DRAFT

The Oklahoma Comprehensive Water Plan

Summary of Technical Work

In general, Oklahoma is blessed with an abundance of water. Surface water supplies, including water stored in numerous reservoirs, are particularly bountiful in the east while western Oklahoma and other areas of the state are blessed with plentiful groundwater supplies and tremendous amounts of water in storage. Still, many Oklahomans lack access to dependable sources of water due to the geographic location of supplies, insufficient infrastructure or storage, water quality constraints, and other limiting factors.

Surface water supplies are, in most parts of the state, subject to seasonal variability. Often, availability is at its lowest when demand is the highest. The ability to store water in reservoirs – an integral element of surface water management – can do much to mitigate the impacts of drought episodes and other water emergencies. Groundwater supplies, particularly bedrock aquifers, are less susceptible to seasonal fluctuations, yet they do experience localized impacts due to concentrated demands or prolonged periods of decreased recharge. Often complex geologic factors also impact a particular aquifer's ability to supply water. The amount of water in storage, depth to water, and well yields vary significantly between aquifers. And in relatively shallow alluvial aquifers, both the aquifer and overlying stream are often hydrologically linked, each resource impacting the other.

The **Oklahoma Comprehensive Water Plan (OCWP) Water Demand Analysis**, which considered all factors impacting Oklahoma's water use through 2060 in 82 planning basins consolidated into 13 Watershed Planning Regions, predicts that future consumptive demands will put a strain on surface and groundwater supplies in most areas of the state, some much more than others. The study was augmented with data from almost 800 state water systems collected through the **OCWP Water Provider Survey**.

OCWP Watershed Planning Regions & Basins

The OCWP evaluated the impacts of forecasted demands on the **physical availability** of Oklahoma's surface and groundwater supplies through the next 50 years. More specifically, utilizing a suite of planning tools, the OCWP predicted the amount, timing, frequency and probability of potential water shortages. A number of planning basins showed significant surface water supply shortages (referred to as "gaps") and moderate groundwater depletions (where use exceeds aquifer recharge). Utilizing results of the Water Demand Analysis, selected options were evaluated as to their effectiveness in addressing gaps and depletions. A number were found to be potentially effective and are discussed in detail in 13 Watershed Planning Region Reports, and in a summary fashion in the OCWP Executive Report, the central product of the OCWP's five-year development process.

Physical water availability is not the only vital factor in providing reliable water supply. **Water quality**, which varies considerably across the state, also has major implications for water users. Quality is significantly influenced by land use, geography, geology, water quantity, both natural and human-induced pollution, and many other factors. Utilizing current and historical data collected primarily by state and federal water agencies, the OCWP assessed surface water quality in all 82 basins. This effort included an **analysis of water quality trends** in certain regularly monitored parameters (such as nitrogen, phosphorus, turbidity, etc.) and the effect these have on the usability of surface water supplies. (Groundwater quality was not assessed due to the availability of sufficient data.) While great strides have been made in protecting Oklahoma's surface and groundwaters, increasing use coupled with growth and development will continue to pose water quality challenges.

The **availability of water for new permits** is also an important consideration when evaluating the future impacts of increased demands on availability. With the exception of waters under the jurisdiction of the Grand River Dam Authority and those used for domestic purposes statewide, the Oklahoma Water Resources Board (OWRB) requires a permit for all beneficial uses of water. OCWP analyses indicated that the limited availability of unpermitted surface water will prevent some basins from meeting forecasted demands. Conversely, permitted groundwater is not a concern in any planning basin. In an additional effort to address state water management policies that could augment supply reliability, the OCWP evaluated several measures that could be implemented to improve the accuracy of water availability calculations and maximize efficiency in the administration of water rights and permits.

DRAFT

The OCWP has concluded that providing reliable future water supplies to Oklahoma citizens will be seriously jeopardized without adequate funding to address the state's burgeoning **infrastructure requirements**. The absence of adequate and compliant drinking water and wastewater systems - even in the presence of abundant, high quality water - can limit economic growth and community development, impact water quality, threaten human health, increase future costs, and result in the waste and inefficient use of water. The OCWP evaluated **future drinking water and wastewater infrastructure costs** and, furthermore, evaluated the financial investments and programmatic options necessary to address the state's future need.

The OCWP also analyzed a number of other variables that might impact the ability of state water supplies to meet future demands. **A changing climate** could affect both supply and demand, significantly altering the way in which Oklahoma will use its water resources. The future timing, magnitude and location of precipitation events could shift, directly affecting water availability, while temperature variations could impact demand patterns.

As a part of the water supply options analysis, the OCWP assessed opportunities to decrease demands through **water conservation** practices. Two scenarios were modeled to predict water savings associated with specific conservation measures in the state's largest water use sectors: municipal/industrial and crop irrigation. This analysis revealed promise in alleviating water shortages in most basins throughout the state, as well as the potential to make more water available for both consumptive and non-consumptive uses, save energy, delay the need for new infrastructure, and decrease costs to citizens.

While conservation practices typically decrease demand or lead to more efficient use, a number of options exist to augment water supplies, where feasible, through largely unconventional measures. The OCWP evaluated two such options: **artificial aquifer recharge** and **marginal quality water use**. The OCWP identified five sites across the state where recharge demonstration projects could be most feasible. Concerning marginal sources, the OCWP concluded that, in particular, treated effluent showed good applicability for a number of uses and could provide supplemental sources of supply to alleviate future shortages.

Recognizing the quality of life and economic value of the environmental and recreational aspects of water to the state, the OCWP investigated a potential **instream flow program** for Oklahoma. Instream flow, which received considerable interest from the public throughout OCWP development, generally describes the amount of water set aside in a stream or river to ensure that downstream environmental, social, and economic benefits are met.

The OCWP commissioned **stakeholder groups** specifically representing agricultural, climatological, and water quality interests to assess and recommend future water research, monitoring, and policy requirements related to each of those areas. Those groups provided unique and invaluable expertise in identifying future state program and funding initiatives and priorities.

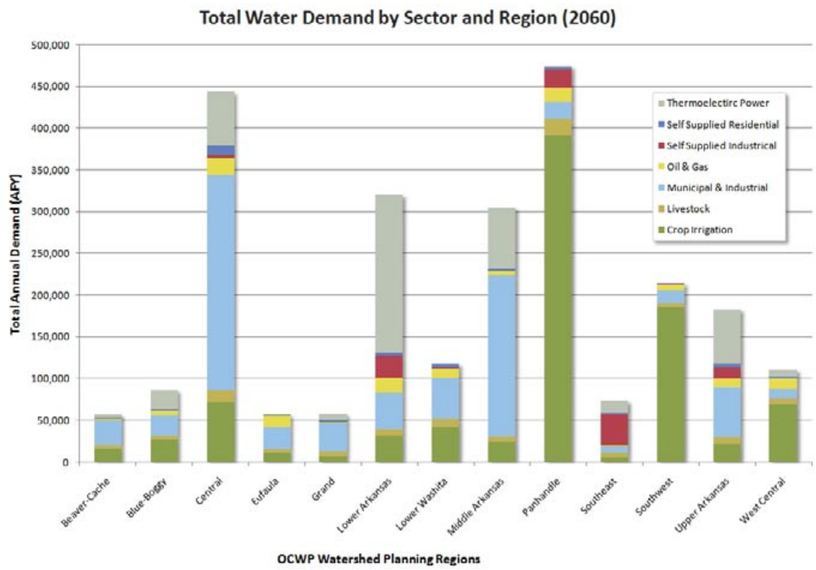
DRAFT

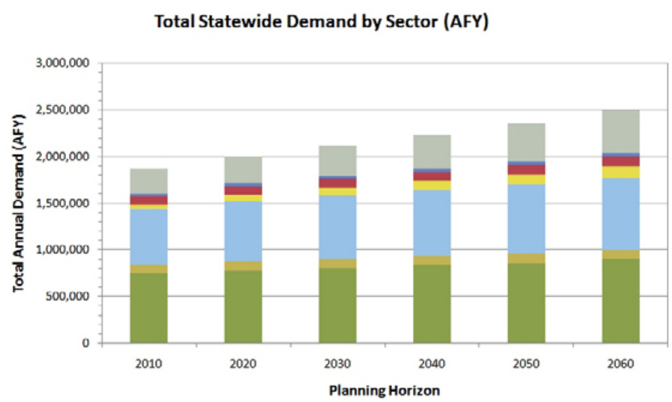
Looking Ahead to 2060

OCWP Technical Results and Findings

As part of its primary objective to ensure reliable water supplies for all water users in the state through 2060 and beyond, the Oklahoma Comprehensive Water Plan examined a number of technical issues related to water availability, both today and in the future. Coupled with OCWP policy recommendations, the results of these evaluations provide the basis for detailed local and statewide implementation of water strategies and initiatives:

Water Demand Forecasts (Water Sectors and Sources):



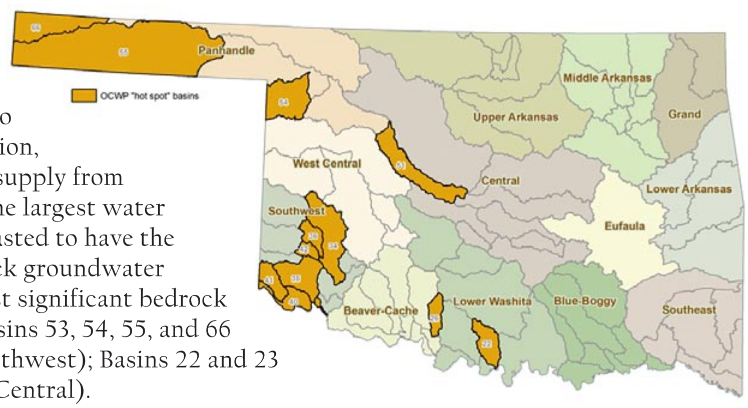


- Statewide, consumptive demand for water will increase by 33% between 2010 and 2060, not considering the potential decreases in demand that might stem from more aggressive water conservation measures.
- Crop Irrigation is forecasted to be the largest water use sector, consuming 897,464 acre-feet per year (AFY), or approximately 36% of the total demand. [One acre-foot equals 325,851 gallons.]
- Crop Irrigation will be the largest growth sector in the Panhandle, West Central and Southwest OCWP Watershed Planning Regions.
- Thermoelectric Power will be the largest growth demand sector in the Upper Arkansas, Lower Arkansas, Southeast and Blue-Boggy regions.
- Municipal/Industrial will be the largest growth demand sector in the Middle Arkansas, Eufaula, Grand, Lower Washita, Beaver-Cache and Central regions.
- In 2060, crop irrigation will be the largest water use sector in the Panhandle, Southwest, West Central and Blue-Boggy Regions; municipal/industrial will be the primary water use sector in the Middle Arkansas, Eufaula, Grand, Lower Washita, Beaver-Cache and Central Regions; thermoelectric power will be the largest in the Upper Arkansas and Lower Arkansas Regions; Self-Supplied industrial will be the largest sector in the Southeast Region.
- The Oil and Gas water use sector will experience the largest growth rate statewide, approaching 300%, with pronounced growth in the Southwest, West Central, Panhandle, Upper Arkansas and Lower Arkansas Regions.
- The Panhandle Region will experience the largest 2060 water demand at 473,840 ac-ft/year and the Eufaula Region will have the lowest demand at 55, 640 ac-ft/year.
- Generally, indoor water use (per capita) is highest in west and northwest Oklahoma, with a decreasing trend toward the east.
- Concerning the source of water (surface water, alluvial groundwater, and bedrock groundwater) utilized in Oklahoma, bedrock groundwater is the primary source forecasted to supply 2060 demands in the Panhandle, Southwest and Grand Regions. Alluvial groundwater will be the primary source in the West Central Region only. Surface water will be the primary supply source in all other regions.

DRAFT

Water Supply Shortages & Limitations:

- Surface water gaps, where the demand for water is projected to exceed available supply at times, are forecasted in 55 of the 82 OCWP basins by 2060. The 10 most severe physical availability constraints (i.e., considering the severity and probability of gaps) will be found in Basin 22 (Lower Arkansas); Basins 77 and 78 (Middle Arkansas); Basins 51, 56, and 57 (Central); Basin 26 (Beaver-Cache); Basins 34 and 42 (Southwest); and Basin 63 (Upper Arkansas).
- The OCWP forecasted 21 basins to experience insufficient surface water permit availability to meet forecasted surface water demands in 2060. The 10 most severe permit availability problems are forecasted in Basins 50 and 51 (Central); Basins 52, 53, 55, 65 and 66 (Panhandle); Basins 36 and 37 (Southwest); and Basin 20 (West Central).
- Based upon current trends and attainment of standards for beneficial uses, 27 basins are considered to exhibit poor surface water quality and thus may face particular challenges in their ability to provide adequate and reliable supply. Of the 10 most questionable basins, four are in the Beaver-Cache Region, two are in the West Central Region, and the rest are in the Middle Arkansas, Lower Washita, Southwest and the Upper Arkansas Regions.
- Considering overall surface water availability constraints – which is a collective assessment of physical, permit/legal and water quality characteristics – the 10 basins projected to have the most severe limitations in meeting 2060 demands are Basin 51 (Central); Basins 34, 40 and 42 (Southwest); Basins 26 and 30 (Beaver-Cache); Basins 53, 65 and 66 (Panhandle); and Basin 22 (Lower Washita).
- Alluvial groundwater depletions, while generally minor, were forecasted to occur in 64 planning basins by at least 2060. Considering the rates of depletion and the amount of depletion relative to the amount of groundwater in storage within the aquifer, the 10 basins projected to experience the most severe impacts are Basins 52 and 53 (Panhandle); Basins 34, 36, 38 and 42 (Southwest); Basin 47 (Lower Arkansas); Basins 51 and 56 (Central); and Basin 63 (Upper Arkansas).
- Bedrock groundwater depletions, also generally minor, were forecasted to occur in 34 basins. The Panhandle Region, which obtains 98 percent of its water supply from the Ogallala and is projected to have the largest water demand of any region in 2060, is forecasted to have the top four basins with the largest bedrock groundwater depletions. The 10 basins with the most significant bedrock groundwater depletion impacts are Basins 53, 54, 55, and 66 (Panhandle); Basins 38, 40 and 41 (Southwest); Basins 22 and 23 (Lower Washita) and Basin 18 (West Central).



OCWP Hot Spots

- Although groundwater depletions are projected to occur in Oklahoma, they are generally minimal compared to the volume of water in aquifer storage. However, localized depletions may impact water quality, existing well production and yields, or cause other adverse impacts groundwater users.
- The OCWP identified 12 "Hot Spot" planning basins, or those projected to have the greatest water supply challenges: Basin 22 (Lower Washita); Basin 26 (Beaver-Cache); Basins 34, 36, 38, 40, 41 and 42 (Southwest); Basin 51 (Central); and Basins 54, 55 and 66 (Panhandle).
- Conversely, projections indicate that seven basins statewide (2, 7, 27, 35, 70, 81 and 82) have no future anticipated water shortages through 2060.
- Sufficient permit availability for groundwater use exists statewide (based upon current equal proportionate shares). However, given the private property aspects of groundwater rights, accessibility to supply could limit future use in a particular basin.

Water Supply Options:

- In most basins, managing water demand through conservation activities was shown to be effective in reducing or eliminating gaps or storage depletions, particularly in alluvial aquifers. More specifically, a moderate level of conservation could reduce surface water gaps statewide by 25% and reduce the number of basins with projected surface water gaps from 55 to 42; reduce alluvial groundwater depletions by 32% (basin reduction of 64 to 51); and reduce bedrock groundwater depletions by 15% (basin reduction of 34 to 26).

- Moderate levels of conservation in the irrigation and municipal/industrial sector were shown to have the potential to reduce statewide water consumption by 214,970 acre-feet/year by 2060 and result in cost-savings of $47.5 million per year (2010 dollars) associated with reduced volumes of drinking water and wastewater treatment.
- While tremendous volumes of water exist in storage in the Panhandle Region, users there could encounter particularly unique challenges. To sustain both water supplies and local economies, the continued implementation of irrigation and municipal/industrial conservation practices and technologies – including the use of marginal quality water sources, such as treated effluent – is strongly encouraged.
- Utilizing out-of-basin supplies and constructing viable new reservoir sites were considered potentially effective long-term water supply options in all 82 planning basins that are projected to experience gaps and/or depletions. However, the level of effectiveness is ultimately dependent upon localized conditions.
- Recognizing potential environmental impacts and other restraints, reservoirs have significant potential to provide reliable supply for the future. The Reservoir Use water supply option – which considers the construction of viable in-basin reservoir sites as identified in the OCWP Reservoir Viability Study or construction of a smaller reservoir, or use of an existing reservoir – was shown to be at least potentially effective in reducing or eliminating gaps in 72 basins, 31 of which it was found to be likely effective. In only 3 basins was new reservoir use considered likely ineffective.
- Increasing supply through direct diversions of surface water, without utilizing reservoir storage or associated releases upstream, was found to be likely ineffective in addressing basin gaps and depletions statewide. This is primarily because, in all cases, direct stream diversions cause or increase gaps during certain months and therefore does not increase supply reliability. However, this is not to say that increased use of surface water in the majority of these basins would not be a good option, but rather storage (either in reservoirs or off-stream) would be required.
- Increased supply from groundwater was considered at least potentially effective in all but five basins. In these few basins the vast majority of groundwater resources are in the form of minor aquifers that may not be able to provide reliable supply. While depletions could be exacerbated in some instances, the OCWP has found that future increased use of groundwater is a highly effective option to mitigating surface water gaps and stabilizing supply in the majority of basins.

Special Studies:

- Findings of the OCWP Artificial Aquifer Recharge Workgroup determined that artificial recharge of groundwater is a viable option in augmenting supplies to meet future demands in several areas of the state. The most viable sites include the Arbuckle-Simpson aquifer near Ada, Rush Springs aquifer near Eakly, North Canadian alluvial aquifer near Woodward, Antlers bedrock aquifer near Durant, and Enid Isolated Terrace near Enid.
- The OCWP Marginal Quality Water Workgroup studied the potential utilization of several categories of water sources – such as brackish groundwater, treated wastewater effluent, production water from oil and gas operations, and stormwater runoff – demonstrating marginal quality. It was concluded that certain sources could augment supply in some areas of Oklahoma. Treated effluent showed particular promise in helping to meet future demand for municipal/industrial non-potable, crop irrigation, thermoelectric power and self-supplied industrial uses. However, local applicability and regulatory requirements must be considered. The depth to abundant, naturally occurring brackish and saline groundwaters varies across the state, from less than 500 feet to more than 1,000 feet, yet relatively little information currently exists on the extent (geographic area and volume) of these resources. However, depending upon site-specific conditions and local needs, brackish groundwater could be used to augment current supplies or as a backup supply in times of water shortage. The OCWP recommends that local water users evaluate this option when and where appropriate. Particularly important is the pursuit of a robust characterization of this supply resource by state and federal agencies.
- The **OCWP Instream Flow Workgroup** proposed several steps necessary in determining the suitability and feasibility of an instream/environmental flow program for Oklahoma, which among other things would help ensure protection of Oklahoma's third largest industry – tourism and recreation. While the absence of a policy precludes the water plan from calculating precise non-consumptive demands, the steps outlined in the consensus report and reflected in the priority recommendations moves the state closer to addressing this important issue.
- Through the **Potential Reservoir Viability Study**, the OCWP evaluated and determined the viability of a number of previously studied reservoir sites across the state. Sites were categorized from 0 to 4. There were

68 category 3 and 4 reservoirs identified in Oklahoma, general representing the most viable projects. While the OCWP does not recommend the construction of any specific project, due to the absence of a clearly demonstrated need, reservoir construction remains a viable option for basins and regions in the state.

- Through the **Water Transfer and Conveyance Study**, the OCWP evaluated several alignments for a statewide water conveyance system, including the original northern and southern systems proposed in the 1980 OCWP as well as four alternative alignments considering utilization of Lake Texoma for western and northwestern Oklahoma, Kaw Lake for distribution to north central and northwestern Oklahoma, and extension of the original northern route southward to west and southwest Oklahoma. The cost/benefit analysis, presented in the Water Transfer and Conveyance Study report, showed these projects to be extremely expensive relative to the benefits; none are recommended. However, the analysis determined that regional conveyance systems have potential and should be further explored.
- The Oklahoma Climatological Survey concluded that Oklahoma could be considerably impacted by a changing climate. To address this issue, the OCWP commissioned the **Conservation and Climate Change Study**, which assessed the potential implications of a range of climate change scenarios on surface water availability and future demand patterns in Oklahoma over the next 50 years. To this end, the studies considered two scenarios: slightly warmer temperatures and significantly greater precipitation (Scenario Q4) and significantly warmer temperatures and significantly less precipitation (Scenario Q1). A hydrology runoff model was used to estimate impacts to streamflow, and thus water availability.
    - ◊ Scenario Q4 showed statewide increases in temperature ranging from 3.5°F to 6.0°F; the largest increases were forecasted for the Panhandle Region. Precipitation also increased throughout the state, approaching 3.5 inches in several regions. Runoff was also projected to increase statewide. Scenario Q1 demonstrated increases in statewide temperature ranging from 6.0°F to 8.0°F. Reductions in precipitation were forecasted across Oklahoma with decreases ranging from 0 to 5.0 inches. Scenario Q1 forecasted the greatest impact to streamflow. Statewide basin-level decreases ranged from 4,400 to 7,800,000 AFY.
    - ◊ The climate change study also analyzed potential changes in municipal/industrial and crop irrigation demands from the baseline forecasts as a result of the Q1 and Q4 scenarios. In 2060, Q1 revealed increases in M&I demand of 73,256 AFY (9.5% above the baseline forecast) and increases in irrigation demand of 143,567 AFY (16.0%). Scenario Q4 resulted in M&I demand increases of 32,625 AFY (4.2%) and increases in irrigation demand of 29,093 AFY (3.2%).
    - ◊ As expected, the greatest M&I demand increases were seen in the major population areas as a result of either scenario. Irrigation demand increases were most pronounced under Scenario Q1 in several regions. Scenario Q4 forecasted a fairly uniform distribution of irrigation demand increases across the state with the exception of the Panhandle and Southwest Regions, which had significantly greater increases.
- Future infrastructure needs and their associated costs were forecasted through the **OCWP Infrastructure Financing Needs and Opportunities** analysis. For drinking water infrastructure, $37.9 billion (in 2007 dollars) will be required over the next 50 years to address needs ($87 billion when considering inflation). The greatest financial need will come in the years 2041-2060; over the next 50 years, the Central Region will have the greatest need and the Blue-Boggy Region the least.
- The need for wastewater infrastructure, also important to maintaining a viable water supply system, was determined to be $42.9 billion (in 2010 dollars) over the next 50 years ($79.3 billion when considering inflation). The greatest need will come in the years 2021-2040.
- The OCWP also analyzed the capacity of current financing programs offered by the OWRB to determine their ability to meet the forecasted drinking water and wastewater needs. Current programs were found to be woefully inadequate, both in terms of financial capacity as well as programmatic design.
    - ◊ Analysis of the future capacity of the Drinking Water State Revolving Fund, the primary drinking water financing program offered by the State, revealed a future funding capacity of only $2.4 billion (in 2007 dollars), compared to the $37.9 billion need.
    - ◊ Analysis of the future capacity of the OWRB's programs to meet future wastewater needs revealed a cumulative funding capacity of only $1.9 billion (in 2010 dollars), compared to the $42.9 billion need.
    - ◊ Utilizing the existing framework and authority, the OCWP recommends creation of a new program or restructuring of the existing Financial Assistance Program (FAP) to meet the considerable funding gap.
    - ◊ Recognizing their unique importance to rural Oklahoma economies, the OCWP also evaluated the need of smaller systems (those serving less than 3,000 people). Analysis showed that these systems account for 46% of the future drinking water infrastructure need and 24% of the future wastewater need. It was concluded that future programs must include specific strategies to address and assist small systems.