers, this analysis was used to predict potential groundwater depletions based on the difference between the groundwater demand and recharge rate. While potential storage depletions do not affect the permit availability of water, it is important to understand the extent of these depletions.

More information is available in the OCWP *Physical Water Supply Availability Report* on the OWRB website.

Surface Water Flows (1950-2007)

Eufaula Region



Surface water is the main source of supply in the Eufaula Region. While the region's average physical surface water supply exceeds projected surface water demand, gaps can occur due to seasonal, long-term hydrologic (drought) or localized variability in surface water flows. Several large reservoirs have been constructed to reduce the impacts of drier periods on surface water users.

Estimated Annual Streamflow in 2060

Eufaula Region

	Basin
	48
Streamflow Statistic	AFY
Average Annual Flow	3,993,100
Minimum Annual Flow	182,700

Annual streamflow in 2060 was estimated using historical gaged flow and projections of increased surface water use from 2010 to 2060.

Groundwater Resources

Two major bedrock aquifers, the Garber-Wellington and Vamoosa-Ada, are present in the Eufaula Watershed Planning Region. Two major alluvial aquifers, the Canadian River and North Canadian River, are also located in the region.

Withdrawing groundwater in quantities exceeding the amount of recharge to the aquifer may result in aquifer depletion and reduced storage. Therefore, both storage and recharge were considered in determining groundwater availability.

The Garber-Wellington aquifer consists of fine-grained sandstone interbedded with siltstone and shale. Depth to water varies from less than 100 feet to 250 feet; saturated thickness ranges from 150 to 650 feet. Wells generally yield from 200 to 400 gallons per minute (gpm). Water quality is generally good but in some areas concentrations of nitrate, arsenic, chromium, and selenium may exceed drinking water standards.

The Vamoosa-Ada aquifer consists of 125 to 1,000 feet of interbedded sandstone, shale, and conglomerate. Wells commonly yield 25 to 150 gpm. Water quality is generally good and suitable for use as public supply although iron infiltration and hardness are problems in some areas along with localized contamination resulting from past oil and gas activities.

The Canadian River alluvial aquifer consists of clay and silt downgrading to fine- to coarse-grained sand with lenses of basal gravel. Formation thickness ranges from 20 to 40 feet in the alluvium with a maximum of 50 feet in the terrace deposits. Yields in the alluvium range from 100 to 400 gpm and from 50 to 100 gpm in the terrace. The water is a very hard calcium bicarbonate type with total dissolved solids (TDS) concentrations of approximately 1,000 mg/L. However, the water is generally suitable for most municipal and industrial uses.

Areas without delineated aquifers may have groundwater present. However, specific quantities, yields, and water quality in these areas are currently unknown.

The North Canadian River alluvial aquifer consists of fine- to coarse-grained sand with minor clay and silt and local lenses of basal gravel overlain by dune sand. Formation thickness averages 30 feet in the alluvium with a maximum of 300 feet in the terrace deposits. Yields range from 300 to 600 gpm in the alluvium and from 100 to 300 gpm in the terrace formations. The water is a very hard calcium bicarbonate type.

Minor bedrock aquifers in the region include the East-Central Oklahoma, Kiamichi, and Pennsylvanian. Minor alluvial aquifers include the Ashland Isolated Terrace. Minor aquifers may have a significant amount of water in storage and high recharge rates, but wells generally yield less than 50 gpm. Groundwater from minor aquifers is an important source of water for domestic and stock water use for individuals in outlying areas not served by rural water systems.

Permits to withdraw groundwater from aquifers (groundwater basins) where the maximum annual yield has not been set are "temporary" permits that allocate 2 AFY/acre. The temporary permit allocation is not based on storage, discharge, or recharge amounts, but on a legislative (statute) estimate of maximum needs of most landowners to ensure sufficient availability of groundwater in advance of completed and approved aquifer studies. As a result, the estimated amount of Groundwater Available for New Permits may exceed the estimated aquifer storage amount. For aquifers (groundwater basins) where the maximum annual yield has been determined (with initial storage volumes estimated), updated estimates of amounts in storage were calculated based on actual reported use of groundwater instead of simulated usage from all lands.

Groundwater Resources
Eufaula Region

Aquifer			Portion of Region Overlaying Aquifer	Recharge Rate	Current Groundwater Rights	Aquifer Storage in Basin	Equal Proportionate Share	Groundwater Available for New Permits
Name	Type	Class[1]	Percent	Inch/Yr	AFY	AF	AFY/Acre	AFY
Canadian River	Alluvial	Major	7%	2.0	3,000	348,000	temporary 2.0	129,900
North Canadian River	Alluvial	Major	5%	5.0-7.0	1,100	575,000	1.0	101,200
Vamoosa-Ada	Bedrock	Major	3%	0.5-0.7	6,300	1,630,000	2.0	123,300
Garber-Wellington	Bedrock	Major	<1%	1.6	0	0	temporary 2.0	0
Ashland Isolated Terrace	Alluvial	Minor	1%	3.9	600	54,000	temporary 2.0	24,600
East-Central Oklahoma	Bedrock	Minor	22%	2.8	1,000	7,169,000	temporary 2.0	920,100
Kiamichi	Bedrock	Minor	6%	1.1	100	180,000	temporary 2.0	268,700
Pennsylvanian	Bedrock	Minor	37%	1.1	100	12,667,000	temporary 2.0	1,548,500
Non-Delineated Groundwater Source	Bedrock	Minor	N/A		100	N/A	temporary 2.0	N/A
Non-Delineated Groundwater Source	Alluvial	Minor	N/A		0	N/A	temporary 2.0	N/A

1 Bedrock aquifers with typical yields greater than 50 gpm and alluvial aquifers with typical yields greater than 150 gpm are considered major.

Groundwater Resources
Eufaula Region

Major bedrock aquifers in the Eufaula Region include the Garber-Wellington and Vamoosa-Ada. Major alluvial aquifers in the region include the Canadian River and North Canadian River. Major bedrock aquifers are defined as those that have an average water well yield of at least 50 gpm; major alluvial aquifers are those that yield, on average, at least 150 gpm.

Permit Availability

For OCWP water availability analysis, "permit availability" pertains to the amount of water that could be made available for withdrawals under permits issued in accordance with Oklahoma water law.

If water authorized by a stream water right is not put to beneficial use within the specified time, the OWRB may reduce or cancel the unused amount and return the water to the public domain for appropriation to others.

Projections indicate there will be surface water available for new permits through 2060 in the Eufaula Region. Water users throughout the region need to consider the existing rights from major reservoirs. For groundwater, equal proportionate shares in the Eufaula Region range from 1 AFY per acre to 2 AFY per acre. Projections indicate that the use of groundwater to meet in-basin/region demand is not expected to be limited by the availability of permits through 2060.

Surface Water Permit Availability

Oklahoma stream water laws are based on riparian and prior appropriation doctrines. Riparian rights to a reasonable use of water, in addition to domestic use, are not subject to permitting or oversight by the OWRB. An appropriative right to stream water is based on the prior appropriation doctrine, which is often described as "first in time, first in right." If a water shortage occurs, the diverter with the older appropriative water right will have first right among other appropriative right holders to divert the available water up to the authorized amount.

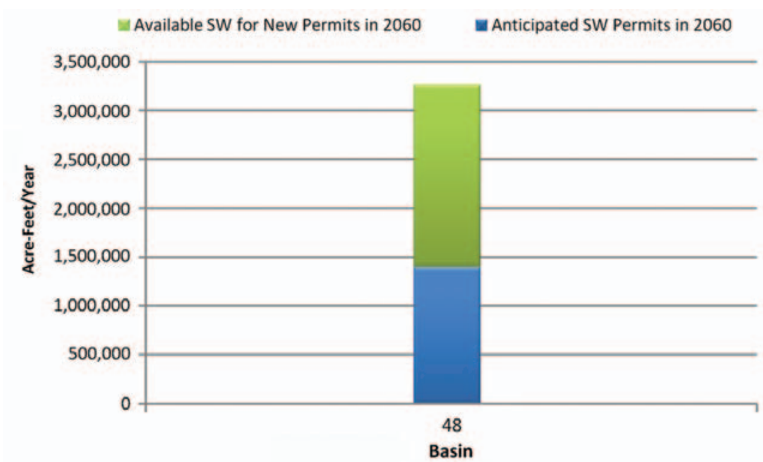
To determine surface water permit availability in each OCWP planning basin in 2060, the analysis utilized OWRB protocol to estimate the average annual streamflow at the basin's outlet point, accounting for both existing and anticipated water uses upstream and downstream, including legal obligations, such as those associated with domestic use and interstate compact requirements.

Groundwater Permit Availability

Groundwater available for permits in Oklahoma is generally based on the amount of land owned or leased that overlies a specific aquifer. For unstudied aquifers, temporary permits are granted allocating 2 AFY/acre. For studied aquifers, an "equal proportionate share" (EPS) is established based on the maximum annual yield of water in the aquifer, which is then allocated to each acre of land overlying the groundwater basin. Once an EPS has been established, temporary permits are then converted to regular permits and all new permits are based on the EPS.

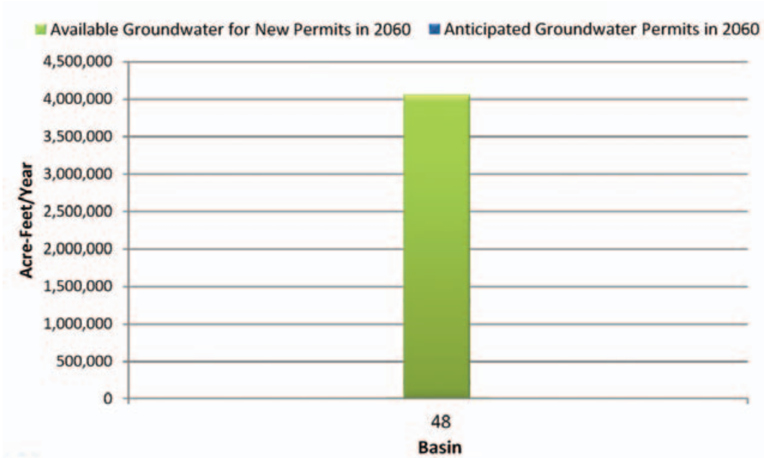
For OCWP analysis, the geographical area overlying all aquifers in each basin was determined and the respective EPS or temporary permit allocations were applied. Total current and anticipated future permit needs were then calculated to project remaining groundwater permit availability.

Surface Water Permit Availability
Eufaula Region



Projections indicate there will be surface water available for new permits through 2060 in the Eufaula Region. Water users throughout the region should consider utilizing existing water rights in Lake Eufaula.

Groundwater Permit Availability
Eufaula Region



Projections indicate that the use of groundwater to meet in-basin/region demand is not expected to be limited by the availability of permits through 2060 in the Eufaula Region.

Water Quality

Water quality of the Eufaula Watershed Planning Region is defined by the lower Canadian River watershed and several minor and major water supply reservoirs, most contained within the Cross Timbers (CT) and Arkansas Valley (AV) ecoregions with nominal influence from the Central Irregular Plains and Ouachita Mountains along the northeastern and southern borders.

The Northern Cross Timbers covers the northern one-third of the region. The area is more forested than neighboring plains with intervening grasslands and mixed land use. Streams are diverse through the ecoregion. They are shallower, sand/silt/clay dominated, and highly incised. The area is typified by the North Canadian and Deep Fork Rivers and their respective arms in Lake Eufaula, as well as the terminal end of the reservoir. Other lakes include Sportsman and Wewoka in the west and Dripping Springs and Okmulgee in the north. Stream salinity is moderate to high along the major river systems with mean conductivity from 680 µS/cm (Deep Fork) to 725 µS/cm (North Canadian). Selective tributaries are lower, including Coal and Wewoka Creeks with means less than 450 µS/cm. Conductivity in smaller lakes ranges from 100-250 µS/cm while Eufaula ranges from 350 µS/cm on the Deep Fork arm to nearly 600 µS/cm on the North Canadian arm. Streams are classified as eutrophic to hyper-eutrophic with mean total phosphorus (TP) concentrations ranging from 0.15 (Coal Creek) to 0.20 ppm (North Canadian) and total nitrogen (TN) from 1.04 (Deep Fork) to 2.72 ppm (North Canadian). Classified as mesotrophic (Sportsman and Okmulgee) to eutrophic, lakes are typically phosphorus limited with low to high nutrient concentrations. Eufaula is co-limited for TN/TP. Stream clarity is average (Coal Creek mean turbidity = 40 NTU) to very poor (North Canadian = 124 NTU). Lake clarity ranges from poor (Eufaula North Canadian Secchi depth = 57cm) to excellent (Dripping Springs = 101 cm) while many have average clarity. Ecological diversity is fair and is impacted by poor habitat and sedimentation.

The Lower Canadian Hills of the Arkansas Valley dominate the lower two-thirds of the region. (The Fourche Mountains run along the southern edge but are not included in this description.) As a transitional area, the AV is a diverse ecoregion with a mixture of broad valley plains, floodplains, hills, terraces, and mountains. Prairie grasslands and oak savannas, along with pasture land and croplands, dominate the valleys. The floodplains and terraces are characterized by bottomland

Lake Trophic Status

A lake's trophic state, essentially a measure of its biological productivity, is a major determinant of water quality.

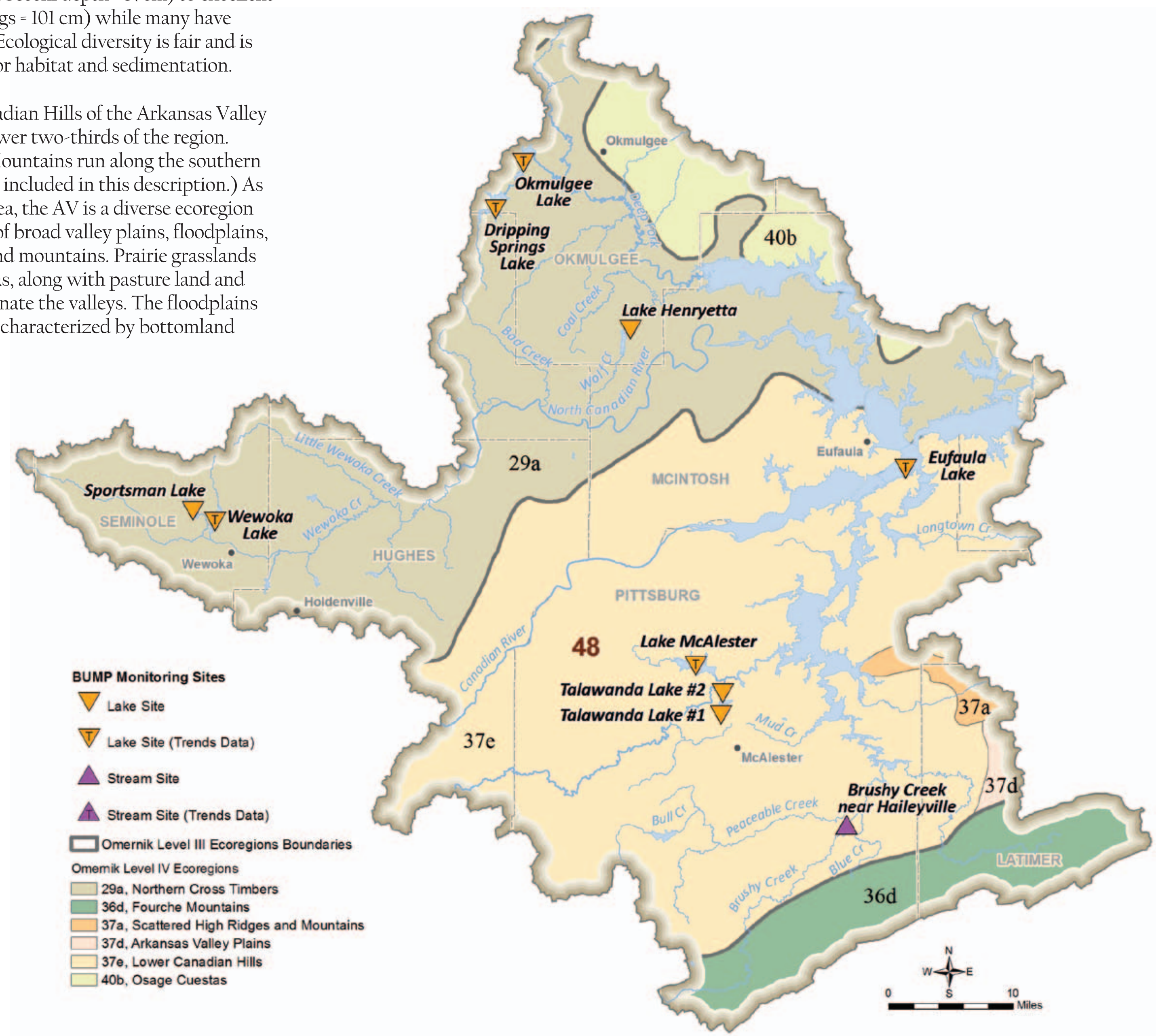
Oligotrophic: Low primary productivity and/or low nutrient levels.

Mesotrophic: Moderate primary productivity with moderate nutrient levels.

Eutrophic: High primary productivity and nutrient rich.

Hypereutrophic: Excessive primary productivity and excessive nutrients.

Ecoregions
Eufaula Region



The Eufaula Planning Region is dominated by the Cross Timbers and Arkansas Valley ecoregions. Water quality is highly influenced by both geology and land use practices and ranges from poor to excellent depending on drainage and location.

Water Quality Impairments
Eufaula Region

Regional water quality impairments based on the 2008 *Integrated Water Quality Assessment Report*. A few surface waters in this region are negatively impacted by mine drainage.

Water Quality Impairments

A waterbody is considered to be impaired when its quality does not meet the standards prescribed for its beneficial uses in the Oklahoma Water Quality Standards (OWQS). For example, impairment of the Public and Private Water Supply beneficial use means the use of the waterbody as a drinking water supply is hindered. Impairment of the Agricultural use means the use of the waterbody for livestock watering, irrigation, or other agricultural uses is hindered. Impairments can exist for other uses, such as Fish and Wildlife Propagation or Recreation.

The Beneficial Use Monitoring Program (BUMP), established in 1998 to document and quantify impairments of assigned beneficial uses of the state's lakes and streams, provides information for supporting and updating the OWQS and prioritizing pollution control programs. A set of rules known as "use support assessment protocols" is also used to determine whether beneficial uses of waterbodies are being supported.

In an individual waterbody, after impairments have been identified, a Total Maximum Daily Load (TMDL) study is conducted to establish the sources of impairments—whether from point sources (discharges) or nonpoint sources (runoff). The study will then determine the amount of reduction necessary to meet the applicable water quality standards in that waterbody and allocate loads among the various contributors of pollution.

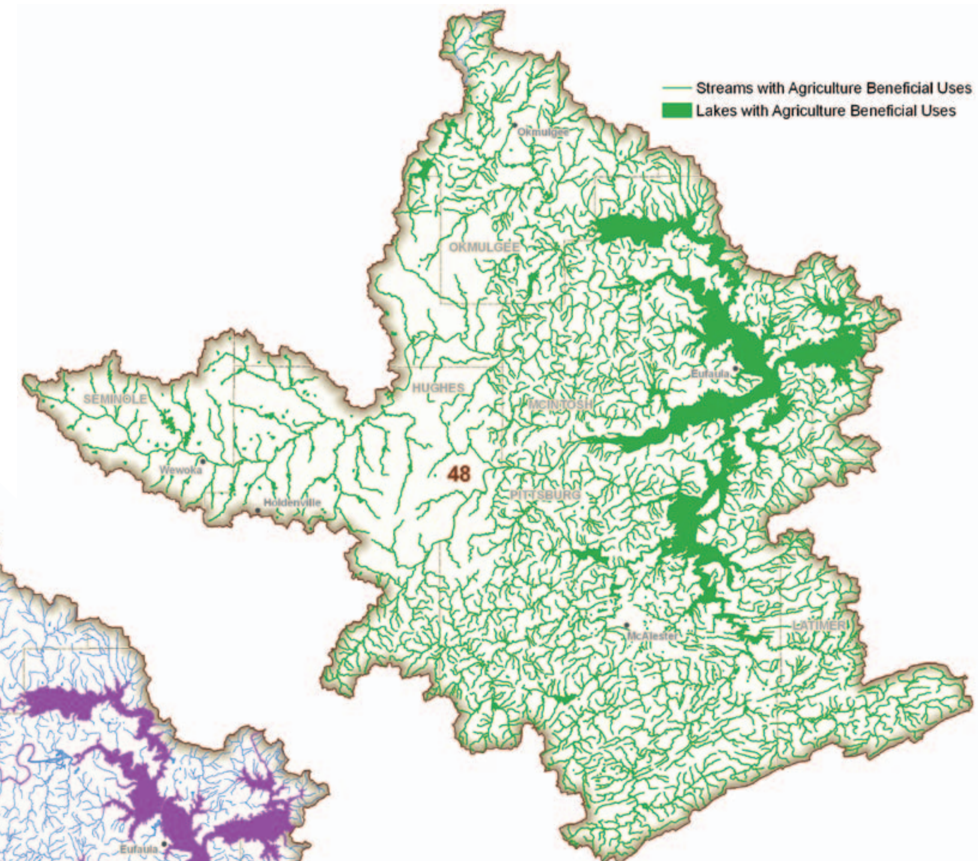
For more detailed review of the state's water quality conditions, see the most recent versions of the OWRB's *BUMP Report*, and the *Oklahoma Integrated Water Quality Assessment Report*, a comprehensive assessment of water quality in Oklahoma's streams and lakes required by the federal Clean Water Act and developed by the ODEQ.

hardwood forests. Areas of relief have a mixture of oak-hickory and oak-hickory-pine forests. Streams lie in narrow to broad meandering channels with a mixture of soft and hard substrates and varying depths. Small streams are disconnected pools during the summer but overall have good to exceptional habitat. Characteristic watersheds are the Canadian River from west to east and several small watersheds to the south, including Brushy Creek. The southern portion of Eufaula is the major reservoir, including the Canadian River and Gaines and Longtown Creek arms, as well as the main portion of the lake. Other lakes in the area are the Talawandas and McAlester. Salinity is relatively high in the Canadian (mean conductivity = 980 µS/cm) but is moderate along the southern edge (Brushy Creek = 380 µS/cm). Lakes follow the same pattern. Conductivity along the Canadian arm is typically greater than 500 µS/cm, while the southern arms are less than 400 µS/cm. The Talawandas and McAlester Lakes are much lower, ranging from 80-170 µS/cm. The Canadian is eutrophic (mean TP = 0.31 ppm; TN = 1.47 ppm) while Brushy Creek is mesotrophic with much lower nutrient concentrations (mean TP = 0.15; TN = 0.94 ppm). Lakes are mesotrophic (Talawandas) to eutrophic (Eufaula and McAlester) and phosphorus limited with low to moderate nutrient concentrations. Stream water clarity is average (Canadian = 53 NTU; Brushy = 49 NTU). Eufaula clarity is poor on the Canadian arm (43 cm) to good on the Longtown arm (82 cm) while the Talawandas have excellent clarity (140-155 cm). Ecological diversity is moderate in the western portion of the ecoregion but can be extremely high in the portion that is included in the Lower Arkansas Watershed Planning Region. Diversity is limited by habitat loss and sedimentation.

The Eufaula Region is underlain by several major and minor bedrock and alluvial aquifers. Water from the Canadian and North Canadian River alluvial aquifers is predominantly of a calcium magnesium bicarbonate type and variable in dissolved solids content. They are generally suitable for most purposes. Major bedrock aquifers in the region include the Garber-Wellington and Vamoosa-Ada with both intersecting the region along its western tip. The Garber-Wellington is of a calcium magnesium bicarbonate type and ranges from hard to very hard. In general, concentrations of dissolved solids, chloride and sulfate are low. Water from the aquifer is normally suitable for public water supply but locally concentrations of nitrates, sulfate, chloride, fluoride, arsenic, chromium, and selenium may exceed drinking water standards. The Vamoosa-Ada water quality is generally good but is impacted by iron infiltration and hardness. Chloride and sulfate concentrations are generally low. Except for areas of local contamination resulting from past oil and gas activities, water is suitable for use as public supply.

Surface Waters with Designated Beneficial Use for Agriculture

Eufaula Region



Surface Waters with Designated Beneficial Use for Public/Private Water Supply

Eufaula Region

Water Quality Standards Implementation
Eufaula Region

The Oklahoma Department of Environmental Quality has completed a TMDL study on Mud Creek. Several other TMDL studies are underway or scheduled.

Water Quality Standards and Implementation

The Oklahoma Water Quality Standards (OWQS) are the cornerstone of the state's water quality management programs. The OWQS are a set of rules promulgated under the federal Clean Water Act and state statutes, designed to maintain and protect the quality of the state's waters. The OWQS designate beneficial uses for streams, lakes, other bodies of surface water, and groundwater that has a mean concentration of Total Dissolved Solids (TDS) of 10,000 milligrams per liter or less. Beneficial uses are the activities for which a waterbody can be used based on physical, chemical, and biological characteristics as well as geographic setting, scenic quality, and economic considerations. Beneficial uses include categories such as Fish and Wildlife Propagation, Public and Private Water Supply, Primary (or Secondary) Body Contact Recreation, Agriculture, and Aesthetics.

The OWQS also contain standards for maintaining and protecting these uses. The purpose of the OWQS is to promote and protect as many beneficial uses as are attainable and to assure that degradation of existing quality of waters of the state does not occur.

The OWQS are applicable to all activities which may affect the water quality of waters of the state, and are to be utilized by all state environmental agencies in implementing their programs to protect water quality. Some examples of these implementation programs are permits for point source (e.g. municipal and industrial) discharges into waters of the state; authorizations for waste disposal from concentrated animal feeding operations; regulation of runoff from nonpoint sources; and corrective actions to clean up polluted waters.

More information about OWQS and the latest revisions can be found on the OWRB website.

Surface Water Protection

The Oklahoma Water Quality Standards (OWQS) provide protection for surface waters in many ways.

Appendix B Areas are designated in the OWQS as containing waters of recreational and/or ecological significance. Discharges to waterbodies may be limited in these areas.

Source Water Protection Areas are derived from the state's Source Water Protection Program, which analyzes existing and potential threats to the quality of public drinking water in Oklahoma.

The **High Quality Waters** designation in the OWQS refers to waters that exhibit water quality exceeding levels necessary to support the propagation of fishes, shellfishes, wildlife, and recreation in and on the water. This designation prohibits any new point source discharges or additional load or increased concentration of specified pollutants.

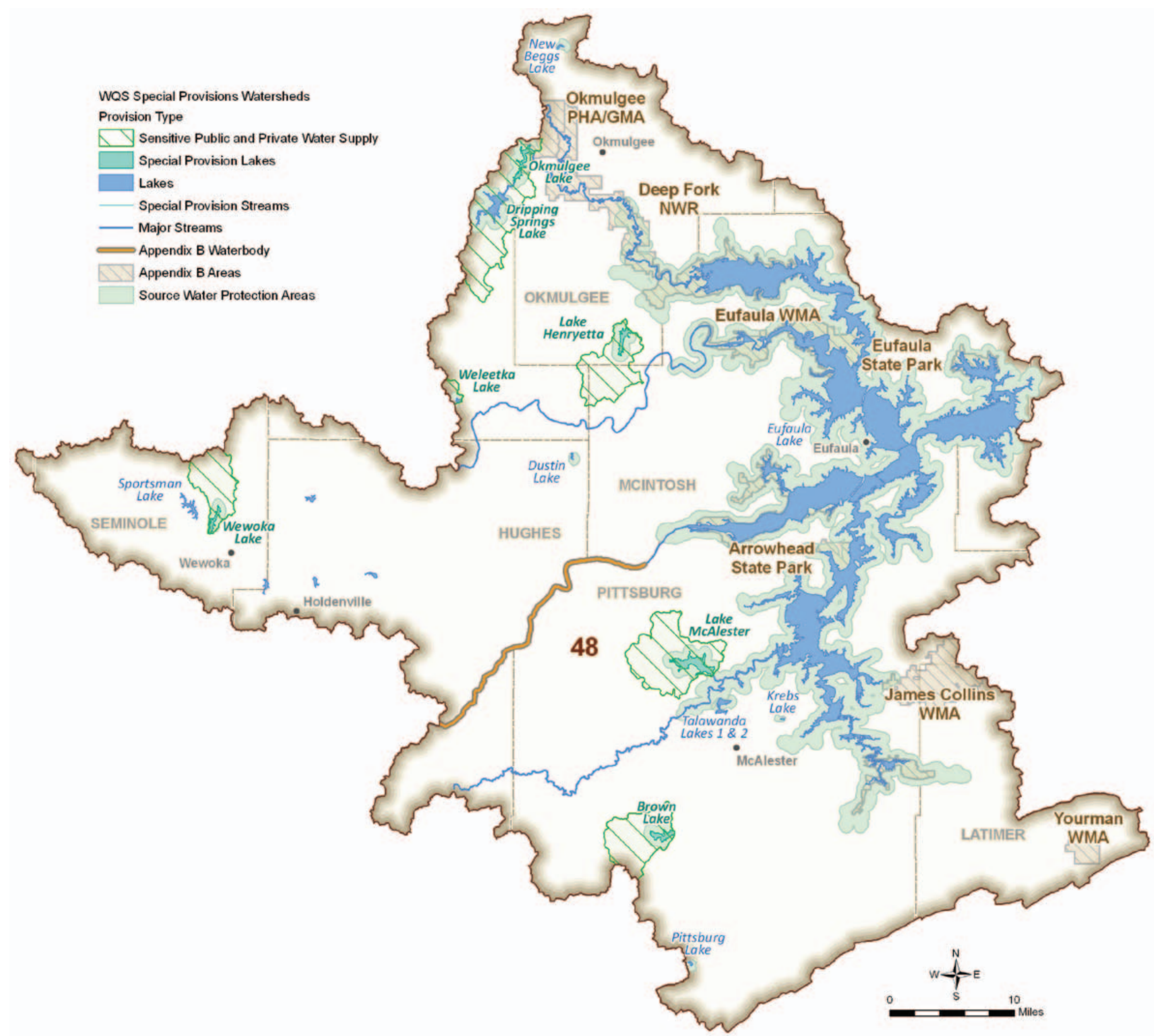
The **Sensitive Water Supplies (SWS)** designation applies to public and private water supplies possessing conditions making them more susceptible to pollution events, thus requiring additional protection. This designation restricts point source discharges in the watershed and institutes a 10 μg/L (micrograms per liter) chlorophyll-a criterion to protect against taste and odor problems and reduce water treatment costs.

Outstanding Resource Waters are those constituting outstanding resources or of exceptional recreational and/or ecological significance. This designation prohibits any new point source discharges or additional load or increased concentration of specified pollutants.

Waters designated as **Scenic Rivers** in Appendix A of the OWQS are protected through restrictions on point source discharges in the watershed. A 0.037 mg/L total phosphorus criterion is applied to all Scenic Rivers in Oklahoma.

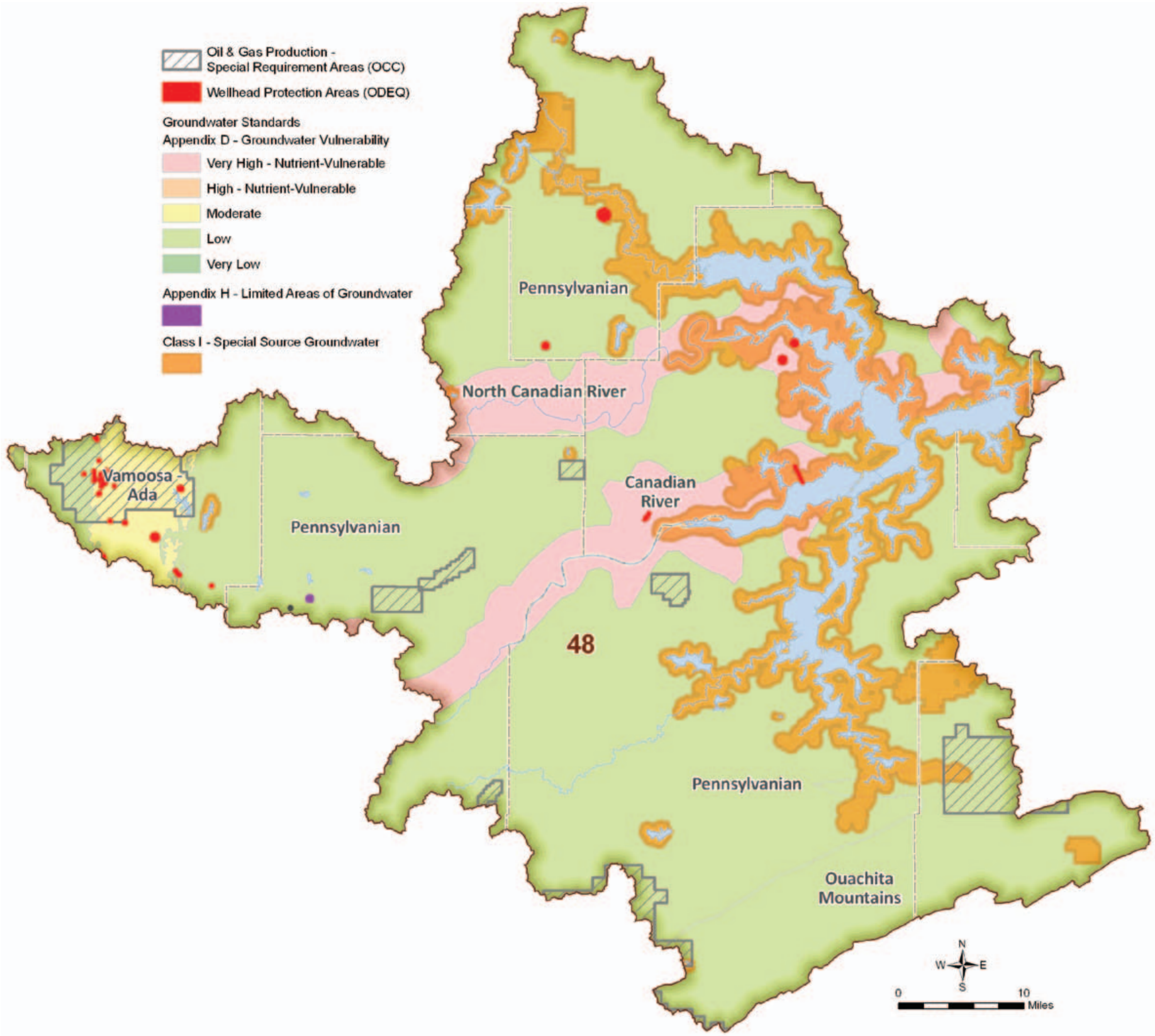
Nutrient-Limited Watersheds are those containing a waterbody with a designated beneficial use that is adversely affected by excess nutrients.

Surface Water Protection Areas
Eufaula Region



Special OWQS provisions in place to protect surface waters. Because Dustin Lake, Krebs Lake, and Talawanda #2 are public water supply reservoirs and have relatively small watersheds, they could potentially benefit from Sensitive Water Supply designations. This could provide protection from new or increased loading from point sources and provide limits for algae (chlorophyll-a) that can cause taste and odor problems and increased treatment costs.

Groundwater Protection Areas
Eufaula Region



Various types of protection are in place to prevent degradation of groundwater and address vulnerability. The North Canadian and Canadian River alluvial aquifers have been identified as very highly vulnerable.

Groundwater Protection

The Oklahoma Water Quality Standards (OWQS) sets the criteria for protection of groundwater quality as follows: "If the concentration found in the test sample exceeds [detection limit], or if other substances in the groundwater are found in concentrations greater than those found in background conditions, that groundwater shall be deemed to be polluted and corrective action may be required."

Wellhead Protection Areas are established by the Oklahoma Department of Environmental Quality (ODEQ) to improve drinking water quality through the protection of groundwater supplies. The primary goal is to minimize the risk of pollution by limiting potential pollution-related activities on land around public water supplies.

Oil and Gas Production Special Requirement Areas, enacted to protect groundwater and/or surface water, can consist of specially lined drilling mud pits (to prevent leaks and spills) or tanks whose contents are removed upon completion of drilling activities; well set-back distances from streams and lakes; restrictions on fluids and chemicals; or other related protective measures.

Nutrient-Vulnerable Groundwater is a designation given to certain hydrogeologic basins that are designated by the OWRB as having high or very high vulnerability to contamination from surface sources of pollution. This designation can impact land application of manure for regulated agriculture facilities.

Class 1 Special Source Groundwaters are those of exceptional quality and particularly vulnerable to contamination. This classification includes groundwaters located underneath watersheds of Scenic Rivers, within OWQS Appendix B areas, or underneath wellhead or source water protection areas.

Appendix H Limited Areas of Groundwater are localized areas where quality is unsuitable for default beneficial uses due to natural conditions or irreversible human-induced pollution.

NOTE: The State of Oklahoma has conducted a successful surface water quality monitoring program for more than fifteen years. A new comprehensive groundwater quality monitoring program is in the implementation phase and will soon provide a comparable long-term groundwater resource data set.

Water Quality Trends Study

As part of the *2012 OCWP Update*, OWRB monitoring staff compiled more than ten years of Beneficial Use Monitoring Program (BUMP) data and other resources to initiate an ongoing statewide comprehensive analysis of surface water quality trends.

Reservoir Trends: Water quality trends for reservoirs were analyzed for chlorophyll-a, conductivity, total nitrogen, total phosphorus, and turbidity at sixty-five reservoirs across the state. Data sets were of various lengths, depending on the station's period of record. The direction and magnitude of trends varies throughout the state and within regions. However, when considered statewide, the final trend analysis revealed several notable details.

- Chlorophyll-a and nutrient concentrations continue to increase at a number of lakes. The proportions of lakes exhibiting a significant upward trend were 42% for chlorophyll-a, 45% for total nitrogen, and 12% for total phosphorus.
- Likewise, conductivity and turbidity have trended upward over time. Nearly 28% of lakes show a significant upward trend in turbidity, while nearly 45% demonstrate a significant upward trend for conductivity.

Stream Trends: Water quality trends for streams were analyzed for conductivity, total nitrogen, total phosphorus, and turbidity at sixty river stations across the state. Data sets were of various lengths, depending on the station's period of record, but generally, data were divided into historical and recent datasets and analyzed separately and as a whole. The direction and magnitude of trends varies throughout the state and within regions. However, when considered statewide, the final trend analysis revealed several notable details.

- Total nitrogen and phosphorus are very different when comparing period of record to more recent data. When considering the entire period of record, approximately 80% of stations showed a downward trend in nutrients. However, if only the most recent data (approximately 10 years) are considered, the percentage of stations with a downward trend decreases to 13% for nitrogen and 30% for phosphorus. The drop is accounted for in stations with either significant upward trends or no detectable trend.
- Likewise, general turbidity trends have changed over time. Over the entire period of record, approximately 60% of stations demonstrated a significant upward trend. However, more recently, that proportion has dropped to less than 10%.
- Similarly, general conductivity trends have changed over time, albeit less dramatically. Over the entire period of record, approximately 45% of stations demonstrated a significant upward trend. However, more recently, that proportion has dropped to less than 30%.

Typical Impact of Trends Study Parameters

Chlorophyll-a is a measure of algae growth. When algae growth increases, there is an increased likelihood of taste and odor problems in drinking water as well as aesthetic issues.

Conductivity is a measure of the ability of water to pass electrical current. In water, conductivity is affected by the presence of inorganic dissolved solids, such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Conductivity in streams and rivers is heavily dependent upon regional geology and discharges. High specific conductance indicates high concentrations of dissolved solids, which can affect the suitability of water for domestic, industrial, agricultural, and other uses. At higher conductivity levels, drinking water may have an unpleasant taste or odor or may even cause gastrointestinal distress. High concentration may also cause deterioration of plumbing fixtures and appliances. Relatively expensive water treatment processes, such as reverse osmosis, are required to remove excessive dissolved solids from water. Concerning agriculture, most crops cannot survive if the salinity of the water is too high.

Total Nitrogen is a measure of all dissolved and suspended nitrogen in a water sample. It includes kjeldahl nitrogen (ammonia + organic), nitrate, and nitrite nitrogen. It is naturally abundant in the environment and is a key element necessary for growth of plants and animals. Excess nitrogen from polluting sources can lead to significant water quality problems, including harmful algal blooms, hypoxia, and declines in wildlife and habitat.

Total Phosphorus is one of the key elements necessary for growth of plants and animals. Excess phosphorus leads to significant water quality problems, including harmful algal blooms, hypoxia, and declines in wildlife and habitat. Increases in total phosphorus can lead to excessive growth of algae, which can increase taste and odor problems in drinking water as well as increased costs for treatment.

Turbidity refers to the clarity of water. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. Increases in turbidity can increase treatment costs and have negative effects on aquatic communities by reducing light penetration.

Reservoir Water Quality Trends

Eufaula Region

Site / Parameter	Dripping Springs Lake (1994-2009)	Eufaula Lake (1995-2009)	Lake McAlester (1995-2009)	Okmulgee Lake (1995-2007)	Wewoka Lake (1994-2009)
Chlorophyll-a (mg/m3)	NT	↑	↑	NT	↑
Conductivity (us/cm)	↑	NT	NT	NT	NT
Total Nitrogen (mg/L)	↑	↑	NT	NT	↑
Total Phosphorus (mg/L)	NT	↑	↓	NT	NT
Turbidity (NTU)	NT	NT	↓	NT	↑

Increasing Trend ↑ **Decreasing Trend** ↓ NT = No significant trend detected

Trend magnitude and statistical confidence levels vary for each site. Site-specific information can be obtained from the OWRB Water Quality Division.

Notable concerns for reservoir water quality include the following:

- Significant upward trends for both chlorophyll-a and total nitrogen on several reservoirs.

Stream Water Quality Trends

Eufaula Region

Site	Canadian River near Calvin		Canadian River near Whitefield		Deep Fork River near Beggs		North Canadian River near Wetumka	
Parameter	All Data Trend (1965-1995, 1998-2009)[1]	Recent Trend (1998-2009)	All Data Trend (1944-1990, 1999-2009)[1]	Recent Trend (1999-2009)	All Data Trend (1946-1993, 1998-2009)[1]	Recent Trend (1998-2009)	All Data Trend (1951-1995, 1999-2009)[1]	Recent Trend (1999-2009)
Conductivity (us/cm)	↑	NT	↑	↑	↓	NT	NT	NT
Total Nitrogen (mg/L)	↓	↑	↓	↑	↓	↑	↑	↑
Total Phosphorus (mg/L)	↓	NT	↓	NT	↓	NT	↓	↑
Turbidity (NTU)	NT	NT	NT	NT	↑	NT	↑	NT

Increasing Trend ↑ **Decreasing Trend** ↓ NT = No significant trend detected

Trend magnitude and statistical confidence levels vary for each site. Site-specific information can be obtained from the OWRB Water Quality Division.

1 Date ranges for analyzed data represent the earliest site visit date and may not be representative of all parameters.

Notable concerns for stream water quality include the following:

- Significant upward trend for conductivity and total nitrogen on the Canadian River.
- Significant increase in turbidity over the entire period of record on the Deep Fork and North Canadian Rivers and total phosphorus on the North Canadian.

Water Demand

Water needs in the Eufaula Region account for about 2% of the total statewide demand. Regional demand will increase by 36% (14,790 AFY) from 2010 to 2060. The highest demand and most significant growth in demand over this period will be in the Municipal and Industrial demand sector. However, there will also be significant growth in the Crop Irrigation and Oil and Gas demand sectors.

Municipal and Industrial (M&I) demand is projected to account for approximately 49% of the region's total 2060 demand. Currently, 92% of the demand from this sector is supplied by surface water, 2% by alluvial groundwater, and 6% by bedrock groundwater.

Oil and Gas demand is projected to account for 24% of the total 2060 demand. Currently, 87% of the demand from this sector is supplied by surface water and 13% by bedrock groundwater.

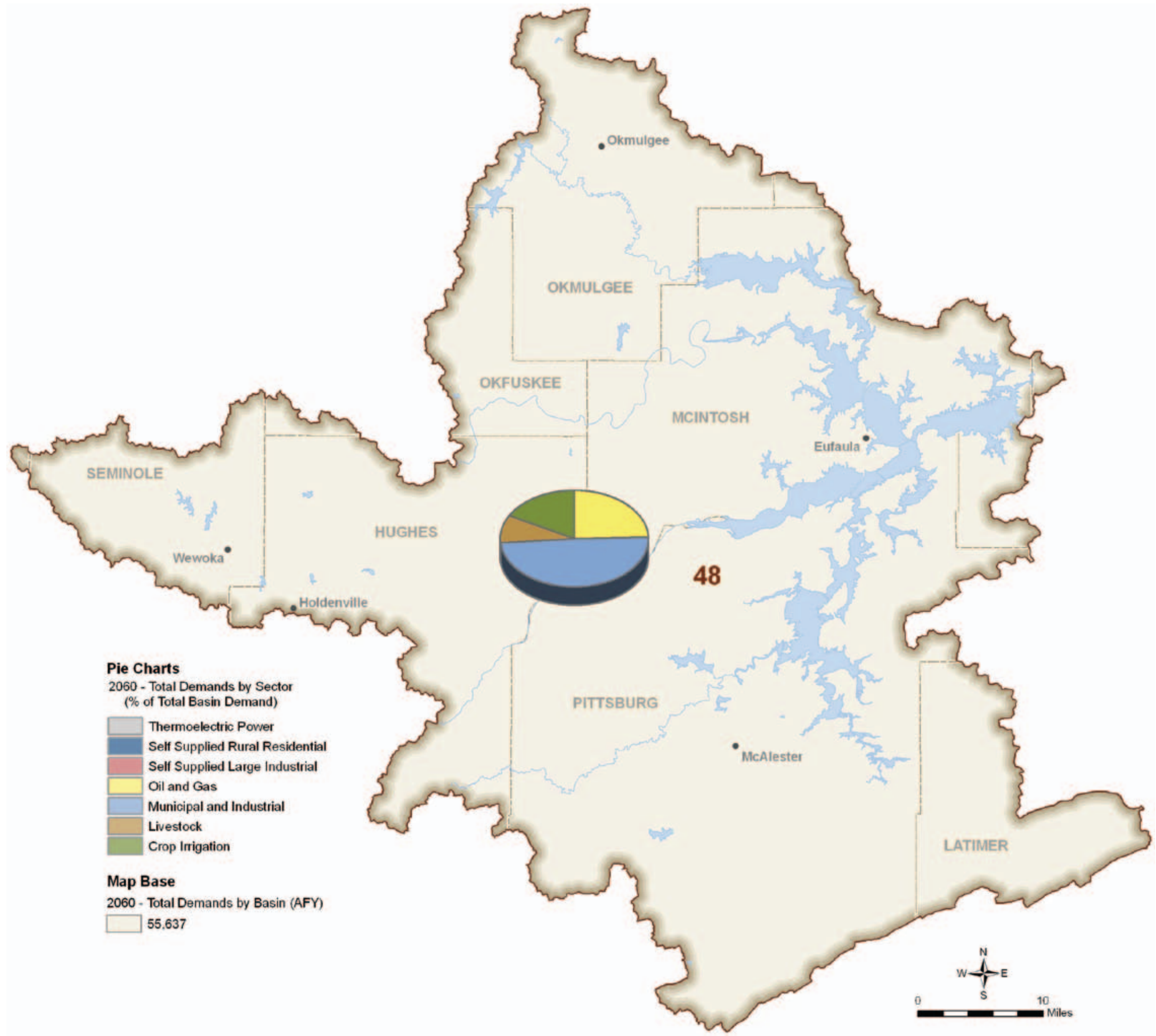
Crop Irrigation demand is expected to account for 19% of the total 2060 demand. Currently, 83% of the demand from this sector is supplied by surface water, 11% by alluvial groundwater, and 6% by bedrock groundwater. The predominant irrigated crops in the Eufaula Region are pasture grasses.

Livestock demand is projected to account for 7% of the total 2060 demand. Currently, 83% of the demand from this sector is supplied by surface water, 11% by alluvial groundwater, and 6% by bedrock groundwater. Livestock use in the region is predominantly hogs, chickens, and cattle for cow-calf production.

Self-Supplied Residential demand is projected to account for 1% of the total 2060 demand. Currently, 94% of the demand from this sector is supplied by alluvial groundwater and 6% by bedrock groundwater.

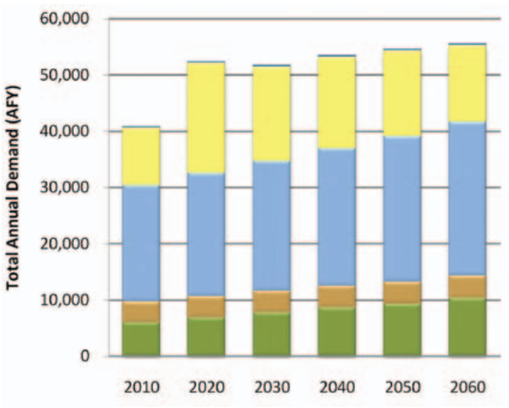
There is no Self-Supplied Industrial or Thermoelectric demand in the region.

Total 2060 Water Demand by Sector and Basin
(Percent of Total Basin Demand)
Eufaula Region

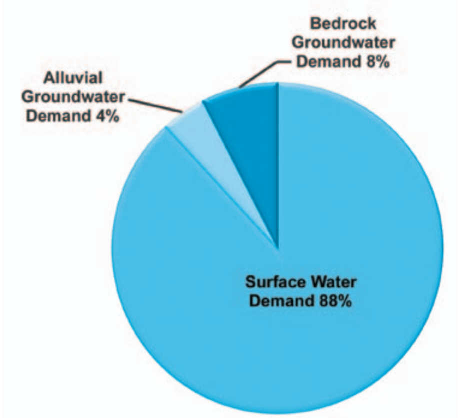


Municipal and Industrial is expected to remain the largest demand sector in the region, accounting for 49% of the projected total regional demand in 2060.

Total Water Demand by Sector
Eufaula Region



Supply Sources Used to Meet Current Demand (2010)
Eufaula Region



This region's water needs account for about 2% of the total statewide demand. Regional demand will increase by 36% (14,790 AFY) from 2010 to 2060. The majority of the demand and growth in demand over this period will be in the Municipal and Industrial, Crop Irrigation, and Oil and Gas sectors.

Total Water Demand by Sector
Eufaula Region

Planning Horizon	Crop Irrigation	Livestock	Municipal & Industrial	Oil & Gas	Self-Supplied Industrial	Self-Supplied Residential	Thermoelectric Power	Total
	AFY							
2010	6,030	3,720	20,670	10,210	0	200	0	40,850
2020	6,910	3,780	21,970	19,570	0	220	0	52,440
2030	7,780	3,830	23,170	16,730	0	230	0	51,740
2040	8,650	3,880	24,470	16,290	0	250	0	53,540
2050	9,320	3,930	25,890	15,250	0	260	0	54,660
2060	10,400	3,980	27,360	13,610	0	280	0	55,640

Water Demand

Water demand refers to the amount of water required to meet the needs of people, communities, industry, agriculture, and other users. Growth in water demand frequently corresponds to growth in population, agriculture, industry, or related economic activity. Demands have been projected from 2010 to 2060 in ten-year increments for seven distinct consumptive water demand sectors.

Water Demand Sectors

- **Thermoelectric Power:** Thermoelectric power producing plants, using both self-supplied water and municipal-supplied water, are included in the thermoelectric power sector.
- **Self-Supplied Residential:** Households on private wells that are not connected to a public water supply system are included in the SSR sector.
- **Self-Supplied Industrial:** Demands from large industries that do not directly depend upon a public water supply system are included in the SSI sector. Water use data and employment counts were included in this sector when available.
- **Oil and Gas:** Oil and gas drilling and exploration activities, excluding water used at oil and gas refineries (typically categorized as Self-Supplied Industrial use), are included in the oil and gas sector.
- **Municipal and Industrial:** These demands represent water that is provided by public water systems to homes, businesses, and industries throughout Oklahoma, excluding water supplied to thermoelectric power plants.
- **Livestock:** Livestock demands were evaluated by livestock group (beef, poultry, etc.) based on the 2007 Agriculture Census.
- **Crop Irrigation:** Water demands for crop irrigation were estimated using 2007 Agriculture Census data for irrigated acres by crop type and county. Crop irrigation requirements were obtained primarily from the Natural Resource Conservation Service Irrigation Guide Reports.

OCWP demands were not projected for non-consumptive or instream water uses, such as hydroelectric power generation, fish and wildlife, recreation, and instream flow maintenance. Projections, which were augmented through user/stakeholder input, are based on standard methods using data specific to each sector and OCWP planning basin.

Projections were initially developed for each county in the state, then allocated to each of the 82 basins. To provide regional context, demands were aggregated by Watershed Planning Region. Water shortages were calculated at the basin level to accurately determine areas where shortages may occur. Therefore, gaps, depletions, and options are presented in detail in the basin summaries and subsequent sections. Future demand projections were developed independent of available supply, water quality, or infrastructure considerations. The impacts of climate change, increased water use efficiency, conservation, and non-consumptive uses, such as hydropower, are presented in supplemental OCWP reports.

Present and future demands were applied to supply source categories to facilitate an evaluation of potential surface water gaps and alluvial and bedrock aquifer storage depletions at the basin level. For this baseline analysis, the proportion of each supply source used to meet future demands for each sector was held constant at the proportion established through current, active water use permit allocations. For example, if the crop irrigation sector in a basin currently uses 80% bedrock groundwater, then 80% of the projected future crop irrigation demand is assumed to use bedrock groundwater. Existing out-of-basin supplies are represented as surface water supplies in the receiving basin.

Public Water Providers

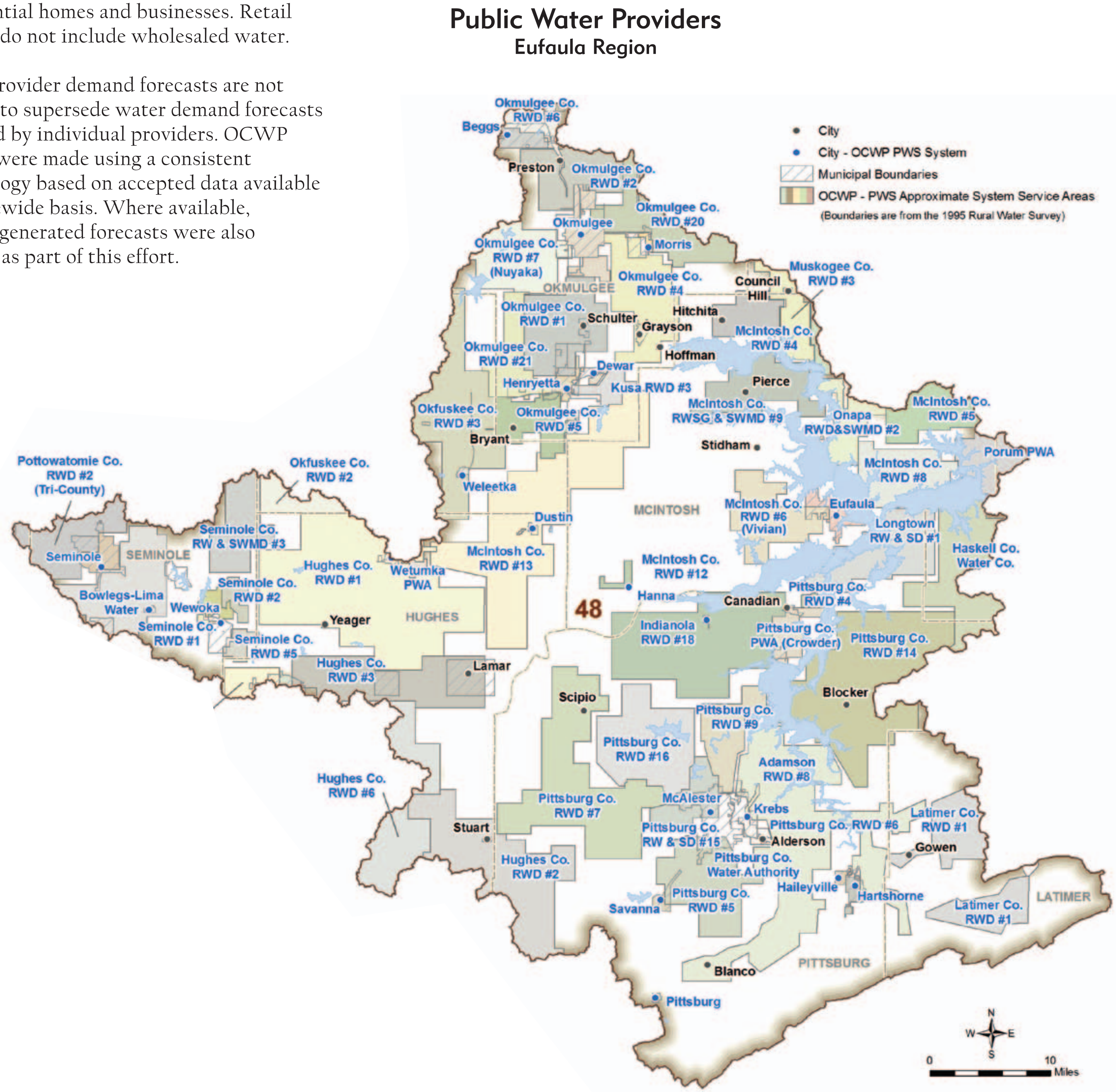
There are more than 1,600 Oklahoma water systems permitted or regulated by the Oklahoma Department of Environmental Quality (ODEQ); 785 systems were analyzed in detail for the *2012 OCWP Update*. The public systems selected for inclusion, which collectively supply approximately 94% of the state's current population, consist of municipal or community water systems and rural water districts that were readily identifiable as non-profit, local governmental entities. This and other information provided in the OCWP will support provider-level planning by providing insight into future supply and infrastructure needs.

The Eufaula Region includes 52 of the 785 public supply systems analyzed for the *2012 OCWP Update*. The Public Water Providers map indicates the approximate service areas of these systems. (The map may not accurately represent existing service areas or legal boundaries. In addition, water systems often serve multiple counties and can extend into multiple planning basins and regions.)

In terms of population served (excluding provider-to-provider sales), the five largest systems in the region, in decreasing order, are McAlester PWA, Okmulgee, Henryetta, Seminole, and Pittsburg Co. RW&S District #1 (Longtown). Together, these five systems serve over 40% of the combined OCWP public water providers' population in the region.

Demands upon public water systems, which comprise the majority of the OCWP's Municipal and Industrial (M&I) water demand sector, were analyzed at both the basin and provider level. Retail demand projections detailed in the Public Water Provider Demand Forecast table were developed for each of the OCWP providers in the region. These projections include estimated system losses, defined as water lost either during water production or distribution to residential homes and businesses. Retail demands do not include wholesaled water.

OCWP provider demand forecasts are not intended to supersede water demand forecasts developed by individual providers. OCWP analyses were made using a consistent methodology based on accepted data available on a statewide basis. Where available, provider-generated forecasts were also reviewed as part of this effort.



Population and Demand Projection Data

Provider level population and demand projection data, developed specifically for OCWP analyses, focus on retail customers for whom the system provides direct service. These estimates were generated from Oklahoma Department of Commerce population projections. In addition, the 2008 OCWP Provider Survey contributed critical information on water production and population served that was used to calculate per capita water use. Population for 2010 was estimated and may not reflect actual 2010 Census values. Exceptions to this methodology are noted.

Public Water Providers/Retail Population Served (1 of 2)

Eufaula Region

Provider	SDWIS ID[1]	County	Retail Per Capita (GPD)[2]	Population Served					
				2010	2020	2030	2040	2050	2060
BEGGS	OK1020707	Okmulgee	106	1,430	1,528	1,627	1,725	1,824	1,923
DEWAR	OK3005613	Okmulgee	184	968	1,048	1,108	1,168	1,237	1,307
DUSTIN	OK1020511	Hughes	101	515	576	638	700	772	844
EUFAULA PWA	OK1020514	McIntosh	167	4,497	5,047	5,598	6,225	6,929	7,678
HAILEYVILLE	OK3006111	Pittsburg	327	907	946	986	1,025	1,074	1,124
HANNA PWA	OK2004902	McIntosh	80	521	590	625	694	764	868
HARTSHORNE	OK3006101	Pittsburg	128	2,376	2,486	2,573	2,683	2,803	2,946
HENRYETTA	OK1020709	Okmulgee	85	8,269	8,869	9,406	9,956	10,531	11,093
HUGHES CO RWD #1	OK3003201	Hughes	83	1,127	1,257	1,385	1,522	1,673	1,822
HUGHES CO RWD #2	OK1010414	Hughes	22	1,121	1,251	1,379	1,515	1,665	1,814
HUGHES CO RWD #3	OK3003202	Hughes	328	207	231	255	280	308	335
HUGHES CO RWD #5	OK3003204	Hughes	263	802	895	987	1,084	1,192	1,298
KREBS UTILITY AUTHORITY	OK1020606	Pittsburg	106	2,133	2,234	2,325	2,426	2,538	2,659
MCALESTER PWA	OK1020609	Pittsburg	271	17,977	18,811	19,527	20,360	21,312	22,342
MCINTOSH CO RWD #4 (HITCHITA)	OK3004906	McIntosh	150	419	470	522	580	645	715
MCINTOSH CO RWD #6 (VIVIAN)	OK2004913	McIntosh	69	2,213	2,478	2,754	3,060	3,406	3,773
MCINTOSH CO RWD #8 (TEXANNA)	OK1020529	McIntosh	77	4,034	4,517	5,019	5,577	6,207	6,877
MCINTOSH CO RWS & SWMD #9	OK3004907	McIntosh	141	1,465	1,640	1,822	2,025	2,254	2,497
MCINTOSH CO RWD #12 (SHELL CREEK)	OK2004919	McIntosh	150	181	203	225	250	279	309
MCINTOSH CO RWD #13 (WELLS)	OK2005603	Okmulgee	80	1,509	1,619	1,716	1,816	1,920	2,024
MORRIS	OK3005610	Okmulgee	184	1,466	1,573	1,669	1,765	1,872	1,968
MUSKOGEE CO RWD #3	OK1020710	Muskogee	266	3,023	3,125	3,218	3,299	3,380	3,461
OKMULGEE	OK1020708	Okmulgee	330	13,282	14,263	15,119	16,003	16,917	17,831
OKMULGEE CO RWD #1	OK3005605	Okmulgee	61	1,846	1,981	2,100	2,222	2,350	2,477
OKMULGEE CO RWD #2 (PRESTON)	OK3005604	Okmulgee	160	3,103	3,330	3,529	3,735	3,949	4,162
OKMULGEE CO RWD #3	OK3005603	Okmulgee	184	235	252	267	283	299	315
OKMULGEE CO RWD #4	OK3005602	Okmulgee	74	2,082	2,235	2,368	2,506	2,650	2,793
OKMULGEE CO RWD #5 (BRYANT)	OK2005604	Okmulgee	156	766	822	871	921	974	1,027
OKMULGEE CO RWD #20	OK3005606	Okmulgee	107	2,332	2,503	2,652	2,807	2,968	3,129
OKMULGEE CO RWD #21	OK3005607	Okmulgee	100	510	548	580	614	649	685
PITTSBURG	OK1020604	Pittsburg	67	286	296	306	315	335	345
PITTSBURG CO PWA (CROWDER)	OK1020603	Pittsburg	179	2,233	2,332	2,431	2,530	2,630	2,779
PITTSBURG CO RW&SD #1 (LONGTOWN)	OK1020623	Pittsburg	53	5,154	5,393	5,597	5,836	6,109	6,403

Public Water Providers/Retail Population Served (2 of 2)

Eufaula Region

Provider	SDWIS ID[1]	County	Retail Per Capita (GPD)[2]	Population Served					
				2010	2020	2030	2040	2050	2060
PITTSBURG CO RWD #4 (CANADIAN)	OK1020612	Pittsburg	117	179	186	194	201	208	222
PITTSBURG CO RWD #5	OK3006115	Pittsburg	86	1,642	1,718	1,783	1,859	1,947	2,040
PITTSBURG CO RWD #6 (ALDERSON	OK3006109	Pittsburg	156	307	318	330	341	364	375
PITTSBURG CO RWD #7 (HAYWOOD)	OK3006108	Pittsburg	255	1,920	2,009	2,085	2,174	2,276	2,386
PITTSBURG CO RWD #8 (ADAMSON)	OK3006112	Pittsburg	80	5,053	5,287	5,487	5,721	5,989	6,278
PITTSBURG CO RWD #9	OK3006107	Pittsburg	112	505	529	549	572	599	628
PITTSBURG CO RWD #14	OK1020625	Pittsburg	126	1,162	1,216	1,262	1,316	1,378	1,444
PITTSBURG CO RW&SD #15	OK3006102	Pittsburg	186	141	148	154	160	168	176
PITTSBURG CO RWD #16	OK3006106	Pittsburg	96	808	846	878	915	958	1,004
PITTSBURG CO RWD #18 (INDIANOLA)	OK3006110	Pittsburg	139	2,062	2,165	2,165	2,268	2,371	2,474
PITTSBURG CO WATER AUTHORITY	OK1020616	Pittsburg	68	26	27	29	30	31	33
SAVANNA	OK3006104	Pittsburg	185	736	775	805	844	883	922
SEMINOLE	OK2006720	Seminole	150	6,847	7,073	7,259	7,445	7,671	7,887
SEMINOLE CO RWD #1	OK3006702	Seminole	55	390	402	413	424	436	449
SEMINOLE CO RWD #2	OK3006701	Seminole	74	317	327	336	345	355	365
SEMINOLE CO RWD #5	OK3006704	Seminole	70	198	205	210	216	222	228
WELEETKA	OK1020512	Okfuskee	103	1,111	1,143	1,165	1,198	1,219	1,263
WEWOKA WATER WORKS	OK1020510	Seminole	198	3,592	3,707	3,807	3,907	4,022	4,134

1 SDWIS - Safe Drinking Water Information System

2 RED ENTRY indicates data were taken from 2007 OWRB Water Rights Database. GPD=gallons per day.

Public Water Provider Demand Forecast (1 of 2)

Eufaula Region

Provider	SDWIS ID[1]	County	Demand (AFY)					
			2010	2020	2030	2040	2050	2060
BEGGS	OK1020707	Okmulgee	170	181	193	205	217	228
DEWAR	OK3005613	Okmulgee	199	216	228	241	255	269
DUSTIN	OK1020511	Hughes	58	65	72	79	87	95
EUFAULA PWA	OK1020514	McIntosh	841	944	1,047	1,165	1,296	1,436
HAILEYVILLE	OK3006111	Pittsburg	333	347	361	376	394	412
HANNA PWA	OK2004902	McIntosh	47	53	56	62	68	78
HARTSHORNE	OK3006101	Pittsburg	340	355	368	384	401	421
HENRYETTA	OK1020709	Okmulgee	787	844	896	948	1,003	1,056
HUGHES CO RWD #1	OK3003201	Hughes	104	116	128	141	155	169
HUGHES CO RWD #2	OK1010414	Hughes	28	31	34	37	41	45
HUGHES CO RWD #3	OK3003202	Hughes	76	85	94	103	113	123
HUGHES CO RWD #5	OK3003204	Hughes	237	264	291	320	351	383
KREBS UTILITY AUTHORITY	OK1020606	Pittsburg	254	266	277	289	302	317
MCALESTER PWA	OK1020609	Pittsburg	5,458	5,711	5,929	6,182	6,470	6,783
MCINTOSH CO RWD #4 (HITCHITA)	OK3004906	McIntosh	70	79	88	97	108	120
MCINTOSH CO RWD #6 (VIVIAN)	OK2004913	McIntosh	172	192	214	237	264	293
MCINTOSH CO RWD #8 (TEXANNA)	OK1020529	McIntosh	348	389	432	481	535	593
MCINTOSH CO RWS & SWMD #9	OK3004907	McIntosh	232	259	288	320	357	395
MCINTOSH CO RWD #12 (SHELL CREEK)	OK2004919	McIntosh	31	34	38	42	47	52
MCINTOSH CO RWD #13 (WELLS)	OK2005603	Okmulgee	135	145	153	162	172	181
MORRIS	OK3005610	Okmulgee	302	324	344	364	386	406
MUSKOGEE CO RWD #3	OK1020710	Muskogee	901	931	959	983	1,007	1,031
OKMULGEE	OK1020708	Okmulgee	4,913	5,276	5,592	5,919	6,257	6,595
OKMULGEE CO RWD #1	OK3005605	Okmulgee	126	135	143	151	160	169
OKMULGEE CO RWD #2 (PRESTON)	OK3005604	Okmulgee	556	597	632	669	708	746
OKMULGEE RWD #3 (KUSA)	OK3005603	Okmulgee	48	52	55	58	62	65
OKMULGEE CO RWD #4	OK3005602	Okmulgee	172	184	195	206	218	230
OKMULGEE CO RWD #5 (BRYANT)	OK2005604	Okmulgee	134	144	152	161	170	179
OKMULGEE CO RWD #20	OK3005606	Okmulgee	280	301	319	337	356	376
OKMULGEE CO RWD #21	OK3005607	Okmulgee	57	61	65	69	73	77
PITTSBURG	OK1020604	Pittsburg	21	22	23	24	25	26
PITTSBURG CO PWA (CROWDER)	OK1020603	Pittsburg	448	468	488	508	528	558
PITTSBURG CO RW&SD #1 (LONGTOWN)	OK1020623	Pittsburg	305	319	331	345	361	378

Projections of Retail Water Demand

Each public water supply system has a "retail" demand, defined as the amount of water used by residential and non-residential customers within that provider's service area. Public-supplied residential demand includes water provided to households for domestic uses both inside and outside the home. Non-residential demand includes customer uses at office buildings, shopping centers, industrial parks, schools, churches, hotels, and related locations served by a public water supply system. Retail demand doesn't include wholesale water to other providers.

Municipal and Industrial (M&I) demand is driven by projected population growth and specific customer characteristics. Demand forecasts for each public system are estimated from average water use (in gallons per capita per day) multiplied by projected population. Oklahoma Department of Commerce 2002 population projections (unpublished special tabulation for the OWRB) were calibrated to 2007 Census estimates and used to establish population growth rates for cities, towns, and rural areas through 2060. Population growth rates were applied to 2007 population-served values for each provider to project future years' service area (retail) populations.

The main source of data for per capita water use for each provider was the 2008 OCWP Provider Survey conducted by the OWRB in cooperation with the Oklahoma Rural Water Association and Oklahoma Municipal League. For each responding provider, data from the survey included population served, annual average daily demand, total water produced, wholesale purchases and sales between providers, and estimated system losses.

For missing or incomplete data, the weighted average per capita demand was used for the provider's county. In some cases, provider survey data were supplemented with data from the OWRB water rights database. Per capita supplier demands can vary over time due to precipitation and service area characteristics, such as commercial and industrial activity, tourism, or conservation measures. For the baseline demand projections described here, per capita demand was held constant through each of the future planning year scenarios. OCWP estimates of potential reductions in demand from conservation measures are analyzed on a basin and regional level but not for individual systems.

Public Water Provider Demand Forecast (2 of 2)
Eufaula Region

Provider	SDWIS ID[1]	County	Demand (AFY)					
			2010	2020	2030	2040	2050	2060
PITTSBURG CO RWD #4 (CANADIAN)	OK1020612	Pittsburg	23	24	25	26	27	29
PITTSBURG CO RWD #5	OK3006115	Pittsburg	158	166	172	179	188	197
PITTSBURG CO RWD #6 (ALDERSON)	OK3006109	Pittsburg	54	56	58	60	64	66
PITTSBURG CO RWD #7 (HAYWOOD)	OK3006108	Pittsburg	548	574	596	621	650	681
PITTSBURG CO RWD #8 (ADAMSON)	OK3006112	Pittsburg	453	474	492	513	537	563
PITTSBURG CO RWD #9	OK3006107	Pittsburg	63	66	69	72	75	79
PITTSBURG CO RWD #14	OK1020625	Pittsburg	164	172	178	186	194	204
PITTSBURG CO RW&SD #15	OK3006102	Pittsburg	29	31	32	33	35	37
PITTSBURG CO RWD #16	OK3006106	Pittsburg	87	91	94	98	103	108
PITTSBURG CO RWD #18 (INDIANOLA)	OK3006110	Pittsburg	321	337	337	353	369	385
PITTSBURG CO WATER AUTHORITY	OK1020616	Pittsburg	2	2	2	2	2	2
SAVANNA	OK3006104	Pittsburg	152	160	167	175	183	191
SEMINOLE	OK2006720	Seminole	1,150	1,188	1,220	1,251	1,289	1,325
SEMINOLE CO RWD #1	OK3006702	Seminole	24	25	25	26	27	28
SEMINOLE CO RWD #2	OK3006701	Seminole	26	27	28	29	30	30
SEMINOLE CO RWD #5	OK3006704	Seminole	16	16	16	17	17	18
WELEETKA	OK1020512	Okfuskee	128	132	135	138	141	146
WEWOKA WATER WORKS	OK1020510	Seminole	795	820	842	864	890	915

1 SDWIS - Safe Drinking Water Information System

Retail demand projections detailed in the Public Water Provider Demand Forecast table were developed for each of the OCWP providers in the region. These projections include estimated system losses, defined as water lost either during water production or distribution to residential homes and businesses. Retail demand does not include wholesaled water.

Wholesale Water Transfers (1 of 2)
Eufaula Region

Provider	SDWIS ID[1]	Sales			Purchases		
		Sells To	Emergency or Ongoing	Treated or Raw or Both	Purchases from	Emergency or Ongoing	Treated or Raw or Both
BEGGS	OK1020707	Okmulgee Co RWD #2	O	T			
DEWAR	OK3005613	Okmulgee Co RWD #4	E	T	Henryetta		T
HAILEYVILLE	OK3006111				Pittsburg Co PWA	O	T
HARTSHORNE	OK3006101				Pittsburg Co PWA	O	T
HENRYETTA	OK1020709	McIntosh Co RWD #13 (Wells) Dewar Okmulgee RWD #3 (Kusa) Okmulgee Co RWD #21 Okmulgee Co RWD #5 (Bryant)	E O O O O	T T T T T			
HUGHES CO RWD #1	OK3003201				Okfuskee Co RWD #2 Wetumka	O O	T T
HUGHES CO RWD #3	OK3003202				Holdenville (Central Region)		T
HUGHES CO RWD #5	OK3003204				Wewoka Water Works Holdenville (Central Region)	O O	T T
KREBS UTILITY AUTHORITY	OK1020606				McAlester PWA	E	T
MCALESTER PWA	OK1020609	Pittsburg Co RWD #7 Pittsburg Co RWD #5 Pittsburg Co RWD #6 Krebs Utility Authority Pittsburg Co RWD #9 Pittsburg Co RWD #16	O O O E O	T T T T T T			
MCINTOSH CO RWD #3 (VICTOR)	OK3004903				Checotah	O	T
MCINTOSH CO RWD #4 (HITCHITA)	OK3004906				Muskogee Co RWD #3	O	T
MCINTOSH CO RWD #13 (WELLS)	OK2005603				Henryetta	E	T
MORRIS	OK3005610				Okmulgee	O	T
MUSKOGEE CO RWD #3	OK1020710	McIntosh Co RWD #4	O	T			
OKMULGEE	OK1020708	Okmulgee Co RWD #6 Okmulgee Co RWD #20 Okmulgee Co RWD #7 Okmulgee Co RWD #4 Okmulgee Co RWD #1 Okmulgee Co RWD #2 Morris	O O O O O O	T T T T T T T			
OKMULGEE CO RWD #1	OK3005605				Okmulgee	O	T
OKMULGEE CO RWD #2 (PRESTON)	OK3005604	Morris Beggs	E E	T T	Okmulgee Beggs	O O	T T
OKMULGEE CO RWD #3 (KUSA)	OK3005603				Henryetta	O	T
OKMULGEE CO RWD #4	OK3005602				Okmulgee Dewar	O E	T T

Wholesale Water Transfers

Some providers sell water on a "wholesale" basis to other providers, effectively increasing the amount of water that the selling provider must deliver and reducing the amount that the purchasing provider diverts from surface and groundwater sources. Wholesale water transfers between public water providers are fairly common and can provide an economical way to meet demand. Wholesale quantities typically vary from year to year depending upon growth, precipitation, emergency conditions, and agreements between systems.

Water transfers between providers can help alleviate costs associated with developing or maintaining infrastructure, such as a reservoir or pipeline; allow access to higher quality or more reliable sources; or provide additional supplies only when required, such as in cases of supply emergencies. Utilizing the 2008 OCWP Provider Survey and OWRB water rights data, the Wholesale Water Transfers table presents a summary of known wholesale arrangements for providers in the region. Transfers can consist of treated or raw water and can occur on a regular basis or only during emergencies. Providers commonly sell to and purchase from multiple water providers.

Wholesale Water Transfers (2 of 2)
Eufaula Region

Provider	SDWIS ID[1]	Sales			Purchases		
		Sells To	Emergency or Ongoing	Treated or Raw or Both	Purchases from	Emergency or Ongoing	Treated or Raw or Both
OKMULGEE CO RWD #5 (BRYANT)	OK2005604				Henryetta	E	T
OKMULGEE CO RWD #20	OK3005606				Okmulgee Okmulgee Co RWD #6	O O	T T
PITTSBURG CO PWA (CROWDER)	OK1020603	Pittsburg Co RWD #8 (Adamson) Haileyville Hartshorne Pittsburg Co RWD #18 (Indianola)	O O O O	T T T T			
PITTSBURG CO RWD #5	OK3006115				McAlester PWA	O	T
PITTSBURG CO RWD #6 (ALDERSON)	OK3006109				McAlester PWA	O	T
PITTSBURG CO RWD #7 (HAYWOOD)	OK3006108				McAlester PWA	O	T
PITTSBURG CO RWD #8 (ADAMSON)	OK3006112				Pittsburg Co PWA	O	T
PITTSBURG CO RWD #9 MCALESTER	OK3006107				McAlester PWA	O	T
PITTSBURG CO RWD #16	OK3006106				McAlester PWA		T
PITTSBURG CO RWD #18 (INDIANOLA)	OK3006110				Pittsburg Co PWA	O	T
SEMINOLE CO RWD #1	OK3006702				Wewoka Water Works	O	T
SEMINOLE CO RWD #2	OK3006701				Wewoka Water Works	O	T
SEMINOLE CO RWD #5	OK3006704				Wewoka Water Works	O	T
WEWOKA WATER WORKS	OK1020510	Seminole Co RWD #1 Seminole Co RWD #2 Seminole Co RWD #5 Hughes Co RWD #5	O O O O	T T T T			

1 SDWIS - Safe Drinking Water Information System

Public Water Provider Water Rights and Withdrawals - 2010 (1 of 2)

Eufaula Region

Provider	SDWIS ID[1]	County	Permitted Quantity	Source		
				Permitted Surface Water	Permitted Alluvial Groundwater	Permitted Bedrock Groundwater
			AFY	Percent		
BEGGS	OK1020707	Okmulgee	513	100%	0%	0%
DEWAR	OK3005613	Okmulgee	---	---	---	---
DUSTIN	OK1020511	Hughes	26	0%	0%	100%
EUFAULA PWA	OK1020514	McIntosh	1,746	100%	0%	0%
HAILEYVILLE	OK3006111	Pittsburg	---	---	---	---
HANNA PWA	OK2004902	McIntosh	386	0%	0%	100%
HARTSHORNE	OK3006101	Pittsburg	---	---	---	---
HENRYETTA	OK1020709	Okmulgee	4,320	100%	0%	0%
HUGHES CO RWD #1	OK3003201	Hughes	157	0%	100%	0%
HUGHES CO RWD #2	OK1010414	Hughes	425	71%	29%	---
HUGHES CO RWD #3	OK3003202	Hughes	---	---	---	---
HUGHES CO RWD #5	OK3003204	Hughes	---	---	---	---
KREBS UTILITY AUTHORITY	OK1020606	Pittsburg	558	100%	0%	0%
MCALESTER PWA	OK1020609	Pittsburg	31,500	100%	0%	0%
MCINTOSH CO RWD #4 (HITCHITA)	OK3004906	McIntosh	---	---	---	---
MCINTOSH CO RWD #6 (VIVIAN)	OK2004913	McIntosh	---	---	---	---
MCINTOSH CO RWD #8 (TEXANNA)	OK1020529	McIntosh	---	---	---	---
MCINTOSH CO RWS & SWMD #9	OK3004907	McIntosh	602	100%	0%	0%
MCINTOSH CO RWD #12 (SHELL CREEK)	OK2004919	McIntosh	---	---	---	---
MCINTOSH CO RWD #13 (WELLS)	OK2005603	Okmulgee	200	0%	0%	100%
MORRIS	OK3005610	Okmulgee	---	---	---	---
MUSKOGEE CO RWD #3	OK1020710	Muskogee	579	100%	0%	0%
OKMULGEE	OK1020708	Okmulgee	12,234	100%	0%	0%
OKMULGEE CO RWD #1	OK3005605	Okmulgee	---	---	---	---
OKMULGEE CO RWD #2 (PRESTON)	OK3005604	Okmulgee	---	---	---	---
OKMULGEE RWD #3 (KUSA)	OK3005603	Okmulgee	---	---	---	---
OKMULGEE CO RWD #4	OK3005602	Okmulgee	---	---	---	---
OKMULGEE CO RWD #5 (BRYANT)	OK2005604	Okmulgee	208	0%	---	100%
OKMULGEE CO RWD #20	OK3005606	Okmulgee	---	---	---	---
OKMULGEE CO RWD #21	OK3005607	Okmulgee	---	---	---	---
PITTSBURG	OK1020604	Pittsburg	250	100%	0%	0%
PITTSBURG CO PWA (CROWDER)	OK1020603	Pittsburg	530	100%	0%	0%

Provider Water Rights

Public water providers using surface water or groundwater obtain water rights from the OWRB. Water providers purchasing water from other suppliers or sources are not required to obtain water rights as long as the furnishing entity has the appropriate water right or other source of authority. Each public water provider's current water right(s) and source of supply have been summarized in this report. The percentage of each provider's total 2007 water rights from surface water, alluvial groundwater, and bedrock groundwater supplies was also calculated, indicating the relative proportions of sources available to each provider.

A comparison of existing water rights to projected demands can show when additional water rights or other sources and in what amounts might be needed. Forecasts of conditions for the year 2060 indicate where additional water rights may be needed to satisfy demands by that time. However, in most cases, wholesale water transfers to other providers must also be addressed by the selling provider's water rights. Thus, the amount of water rights required will exceed the retail demand for a selling provider and will be less than the retail demand for a purchasing provider.

In preparing to meet long-term needs, public water providers should consider strategic factors appropriate to their sources of water. For example, public water providers who use surface water can seek and obtain a "schedule of use" as part of their stream water right, which addresses projected growth and consequent increases in stream water use. Such schedules of use can be employed to address increases that are anticipated to occur over many years or even decades, as an alternative to the usual requirement to use the full authorized amount of stream water in a seven-year period. On the other hand, public water providers that utilize groundwater should consider the prospect that it may be necessary to purchase or lease additional land in order to increase their groundwater rights.

Public Water Provider Water Rights and Withdrawals - 2010 (2 of 2)

Eufaula Region

Provider	SDWIS ID[1]	County	Permitted Quantity	Source		
				Permitted Surface Water	Permitted Alluvial Groundwater	Permitted Bedrock Groundwater
			AFY	Percent		
PITTSBURG CO RW&SD #1 (LONGTOWN)	OK1020623	Pittsburg	1,000	100%	0%	0%
PITTSBURG CO RWD #4 (CANADIAN)	OK1020612	Pittsburg	5	100%	0%	0%
PITTSBURG CO RWD #5	OK3006115	Pittsburg	---	---	---	---
PITTSBURG CO RWD #6 (ALDERSON)	OK3006109	Pittsburg	---	---	---	---
PITTSBURG CO RWD #7 (HAYWOOD)	OK3006108	Pittsburg	692	100%	0%	0%
PITTSBURG CO RWD #8 (ADAMSON)	OK3006112	Pittsburg	---	---	---	---
PITTSBURG CO RWD #9 MCALESTER	OK3006107	Pittsburg	---	---	---	---
PITTSBURG CO RWD #14	OK1020625	Pittsburg	565	100%	0%	0%
PITTSBURG CO RW&SD #15	OK3006102	Pittsburg	---	---	---	---
PITTSBURG CO RWD #16	OK3006106	Pittsburg	---	---	---	---
PITTSBURG CO RWD #18 (INDIANOLA)	OK3006110	Pittsburg	---	---	---	---
PITTSBURG CO WATER AUTHORITY	OK1020616	Pittsburg	2,800	100%	0%	0%
SAVANNA	OK3006104	Pittsburg	---	---	---	---
SEMINOLE	OK2006720	Seminole	7,250	41%	59%	0%
SEMINOLE CO RWD #1	OK3006702	Seminole	---	---	---	---
SEMINOLE CO RWD #2	OK3006701	Seminole	---	---	---	---
SEMINOLE CO RWD #5	OK3006704	Seminole	---	---	---	---
WELEETKA	OK1020512	Okfuskee	233	100%	0%	0%
WEWOKA WATER WORKS	OK1020510	Seminole	957	100%	0%	0%

1 SDWIS - Safe Drinking Water Information System

Provider Supply Plans

In 2008, a survey was sent to 785 municipal and rural water providers throughout Oklahoma to collect vital background water supply and system information. Additional detail for each of these providers was solicited in 2010 as part of follow-up interviews conducted by the ODEQ. The 2010 interviews sought to confirm key details of the earlier survey and document additional details regarding each provider's water supply infrastructure and plans. This included information on existing sources of supply (including surface water, groundwater, and other providers), short-term supply and infrastructure plans, and long-term supply and infrastructure plans.

In instances where no new source was identified, maintenance of the current source of supply is expected into the future. Providers may or may not have secured the necessary funding to implement their stated plans concerning infrastructure needs, commonly including additional wells or raw water conveyance, storage, and replacement/upgrade of treatment and distribution systems.

Additional support for individual water providers wishing to pursue enhanced planning efforts is documented in the *Public Water Supply Planning Guide*. This guide details how information contained in the OCWP Watershed Planning Region reports and related planning documents can be used to formulate provider-level plans to meet present and future needs of individual water systems.

OCWP Provider Survey
Eufaula Region

Beggs (Okmulgee County)
Current Source of Supply
Primary source: Beggs Lake
Short-Term Needs
Infrastructure improvements: replace portion of distribution system and looping lines. Enlarge existing water storage tank.
Long-Term Needs
None identified.

Town of Dewar (Okmulgee County)
Current Source of Supply
Primary source: Town of Henryetta
Short-Term Needs
Infrastructure improvements: replace distribution system lines.
Long-Term Needs
Infrastructure improvements: replace portion of distribution lines.

Town of Dustin (Hughes County)
Current Source of Supply
Primary source: Dustin City Lake
Short-Term Needs
New supply source: McIntosh County RWD 12, add 2 wells.
Infrastructure improvements: add standpipe; replace portion of distribution system lines.
Long-Term Needs
New supply source: McIntosh County RWD 12, add 2 wells.

Eufaula PWA (McIntosh County)
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
None identified.
Long-Term Needs
None identified.

City of Haileyville (Pittsburg County)
Current Source of Supply
Primary source: Pittsburg PWA
Short-Term Needs
Infrastructure improvements: replace fire hydrants.
Long-Term Needs
None identified.

Hanna PWA (McIntosh County)
Current Source of Supply
Primary source: groundwater
Short-Term Needs
None identified.
Long-Term Needs
None identified.

City of Hartshorne (Pittsburg County)
Current Source of Supply
Primary source: Pittsburg County Water Authority
Short-Term Needs
Infrastructure improvements: replace distribution lines.
Long-Term Needs
None identified.

City of Henryetta (Okmulgee County)
Current Source of Supply
Primary source: Henryetta Lake
Short-Term Needs
New supply source: North Canadian River as primary source.
Long-Term Needs
None identified.

Hughes County RWD 1
Current Source of Supply
Primary source: Okfuskee 2, City of Wetumka
Short-Term Needs
None identified.
Long-Term Needs
Infrastructure improvements: drill additional wells.

Hughes County RWD 2
Current Source of Supply
Primary source: Shed Lake
Short-Term Needs
New supply source: groundwater.
Infrastructure improvements: develop well system including backup wells.
Long-Term Needs
None identified.

Hughes County RWD 3
Current Source of Supply
Primary source: City of Holdenville
Short-Term Needs
Infrastructure improvements: upgrading distribution system lines.
Long-Term Needs
New supply source: groundwater
Infrastructure improvements: drill new wells.

Hughes County RWD 5
Current Source of Supply
Primary source: Cities of Wewoka and Holdenville
Short-Term Needs
None identified.
Long-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill new wells.

Krebs Utility Authority (Pittsburg County)
Current Source of Supply
Primary source: Krebs City Lake, Lake Eufaula
Short-Term Needs
None identified.
Long-Term Needs
Infrastructure improvements: replace distribution system lines.

Okmulgee County RWD 3 (KUSA)
Current Source of Supply
Primary sources: City of Henryetta
Short-Term Needs
None identified.
Long-Term Needs
Infrastructure improvements: add distribution system lines.

City of McAlester PWA (Pittsburg County)
Current Source of Supply
Primary source: Lakes McAlester, Talawanda 1&2; Eufaula.
Short-Term Needs
Infrastructure improvements: install a new clarifier and rehabilitate 3 filters at WTP.
Long-Term Needs
Infrastructure improvements: replace portion of main line; relocate portion of water lines.

McIntosh County RWD 13 (Okmulgee County)
Current Source of Supply
Primary source: groundwater
Emergency source: City of Henryetta
Short-Term Needs
Infrastructure improvements: replace distribution system lines.
Long-Term Needs
Infrastructure improvements: replace distribution system lines.

McIntosh County RWD 6 (Vivian)
Current Source of Supply
Primary source: groundwater
Short-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill new wells.
Long-Term Needs
None identified.

McIntosh County RWD 8 (Texanna)
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
Infrastructure improvements: new WTP.
Long-Term Needs
None identified.

McIntosh County RWS & SWMD 9
Current Source of Supply
Primary source: City of Checotah
Short-Term Needs
None identified.
Long-Term Needs
None identified.

McIntosh County RWD 12 (Shell Creek)
Current Source of Supply
Primary source: groundwater
Short-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill additional well.
Long-Term Needs
None identified.

McIntosh County RWD 4 (Hitchita)
Current Source of Supply
Primary source: Muskogee Co RWD 3
Short-Term Needs
None identified.
Long-Term Needs
None identified.

City of Morris (Okmulgee County)
Current Source of Supply
Primary source: City of Okmulgee
Short-Term Needs
Infrastructure improvements: replace distribution system lines.
Long-Term Needs
Infrastructure improvements: add distribution system lines.

Muskogee County RWD 3
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
Infrastructure improvements: add clarifier to WTP; new water intake.
Long-Term Needs
None identified.

City of Okmulgee (Okmulgee County)
Current Source of Supply
Primary source: Lake Okmulgee, Dripping Springs
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Okmulgee County RWD 2 (Preston)
Current Source of Supply
Primary source: City of Okmulgee, City of Beggs
Short-Term Needs
Infrastructure improvement: add new pump station; replace portion of distribution system lines.
Long-Term Needs
Infrastructure improvement: upgrade distribution system lines; add storage.

Okmulgee County RWD 4
Current Source of Supply
Primary source: City of Okmulgee
Emergency source: Town of Dewar
Short-Term Needs
None identified.
Long-Term Needs
Infrastructure improvement: replace distribution system lines.

Okmulgee County RWD 1
Current Source of Supply
Primary source: City of Okmulgee
Short-Term Needs
None identified.
Long-Term Needs
New supply source: purchase from Towns of Henryetta and Okmulgee.
Infrastructure improvement: replace distribution system lines; add storage tank.

Okmulgee County RWD 20
Current Source of Supply
Primary source: City of Okmulgee
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Okmulgee County RWD 21
Current Source of Supply
Primary source: City Henryetta
Short-Term Needs
Infrastructure improvement: upsize distribution system lines; add water tower.
Long-Term Needs
None identified.

Okmulgee County RWD 5 (Bryant)
Current Source of Supply
Primary source: groundwater, City of Henryetta
Short-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill additional well.
Long-Term Needs
Infrastructure improvement: upgrade distribution system lines.

Okmulgee County RWD 7 (Nuyaka)
Current Source of Supply
Primary source: City of Okmulgee, Okmulgee County RWD 6
Short-Term Needs
Infrastructure improvement: add distribution system lines; add water tower.
Long-Term Needs
Infrastructure improvement: add distribution system lines.

Town of Pittsburg (Pittsburg County)
Current Source of Supply
Primary source: Pittsburg Lake
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County PWA (Crowder)
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
Infrastructure improvement: replace distribution system lines; upgrade surface WTP with superpulsators.
Long-Term Needs
Infrastructure improvement: Refurbish water tower.

Pittsburg County RW&S 1 (Longtown)
Current Source of Supply
Primary sources: Lake Eufaula
Short-Term Needs
Infrastructure improvements: add distribution system lines; refurbish water towers; new WTP.
Long-Term Needs
None identified.

Pittsburg County RWD 4
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
Infrastructure improvement: WTP upgrades.
Long-Term Needs
None identified.

Pittsburg County RWD 5
Current Source of Supply
Primary source: City of McAlester
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County RWD 6
Current Source of Supply
Primary source: City of McAlester
Emergency source: Adamson Water, City of Krebs
Short-Term Needs
None identified.
Long-Term Needs
None identified. Adamson RWD 8 (Pittsburg County)

Pittsburg County RWD 7
Current Source of Supply
Primary source: City of McAlester
Emergency source: Hughes County RWD 2, RWD 15
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County RWD 8 (Adamson)
Current Source of Supply
Primary source: Pittsburg County PWA
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County RWD 9
Current Source of Supply
Primary source: City of McAlester
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County RWD 14
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
None identified.
Long-Term Needs
Infrastructure improvements: Expand WTP

Pittsburg County RW&SD 15
Current Source of Supply
Primary source: U.S. Army Ammunition Plant (Brown Lake)
Emergency source: RWD 7, Hughes County RWD 2
Short-Term Needs
None identified.
Long-Term Needs
None identified.

Pittsburg County RWD 16
Current Source of Supply
Primary source: City of McAlester
Short-Term Needs
New supply source: additional connection to McAlester
Infrastructure improvements: replace portion of distribution system lines.
Long-Term Needs
None identified.

Pittsburg County RWD 18 (Indianola)
Current Source of Supply
Primary source: Pittsburg County PWA
Emergency source: Indianola #9
Short-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill new wells.
Long-Term Needs
New supply source: groundwater.
Infrastructure improvements: drill additional wells.

Pittsburg County Water Authority
Current Source of Supply
Primary source: Lake Eufaula
Short-Term Needs
None identified.
Long-Term Needs
None identified.

OCWP Provider Survey
Eufaula Region

Town of Savanna (Pittsburg County)
Current Source of Supply
Primary source: US Army Ammunition Plant (Brown Lake)
Short-Term Needs
Infrastructure improvements: replace distribution lines.
Long-Term Needs
None identified.

City of Seminole (Seminole County)
Current Source of Supply
Primary source: groundwater
Short-Term Needs
Infrastructure improvements: add storage.
Long-Term Needs
None identified.

Seminole County RWD 1
Current Source of Supply
Primary source: City of Wewoka
Short-Term Needs
None identified.
Long-Term Needs
New supply source: groundwater
Infrastructure improvements: drill new wells.

Seminole County RWD 5
Current Source of Supply
Primary source: City of Wewoka
Short-Term Needs
Infrastructure improvements: replace portion of distribution system.
Long-Term Needs
None identified.

Seminole County RWD 2
Current Source of Supply
Primary source: City of Wewoka
Short-Term Needs
None identified.
Long-Term Needs
New supply source: groundwater
Infrastructure improvements: drill new wells.

Town of Weleetka (Okfuskee County)
Current Source of Supply
Primary source: Weleetka Lake
Short-Term Needs
Infrastructure improvements: replace portion of distribution system lines; refurbish existing water towers.
Long-Term Needs
Infrastructure improvements: replace water towers; new WTP.

Wewoka Water Works (Seminole County)
Current Source of Supply
Primary source: Wewoka Lake
Short-Term Needs
Infrastructure improvements: upgrades to WTP.
Long-Term Needs
None identified.

Infrastructure Cost Summary
Eufaula Region

Provider System Category[1]	Infrastructure Need (millions of 2007 dollars)			
	Present - 2020	2021 - 2040	2041 - 2060	Total Period
Small	$175	$1,202	$835	$2,212
Medium	$357	$328	$198	$883
Large	$0	$0	$0	$0
Reservoir[2]	$0	$44	$1	$45
Total	$532	$1,574	$1,034	$3,140

1 Large providers are defined as those serving more than 100,000 people, medium systems as those serving between 3,301 and 100,000 people, and small systems as those serving 3,300 or fewer people.
2 The "reservoir" category refers specifically to rehabilitation projects.

- Approximately $3.1 billion is needed to meet the projected drinking water infrastructure needs of the Eufaula Region over the next 50 years. The largest infrastructure costs are expected to occur between 2021 and 2040.
- Distribution and transmission projects account for more than 90% of the providers' estimated infrastructure costs.
- Small providers have the largest overall drinking water infrastructure costs.
- Projects involving rehabilitation of existing reservoirs account for approximately one percent of the total costs.

Drinking Water Infrastructure Cost Summary

As part of the public water provider analysis, regional cost estimates to meet system drinking water infrastructure needs over the next 50 years were prepared. While it is difficult to account for changes that may occur within this extended time frame, it is beneficial to evaluate, at least on the order-of-magnitude level, the long-range costs of providing potable water.

Project cost estimates were developed for a selection of existing water providers, and then weighted to determine total regional costs. The OCWP method is similar to that utilized by the EPA to determine national drinking water infrastructure costs in 2007. However, the OCWP uses a 50-year planning horizon while the EPA uses a 20-year period. Also, the OCWP includes a broader spectrum of project types rather than limiting projects to those eligible for the Drinking Water State Revolving Fund program. While estimated costs for new reservoirs are not included, rehabilitation project costs for existing major reservoirs were applied at the regional level.

More information on the methodology and cost estimates is available in the OCWP *Drinking Water Infrastructure Needs Assessment by Region* report.

Water Supply Options

Limitations Analysis

For each of the state's 82 OCWP basins, an analysis of water supply and demand was followed by an analysis of limitations for surface water, bedrock groundwater, and alluvial groundwater use. Physical availability limitations for surface water were referred to as gaps. Availability limitations for alluvial and bedrock groundwater were referred to as depletions.

For surface water, the most pertinent limiting characteristics considered were (1) physical availability of water, (2) permit availability, and (3) water quality. For alluvial and bedrock groundwater, permit availability was not a limiting factor through 2060, and existing data were insufficient to conduct meaningful groundwater quality analyses. Therefore, limitations for major alluvial and bedrock aquifers were related to physical availability of water and included an analysis of both the amount of any forecasted depletion relative to the amount of water in storage and rate at which the depletion was predicted to occur.

Methodologies were developed to assess limitations and assign appropriate scores for each supply source in each basin. For surface water, scores were calculated weighting the characteristics as follows: 50% for physical availability, 30% for permit availability, and 20% for water quality. For alluvial and bedrock groundwater scores, the magnitude of depletion relative to amount of water in storage and rate of depletion were each weighted 50%.

The resulting supply limitation scores were used to rank all 82 basins for surface water, major alluvial groundwater, and major bedrock groundwater sources (see Water Supply Limitations map in the regional summary). For each source, basins ranking the highest were considered to be "significantly limited" in the ability of that source to meet forecasted demands reliably. Basins with intermediate rankings were considered to be "potentially limited" for that source. For bedrock and alluvial groundwater rankings, "potentially limited" was also the baseline default given to basins lacking major aquifers due to typically lower yields and insufficient data. Basins with the lowest rankings were considered to be "minimally limited" for that source and not projected to have any gaps or depletions.

Based on an analysis of all three sources of water, the basins with the most significant limitations ranking were identified as "Hot Spots." A discussion of the methodologies used in identifying Hot Spots, results, and recommendations can be found in the *OCWP Executive Report*.

Primary Options

To provide a range of potential solutions for mitigation of water supply shortages in each of the 82 OCWP basins, five primary options were evaluated for potential effectiveness: (1) demand management, (2) use of out-of-basin supplies, (3) reservoir use, (4) increasing reliance on surface water, and (5) increasing reliance on groundwater. For each basin, the potential effectiveness of each primary option was assigned one of three ratings: (1) typically effective, (2) potentially effective, and (3) likely ineffective (see Water Supply Option Effectiveness map in the regional summary). For basins where shortages are not projected, no options are necessary and thus none were evaluated.

Demand Management

"Demand management" refers to the potential to reduce water demands and alleviate gaps or depletions by implementing conservation or drought management measures. Demand management is a vitally important tool that can be implemented either temporarily or permanently to decrease demand and increase available supply. "Conservation measures" refer to long-term activities that result in consistent water savings throughout the year, while "drought management" refers to short-term measures, such as temporary restrictions on outdoor watering. Municipal and industrial conservation techniques can include modifying customer behaviors, using more efficient plumbing fixtures, or eliminating water leaks. Agricultural conservation techniques can include reducing water demand through more efficient irrigation systems and production of crops with decreased water requirements.

Two specific scenarios for conservation were analyzed for the OCWP—moderate and substantial—to assess the relative effectiveness in reducing statewide water demand in the two largest demand sectors, Municipal/Industrial and Crop Irrigation. For the Watershed Planning Region reports, only moderately expanded conservation activities were considered when assessing the overall effectiveness of the demand management option for each basin. A broader analysis of moderate and substantial conservation measures statewide is discussed below and summarized in the "Expanded Options" section of the *OCWP Executive Report*.

Demand management was considered to be "typically effective" in basins where it would likely eliminate both gaps and storage depletions and "potentially effective" in basins where it would likely either reduce gaps and depletions or eliminate either gaps or depletions (but not both). There were no basins where demand management could not reduce gaps and/or storage depletions to at least some extent; therefore this option was not rated "likely ineffective" for any basin.

Out-of-Basin Supplies

Use of "out-of-basin supplies" refers to the option of transferring water through pipelines from a source in one basin to another basin. This option was considered a "potentially effective" solution in all basins due to its general potential in eliminating gaps and depletions. The option was not rated "typically effective" because complexity and cost make it only practical as a long-term solution. The effectiveness of this option for a basin was also assessed with the consideration of potential new reservoir sites within the respective region as identified in the Expanded Options section below and the OCWP *Reservoir Viability Study*.

Reservoir Use

"Reservoir Use" refers to the development of additional in-basin reservoir storage. Reservoir storage can be provided through increased use of existing facilities, such as reallocation of existing purposes at major federal reservoir sites or rehabilitation of smaller NRCS projects to include municipal and/or industrial water supply, or the construction of new reservoirs.

The effectiveness rating of reservoir use for a basin was based on a hypothetical reservoir located at the furthest downstream basin outlet. Water transmission and legal or water quality constraints were not considered; however, potential constraints in permit availability were noted. A site located further upstream could potentially provide adequate yield to meet demand, but would likely require greater storage than a site located at the basin outlet. The effectiveness rating was also largely contingent upon the existence of previously studied reservoir sites (see the Expanded Options section below) and/or the ability of new streamflow diversions with storage to meet basin water demands.

Reservoir use was considered "typically effective" in basins containing one or more potentially viable reservoir sites unless the basin was fully allocated for surface water and had no permit availability. For basins with no permit availability, reservoir use was considered "potentially effective," since diversions would be limited to existing permits. Reservoir use was also considered "potentially effective" in basins that generate sufficient reservoir yield to meet future demand. Statewide, the reservoir use option was considered "likely ineffective" in only three basins (Basins 18, 55, and 66), where it was determined that insufficient streamflow would be available to provide an adequate reservoir yield to meet basin demand.

Increasing Reliance on Surface Water

"Increasing reliance on surface water" refers to changing the surface water-groundwater use ratio to meet future demands by increasing surface water use. For baseline analysis, the proportion of future demand supplied by surface water and groundwater for each sector is assumed equal to current proportions. Increasing the use of surface water through direct diversions without reservoir storage or releases upstream from storage provides a reliable supply option in limited areas of the state and has potential to mitigate bedrock groundwater depletions and/or alluvial groundwater depletions. However, this option largely depends upon local conditions concerning the specific location, amount, and timing of the diversion.

Due to this uncertainty, the pronounced periods of low streamflow in many river systems across the state, and the potential to create or augment surface water gaps, this option was considered "typically ineffective" for all basins. The preferred alternative statewide is reservoir use, which provides the most reliable surface water supply source.

Increasing Reliance on Groundwater

"Increasing reliance on groundwater" refers to changing the surface water-groundwater use ratio to meet future demands by increasing groundwater use. Supplies from major aquifers are particularly reliable because they generally exhibit higher well yields and contain large amounts of water in storage. Minor aquifers can also contain large amounts of water in storage, but well yields are typically lower and may be insufficient to meet the needs of high volume water users. Site-specific information on the suitability of minor aquifers for supply should be considered prior to large-scale use. Additional groundwater supplies may also be developed through artificial recharge (groundwater storage and recovery), which is summarized in the "Expanded Options" section of the *OWRB Executive Report*.

Increased reliance on groundwater supplies was considered "typically effective" in basins where both gaps and depletions could be mitigated in a measured fashion that did not lead to additional groundwater depletions. This option was considered "potentially effective" in basins where surface water gaps could be mitigated by increased groundwater use, but would likely result in increased depletions in either alluvial or bedrock groundwater storage. Increased reliance on groundwater supplies was considered "typically ineffective" in basins where there were no major aquifers.

Expanded Options

In addition to the standard analysis of primary options for each basin, specific OCWP studies were conducted statewide on several more advanced though less conventional options that have potential to reduce basin gaps and depletions. More detailed summaries of these options are available in the *OWRB Executive Report*. Full reports are available on the OWRB website.

Expanded Conservation Measures

Water conservation was considered an essential component of the "demand management" option in basin-level analysis of options for reducing or eliminating gaps and storage depletions. At the basin level, moderately expanded conservation measures were used as the basis for analyzing effectiveness. In a broader OCWP study, summarized in the *OCWP Executive Report* and documented in the OCWP *Water Demand Forecast Report Addendum: Conservation and Climate Change*, both moderately and substantially expanded conservation activities were analyzed at a statewide level for the state's two largest demand sectors: Municipal/Industrial (M&I) and Crop Irrigation. For each sector, two scenarios were analyzed: (1) moderately expanded conservation activities, and (2) substantially expanded conservation activities. Water savings for the municipal and industrial and crop irrigation water use sectors were assessed, and for the M&I sector, a cost-benefit analysis was performed to quantify savings associated with reduced costs in drinking water production and decreased wastewater treatment. The energy savings and associated water savings realized as a result of these decreases were also quantified.

Artificial Aquifer Recharge

In 2008, the Oklahoma Legislature passed Senate Bill 1410 requiring the OWRB to develop and implement criteria to prioritize potential locations throughout the state where artificial recharge demonstration projects are most feasible to meet future water supply challenges. A workgroup of numerous water agencies and user groups was organized to identify suitable locations in both alluvial and bedrock aquifers. Fatal flaw and threshold screening analyses resulted in identification of six alluvial sites and nine bedrock sites. These sites were subjected to further analysis that resulted in five sites deemed by the workgroup as having the best potential for artificial recharge demonstration projects.

Where applicable, potential recharge sites are noted in the "Increasing Reliance on Groundwater" option discussion in basin data and analysis sections of the Watershed Planning Region Reports. The site selection methodology and results for the five selected sites are summarized in the *OCWP Executive Report*; more detailed information on the workgroup and study is presented in the OCWP *Artificial Aquifer Recharge Issues and Recommendations* report.

Marginal Quality Water Sources

In 2008, the Oklahoma Legislature passed Senate Bill 1627 requiring the OWRB to establish a technical workgroup to analyze the expanded use of marginal quality water (MQW) from various sources throughout the state. The group included representatives from state and federal agencies, industry, and other stakeholders. Through facilitated discussions, the group defined MQW as that which has been historically unusable due to technological or economic issues associated with diverting, treating, and/or conveying the water. Five categories of MQW were identified for further characterization and technical analysis: (1) treated wastewater effluent, (2) stormwater runoff, (3) oil and gas flowback/produced water, (4) brackish surface and groundwater, and (5) water with elevated levels of key constituents, such as nitrates, that would require advanced treatment prior to beneficial use.

A phased approach was utilized to meet the study's objectives, which included quantifying and characterizing MQW sources and their locations for use through 2060, assessing constraints to MQW use, and matching identified sources of MQW with projected water shortages across the state. Feasibility of actual use was also reviewed. Of all the general MQW uses evaluated, water reuse—beneficially using treated wastewater to meet certain demand—is perhaps the most commonly applied elsewhere in the U.S. Similarly, wastewater was determined to be one of the most viable sources of marginal quality water for short-term use in Oklahoma. Results of the workgroup's study are summarized in the *OCWP Executive Report*; more detailed information on the workgroup and study is presented in the OCWP *Marginal Quality Water Issues and Recommendations* report.

Potential Reservoir Development

Oklahoma is the location of many reservoirs that provide a dependable, vital water supply source for numerous purposes. While economic, environmental, cultural, and geographical constraints generally limit the construction of new reservoirs, significant interest persists due to their potential in meeting various future needs, particularly those associated with municipalities and regional public supply systems.

As another option to address Oklahoma's long-range water needs, the OCWP *Reservoir Viability Study* was initiated to identify potential reservoir sites throughout the state that have been analyzed to various degrees by the OWRB, Bureau of Reclamation (BOR), U.S. Army Corps of Engineers (USACE), Natural Resources Conservation Service (NRCS), and other public or private agencies. Principal elements of the study included extensive literature search; identification of criteria to determine a reservoir's viability; creation of a database to store essential information for each site; evaluation of sites; Geographic Information System (GIS) mapping of the most viable sites; aerial photograph and map reconnaissance; screening of environmental, cultural, and endangered species issues; estimates of updated construction costs; and categorical assessment of viability. The study revealed more than 100 sites statewide. Each was assigned a ranking, ranging from Category 4 (sites with at least adequate information that are viable candidates for future development) to Category 0 (sites that exist only on a historical map and for which no study data can be verified).

This analysis does not necessarily indicate an actual need or specific recommendation to build any potential project. Rather, these sites are presented to provide local and regional decision-makers with additional tools as they anticipate future water supply needs and opportunities. Study results present only a cursory examination of the many factors associated with project feasibility or implementation. Detailed investigations would be required in all cases to verify feasibility of construction and implementation. A summary of potential reservoir sites statewide is available in the *OCWP Executive Report*; more detailed information on the study is presented in the OCWP *Reservoir Viability Study*. Potential reservoir development sites for this Watershed Planning Region appear on the following table and map.

Reservoir Project Viability Categorization

Category 4: Sites with at least adequate information that are viable candidates for future development.

Category 3: Sites with sufficient data for analysis, but less than desirable for current viability.

Category 2: Sites that may contain fatal flaws or other factors that could severely impede potential development.

Category 1: Sites with limited available data and lacking essential elements of information.

Category 0: Typically sites that exist only on an historical map. Study data cannot be located or verified.

Potential Reservoir Sites (Categories 3 & 4)

Eufaula Region

Name	Category	Stream	Basin	Purposes[1]	Total Storage	Conservation Pool			Primary Study		Updated Cost Estimate[2] (2010 dollars)
						Surface Area	Storage	Dependable Yield	Date	Agency	
					AF	Acres	AF	AFY			
Higgins (Wilburton)	4	Gaines Creek	48	WS, R, FW	272,500	7,400	190,500	68,000	1973	Bureau of Reclamation	$84,651,000
Wetumka	3	Wewoka Creek	48	WS, R, FW, FC	320,000	11,400	210,000	67,213	1985	USACE	$328,410,000

1 WS=Water Supply, R=Recreation, HP=Hydroelectric Power, IR=Irrigation, WQ=Water Quality, FW=Fish & Wildlife, FC=Flood Control, LF=Low Flow Regulation, N=Navigation, C=Conservation, CW=Cooling Water

2 The majority of cost estimates were updated using the costs as estimated in previous project reports combined with the USACE Civil Works Construction Cost Index System (CWCCIS) annual escalation figures to scale the original cost estimates to present-day cost estimates. These estimated costs may not accurately reflect current conditions at the proposed project site and are meant to be used for general comparative purposes only.

Expanded Water Supply Options
Eufaula Region

Oklahoma Comprehensive Water Plan

Data & Analysis
Eufaula Watershed Planning Region

Basin 48

Basin 48 Summary

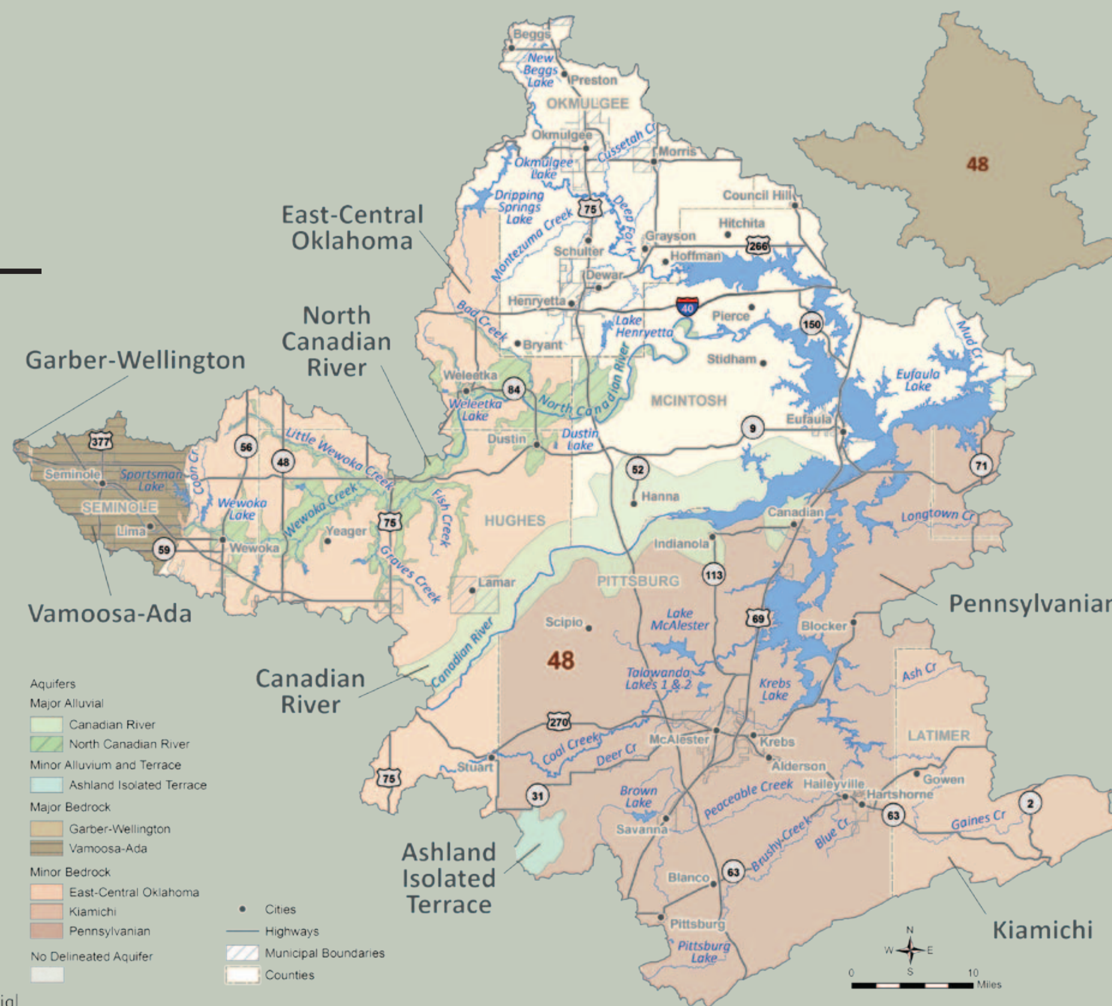
Synopsis

- Water users in Basin 48 are expected to continue to rely primarily on surface water supplies, including Lake Eufaula and other reservoirs in the basin.
- Alluvial and bedrock groundwater storage depletions may occur by 2020 but will be minimal in size relative to aquifer storage in the basin. However, localized storage depletions may cause adverse effects for users.
- To reduce the risk of adverse effects on water supplies, it is recommended that storage depletions be decreased where economically feasible.
- Additional conservation could reduce the adverse effects of localized alluvial and bedrock groundwater storage depletions.
- Additional reservoir storage could be utilized to mitigate alluvial or bedrock groundwater storage depletions.

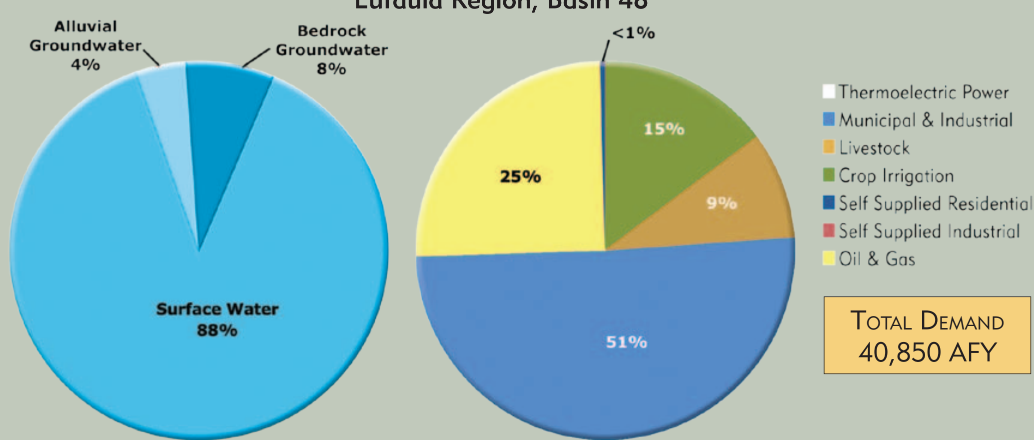
The Eufaula Watershed Planning Region is made up of a single basin, Basin 48. About 51% of the 2010 demand was from the Municipal and Industrial demand sector. Oil and Gas (25%) was the second-largest demand sector in 2010. Surface water is used to meet 88% of the current demand in the basin. Groundwater satisfies about 12% of the current demand (4% alluvial and 8% bedrock). The peak summer month demand in Basin 48 is about 2.2 times the monthly winter demand, which is similar to the overall statewide pattern.

Basin 48 has abundant surface water supplies primarily from the Canadian River, North Canadian River, and Lake Eufaula. The Canadian River below Eufaula Dam typically has substantial flows throughout the year. However, the river can experience periods of low flow during any month of the year. Lake Eufaula was constructed on the Canadian River in 1964 by the Corps of Engineers for flood control, water supply, navigation, and hydropower purposes (modified to include recreation). Lake Eufaula has a dependable water supply yield of 56,000

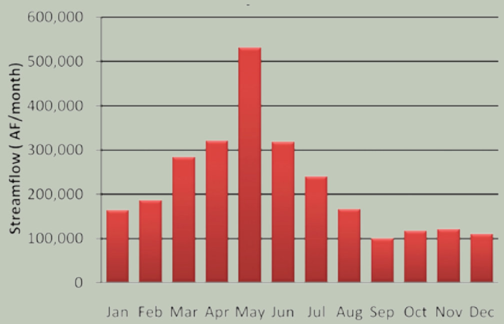
Water Resources
Eufaula Region, Basin 48



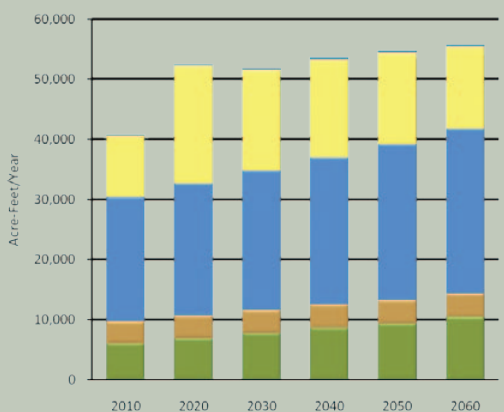
Current Demand by Source and Sector
Eufaula Region, Basin 48



Median Historical Streamflow at the Basin Outlet
Eufaula Region, Basin 48



Projected Water Demand
Eufaula Region, Basin 48



AFY and serves numerous users, but the lake is currently fully allocated. Lake McAlester provides 9,200 AFY of dependable yield to the City of McAlester. Dripping Springs Lake provides 7,200 AFY of dependable yield to the City of Okmulgee. Each of these lakes is fully allocated. There are six additional significant lakes in the region: Henryetta, Okmulgee, Sportsman, Talawanda #2, Weleetka, and Wewoka. All of these lakes except Sportsman provide municipal water supply. Sportsman Lake is currently used primarily for flood control and recreation. The ability of these reservoirs to provide future water supplies could not be evaluated due to the absence of water yield information. Relative to other basins statewide, the surface water quality in Basin 48 is considered good, although there are several water bodies impaired for Public and Private Water Supply and Agricultural use. The availability of permits is not expected to limit the development of surface water supplies for in-basin use through 2060.

The majority of groundwater rights in the basin are from the Vamoosa-Ada major bedrock aquifer, Canadian River major alluvial aquifer, and North Canadian River major alluvial aquifer. These aquifers possess substantial storage in the basin but underlie only a small portion of the basin. There are also permits in multiple minor alluvial and bedrock aquifers. Site-specific information on the suitability of the minor aquifers for supply should be considered before large scale use. The use of groundwater to meet in-basin demand is not expected to be limited by the availability of permits through 2060. There are no significant basin-wide groundwater quality issues in the basin.

The projected 2060 water demand of 55,640 AFY in Basin 48 reflects a 14,790 AFY increase (36%) over the 2010 demand.

Gaps & Depletions

Based on projected demand and historical hydrology, alluvial and bedrock groundwater storage depletions are projected to occur by 2020. There are no surface water gaps expected through 2060 in this basin due to the yield of Lake Eufaula and other lakes. Alluvial groundwater depletions are expected to be up to 410 AFY and have a 24% probability of occurring in at least one month of the year by 2060. Bedrock groundwater storage depletions will be 530 AFY in 2060. Alluvial and bedrock groundwater storage depletions are largest and most likely to occur during the summer months. Projected annual alluvial and bedrock groundwater storage depletions will be minimal relative to the amount of water stored in the basin's aquifers; however localized storage depletions may adversely impact well yields, water quality, and/or pumping costs.

Lake Eufaula and other lakes in the basin are capable of providing dependable water supplies to existing users. With new infrastructure they could be used to meet all of Basin 48's future surface water demand during periods of low streamflow; however these lakes are currently fully allocated.

Water Supply Limitations
Eufaula Region, Basin 48

- Surface Water
- Alluvial Groundwater
- Bedrock Groundwater

Minimal Potential Significant

Water Supply Option Effectiveness
Eufaula Region, Basin 48

- Demand Management
- Out-of-Basin Supplies
- Reservoir Use
- Increasing Supply from Surface Water
- Increasing Supply from Groundwater

Typically Effective Potentially Effective
Likely Ineffective No Option Necessary

Options

Water users are expected to continue to rely primarily on surface water supplies. To reduce the risk of adverse impacts to the basin's water users, groundwater storage depletions should be decreased where economically feasible.

Moderately expanded permanent conservation activities in the Municipal and Industrial and Crop Irrigation sectors could reduce alluvial and bedrock groundwater storage depletions. Temporary drought management activities may not be necessary since aquifer storage may continue to provide supplies during droughts.

New out-of-basin supplies could be used to augment supplies and mitigate groundwater storage depletions. However, due to the distance to reliable supplies, out-of-basin supplies may not be cost-effective for many users.

New reservoir storage could increase the dependability of available surface water supplies and mitigate alluvial groundwater storage depletions in the basin. The OCWP *Reservoir Viability Study*, which evaluated the potential for reservoirs throughout the state, identified two potentially viable sites (Higgins and Wetumka Reservoirs) in Basin 48. The use of multiple reservoirs in the basin or reservoirs upstream of the basin's outlet may increase the amount of storage necessary to mitigate future storage depletions.

Increased reliance on surface water supplies, without reservoir storage, may create surface water gaps and is not recommended.

Increasing the use of major aquifers, where minor aquifers are currently being used, could transfer storage depletions to more dependable supplies. Any increases in storage depletions would be minimal relative to the volume of water stored in the major aquifers underlying the basin, although those supplies may not be accessible to many users.

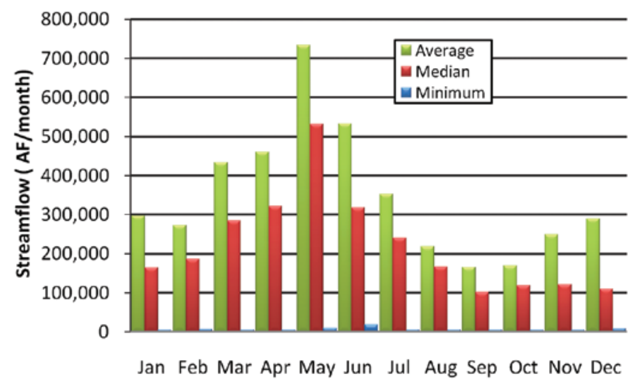
Basin 48 Data & Analysis

Surface Water Resources

- Historical streamflow from 1950 through 2007 was used to estimate the range of future surface water supplies. The Canadian River below Eufaula Dam had a prolonged period of below-average streamflow from the early 1960s to the mid 1970s. From the late 1980s until the early 2000s, precipitation and streamflow were higher than average, demonstrating the long-term hydrologic variability in the basin.
- The median flow in the Canadian River below Eufaula Dam has typically been greater than 100,000 AF/month throughout the year and greater than 280,000 AF/month in the spring and early summer. However, the river can have periods of low flow in any month of the year. Relative to other basins in the state, the surface water quality in Basin 48 is considered good.
- Lake Eufaula is located at the basin outlet and provides up to 56,000 AFY of dependable yield to numerous users but is fully permitted. Lake McAlester provides 9,200 AFY of dependable yield to the City of McAlester. Dripping Springs Lake provides 7,200 AFY of dependable yield to the City of Okmulgee. Each of these lakes is fully allocated. There are six additional significant reservoirs in the region: Henryetta, Okmulgee, Sportsman, Talawanda #2, Weleetka, and Wewoka. The ability of these reservoirs to provide future water supplies could not be evaluated without water yield information.

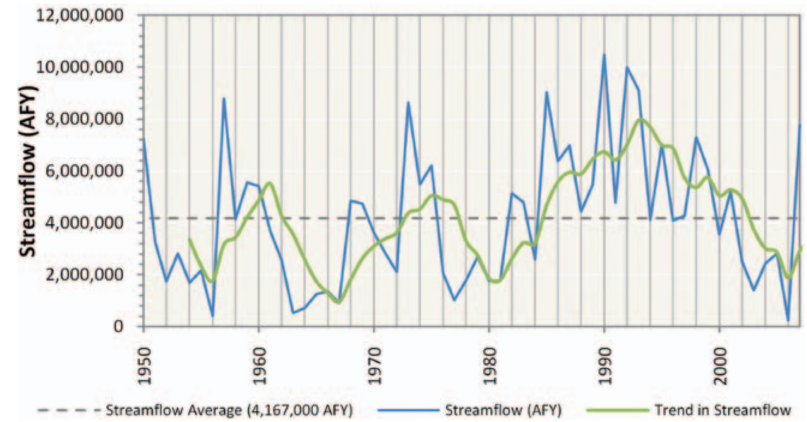
Monthly Historical Streamflow at the Basin Outlet

Eufaula Region, Basin 48



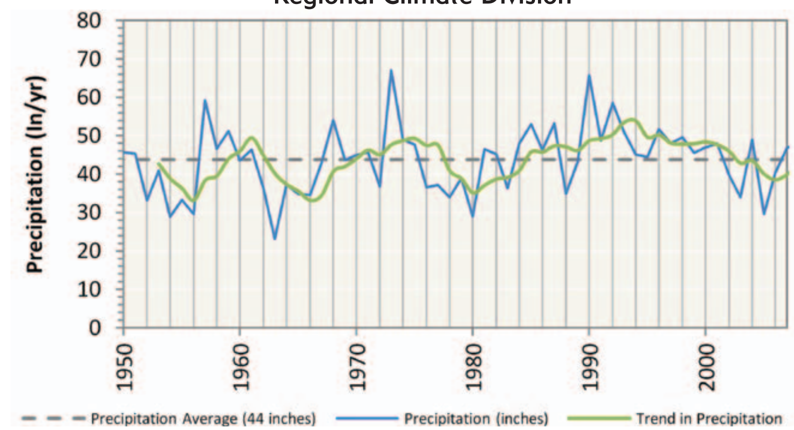
Historical Streamflow at the Basin Outlet

Eufaula Region, Basin 48



Historical Precipitation

Regional Climate Division



Notes & Assumptions

- Precipitation data are based on regional information, while streamflow is basin-specific.
- Measured streamflow implicitly reflects the conditions that exist in the stream at the time the data were recorded (e.g., hydrology, diversions, reservoirs, and infrastructure).
- For water supply planning, the range of potential future hydrologic conditions, including droughts, is represented by 58 years of monthly surface water flows (1950 to 2007). Climate change variations to these flows are documented in a separate OCWP report.
- Surface water supplies are calculated by adjusting the historical streamflow to account for upstream demands, return flows, and out-of-basin supplies.
- The upstream state is assumed to use 60 percent of the flow at the state line based on OWRB permitting protocol.
- Historical flow is based on USGS stream gages at or near the basin outlet. Where a gage did not exist near the outlet or there were missing data in the record, an estimation of flow was determined from representative, nearby gages using statistical techniques.
- Existing surface water rights may restrict the quantity of available surface water to meet future demands. Additional permits would decrease the amount of available water.

Groundwater Resources - Aquifer Summary 2010

Eufaula Region, Basin 48

Aquifer			Portion of Basin Overlaying Aquifer	Current Groundwater Rights	Aquifer Storage in Basin	Equal Proportionate Share	Groundwater Available for New Permits
Name	Type	Class[1]	Percent	AFY	AF	AFY/Acre	AFY
Canadian River	Alluvial	Major	7%	3,000	348,000	temporary 2.0	129,900
North Canadian River	Alluvial	Major	5%	1,100	575,000	1.0	101,200
Vamoosa-Ada	Bedrock	Major	3%	6,300	1,630,000	2.0	123,300
Garber-Wellington	Bedrock	Major	<1%	0	0	temporary 2.0	0
Ashland Isolated Terrace	Alluvial	Minor	1%	600	54,000	temporary 2.0	24,600
East-Central Oklahoma	Bedrock	Minor	22%	1,000	7,169,000	temporary 2.0	920,100
Kiamichi	Bedrock	Minor	6%	100	180,000	temporary 2.0	268,700
Pennsylvanian	Bedrock	Minor	37%	100	12,667,000	temporary 2.0	1,548,500
Non-Delineated Groundwater Source	Bedrock	Minor	N/A	100	N/A	temporary 2.0	N/A
Non-Delineated Groundwater Source	Alluvial	Minor	N/A	0	N/A	temporary 2.0	N/A

1 Bedrock aquifers with typical yields greater than 50 gpm and alluvial aquifers with typical yields greater than 150 gpm are considered major.

Groundwater Resources

- The majority of groundwater rights in the basin are from the Vamoosa-Ada, Canadian River, and North Canadian River aquifers. The Vamoosa-Ada aquifer has more than 1.6 million AF of storage in the basin and receives 4,000 AFY of recharge. The Canadian River and North Canadian River aquifers have combined storage of more than 900,000 AF in the basin. There are also permits in multiple minor alluvial and bedrock aquifers.
- There are no significant groundwater quality issues in the basin.

Notes & Assumptions

- Alluvial groundwater recharge is not considered separately from streamflow in physical supply availability analyses because any increases or decreases in alluvial groundwater recharge or storage would affect streamflow. Therefore, surface water flows are used to represent available alluvial groundwater recharge.
- Site-specific information on minor aquifers should be considered before large scale use. Suitability for long term supply is typically based on recharge, storage yield, capital and operational costs, and water quality.
- Groundwater permit availability is generally based on the amount of land owned or leased that overlies a specific aquifer.
- Temporary permit amounts are subject to change when the aquifer's equal proportionate share is set by the OWRB.
- Current groundwater rights represent the maximum allowable use. Actual use may be lower than the permitted amount.
- Bedrock groundwater recharge is the long-term annual average recharge to aquifers in the basin. Recharge rates on a county- or aquifer-wide level of detail were established from literature (published reports) of each aquifer. Seasonal or annual variability is not considered; therefore the modeled bedrock groundwater supply is independent of changing hydrologic conditions.

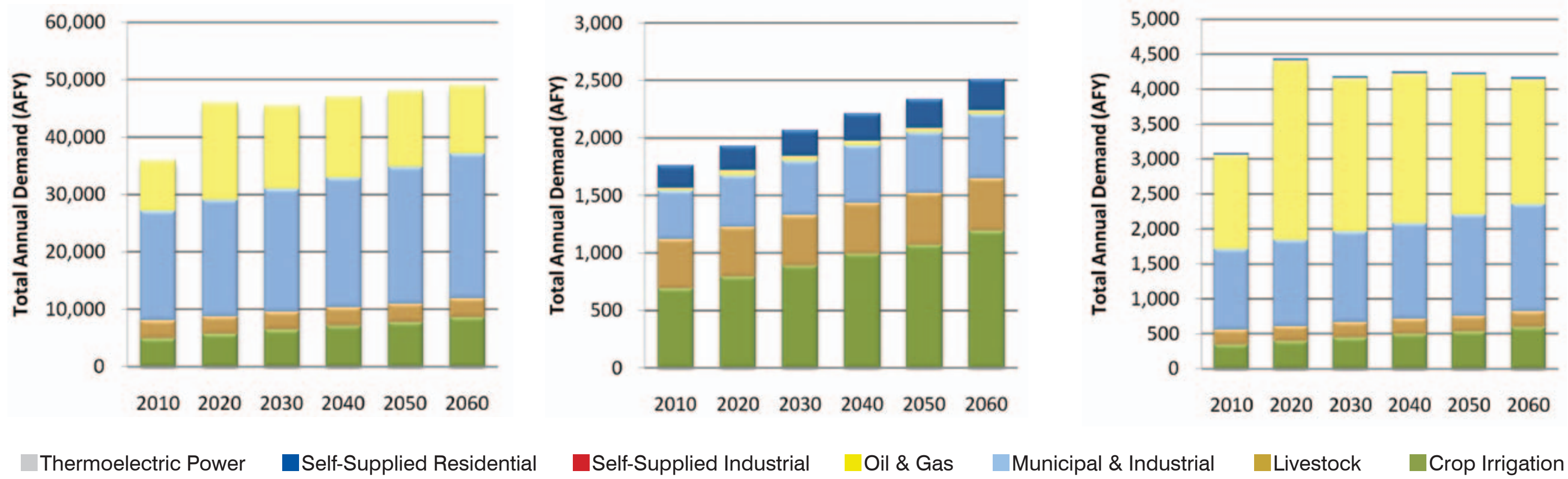
Water Demand

- Basin 48 is the only basin in the Eufaula Watershed Planning Region. The demand will increase by 36% (14,790 AFY) from 2010 to 2060. The highest demand and most significant growth in demand over this period will be in the Municipal and Industrial demand sector. However, there will also be significant growth in the Crop Irrigation and Oil and Gas sectors.
- Surface water is used to meet 88% of the total demand in the basin and its use will increase by 36% (12,950 AFY) from 2010 to 2060. The highest use of surface water and most significant growth in surface water use over this period will be in the Municipal and Industrial sector.
- Alluvial groundwater is used to meet 4% of the total demand in the basin and its use will increase by 43% (750 AFY) from 2010 to 2060. The highest use of and most significant growth in alluvial groundwater use over this period will be in the Crop Irrigation sector.
- Bedrock groundwater is used to meet 8% of the total demand in the basin and its use will increase by 36% (1,090 AFY) from 2010 to 2060. The highest use of and most significant growth in bedrock groundwater use over this period will be in the Oil and Gas sector.

Surface Water Demand by Sector
Eufaula Region, Basin 48

Alluvial Groundwater Demand by Sector
Eufaula Region, Basin 48

Bedrock Groundwater Demand by Sector
Eufaula Region, Basin 48



Total Demand by Sector
Eufaula Region, Basin 48

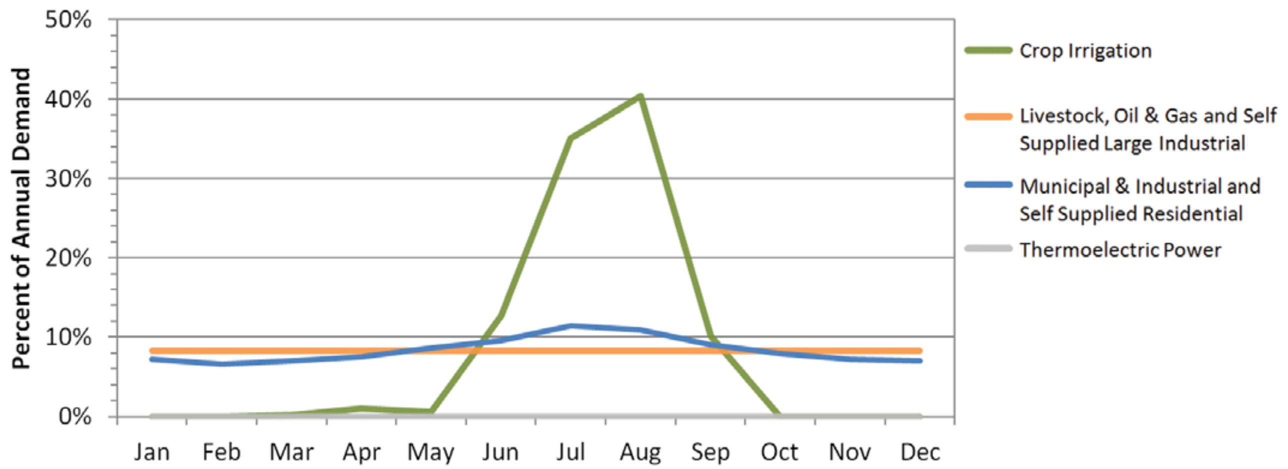
Planning Horizon	Crop Irrigation	Livestock	Municipal & Industrial	Oil & Gas	Self-Supplied Industrial	Self-Supplied Residential	Thermoelectric Power	Total
	AFY							
2010	6,030	3,720	20,670	10,210	0	200	0	40,850
2020	6,910	3,780	21,970	19,570	0	220	0	52,450
2030	7,780	3,830	23,170	16,730	0	230	0	51,740
2040	8,650	3,880	24,470	16,290	0	250	0	53,540
2050	9,320	3,930	25,890	15,250	0	260	0	54,650
2060	10,400	3,980	27,360	13,610	0	280	0	55,640

Notes & Assumptions

- Demand values represent total demand (the amount of water pumped or diverted to meet the needs of the user).
- Values are based on the baseline demand forecast from the OCWP *Water Demand Forecast Report*.
- The effect of climate change, conservation, and non-consumptive uses, such as hydropower, are not represented in this baseline demand analysis but are documented in separate OCWP reports.
- The proportion of each supply source used to meet each water use sector's demand was assumed to be equal to the existing proportion, as represented in water rights.
- The proportions of future demands between water use sectors will vary due to differing growth rates.
- The overall proportion of supplies used to meet demand will change due to differing growth rates among the water use sectors.

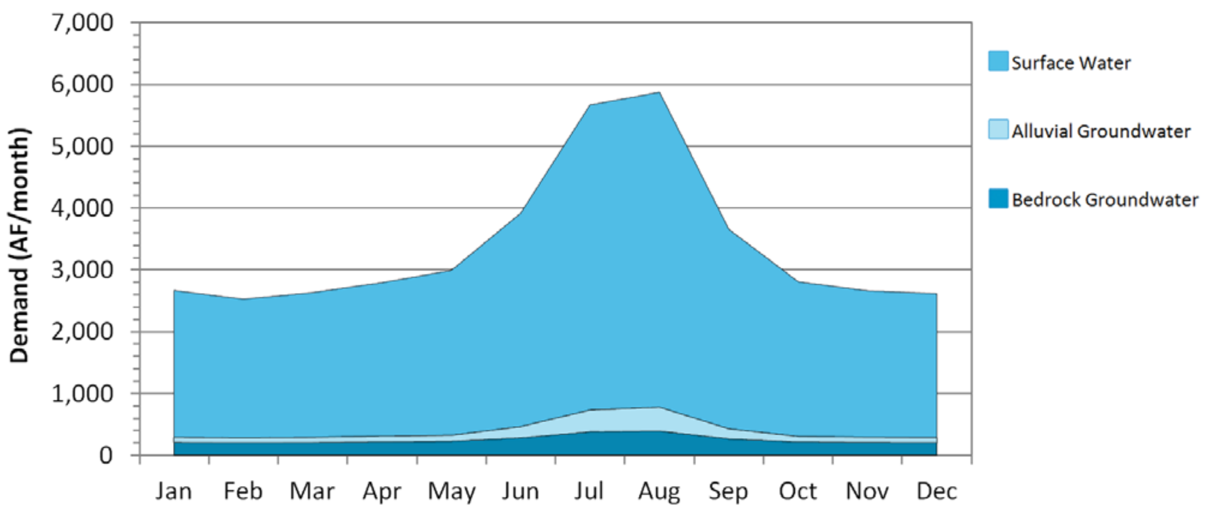
Monthly Demand Distribution by Sector (2010)

Eufaula Region, Basin 48



Monthly Demand Distribution by Source (2010)

Eufaula Region, Basin 48



Current Monthly Demand Distribution by Sector

- The Municipal and Industrial and Self-Supplied Residential demand sectors use 54% more water in summer months than in winter months. Crop Irrigation has a high demand in summer months and little or no demand in winter months. Other demand sectors have more consistent demand throughout the year.

Current Monthly Demand Distribution by Source

- The peak summer month demand in Basin 48 is about 2.2 times the monthly winter demand, which is similar to the overall statewide pattern. Monthly surface water use peaks in the summer at about 2.1 times the winter monthly use. Alluvial groundwater use in the peak summer month is about 4.7 times the monthly winter use. Bedrock groundwater use in the peak summer month is about 1.9 times the monthly winter use.

Gaps and Storage Depletions

- Based on projected demand and historical hydrology, alluvial and bedrock groundwater depletions are projected to occur by 2020. There are no projected surface water gaps.
- Alluvial groundwater storage depletions in Basin 48 may occur throughout the year, peaking in size during the summer. Alluvial groundwater storage depletions in 2060 will be up to 30% (180 AF/month) of the alluvial groundwater demand in the peak summer month and as much as 20% (20 AF/month) of the winter alluvial groundwater demand. There will be a 24% probability of alluvial groundwater storage depletions occurring in at least one month of the year by 2060. Alluvial groundwater storage depletions are most likely to occur during the spring and summer months.
- Bedrock groundwater storage depletions in Basin 48 may occur during the spring, summer, and fall, peaking in size during the summer. Bedrock groundwater storage depletions in 2060 will be 31% (180 AF/month) of the bedrock groundwater demand on average in the peak summer month and an average of 3% (10 AF/month) of the spring bedrock groundwater demand.
- Projected annual alluvial and bedrock groundwater storage depletions will be minimal relative to the amount of water stored in the basin's aquifers. However, localized storage depletions may occur and adversely affect well yields, water quality, and/or pumping costs.
- Lake Eufaula and other lakes in the basin are capable of providing dependable water supplies to existing users, and with new infrastructure, could be used to meet all of Basin 48's future surface water demand during periods of low streamflow. However, the major lakes in the region are currently fully allocated.

Surface Water Gaps by Season (2060 Demand)

Eufaula Region, Basin 48

Months (Season)	Maximum Gap[1]	Median Gap	Probability
	AF/month	AF/month	Percent
Dec-Feb (Winter)	0	0	0%
Mar-May (Spring)	0	0	0%
Jun-Aug (Summer)	0	0	0%
Sep-Nov (Fall)	0	0	0%

1 Amount shown represents largest amount for any one month in season indicated.

Alluvial Groundwater Storage Depletions by Season (2060 Demand)

Eufaula Region, Basin 48

Months (Season)	Maximum Storage Depletion[1]	Median Storage Depletion	Probability
	AF/month	AF/month	Percent
Dec-Feb (Winter)	20	20	2%
Mar-May (Spring)	30	20	7%
Jun-Aug (Summer)	180	160	10%
Sep-Nov (Fall)	60	25	7%

1 Amount shown represents largest amount for any one month in season indicated.

Magnitude and Probability of Annual Gaps and Storage Depletions

Eufaula Region, Basin 48

Planning Horizon	Maximum Gaps/Storage Depletions			Probability of Gaps/ Storage Depletions	
	Surface Water	Alluvial Groundwater	Bedrock Groundwater	Surface Water	Alluvial Groundwater
	AFY			Percent	
2020	0	170	700	0%	16%
2030	0	210	450	0%	17%
2040	0	270	510	0%	19%
2050	0	330	540	0%	24%
2060	0	410	530	0%	24%

Bedrock Groundwater Storage Depletions by Season (2060 Demand)

Eufaula Region, Basin 48

Months (Season)	Storage Depletion[1]
	AF/month
Dec-Feb (Winter)	0
Mar-May (Spring)	10
Jun-Aug (Summer)	180
Sep-Nov (Fall)	70

1 Amount shown represents largest amount for any one month in season indicated.

Notes & Assumptions

- Gaps and Storage Depletions reflect deficiencies in physically available water. Permitting, water quality, infrastructure, and nonconsumptive demand constraints are considered in separate OCWP analyses.
- Local gaps and storage depletions may vary from basin-level values due to local variations in demands and local availability of supply sources.
- For this baseline analysis, each basin's future demand is met by the basin's available supplies.
- For this baseline analysis, the proportion of future demand supplied by surface water and groundwater for each sector is assumed equal to current proportions.
- The amount of available surface water supplies used for OCWP water supply availability analysis includes changes in historical streamflow due to increased upstream demand, return flows, and increases in out-of-basin supplies from existing infrastructure.
- Analysis of bedrock groundwater supplies is based upon recharge from major aquifers.
- Groundwater storage depletions are defined as the amount that future demands exceed available recharge.
- Median gaps and storage depletions are based only on months with gaps or storage depletions.
- Annual probability is based upon the number of years that a gap or depletion occurs in at least one month of that year.

Reducing Water Needs Through Conservation

Eufaula Region, Basin 48

Conservation Activities[1]	2060 Gap/ Storage Depletion			2060 Gap/ Storage Depletion Probability	
	Surface Water	Alluvial GW	Bedrock GW	Surface Water	Alluvial GW
	AFY			Percent	
Existing Conditions	0	410	530	0%	24%
Moderately Expanded Conservation in Crop Irrigation Water Use	0	370	500	0%	24%
Moderately Expanded Conservation in M&I Water Use	0	290	410	0%	17%
Moderately Expanded Conservation in Crop Irrigation and M&I Water Use	0	250	390	0%	16%
Substantially Expanded Conservation in Crop Irrigation and M&I Water Use	0	140	180	0%	14%

1 Conservation Activities are documented in the OCWP Water Demand Forecast Report.

Reliable Diversions Based on Available Streamflow and New Reservoir Storage

Eufaula Region, Basin 48

Reservoir Storage	Diversion
AF	AFY
100	300
500	1,300
1,000	2,200
2,500	5,000
5,000	9,600
Required Storage to Meet Growth in Demand (AF)	7,800
Required Storage to Meet Growth in Surface Water Demand (AF)	6,700

Water Supply Options & Effectiveness

Typically Effective — Potentially Effective — Likely Ineffective — No Option Necessary

Demand Management

Potentially Effective: Moderately expanded permanent conservation activities in the Municipal and Industrial and Crop Irrigation sectors could reduce alluvial groundwater storage depletions by 39% and bedrock groundwater storage depletions by 26%. Temporary drought management activities may not be necessary since aquifer storage may continue to provide supplies during droughts.

Out-of-Basin Supplies

Potentially Effective: New out-of-basin supplies could be used to augment supplies and mitigate storage depletions. However, due to the distance to reliable water supplies, out-of-basin supplies may not be cost-effective for many users.

Reservoir Use

Typically Effective: New reservoir storage could increase the dependability of available surface water supplies and mitigate groundwater storage depletions in the basin. To supply all of the increase in demand from 2010 to 2060, a new river diversion and approximately 7,800 AF of new reservoir storage would be needed at the basin outlet. The use of multiple reservoirs in the basin or reservoirs upstream of the basin's outlet may increase the amount of storage necessary to mitigate future storage depletions. The OCWP *Reservoir Viability Study* evaluated the potential for reservoirs throughout the state; two potentially viable sites (Higgins and Wetumka Reservoirs) were identified in Basin 48.

Increasing Reliance on Surface Water

Likely Ineffective: Increasing the use of surface water through direct diversions, without reservoir storage, may create surface water gaps in the basin and is not recommended.

Increasing Reliance on Groundwater

Potentially Effective: Increasing the use of major aquifers, where minor aquifers are currently being used, could transfer storage depletions to more dependable supplies. Any increases in storage depletions would be minimal relative to the volume of water stored in major aquifers underlying the basin. However, the Vamoosa-Ada, Canadian River, and North Canadian River aquifers underlie only a small portion of the basin and may not be accessible to many users.

Notes & Assumptions

- Water quality may limit the use of supply sources, which may require new or additional treatment before use.
- Infrastructure related to the diversion, conveyance, treatment, and distribution of water will affect the cost-effectiveness of using any new source of supply.
- The ability to reduce demands will vary based on local acceptance of additional conservation and temporary drought management activities.
- Gaps and depletions may be mitigated in individual calendar months without reductions in the annual probability (chance of having shortage during another month).
- River diversion for new or additional reservoir storage is based on a hypothetical on-channel reservoir at the basin outlet. Reported yields will vary depending upon the reservoir location; placement at the basin outlet would likely result in a higher yield.
- Aquifer storage and recovery may provide additional storage or an alternative to surface storage and should be evaluated on a case by case basis.

Glossary

Acre-foot: volume of water that would cover one acre of land to a depth of one foot; equivalent to 43,560 cubic feet or 325,851 gallons.

Alkalinity: measurement of the water's ability to neutralize acids. High alkalinity usually indicates the presence of carbonate, bicarbonates, or hydroxides. Waters that have high alkalinity values are often considered undesirable because of excessive hardness and high concentrations of sodium salts. Waters with low alkalinity have little capacity to buffer acidic inputs and are susceptible to acidification (low pH).

Alluvial aquifer: aquifer with porous media consisting of loose, unconsolidated sediments deposited by fluvial (river) or aeolian (wind) processes, typical of river beds, floodplains, dunes, and terraces.

Alluvial groundwater: water found in an alluvial aquifer.

Alluvium: sediments of clay, silt, gravel, or other unconsolidated material deposited over time by a flowing stream on its floodplain or delta; frequently associated with higher-lying terrace deposits of groundwater.

Appendix B areas: waters of the state into which discharges may be limited and that are located within the boundaries of areas listed in Appendix B of OWRB rules Chapter 45 on Oklahoma's Water Quality Standards (OWQS); including but not limited to National and State parks, forests, wilderness areas, wildlife management areas, and wildlife refuges. Appendix B may include areas inhabited by federally listed threatened or endangered species and other appropriate areas.

Appropriative right: right acquired under the procedure provided by law to take a specific quantity of water by direct diversion from a stream, an impoundment thereon, or a playa lake, and to apply such water to a specific beneficial use or uses.

Aquifer: geologic unit or formation that contains sufficient saturated, permeable material to yield economically significant quantities of water to wells and springs.

Artificial recharge: any man-made process specifically designed for the primary purpose of increasing the amount of water entering into an aquifer.

Attainable uses: best uses achievable for a particular waterbody given water of adequate quality.

Background: ambient condition upstream or upgradient from a facility, practice, or activity that has not been affected by that facility, practice or activity.

Basin: see Surface water basin.

Basin outlet: the furthest downstream geographic point in an OCWP planning basin.

Bedrock aquifer: aquifer with porous media consisting of lithified (semi-consolidated or consolidated) sediments, such as limestone, sandstone, siltstone, or fractured crystalline rock.

Bedrock groundwater: water found in a bedrock aquifer.

Beneficial use: (1) The use of stream or groundwater when reasonable intelligence and diligence are exercised in its application for a lawful purpose and as is economically necessary for that purpose. Beneficial uses include but are not limited to municipal, industrial, agricultural, irrigation, recreation, fish and wildlife, etc., as defined in OWRB rules Chapter 20 on stream water use and Chapter 30 on groundwater use. (2) A classification in OWQS of the waters of the State, according to their best uses in the interest of the public set forth in OWRB rules Chapter 45 on OWQS.

Board: Oklahoma Water Resources Board.

Chlorophyll-a: primary photosynthetic plant pigment used in water quality analysis as a measure of algae growth.

Conductivity: a measure of the ability of water to pass electrical current. High specific conductance indicates high concentrations of dissolved solids.

Conjunctive management: water management approach that takes into account the interactions between groundwaters and surface waters and how those interactions may affect water availability.

Conservation: protection from loss and waste. Conservation of water may mean to save or store water for later use or to use water more efficiently.

Conservation pool: reservoir storage of water for the project's authorized purpose other than flood control.

Consumptive use: a use of water that diverts it from a water supply.

Cultural eutrophication: condition occurring in lakes and streams whereby normal processes of eutrophication are accelerated by human activities.

CWSRF: see State Revolving Fund (SRF).

Dam: any artificial barrier, together with appurtenant works, which does or may impound or divert water.

Degradation: any condition caused by the activities of humans resulting in the prolonged impairment of any constituent of an aquatic environment.

Demand: amount of water required to meet the needs of people, communities, industry, agriculture, and other users.

Demand forecast: estimate of expected water demands for a given planning horizon.

Demand management: adjusting use of water through temporary or permanent conservation measures to meet the water needs of a basin or region.

Demand sectors: distinct consumptive users of the state's waters. For OCWP analysis, seven demand sectors were identified: thermoelectric power, self-supplied residential, self-supplied industrial, oil and gas, municipal and industrial, livestock, and crop irrigation.

Dependable yield: the maximum amount of water a reservoir can dependably supply from storage during a drought of record.

Depletion: a condition that occurs when the amount of existing and future demand for groundwater exceeds available recharge.

Dissolved oxygen: amount of oxygen gas dissolved in a given volume of water at a particular temperature and pressure, often expressed as a concentration in parts of oxygen per million parts of water. Low levels of dissolved oxygen facilitate the release of nutrients from sediments.

Diversion: to take water from a stream or waterbody into a pipe, canal, or other conduit, either by pumping or gravity flow.

Domestic use: in relation to OWRB permitting, the use of water by a natural individual or by a family or household for household purposes, for farm and domestic animals up to the normal grazing capacity of the land whether or not the animals are actually owned by such natural individual or family, and for the irrigation of land not exceeding a total of three acres in area for the growing of gardens, orchards, and lawns. Domestic use also includes: (1) the use of water for agriculture purposes by natural individuals, (2) use of water for fire protection, and (3) use of water by non-household entities for drinking water purposes, restroom use, and the watering of lawns, provided that the amount of water used for any such purposes does not exceed five acre-feet per year.

Drainage area: total area above the discharge point drained by a receiving stream.

DWSRF: see State Revolving Fund (SRF).

Drought management: short-term measures to conserve water to sustain a basin's or region's needs during times of below normal rainfall.

Ecoregion (ecological region): an ecologically and geographically defined area; sometimes referred to as a bioregion.

Effluent: any fluid emitted by a source to a stream, reservoir, or basin, including a partially or completely treated waste fluid that is produced by and flows out of an industrial or wastewater treatment plant or sewer.

Elevation: elevation in feet in relation to mean sea level (MSL).

Equal proportionate share (EPS): portion of the maximum annual yield of water from a groundwater basin that is allocated to each acre of land overlying the basin or subbasin.

Eutrophic: a water quality characterization, or "trophic status," that indicates abundant nutrients and high rates of productivity in a lake, frequently resulting in oxygen depletion below the surface.

Eutrophication: the process whereby the condition of a waterbody changes from one of low biologic productivity and clear water to one of high productivity and water made turbid by the accelerated growth of algae.

Flood control pool: reservoir storage of excess runoff above the conservation pool storage capacity that is discharged at a regulated rate to reduce potential downstream flood damage.

Floodplain: the land adjacent to a body of water which has been or may be covered by flooding, including, but not limited to, the one-hundred year flood (the flood expected to be equaled or exceeded every 100 years on average).

Fresh water: water that has less than five thousand (5,000) parts per million total dissolved solids.

Gap: an anticipated shortage in supply of surface water due to a deficiency of physical water supply or the inability or failure to obtain necessary water rights.

Groundwater: fresh water under the surface of the earth regardless of the geologic structure in which it is standing or moving outside the cut bank of a definite stream.

Groundwater basin: a distinct underground body of water overlain by contiguous land having substantially the same geological and hydrological characteristics and yield capabilities. The area boundaries of a major or minor basin can be determined by political boundaries, geological, hydrological, or other reasonable physical boundaries.

Groundwater recharge: see Recharge.

Hardness: a measure of the mineral content of water. Water containing high concentrations (usually greater than 60 ppm) of iron, calcium, magnesium, and hydrogen ions is usually considered "hard water."

High Quality Waters (HQW): a designation in the OWQS referring to waters that exhibit water quality exceeding levels necessary to support the propagation of fishes, shellfishes, wildlife, and recreation in and on the water. This designation prohibits any new point source discharge or additional load or increased concentration of specified pollutants.

Hydraulic conductivity: the capacity of rock to transmit groundwater under pressure.

Hydrologic unit code: a numerical designation utilized by the United States Geologic Survey and other federal and state agencies as a way of identifying all drainage basins in the U.S. in a nested arrangement from largest to smallest, consisting of a multi-digit code that identifies each of the levels of classification within two-digit fields.

Hypereutrophic: a surface water quality characterization, or "trophic status," that indicates excessive primary productivity and excessive nutrient levels in a lake.

Impaired water: waterbody in which the quality fails to meet the standards prescribed for its beneficial uses.

Impoundment: body of water, such as a pond or lake, confined by a dam, dike, floodgate, or other barrier established to collect and store water.

Infiltration: the gradual downward flow of water from the surface of the earth into the subsurface.

Instream flow: a quantity of water to be set aside in a stream or river to ensure downstream environmental, social, and economic benefits are met (further defined in the OCWP *Instream Flow Issues & Recommendations* report).

Interbasin transfer: the physical conveyance of water from one basin to another.

Levee: a man-made structure, usually an earthen embankment, designed and constructed to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Major groundwater basin: a distinct underground body of water overlain by contiguous land and having essentially the same geological and hydrological characteristics and from which groundwater wells yield at least fifty (50) gallons per minute on the average basinwide if from a bedrock aquifer, and at least one hundred fifty (150) gallons per minute on the average basinwide if from an alluvium and terrace aquifer, or as otherwise designated by the OWRB.

Marginal quality water: waters that have been historically unusable due to technological or economic issues associated with diversion, treatment, or conveyance.

Maximum annual yield (MAY): determination by the OWRB of the total amount of fresh groundwater that can be produced from each basin or subbasin allowing a minimum twenty-year life of such basin or subbasin.

Mesotrophic: a surface water quality characterization, or "trophic status," describing those lakes with moderate primary productivity and moderate nutrient levels.

Million gallons per day (mgd): a rate of flow equal to 1.54723 cubic feet per second or 3.0689 acre-feet per day.

Minor groundwater basin: a distinct underground body of water overlain by contiguous land and having substantially the same geological and hydrological characteristics and which is not a major groundwater basin.

Nitrogen limited: in reference to water chemistry, where growth or amount of primary producers (e.g., algae) is restricted in a waterbody due in large part to available nitrogen.

Non-consumptive use: use of water in a manner that does not reduce the amount of supply, such as navigation, hydropower production, protection of habitat for hunting, maintaining water levels for boating recreation, or maintaining flow, level and/or temperature for fishing, swimming, habitat, etc.

Non-delineated groundwater source: an area where no major or minor aquifer has been studied that may or may not supply a well yield; also referred to as a "non-delineated minor aquifer."

Nonpoint source (NPS): a source of pollution without a well-defined point of origin. Nonpoint source pollution is commonly caused by sediment, nutrients, and organic or toxic substances originating from land use activities. It occurs when the rate of material entering a waterbody exceeds its natural level.

Normal pool elevation: the target lake elevation at which a reservoir was designed to impound water to create a dependable water supply; sometimes referred to as the top of the conservation pool.

Normal pool storage: volume of water held in a reservoir when it is at normal pool elevation.

Numerical criteria: concentrations or other quantitative measures of chemical, physical or biological parameters that are assigned to protect the beneficial use of a waterbody.

Numerical standard: the most stringent of the OWQS numerical criteria assigned to the beneficial uses for a given stream.

Nutrient-impaired reservoir: reservoir with a beneficial use or uses impaired by human-induced eutrophication as determined by a Nutrient-Limited Watershed Impairment Study.

Nutrient-Limited Watershed (NLW): watershed of a waterbody with a designated beneficial use that is adversely affected by excess nutrients as determined by a Carlson's Trophic State Index (using chlorophyll-a) of 62 or greater, or is otherwise listed as "NLW" in Appendix A of the OWQS.

Nutrients: elements or compounds essential as raw materials for an organism's growth and development; these include carbon, oxygen, nitrogen, and phosphorus.

Oklahoma Water Quality Standards (OWQS): rules promulgated by the OWRB in Oklahoma Administrative Code Title 785, Chapter 45, which establish classifications of uses of waters of the state, criteria to maintain and protect such classifications, and other standards or policies pertaining to the quality of such waters.

Oligotrophic: a surface water quality characterization, or "trophic status," describing those lakes with low primary productivity and/or low nutrient levels.

Outfall: a point source that contains the effluent being discharged to the receiving water.

Percolation: the movement of water through unsaturated subsurface soil layers, usually continuing downward to the groundwater or water table (distinguished from Seepage).

Permit availability: the amount of water that could be made available for withdrawals under permits issued in accordance with Oklahoma water law.

pH: the measurement of the hydrogen-ion concentration in water. A pH below 7 is acidic (the lower the number, the more acidic the water, with a decrease of one full unit representing an increase in acidity of ten times) and a pH above 7 (to a maximum of 14) is basic (the higher the number, the more basic the water). In Oklahoma, fresh waters typically exhibit a pH range from 5.5 in the southeast to almost 9.0 in central areas.

Phosphorus limited: in reference to water chemistry, where growth or amount of primary producers (e.g., algae) is restricted in a waterbody due in large part to the amount of available phosphorus.

Physical water availability: amount of water currently in streams, rivers, lakes, reservoirs, and aquifers; sometimes referred to as "wet water."

Point source: any discernible, confined and discrete conveyance, including any pipe, ditch, channel, tunnel, well, discrete fissure, container, rolling stock or concentrated animal feeding operation from which pollutants are or may be discharged. This term does not include return flows from irrigation agriculture.

Potable: describing water suitable for drinking.

Primary Body Contact Recreation (PBCR): a classification in OWQS of a waterbody's use; involves direct body contact with the water where a possibility of ingestion exists. In these cases, the water shall not contain chemical, physical or biological substances in concentrations that irritate the skin or sense organs or are toxic or cause illness upon ingestion by human beings.

Primary productivity: the production of chemical energy in organic compounds by living organisms. In lakes and streams, this is essentially the lowest denominator of the food chain (phytoplankton) bringing energy into the system via photosynthesis.

Prior groundwater right: comparable to a permit, a right to use groundwater recognized by the OWRB as having been established by compliance with state groundwater laws in effect prior to 1973.

Provider: private or public entity that supplies water to end users or other providers. For OCWP analyses, "public water providers" included approximately 785 non-profit, local governmental municipal or community water systems and rural water districts.

Recharge: the inflow of water to an alluvial or bedrock aquifer.

Reservoir: a surface depression containing water impounded by a dam.

Return water or return flow: the portion of water diverted from a water supply that returns to a watercourse.

Reverse osmosis: a process that removes salts and other substances from water. Pressure is placed on the stronger of two unequal concentrations separated by a semi-permeable membrane; a common method of desalination.

Riparian water right (riparian right): the right of an owner of land adjoining a stream or watercourse to use water from that stream for reasonable purposes.

Riverine: relating to, formed by, or resembling a river (including tributaries), stream, etc.

Salinity: the concentration of salt in water measured in milligrams per liter (mg/L) or parts per million (ppm).

Salt water: any water containing more than five thousand (5,000) parts per million total dissolved solids.

Saturated thickness: thickness below the zone of the water table in which the interstices are filled with groundwater.

Scenic Rivers: streams in "Scenic River" areas designated by the Oklahoma Legislature that possess unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values. These areas are listed and described in Title 82 of Oklahoma Statutes, Section 1451.

Sediment: particles transported and deposited by water deriving from rocks, soil, or biological material.

Seepage: the movement of water through saturated material often indicated by the appearance or disappearance of water at the ground surface, as in the loss of water from a reservoir through an earthen dam (distinguished from Percolation).

Sensitive sole source groundwater basin or subbasin: a major groundwater basin or subbasin all or a portion of which has been designated by the U.S. Environmental Protection Agency (EPA) as a "Sole Source Aquifer" and serves as a mechanism to protect drinking water supplies in areas with limited water supply alternatives. It includes any portion of a contiguous aquifer located within five miles of the known areal extent of the surface outcrop of the designated groundwater basin or subbasin.

Sensitive Water Supplies (SWS): designation that applies to public and private water supplies possessing conditions that make them more susceptible to pollution events. This designation restricts point source discharges in the watershed and institutes a 10 µg/L (micrograms per liter) chlorophyll-a criterion to protect against taste and odor problems and reduce water treatment costs.

Soft water: water that contains little to no magnesium or calcium salts.

State Revolving Fund (SRF): fund or program used to provide loans to eligible entities for qualified projects in accordance with Federal law, rules and guidelines administered by the EPA and state. Two separate SRF programs are administered in Oklahoma: the Clean Water SRF is intended to control water pollution and is administered by OWRB; the Drinking Water SRF was created to provide safe drinking water and is administered jointly by the OWRB and ODEQ.

Storm sewer: a sewer specifically designed to control and convey stormwater, surface runoff, and related drainage.

Stream system: drainage area of a watercourse or series of watercourses that converges in a large watercourse with defined boundaries.

Stream water: water in a definite stream that includes water in ponds, lakes, reservoirs, and playa lakes.

Streamflow: the rate of water discharged from a source indicated in volume with respect to time.

Surface water: water in streams and waterbodies as well as diffused over the land surface.

Surface water basin: geographic area drained by a single stream system. For OCWP analysis, Oklahoma has been divided into 82 surface water basins (also referenced as "planning basins").

Temporary permit: for groundwater basins or subbasins for which a maximum annual yield has not been determined, temporary permits are granted to users allocating two acre-feet of water per acre of land per year. Temporary permits are for one-year terms that can be revalidated annually by the permittee. When the maximum annual yield and equal proportionate share are approved by the OWRB, all temporary permits overlying the studied basin are converted to regular permits at the new approved allocation amount.

Terrace deposits: fluvial or wind-blown deposits occurring along the margin and above the level of a body of water and representing the former floodplain of a stream or river.

Total dissolved solids (TDS): a measure of the amount of dissolved material in the water column, reported in mg/L, with values in fresh water naturally ranging from 0-1000 mg/L. High concentrations of TDS limit the suitability of water as a drinking and livestock watering source as well as irrigation supply.

Total maximum daily load (TMDL): sum of individual wasteload allocations for point sources, safety reserves, and loads from nonpoint source and natural backgrounds.

Total nitrogen: for water quality analysis, a measure of all forms of nitrogen (organic and inorganic). Excess nitrogen can lead to harmful algae blooms, hypoxia, and declines in wildlife and habitat.

Total phosphorus: for water quality analysis, a measure of all forms of phosphorus, often used as an indicator of eutrophication and excessive productivity.

Transmissivity: measure of how much water can be transmitted horizontally through an aquifer. Transmissivity is the product of hydraulic conductivity of the rock and saturated thickness of the aquifer.

Tributary: stream or other body of water, surface or underground, that contributes to another larger stream or body of water.

Trophic State Index (TSI): one of the most commonly used measurements to compare lake trophic status, based on algal biomass. Carlson's TSI uses chlorophyll-a concentrations to define the level of eutrophication on a scale of 1 to 100, thus indicating the general biological condition of the waterbody.

Trophic status: a lake's trophic state, essentially a measure of its biological productivity. The various trophic status levels (Oligotrophic, Mesotrophic, Eutrophic, and Hypereutrophic) provide a relative measure of overall water quality conditions in a lake.

Turbidity: a combination of suspended and colloidal materials (e.g., silt, clay, or plankton) that reduce the transmission of light through scattering or absorption. Turbidity values are generally reported in Nephelometric Turbidity Units (NTUs).

Vested stream water right (vested right): comparable to a permit, a right to use stream water recognized by the OWRB as having been established by compliance with state stream water laws in effect prior to 1963.

Waste by depletion: unauthorized use of wells or groundwater; drilling a well, taking, or using fresh groundwater without a permit, except for domestic use; taking more fresh groundwater than is authorized by permit; taking or using fresh groundwater so that the water is lost for beneficial use; transporting fresh groundwater from a well to the place of use in such a manner that there is an excessive loss in transit; allowing fresh groundwater to reach a pervious stratum and be lost into cavernous or otherwise pervious materials encountered in a well; drilling wells and producing fresh groundwater there from except in accordance with well spacing requirements; or using fresh groundwater for air conditioning or cooling purposes without providing facilities to aerate and reuse such water.

Waste by pollution: permitting or causing the pollution of a fresh water strata or basin through any act that will permit fresh groundwater polluted by minerals or other waste to filter or intrude into a basin or subbasin, or failure to properly plug abandoned fresh water wells.

Water quality: physical, chemical, and biological characteristics of water that determine diversity, stability, and productivity of the climax biotic community or affect human health.

Water right: right to the use of stream or groundwater for beneficial use reflected by permits or vested rights for stream water or permits or prior rights for groundwater.

Wastewater reuse: treated municipal and industrial wastewater captured and reused commonly for non-potable irrigation and industrial applications to reduce demand upon potable water systems.

Water supply: a body of water, whether static or moving on or under the surface of the ground, or in a man-made reservoir, available for beneficial use on a dependable basis.

Water supply availability: for OCWP analysis, the consideration of whether or not water is available that meets three necessary requirements: physical water is present, the water is of a usable quality, and a water right or permit to use the water has been or can be obtained.

Water supply options: alternatives that a basin or region may implement to meet changing water demands. For OCWP analysis, "primary options" include demand management, use of out-of-basin supplies, reservoir use, increasing reliance on surface water, and increasing reliance on groundwater; "expanded options" include expanding conservation measures, artificial aquifer recharge, use of marginal quality water sources, and potential reservoir development.

Water table: The upper surface of a zone of saturation; the upper surface of the groundwater.

Waterbody: any specified segment or body of waters of the state, including but not limited to an entire stream or lake or a portion thereof.

Watercourse: the channel or area that conveys a flow of water.

Waters of the state: all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon the state.

Watershed: the boundaries of a drainage area of a watercourse or series of watercourses that diverge above a designated location or diversion point determined by the OWRB.

Well: any type of excavation for the purpose of obtaining groundwater or to monitor or observe conditions under the surface of the earth; does not include oil and gas wells.

Well yield: amount of water that a water supply well can produce (usually in gpm), which generally depends on the geologic formation and well construction.

Wholesale: for purposes of OCWP Public Water Provider analyses, water sold from one public water provider to another.

Withdrawal: water removed from a supply source.

AF: acre-foot or acre-feet

AFD: acre-feet per day

AFY: acre-feet per year

BMPs: best management practices

BOD: biochemical oxygen demand

cfs: cubic feet per second

CWAC: Cool Water Aquatic Community

CWSRF: Clean Water State Revolving Fund

DO: dissolved oxygen

DWSRF: Drinking Water State Revolving Fund

EPS: equal proportionate share

FACT: Funding Agency Coordinating Team

gpm: gallons per minute

HLAC: Habitat Limited Aquatic Community

HQW: High Quality Waters

HUC: hydrologic unit code

M&I: municipal and industrial

MAY: maximum annual yield

mgd: million gallons per day

µS/cm: microsiemens per centimeter (see specific conductivity)

mg/L: milligrams per liter

NLW: nutrient-limited watershed

NPS: nonpoint source

NPDES: National Pollutant Discharge Elimination System

NRCS: Natural Resources Conservation Service

NTU: Nephelometric Turbidity Unit (see "Turbidity")

OCWP: Oklahoma Comprehensive Water Plan

ODEQ: Oklahoma Department of Environmental Quality

O&G: Oil and Gas

ORW: Outstanding Resource Water

OWQS: Oklahoma Water Quality Standards

OWRB: Oklahoma Water Resources Board

PBCR: Primary Body Contact Recreation

pH: hydrogen ion activity

ppm: parts per million

RD: Rural Development

REAP: Rural Economic Action Plan

SBCR: Secondary Body Contact Recreation

SDWIS: Safe Drinking Water Information System

SRF: State Revolving Fund

SSI: Self-Supplied Industrial

SSR: Self-Supplied Residential

SWS: Sensitive Water Supply

TDS: total dissolved solids

TMDL: total maximum daily load

TSI: Trophic State Index

TSS: total suspended solids

USACE: United States Army Corps of Engineers

USEPA: United States Environmental Protection Agency

USGS: United States Geological Survey

WLA: wasteload allocation

WWAC: Warm Water Aquatic Community

Water Quantity Conversion Factors

Desired Unit

Initial Unit	CFS	GPM	MGD	AFY	AFD
CFS	—	450	.646	724	1.98
GPM	.00222	—	.00144	1.61	.00442
MGD	1.55	695	—	1120	3.07
AFY	.0014	.62	.00089	—	.00274
AFD	.504	226	.326	365	—

EXAMPLE: Converting from MGD to CFS. To convert from an initial value of 140 MGD to CFS, multiply 140 times 1.55 to come up with the desired conversion, which would be 217 CFS (140 X 1.55 = 217).

CFS: cubic feet per second
GPM: gallons per minute
MGD: millions gallons per day
AFY: acre-feet per year
AFD: acre-feet per day
1 acre-foot: 325,851 gallons

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