Southeast Oklahoma Raw Water Supply System

Final Report
Conceptual Plan

OKLAHOMA CITY WATER UTILITIES TRUST (OCWUT)

Project No. WC-0660

September 2014

CDM Smith

in association with:

Poe & Associates
Triad Design Group
Johnson and Associates

THE OKLAHOMA CITY WATER UTILITIES TRUST

Project No. WC-0660

Southeast Oklahoma Raw Water Supply System Plan

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9/23/14

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RECEIVED by the Trustees and signed by the Chairman of the Oklahoma City Water Utilities Trust this 21st day of October, 2014

ATTEST:

OKLAHOMA CITY WATER UTILITIES TRUST OFFICIAL SEAL OKLAHOMA

Secretary

CHAIRMAN

Concurred by the Council and signed by the Mayor of the City of Oklahoma City this 4th day of November, 2014.

SEAL OF THE CITY OF OKLAHOMA CITY

City Clerk

Mayor

OCWUT Standard 8/25/2011

Executive Summary Synopsis

This report is the Conceptual Plan to implement an expansion of the existing Southeast Oklahoma Raw Water Supply System. The existing Atoka pipeline and pumping system is 50 years old and the pump stations were recently upgraded in 2012. This system delivers water from the Atoka and McGee Creek Reservoirs to the Stanley Draper Reservoir in Oklahoma City.

Water demands established in the *2009 Regional Raw Water Supply Study for Central Oklahoma* (2009 Study) were used to determine the total volume of water needed from southeast Oklahoma in 2060 (300,000 acre-feet per year (AFY)). Existing water rights in McGee and Atoka Reservoirs are approximately 130,000 AFY; therefore, the amount of additional water rights and supply needed from southeast Oklahoma is 170,000 AFY.

Hydrologic analysis of Sardis Reservoir and the Kiamichi River Basin was performed. The analysis indicated that water supplies exceeding the 170,000 AFY requirement could be available. Hydraulic and financial analyses were used to determine a phased implementation plan for recommended infrastructure improvements that would be needed to meet the 2060 water demand. Conceptual level designs of the water supply facilities to meet the 2060 demand were prepared.

The recommended phases of the plan through 2060 are as follows:

[illegible]	[illegible]	[illegible]	[illegible]
2021	66-inch pipeline parallel to existing pipeline with lake intake and pump station at Atoka Reservoir including two new pump stations at Stonewall and Konawa sites.	111	$560,000,000
2025	Pumping capacity at Atoka Pump station and Stonewall and Konawa pump stations increased.	151	$30,000,000
2035	New 72-inch pipeline and pump station to deliver water from the Kiamichi River to Atoka Reservoir.	170	$170,000,000
2040	Second new 66-inch pipeline, capacity upgrades to existing pump stations.	191	$320,000,000
2045	Two pump stations with storage balancing tanks at the existing Ada and Macomb sites. Pumping capacity at Moyers pump station increased.	232	$160,000,000
2055	66-inch pipeline to replace existing 60-inch pipeline. Pumping capacity at Atoka pump station and Stonewall, Ada, Konawa, and Macomb pump stations increased. Pumping capacity at Moyers pump station increased.	313	$410,000,000

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List of Acronyms

$/LF	
1963 Report	1963 Surface Water of the Kiamichi River Basin in Southeastern Oklahoma
2003 Master Plan	2003 Water Master Plan
2009 Study	2009 Regional Raw Water Supply Study for Central Oklahoma
AACEi	Association for the Advancement of Cost Engineering International
AF	acre-feet
AFY	acre-feet per year
ANSI/HI	American National Standards Institute/Hydraulics Institute
APIP	Atoka Pipeline Improvements Project
APSRP	Atoka Pump Station Rehabilitation Project Final Design Report
ASME	American Society of Mechanical Engineers
AWWA	American Water Works Association
BLS	Bureau of Labor Statistics
BPS	booster pump station
CCFRPM	centrifugally cast fiberglass reinforced polymer mortar
CDM Smith Team	CDM Smith, Poe & Associates, Triad Design Group, and Johnson and Associates
cfs	cubic feet per second
City	City of Oklahoma City
COWRA	Central Oklahoma Water Resource Authority
DIP	ductile iron pipe
ECP	embedded cylinder pipe
ENR	Engineering News Record
EPA	United States Environmental Protection Agency
EST	enclosed slanted tower
EVT	enclosed vertical tower
FC	flood control
fps	feet per second used in section 8
FRPP	fiberglass reinforced polymer pipe
ft^2	square feet
FW	fish and wildlife
FWFRP	filament wound fiberglass reinforced plastic
GIS	geographic information system
gpcd	gallons per capita per day
HP	horsepower
HSC	horizontal split case
HVAC	heating, ventilation, and air conditioning
IR	irrigation
kW	kilowatt
kWh	kilowatt hour
LCP	lined cylinder pipe
LS	lakeside
MBS	multiple bore shoreline
MCAA	Mechanical Contractors Association of America

MG	million gallon
mgd	million gallons per day
MSA	Metropolitan Statistical Area
msl	mean sea level
NACE	National Association of Corrosion Engineers
NECA	National Electrical Contractors Association
NPSH Sec. 8	net positive suction head
O&M	operations and maintenance
OCWUT	Oklahoma City Water Utilities Trust
OGE	Oklahoma Gas and Electric
OMB	Office of Management and Budget
ONG	Oklahoma Natural Gas
OPCC	Opinion of Probable Construction Cost
OST	open slanted tower
OVT	open vertical tower
OWRB	Oklahoma Water Resources Board
Participants	COWRA, City of Chickasha, City of Del City, City of Edmond, City of Goldsby, City of Midwest City, City of Moore, City of Norman, City of Seminole, City of Shawnee, and City of Oklahoma City
PCCP	pre-stressed concrete cylinder pipe
PESR	Preliminary Environmental Screening Report
Plan	Southeast Oklahoma Raw Water Supply Plan
POR	preferred operating range
psi	pounds per square inch
psig	pounds per square inch gauge
PSO	Public Service of Oklahoma
R	recreation
R&R	renewal/replacement
RGP	Regional General Permit
ROW	rights-of-way
rpm	revolutions per minute
SBS	single bore shoreline
SCADA	supervisory control and data acquisition
SS	shoreside
State	State of Oklahoma
STELLA	Systems Thinking Experimental Learning Laboratory with Animation
System	Southeast Oklahoma Raw Water Supply System
TDH	total dynamic head
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VFD	variable frequency drive
VT	vertical turbine
VTC	vertical turbine closed
WQ	water quality
WS	water supply
WTP	Water Treatment Plant

Executive Summary

Executive Summary

The City of Oklahoma City (City) and the Oklahoma City Water Utilities Trust (OCWUT) conducted water supply studies in 2003 (Water Master Plan, MWH Americas, Inc., referenced herein as the 2003 Master Plan) and 2009 (Regional Raw Water Supply Study for Central Oklahoma, CDM, referenced herein as the 2009 Study). Both water supply studies indicated that water demand for the City and surrounding areas would exceed water supply by year 2020.

This conceptual report, the Southeast Oklahoma Raw Water Supply Plan (Plan), was prepared to:

1. Use water demands established in the 2009 Study to determine the additional amount of water required to meet the projected water demands of the City and the communities identified in the 2009 Study through year 2060.

2. Determine if water availability in the Kiamichi River Basin is sufficient to supply the additional water needed.

3. Recommend new infrastructure and existing infrastructure improvements required to deliver the additional water from Southeast Oklahoma to Central Oklahoma and the City.

4. Determine a phased implementation plan for the recommended infrastructure improvements.

The results of the Plan are discussed below.

1. Use water demands established in the 2009 Study to determine the additional amount of water required to meet the projected water demands of the City and the communities identified in the 2009 Study through year 2060.

The 2009 Study assessed the feasibility of delivering additional water supplies from southeastern Oklahoma to satisfy water demands through 2060 for the City and its Base Load Cities plus nine communities that participated in the study. The participating communities consisted of the Central Oklahoma Water Resource Authority (COWRA, which includes Calumet, El Reno, Mustang, Okarche, Piedmont, and Yukon), City of Chickasha, City of Del City, City of Edmond, City of Goldsby, City of Midwest City, City of Moore, City of Norman, City of Seminole, City of Shawnee, and City of Oklahoma City (Participants). The City provides wholesale water supply to seven Base Load Cities whose water demands were included in the study—Blanchard, Cashion, Newcastle, Purcell, The Village, Tuttle, and Warr Acres.

Table ES-1 summarizes water demand projections developed by the 2009 Study. The total average day demand was estimated at 353,029 acre-feet per year (AFY) or 315 million gallons per day (mgd) by 2060 for all participants.

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2010	116,127	5,584	0	36,931	158,643	141.63
2015	123,886	6,002	0	41,793	171,680	153.27
2020	132,164	6,432	0	49,466	188,062	167.89
2025	140,994	7,026	0	57,575	205,595	183.54
2030	150,414	7,659	0	65,450	223,523	199.55
2035	160,464	8,430	2,576	71,062	242,533	216.52
2040	171,186	9,379	5,713	76,651	262,929	234.73
2045	182,623	10,544	8,737	82,118	284,021	253.56
2050	194,826	11,874	11,762	87,909	306,371	273.51
2055	207,028	13,206	14,898	94,182	329,313	293.99
2060	219,230	14,537	17,922	101,339	353,029	315.16

A From Table 2-1 of the 2009 Regional Raw Water Supply Plan
B From Table 2-2 of the 2009 Regional Raw Water Supply Plan
C From Table 2-3 of the 2009 Regional Raw Water Supply Plan
D From Table 2-4 of the 2009 Regional Raw Water Supply Plan

The City draws its water supply from two systems—the Southeastern Oklahoma System and the North Canadian River System. The Atoka and the McGee Creek Reservoirs are currently used as source waters for the Southeastern Oklahoma System. Raw water from these sources is delivered to the Stanley Draper Reservoir, a terminal reservoir, via the Atoka raw water transmission system (Exhibit A-1, Appendix A). The 2009 Study identified the Sardis Reservoir and the Kiamichi River Basin as potential new source water supplies that could supplement the existing Southeastern Oklahoma System. The North Canadian River System includes three existing reservoirs that serve as source water supplies—Canton Reservoir, Overholser Reservoir, and Hefner Reservoir (Exhibit A-2, Appendix A).

Table ES-2 summarizes the current permitted water rights and additional water rights required to meet 2060 water demands. The City holds a total of 211,667 AFY in permitted water rights from the Southeastern Oklahoma and North Canadian River Systems. However, the 2003 Master Plan indicates that the full permit amount of 80,000 AFY may not always be available from the North Canadian River System and the dependable yield may be 50,000 AFY or less.

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North Canadian River Permit	80,000	50,000
Atoka Reservoir Permit	91,667	91,667
McGee Creek Reservoir Permit	40,000	40,000
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Projected 2060 Demand	353,029	353,029
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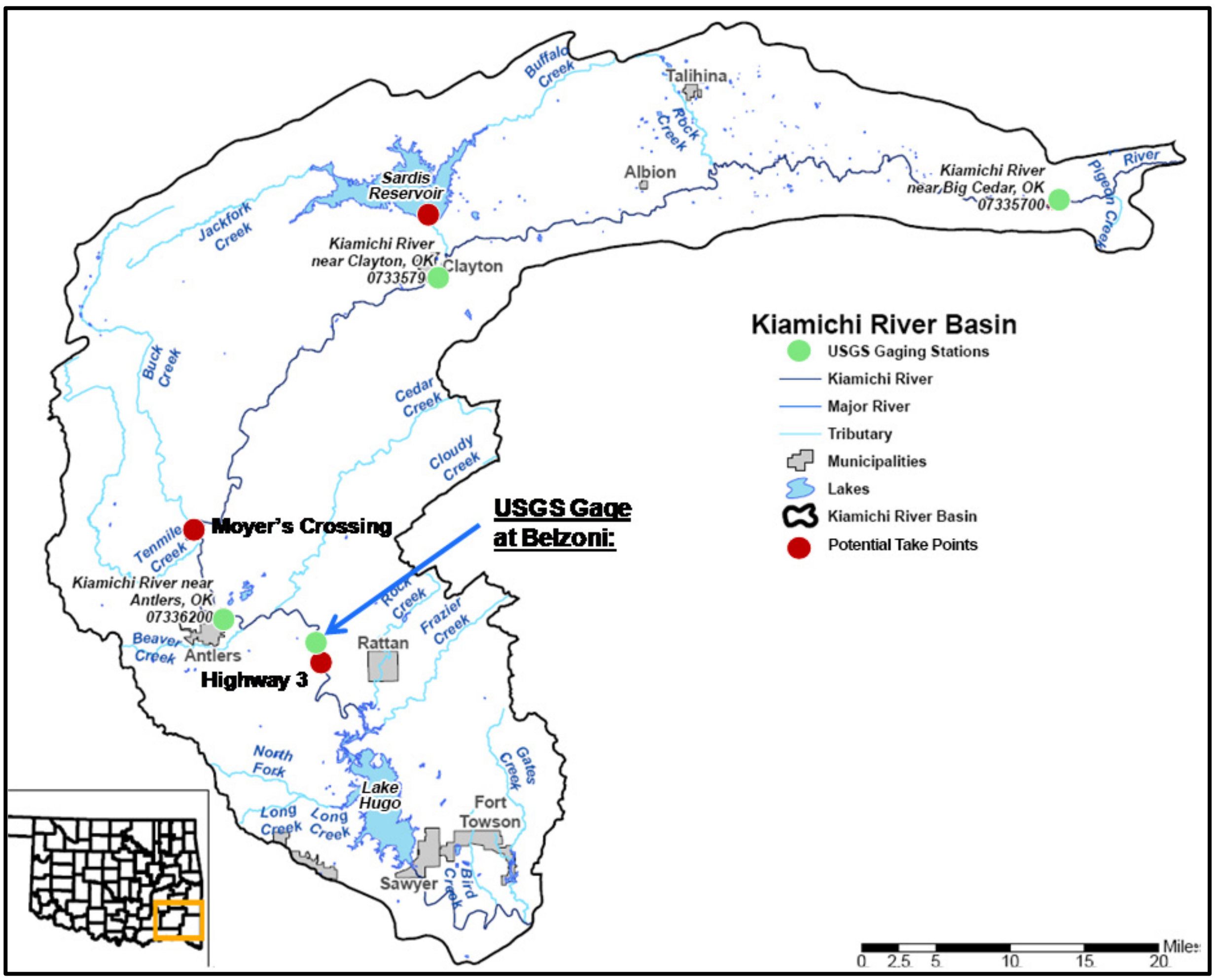
As presented in Table ES-2, there remains a 140,000 – 170,000 AFY deficit relative to 2060 water demands. For this report, 170,000 AFY was used as the more conservative estimate of rights required to meet the projected demand.

2. Determine if water availability in the Kiamichi River Basin is sufficient to supply the additional water needed.

Currently, there is no infrastructure to deliver water from the Kiamichi River Basin into OCWUT's McGee Creek/Atoka raw water transmission system. The 2009 Study considered four source water alternatives (also referred to as 'take points') shown in **Figure ES-1**. These take points include Sardis Reservoir, Hugo Reservoir, the Kiamichi River at Moyers Crossing, and the Kiamichi River at Highway 3. It should be noted that the Hugo Reservoir take point option was not considered in this study. Excluding this take point was based on the additional distance that would be required to pump from Hugo Reservoir, and the fact that the Highway 3 location is actually located in the back waters of Hugo Reservoir; therefore, there is a relatively small amount of additional watershed area added when the take point is within Hugo Reservoir versus the Highway 3 location.



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The main conclusions from the Kiamichi River Basin water availability analysis are listed below. All results are contingent upon the data and assumptions built into the analysis as described in Section 3.

- Sardis Reservoir cannot provide 100 percent reliable water supply to meet Central Oklahoma's 2060 demand. While it could provide the full amount in most years, it would not be able to support demand through the drought of record, if it were to recur. There is 98 percent reliability (meaning that the Central Oklahoma Service Area's 2060 demand can be met in all but one year of the historical record) under currently modeled conditions using Sardis Reservoir as the intake point and the full conservation pool.

- There is 100 percent reliability (meaning that the Central Oklahoma Service Area's 2060 demand can be met all of the time) under currently modeled conditions using Highway 3 or Moyers Crossing as the intake point on the Kiamichi River with constant pumping. In general, either of these intake points provides increased flexibility and reliability in meeting projected 2060 water demands over using Sardis Reservoir as the intake point. This is because the river can be used as the supply source when flow is plentiful (retaining water in Sardis Reservoir), and Sardis Reservoir can be used to augment river flow and supply only when needed. Using Sardis Reservoir to augment the Kiamichi for 2060 demands would result in Sardis utilizing only the top 47 percent of storage (approximately), whereas using Sardis as the sole source would require the entire conservation pool during severe droughts.

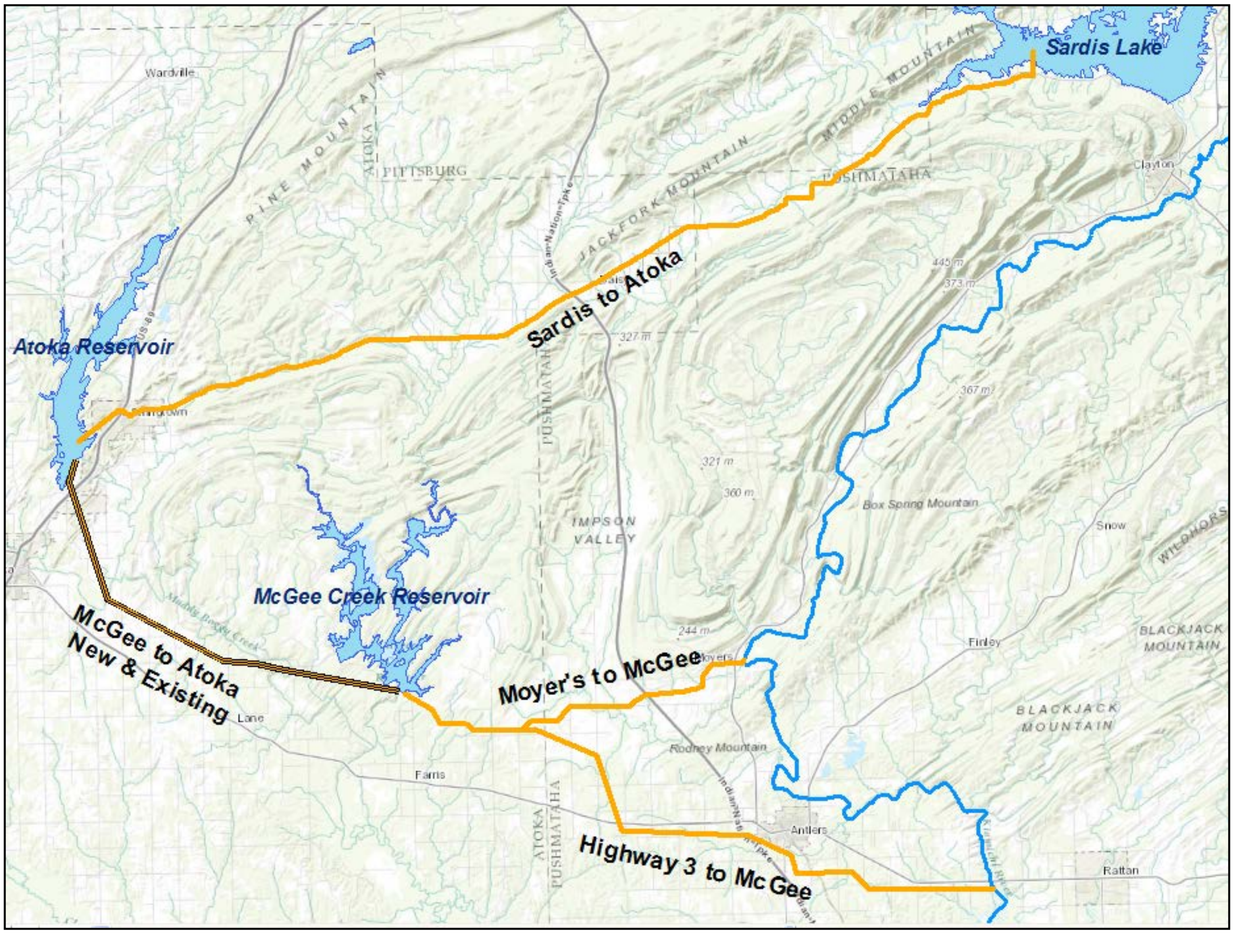
3. **Recommend new infrastructure and existing infrastructure improvements required to deliver the additional water from Southeast Oklahoma to Central Oklahoma and the City.**

The various alternatives to deliver water from southeastern Oklahoma to central Oklahoma are described below. These routes were preliminarily evaluated in the 2009 Study with the most feasible routes carried forward for further evaluation in this study.

Four pipeline routes between the Kiamichi River Basin and Atoka Reservoir were analyzed:

- Scenario K1: Sardis Reservoir to Atoka Reservoir
- Scenario K2: Moyers Crossing to Atoka Reservoir
- Scenario K3: Highway 3 to Atoka Reservoir
- Scenario K4: Combinations of Sardis Reservoir, Moyers Crossing, and Highway 3 sources to Atoka Reservoir

An overview of these routes is shown in **Figure ES-2**.



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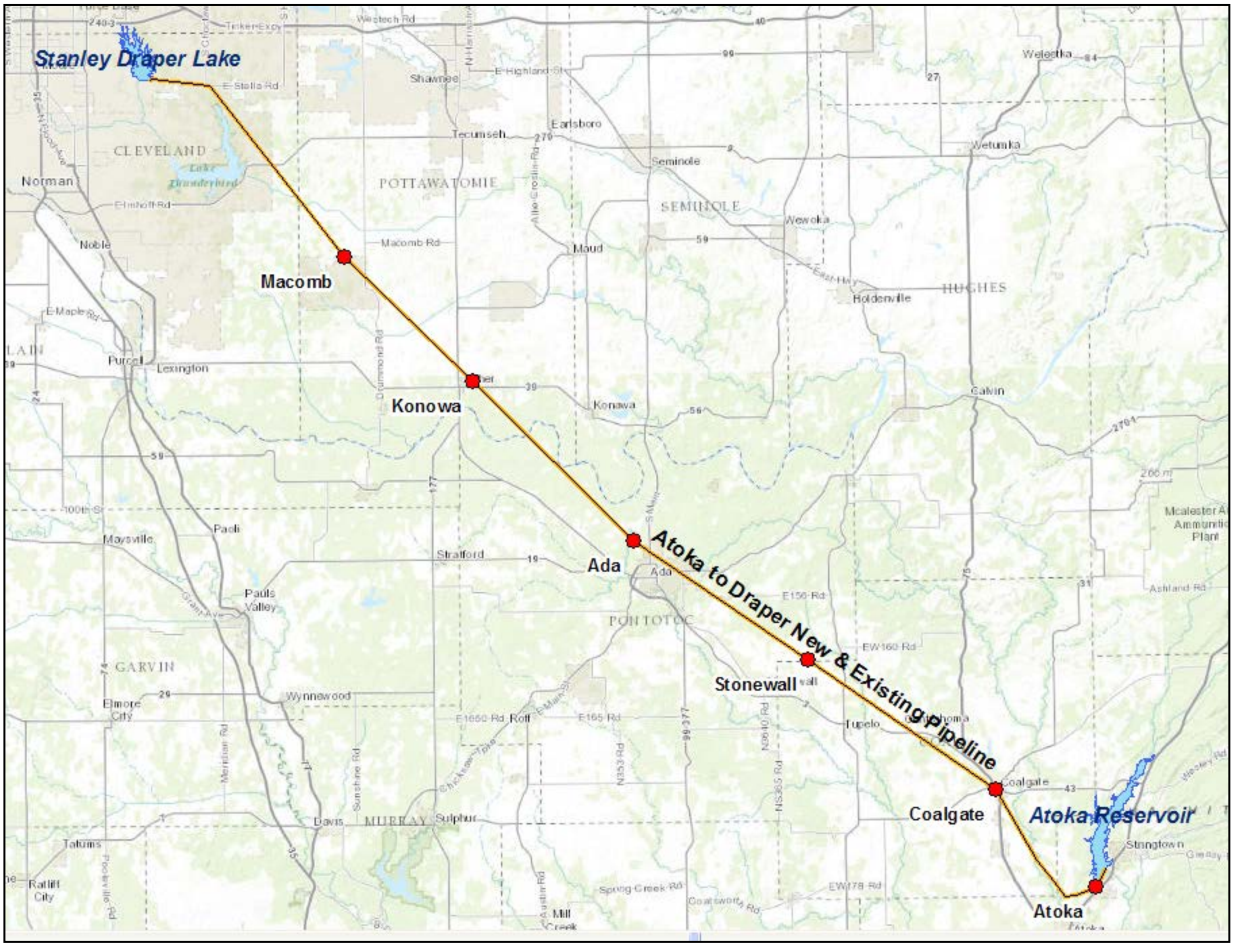
The pipeline routing between Atoka Reservoir and Stanley Draper Reservoir will generally follow the existing OCWUT pipeline route (shown in **Figure ES-3**) between these reservoirs. Four options for bringing the raw water supply from Atoka Reservoir to Stanley Draper Reservoir were analyzed:

- Scenario A1: Add one new parallel pipeline and rehabilitate the existing pipeline
- Scenario A2: Add two new parallel pipelines (one now, the other later) and rehabilitate the existing pipeline
- Scenario A3: Add one new pipeline and replace the existing pipeline
- Scenario A4: Add two new parallel pipelines (one now, the other later) and replace the existing pipeline



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The Atoka to Draper systems of supply lines was analyzed for the following configurations:

- Two lines keeping the 60-inch existing (New 84-inch, Rehabilitation of existing 60-inch)
- Two lines replacing the 60-inch existing (New 78-inch, Replacing existing 60-inch with 66-inch)
- Three lines keeping the 60-inch existing (two New 60-inch lines, Rehabilitation of existing 60-inch)
- Three lines replacing the 60-inch existing (two New 66-inch lines, Replacing existing 60-inch with 66-inch)

While the Atoka systems all start in Lake Atoka, the Kiamichi system has three possible intake points:

- An intake in Sardis Reservoir
- An intake on the Kiamichi River near Moyers, Oklahoma
- An intake on the Kiamichi River near Highway 3 in the back waters of Lake Hugo

The Kiamichi Basin to Atoka systems of supply lines was analyzed for the following configurations:

- One line from Sardis to Atoka (New 72-inch)
- One line from Moyers to Atoka (New 72-inch)
- One line from Highway 3 to Atoka (New 78-inch and 72-inch)
- Two lines, one from Sardis (New 54-inch) and one from Moyers (New 54-inch)

The hydraulic analysis determined the line sizing, flow velocities, and pipeline pressures for each of the alternatives analyzed. These calculated parameters indicated that all of the systems are viable alternatives. The information on pipe sizes, pressures, and horsepower requirements were used to prepare the life cycle cost analysis for each of the alternatives.

Data from the hydraulic analysis was used to develop capital costs for each of the proposed scenarios. In addition, calculated horsepower requirements were determined for each of the scenarios. This information was then analyzed financially in several different ways to determine the most cost-effective systems to continue into preliminary design. A life cycle approach was used that included the phasing of the infrastructure to be able to meet the demand at any point within the life of the project from 2020 to 2060.

There were several modifications to the alternatives analyzed to adjust timing and demand to see if more economical solutions could be determined.

There were multiple iterations of viewing the effect of facilities timing and final construction costs. When all factors were taken into consideration, there was a preference towards the alternatives with the lowest early costs, so that the capital costs could more closely match the rate payer base at the time the construction cost would occur. The recommended alternatives would keep the initial costs lower than others that were analyzed.

The cost estimates for the Plan are conceptual planning level estimates made without benefit of detailed surveys and geotechnical information. Key price factors affecting construction costs will be labor rates, fuel costs, and material costs, primarily the concrete and steel used for the piping systems.

The recommended infrastructure improvements and existing system improvements for the delivery system from the Atoka Reservoir to the Stanley Draper Reservoir are as follows:

> Construct three new parallel 66-inch pipes and new pumping stations in a phased sequence with a total system capacity of 313 mgd.

The recommended infrastructure improvements and existing system improvements for the delivery system from the Kiamichi River Basin water supply are as follows:

> Construct a 72-inch line from the Kiamichi River in the vicinity of Moyers Crossing to a balancing tank upstream of the existing McGee pump station at the beginning of the existing McGee Creek to the Atoka delivery system to a pump station at the existing McGee pump station. Construct a 72-inch parallel McGee Creek pipeline from the beginning of the existing McGee Creek to the existing McGee Creek holding tank to the Atoka Reservoir. Construct a low head weir and inlet pump station on the Kiamichi River. Total capacity for this system is 167 mgd.

4. Determine a phased implementation plan for the recommended infrastructure improvements.

Both the hydraulic and cost analyses were performed with a primary goal of phasing implementation in such a way that the infrastructure capacity improvements closely match demand and infrastructure improvement costs are delayed as much as possible. **Table ES-3** provides recommendations for phased implementation of the recommended alternatives.

[illegible]

[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]			
2021	• 66-inch pipeline parallel to existing pipeline with lake intake and pump station at Atoka Reservoir. • Two new pump stations with storage balancing tanks at the existing Stonewall and Konawa sites. • Modifications to existing Draper outfall to accept new line.	36	0	75	111	$560,000,000
2025	• Pumping capacity at Atoka pump station and Stonewall and Konawa line pump stations increased.	76	0	75	151	$30,000,000
2035	• Pumping capacity at Atoka pump station and Stonewall and Konawa line pump stations increased. • 72-inch pipeline from Moyers to Atoka. • Intake, weir structure, and pump station on the Kiamichi River.	95	26	75	170	$170,000,000
2040	• 66-inch pipeline parallel to existing 60-inch and first 66-inch pipeline. • Modifications to existing Draper outfall to accept third line. • Pumping capacity at Moyers pump station increased.	116	47	75	191	$320,000,000
2045	• Two new pump stations with storage balancing tanks at the existing Ada and Macomb sites. • Pumping capacity at Moyers pump station increased.	157	88	75	232	$160,000,000
2055	• 66-inch pipeline to replace existing 60-inch pipeline. • Pumping capacity at Atoka pump station and Stonewall, Ada, Konawa, and Macomb line pump stations increased. • Pumping capacity at Moyers pump station increased.	313	167	0	313	$410,000,000

The demand curve used in this Plan includes a number of assumptions that may change in the future. Some of these assumptions may have significant future variability on demand, such as: the number of participating communities consistent with those listed in the 2009 Plan, water consumption following historical trends, and the probability of the North Canadian River supply delivering 50,000 or 80,000 AFY. The phasing plan was developed with the goal of optimizing costs while providing flexibility to implement phases of the project as actual demands dictate. For example, OCWUT may choose to implement phases of the plan earlier to increase reliability and reduce risk. Conversely, OCWUT may choose to implement demand management policies should drought impact the reliability of the North Canadian River supply or if it desires to delay implementation phases.

The phasing currently shown does not allow the full use of all the existing water rights in McGee Creek and Atoka (132,000 AF, 133 mgd) until 2025 when the first pump station upgrades are implemented. Moving the pump phasing forward would provide the opportunity to pump additional water if additional rights can be obtained by Oklahoma City or its participant cities as outlined in the 2009 study. The key feature of the recommendations included with this report is the ability to be flexible in the timing of projects as customer demands and available water rights become more defined in the future.