AIM NORMAN

Area & Infrastructure Master Plan

Water Utility

Baseline Development Technical Memorandum

City of Norman

Norman, Oklahoma

Prepared by:

In Partnership with:

DRAFT

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List of Acronyms

City	City of Norman
NUA	Norman Utilities Authority
µg/L	micrograms per liter
ADD	average day demand
AIM Norman	Area & Infrastructure Master Plan
AWWA	American Water Works Association
CIP	capital improvement plan
DBPs	disinfection byproducts
gpcd	gallons per capita per day
gpd	gallons per day
HAA5	haloacetic acid
IFC	International Fire Code
KPI	key performance indicator
LCR	Lead and Copper Rule
LCRI	Lead and Copper Rule Improvements
LRAAs	locational running annual averages
MCLs	maximum contaminant levels
MDD	maximum day demand
mg/L	milligrams per liter
MGD	million gallons per day
NOM	natural organic matter
ODEQ	Oklahoma Department of Environmental Quality
RTCR	Revised Total Coliform Rule
SFE	single-family equivalent
TM	technical memorandum
TTHM	total trihalomethanes
WSA	water service area

1.0 Introduction

The City of Norman (City) and the Norman Utilities Authority (NUA) are developing an Area & Infrastructure Master Plan (AIM Norman) that will cover a wide spectrum of city planning aspects, including land use, transportation, stormwater management, water infrastructure, wastewater infrastructure, parks, and housing. The AIM Norman effort includes updates to related master plans for the City's infrastructure, including transportation, stormwater, water, and wastewater. This technical memorandum (TM) is the first in a series of TMs that will be incorporated into the Water Master Plan Report. The purpose of this TM is to establish a baseline for upcoming water system evaluations that will be used to identify future capital improvements. This TM will cover the following:

- Summary of previous water planning documents
- Analysis of historical water consumption
- Projections of future water demands
- Review of historical water quality data

1.1 Water System Overview

The NUA water system serves the urban area within the city limits. The water system includes two primary components:

- Water Distribution System – The pipes and tanks that convey water from the sources of supply to each customer.
- Sources of Supply – The NUA water system has three sources of supply.
    - Surface water from Lake Thunderbird treated at the Vernon Campbell Water Treatment Plant
    - Groundwater from the Garber-Wellington aquifer supplied from 43 groundwater wells
    - Wholesale treated water purchased from Oklahoma City

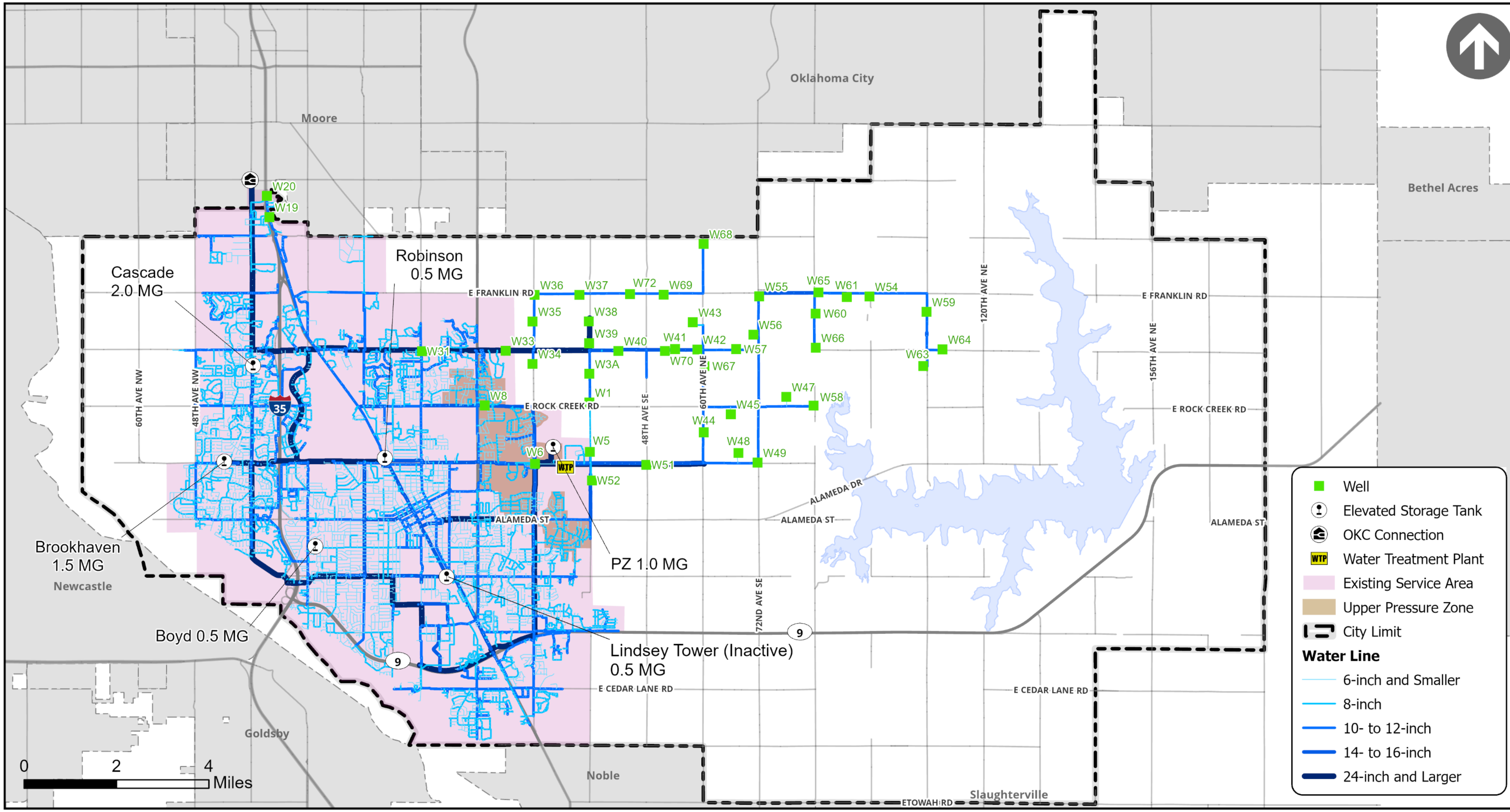
NUA's current water service area (WSA) extends from 48th Avenue West to 36th Avenue East as shown below in Map 1.1. Approximately 90% of the City's population resides within the water service boundary.

1.2 Operations and Management

The NUA is a public trust that oversees policy and financial authorizations as they relate to City-managed utilities. The elected mayor and City Council members also serve as the Board of Trustees for NUA. Three of the Norman Utilities Department Divisions administer and operate the water utility: Administration & Engineering, Water Treatment, and Line Maintenance. The Utilities Department has adopted the following Mission Statement:

> *Providing environmentally sound, efficient utility service to our customers in a professional, safe manner at sustainable rates through six divisions.*

Map 1.1: Water System Overview



1.3 Related Documents

Table 1.1 summarizes the previous work by others that was used in the baseline development. The reference names listed in the table are used throughout this report to refer to each document.

Table 1.1: Related Documents

Document	Author/Agency	Date	Reference Name
2060 Strategic Water Supply Plan	Carollo	2014	2060 Water Supply Plan
Update Distribution System Modeling	Alan Plummer Associates, Inc.	2018	2018 Modeling Update
AIM Norman Area & Infrastructure Master Plan - Norman Today	RDG	2024	Norman Today

1.4 Historical Data Collection

The following data was provided by NUA for the use in the creation of this baseline development:

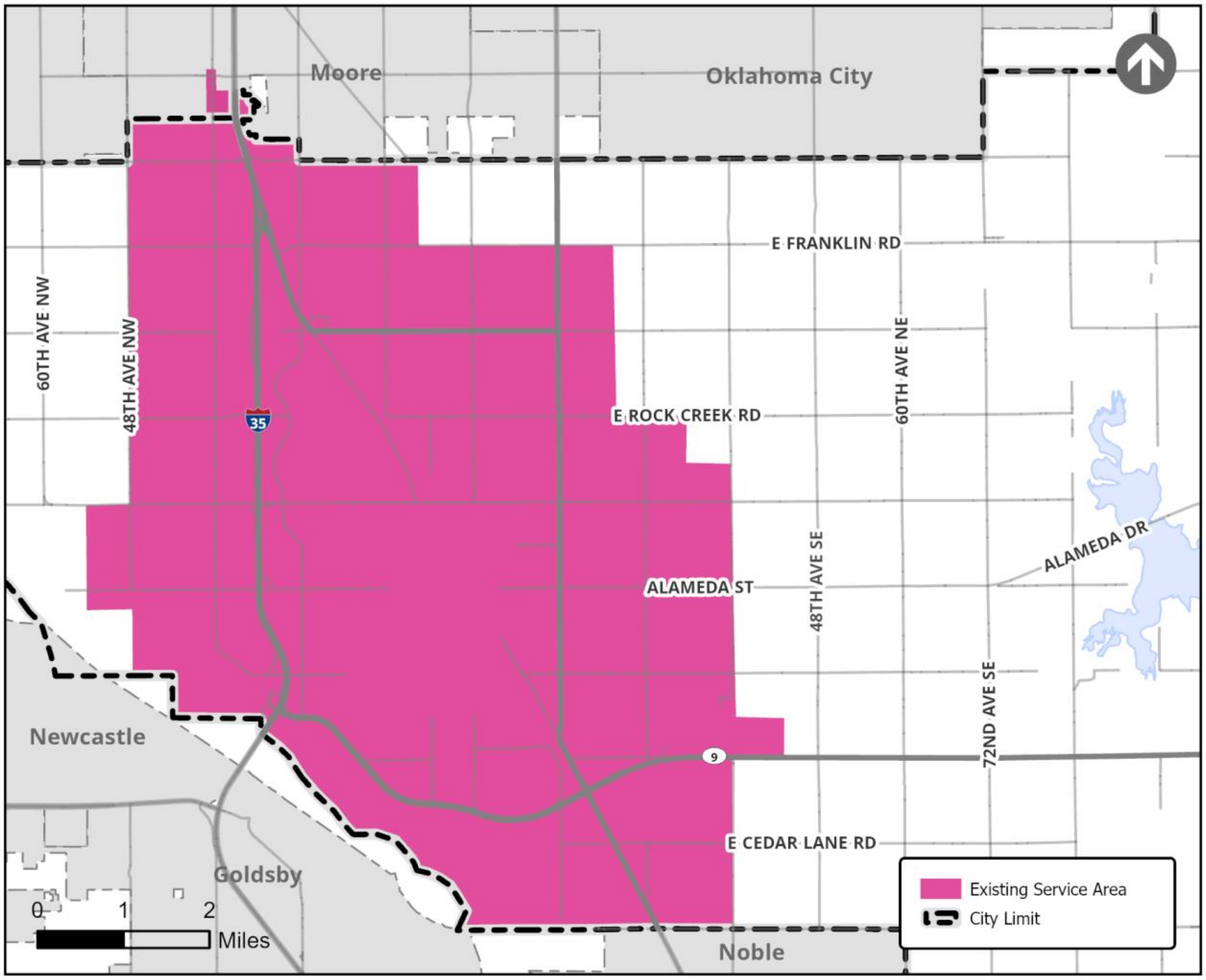
- Customer Meter Data (2019–2023)
- Water Production Data (1990–2023)
- Monthly Operating Reports (2014–2023)
- Water Audit Reports (2019–2023)
- Water Quality Data (2010–2023)
- GIS base files with water infrastructure information

2.0 Water Service Area

2.1 Water Service Area

The existing NUA water distribution system serves a portion of the City. The NUA water service area (WSA) is illustrated in Map 2.1. In general, the current boundary extends from 48th Avenue West to 36th Avenue East as shown below. Future WSA expansion will be based on future urban expansion related to future land use and will be discussed further in the *Norman Tomorrow: Vision & Future Land Use* report.

Map 2.1: Water Service Area Overview

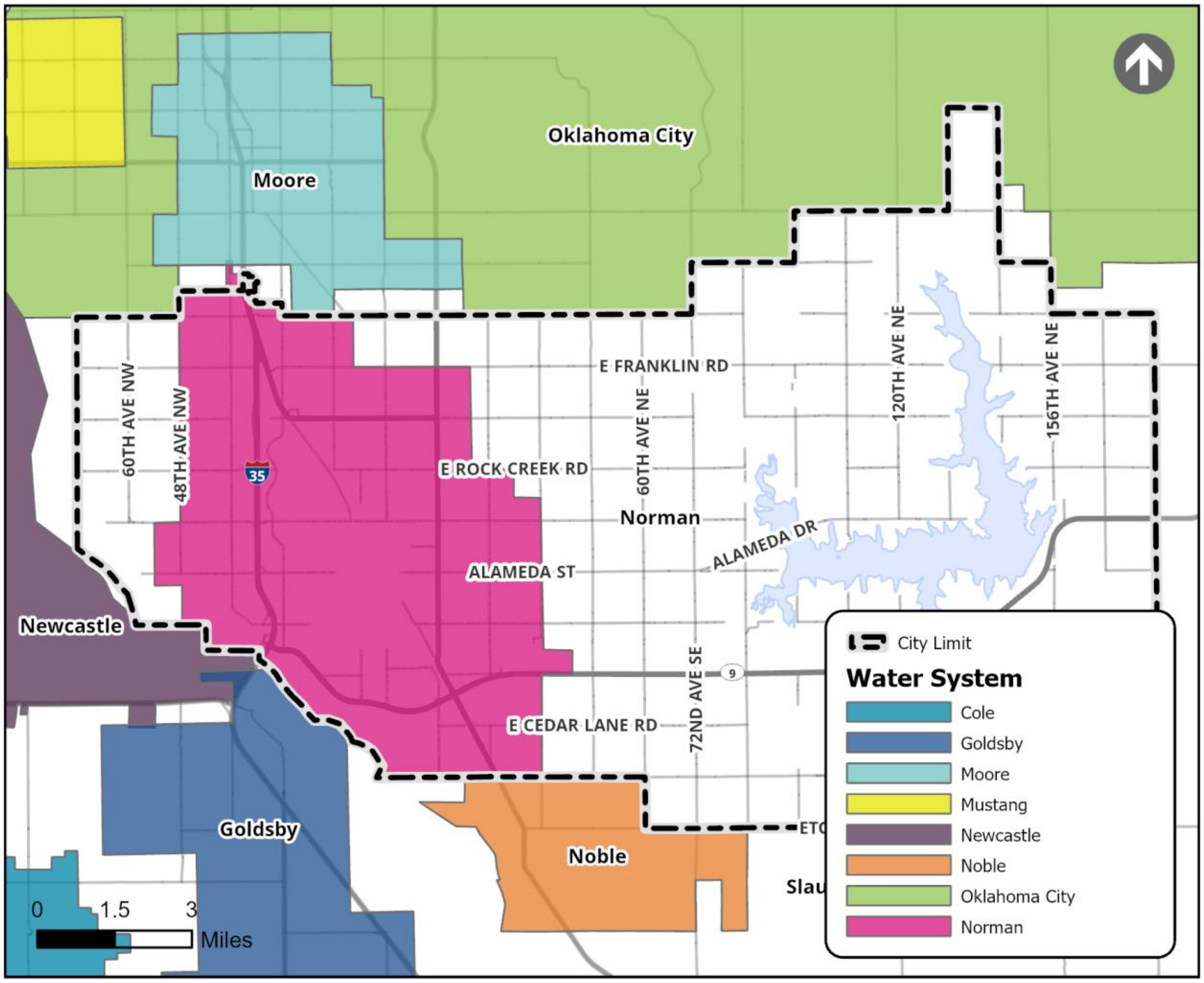


2.2 Adjacent Water Utilities

The water utilities adjacent to the NUA WSA are shown in Map 2.2. Clockwise from the north, NUA's WSA is bounded by the following water utilities:

- Moore
- Oklahoma City
- Noble
- Goldsby
- Newcastle

Map 2.2: Adjacent Water Systems



2.3 Land Use

Existing land use for the purpose of this report was derived from the Norman Today report and was used to predict future development demand rates based on land use classification and historical billing data. Future land use is being developed as part of the *Norman Tomorrow: Vision & Future Land Use* report and will be discussed in a future technical memorandum.

3.0 Historical Population and Water Demands

3.1 Historical Water Production

Three main sources of water are used for water supply including surface water, groundwater, and purchased water from a neighboring utility. Figure 3.1 summarizes the annual water supply by source from 2003-2023.

Since 2000, NUA has had the ability to purchase treated water from Oklahoma City via a connection in the northernmost part of the WSA. In 2015, NUA entered into an agreement with the Oklahoma City Water Utilities Trust to regularly purchase treated water based on a subscribed monthly capacity reservation of approximately 1 million gallons per day (MGD).

A majority of NUA's supply is provided by surface water from Lake Thunderbird. The NUA currently has an annual water rights allocation of 3,084 MG of supply from Lake Thunderbird. However, when the lake's water elevation is in the flood pool, NUA's withdrawals do not count towards the water rights allocation. In recent years, NUA has relied on flood pool water to meet demands. The remaining demand is met by groundwater from the Garber-Wellington aquifer underlying Norman via 43 groundwater wells in the eastern portion of the WSA. Further discussion related to existing water supply challenges will be included in the upcoming Water Supply Plan Review Technical Memorandum.

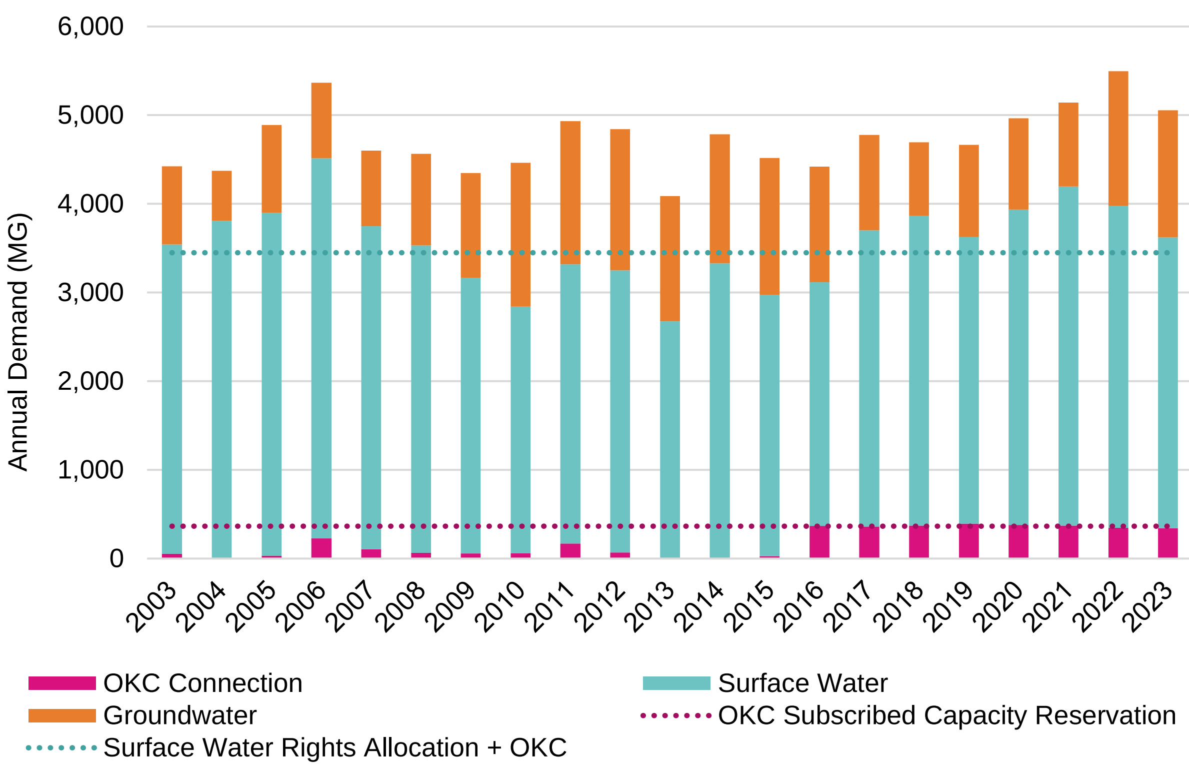


Figure 3.1: Annual Water Production by Source

3.2 Historical Population Growth

Historical population data for both the City and Cleveland County were obtained from the U.S. Census Bureau and are shown in Table 3.1.

Table 3.1: U.S. Census Population Data

Year	Cleveland County Population	City of Norman Population
1990	174,253	80,071
2000	208,016	95,693
2010	255,755	110,925
2020	295,528	128,026

NUA provided historical service population data from 1990–2023, and a summary of the data in five-year intervals is shown in Table 3.2. As of 2022, NUA served a retail population of approximately 113,553 customers via approximately 42,600 meters. Historically, the service population has been approximately 88% of the total City population. The 2060 Water Supply Plan estimated that the NUA service population would be about 90% of the total City population by 2025, and this assumption was used for the purpose of determining the future service population discussed in Section 4.1.

Table 3.2: Historical Water Service Population Data

Year	Service Population	Percent of City of Norman Population
1990	70,462	88%
1995	76,987	88%
2000	84,538	88%
2005	94,398	91%
2010	98,075	88%
2015	104,843	88%
2020	112,151	88%

3.3 Historical Water Demand

NUA provided historical production data from 1990 to 2023. The historical average day demand (ADD) and maximum day demand (MDD), as well as the service population estimates, are shown in Figure 3.2. The figure indicates that the population growth over the last 20 years has generally been linear. However, both the ADD and MDD fluctuated over the period, with the ADD appearing to increase over time, although at a lower rate than the increase in the service population. Local maxima within the data set often correlate to known drought/dry years (2006, 2012, and 2020).

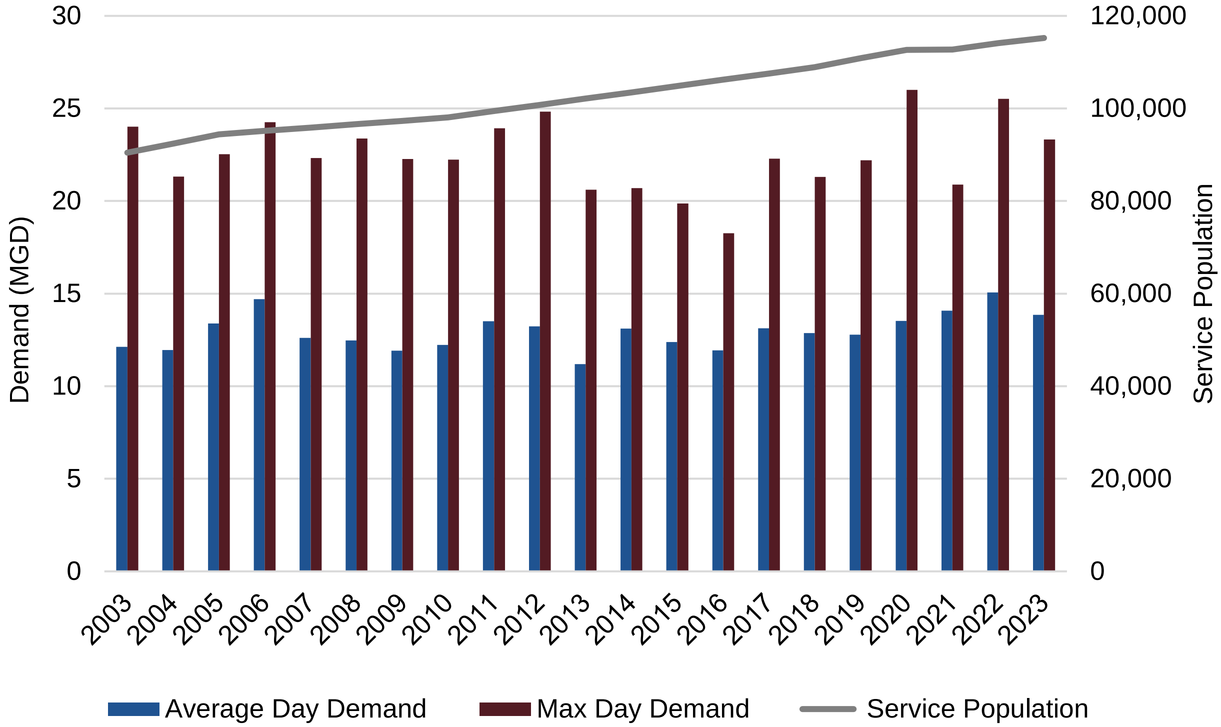


Figure 3.2: Historical Daily Water Demand and Service Population

3.4 Historical Customer Billing Data

Garver categorized consumption into six separate user classes: Residential, Commercial, University of Oklahoma Commercial, Industrial, Municipal, and Public Authority from historical billing data for 2021 and 2022. Figure 3.3 illustrates the percent of the total metered consumption by user class. Residential water use accounts for the highest portion of billed volume at 75.8% of the annual water consumption. The commercial, University of Oklahoma commercial, and industrial account for approximately 13.0%, 5.7%, and 2.9% of the annual water consumption, respectively.

Historical water production and consumption data was used to determine that the ratio of the average day demand to average day consumption has typically been approximately 1.25. This ratio was used for the purposes of adjusting data derived from historical metered consumption to a realistic demand value (Section 3.6 and Section 3.7). Water loss is discussed in more detail in Section 3.8.

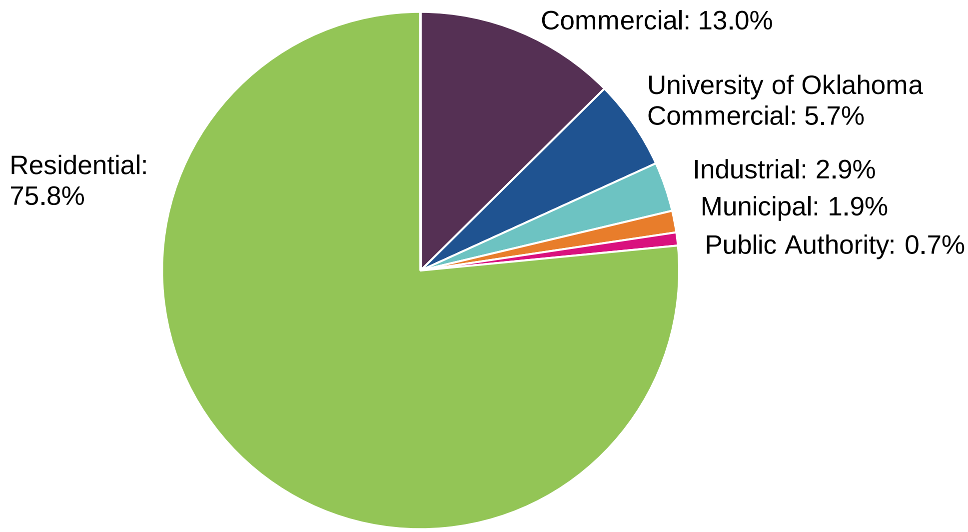


Figure 3.3: Percent Consumption by User Class

3.5 Per Capita Water Demands

Garver evaluated per capita demands using historical service population data and historical water demand data to determine ADD and MDD trends. Figure 3.4 and Figure 3.5 illustrate the per capita demand for ADD and MDD conditions between 2002 and 2022, respectively. The per capita MDD has been steadily decreasing since 2002, while per capita ADD has marginally decreased since 2002.

For the purpose of developing future projections, 136 gallons per capita per day (gpcd) will be used as the ADD baseline with an additional 14 gpcd reserve capacity for a total ADD value of 150 gpcd. A baseline value of 250 gpcd for MDD will be used with an additional reserve capacity of 25 gpcd for a total MDD value of 275 gpcd. These values are shown as dashed horizontal lines on Figure 3.4 and Figure 3.5 for reference. Further discussion of these projections can be found in Section 4.2.

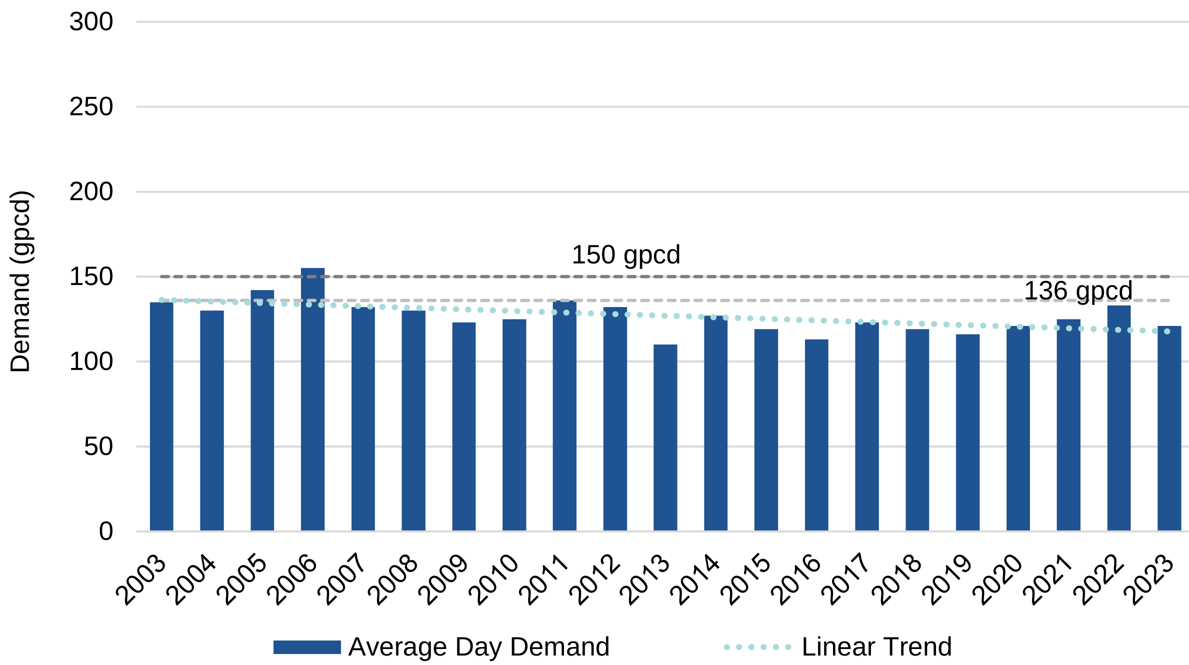


Figure 3.4: Historical Average Day Per Capita Water Demand

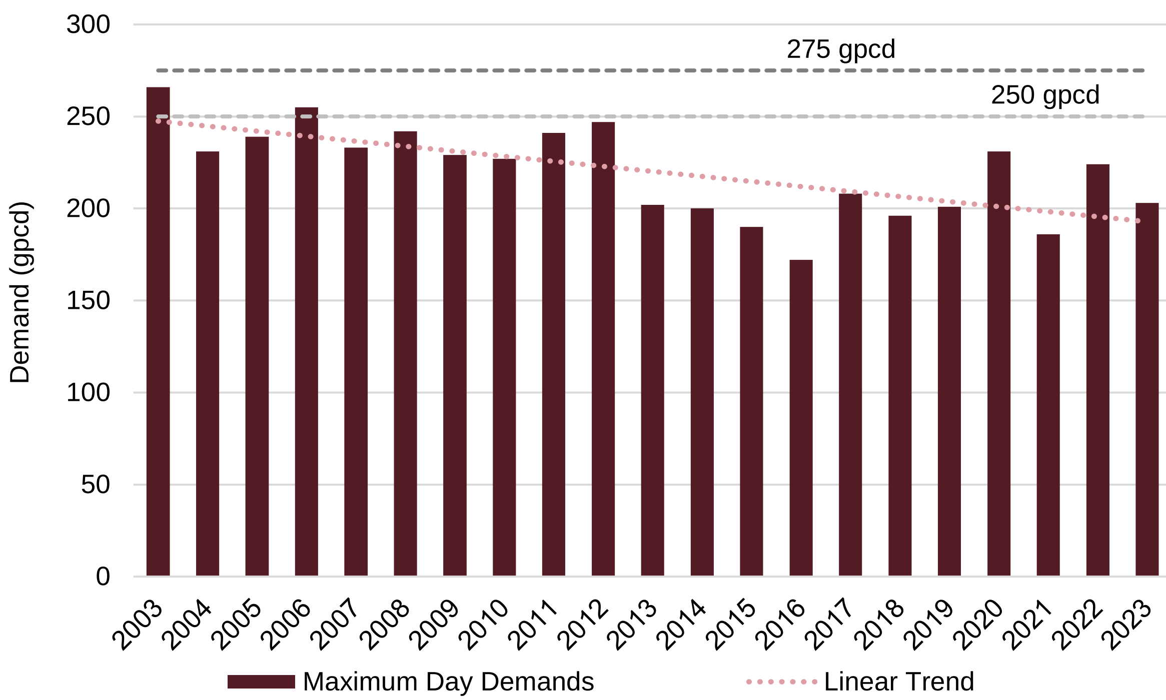


Figure 3.5: Historical Maximum Day Per Capita Water Demand

3.6 Water Demand by Land Use

Garver used historical water consumption data from 2022 and GIS data to determine historical demands associated by existing land use. A GIS analysis was completed to determine the lot size and the existing land use associated with each geolocated meter by extracting data for the nearest parcel. Table 3.3 summarizes the demands by land use category. The projected demand rate values will be used to determine future demand for new developments within the WSA, which will be discussed in more detail in the upcoming Distribution System Hydraulic Model Update Technical Memorandum. For single-family residential developments, the residential area will be assumed to be about 80% of the total development area for high-density developments and 70% for low-density developments to account for the area of streets, detention ponds, and other open spaces.

Table 3.3: Historical and Projected Demands by Customer Class

Customer Class	Customer Sub Class	Total Annual Demand (MG)	Total Area (acre)	Historical Demand (gpd/acre)	Projected Demand Rate (gpd/acre)
Residential	Residential - Multi-Family	6,777	700	2,654	2,700
	Residential - Single Family Attached	1,946	311	1,714	1,800
	Residential - Single Family Detached	30,619	7,575	1,107	See Table 3.4
Industrial	Light Industrial	907	293	848	900
	Heavy Industrial	407	94	1,182	1,200
Commercial	Commercial	5,615	1,745	3,218	3,300
	Office	2,901	403	1,974	2,000

As discussed in Section 3.4, residential users make up over 75% of all consumers within the WSA. A majority of residential users are classified as single-family detached lots. Due to the large percentage of single family detached users, further analysis was completed to determine the varied usage based on lot size. Table 3.4 and Figure 3.6 summarize the differences in usage related to differing lot sizes.

Table 3.4: Single Family Detached Historical Demands by Lot Size

Lot Size (acre)	Total Annual Demand (MG)	Total Area (acre)	Historical Demand (gpd/acre)	Projected Demand Rate (gpd/acre)	Historic Demand (gpd/connection)
<0.14	1,921	358	1,470	1,500	165
0.15 - 0.25	16,372	3,557	1,261	1,300	216
0.26 - 0.50	9,574	1,925	1,363	1,400	361
0.51 - 1.00	1,498	366	1,123	1,200	552
>1.00	1,254	1,041	330	350	577

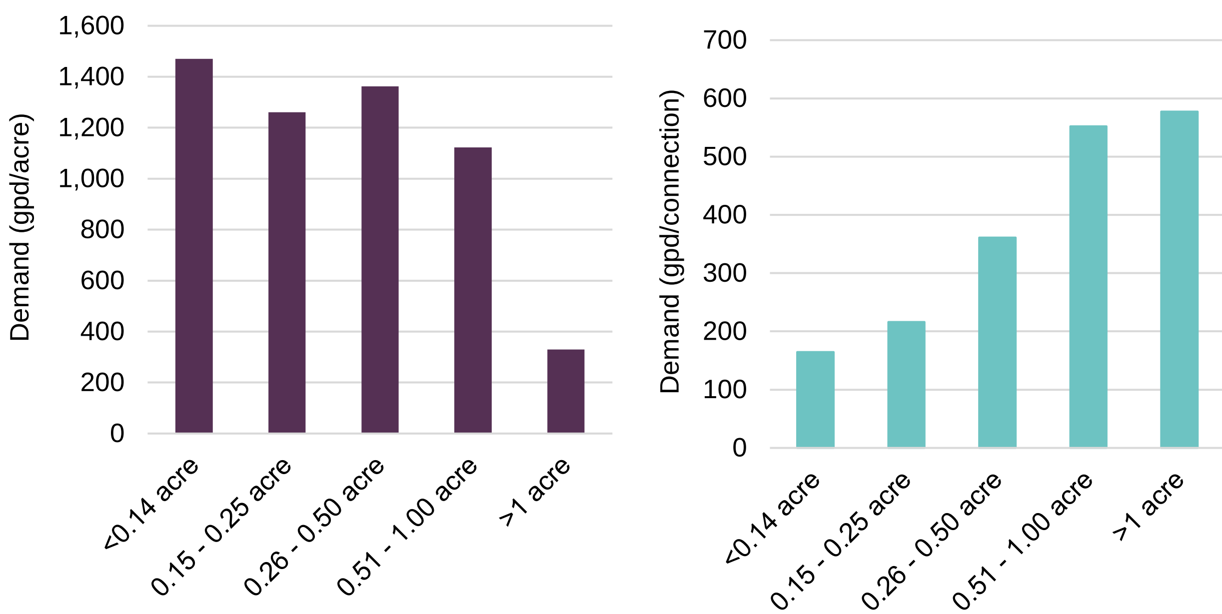


Figure 3.6: Demand by Single Family Detached Lot Sizes

3.7 Single-Family Equivalents

A single-family equivalent (SFE) value was determined using historical billed consumption data provided by NUA. SFE values are used to compare water system demands for other customer classes and the system overall to the demand of a typical single-family detached dwelling. Single family residential demands are often used as the benchmark for demand planning because they tend to represent the majority of system demands and they tend to remain more stable over time compared to other benchmarks. Multi-family, industrial, and commercial demands tend to vary significantly, and changes in these types of demands over time can cause variability in a water system's per capita demands. Once the SFE value has been determined, it can be used to express the system capacity as the number of single-family customer connections the water system can serve currently or in the future.

Garver used historical consumption data to determine the SFE value for the distribution system. The 2022 single-family water demand was determined using the annual consumption of all meters classified as single-family with a diameter of 1-inch or less. The total demand was then divided by the total number of single-family meters within the system, for an estimated value of 250 gallons per day (gpd)/connection. These values are summarized in Table 3.5.

Table 3.5: Single-Family Equivalent Projection

Total Single-Family Demand (MG/year)	Total Single-Family Demand (MGD)	Number of Meters	ADD SFE Value (gpd/SFE)
3,067	8.4	33,641	250

3.8 Water Loss

Garver reviewed water loss audits prepared by NUA for fiscal years 2019-2023. The audits were prepared by NUA using the American Water Works Association (AWWA) Free Water Audit Software.

Figure 3.7 summarizes the normalized total water losses for fiscal years 2019-2023. Total water losses are the sum of real losses (system leakage) and apparent losses (customer meter inaccuracies, unauthorized consumption, and data handling errors). Dividing the total losses by a measure of a water system's size (e.g., number of connections) provides a normalized key performance indicator (KPI) for tracking losses over time and comparing losses to reference data. Urban water systems typically use total or real losses per connection as their primary normalized KPI.

Figure 3.7 also shows the 25th percentile, median, and 75th percentile from the AWWA reference data included in the audit software. NUA's unit total water losses were between the median and the 75th percentile of the AWWA reference data for each fiscal year. During the 2023 fiscal year, NUA's unit total water losses were near the median compared to other systems. Higher losses near the 75th percentile in earlier years may be partially attributed to the impact of apparent losses caused by customer meter inaccuracies. NUA is currently implementing advanced water metering infrastructure to improve customer meter accuracy.

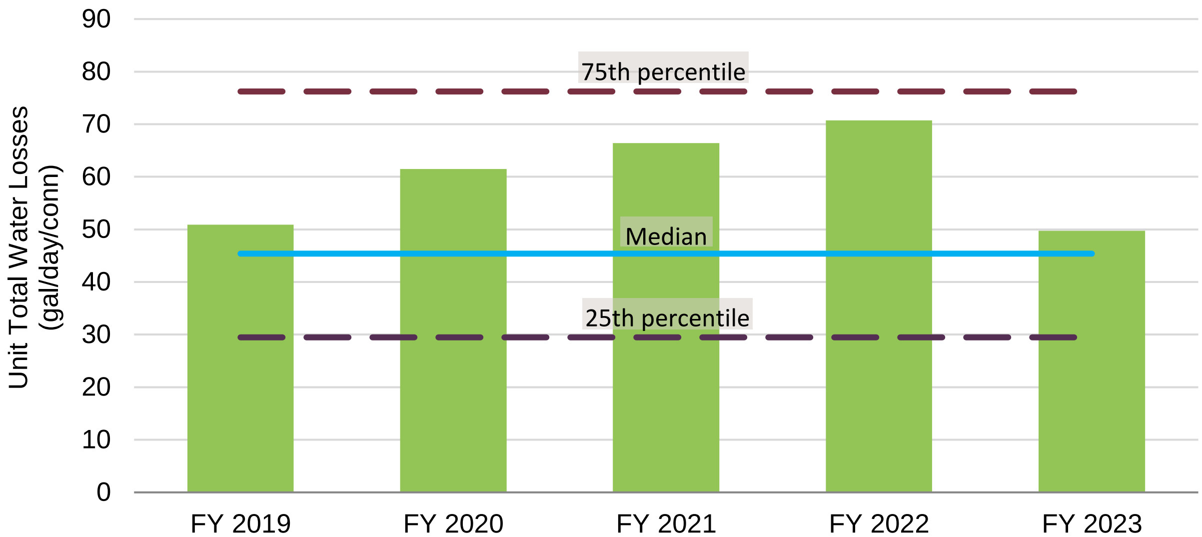


Figure 3.7: Total Unit Water Loss for 2019–2023

4.0 Population and Water Demand Projections

4.1 Population Projections

Garver used the 1.5% annual growth rate projection included in the Norman Today report as the basis of the city population projections through the year 2045 and is presented in Figure 4.1. It was assumed that the service population would be approximately 90% of the city's population, and the growth rate percentage was applied independently to both the city population and the service population.

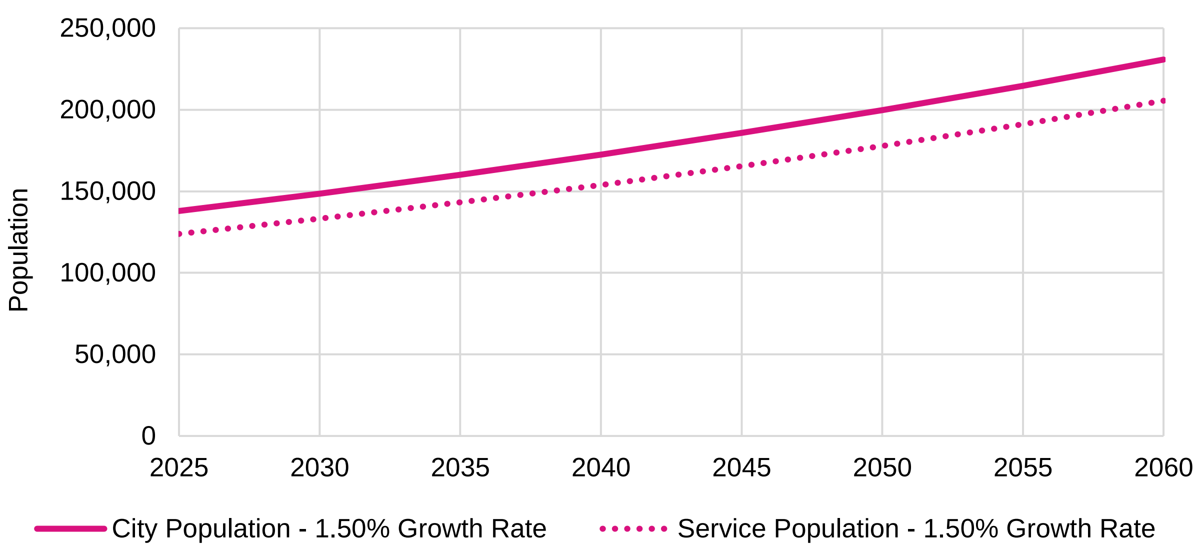


Figure 4.1: City and Service Area Population Projections

Figure 4.2 compares the population projection that was included in the 2060 Water Supply Plan. The population projection completed as part of this baseline development closely aligns with the previous population projection included in the 2060 Water Supply Plan.

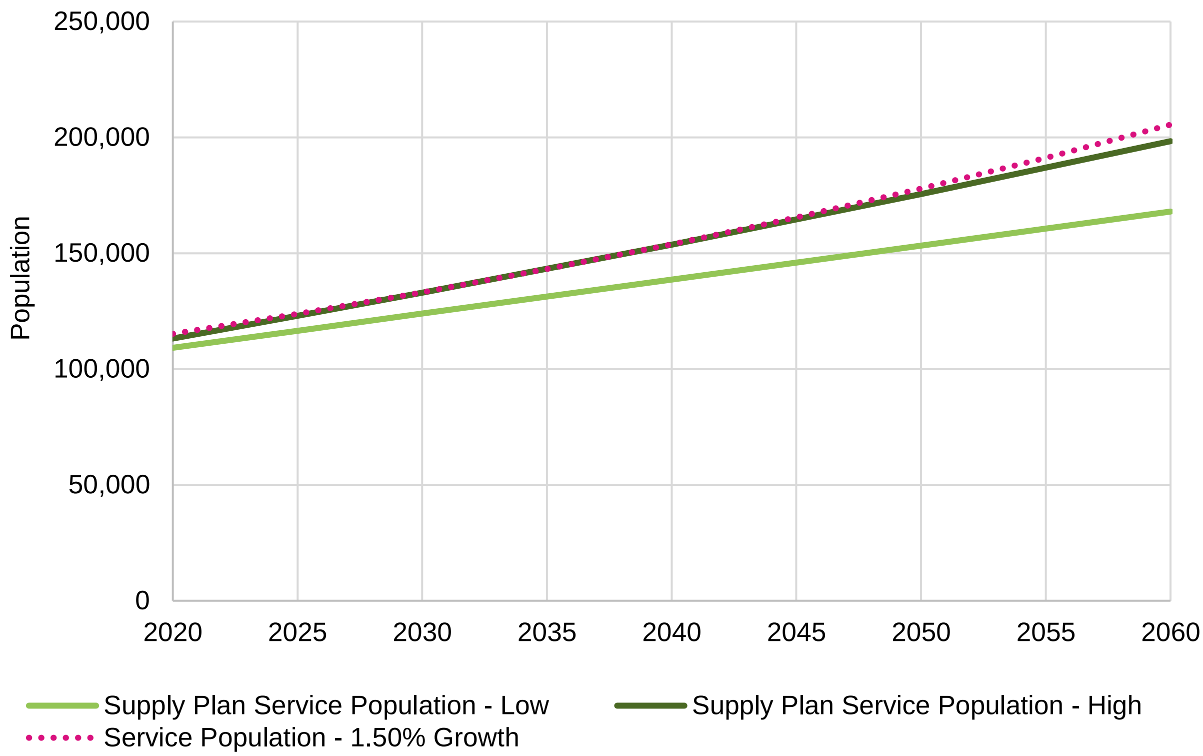


Figure 4.2: Population Projection

4.2 Water Demand Projections

As discussed in Section 3.3 and Section 3.5, the historical service population was used to determine the ADD and MDD per capita values of 136 gpcd and 250 gpcd, respectively. Production data was provided for the years 1990-2022. For the purpose of determining the ADD and MDD per capita demands for the system, only data after 2008 was considered to capture values that more closely reflect current usage. In addition to the values discussed above, a reserve capacity of 10% was included for both the ADD and MDD projections to remain consistent with the 2060 Water Supply Plan. Garver recommends the inclusion of a reserve capacity to mitigate any potential changes to per capita demand as a result of a new large user, unanticipated growth, or severe droughts. The projected ADD and MDD at the projected population discussed in Section 4.1 is shown below in Table 4.1.

Garver determined that the ADD per capita was around 136 gpcd. The value was derived comparing maximum ADD data over the noted period. An additional 10% (14 gpcd) was applied to account for reserve capacity for a total ADD per capita demand of 150 gpcd. This value is within the range of 144–160 gpcd used in the 2060 Water

Supply Plan. Per capita demand varied in the 2060 Water Supply Plan projection due to the inclusion of passive conservation savings. The comparison between Garver's projections and the 2060 Water Supply Plan projections will be discussed in greater detail in the upcoming Water Supply Plan Review Technical Memorandum.

The projected MDD was derived using the MDD over the past 15 years which correlated to a value of 250 gpcd. An additional 10% (25 gpcd) was added to account for reserve capacity for a total MDD of 275 gpcd. This value is within the range of 274–304 gpcd used in the 2060 Water Supply Plan. The 2060 Water Supply Plan values were derived by applying the maximum historical peaking factor between 1990-2012 of 1.9 to the ADD demand discussed above. Garver used the historical daily production data that was provided to determine historical MDD per capita instead of using a peaking factor. The comparison between Garver's projections and the 2060 Water Supply Plan projections will be discussed in greater detail in the upcoming Water Supply Plan Review Technical Memorandum.

Table 4.1: Projected Water Demands

Year	Service Population	ADD (MGD)	ADD Reserve Capacity (MGD)	ADD Total (MGD)	MDD (MGD)	MDD Reserve Capacity (MGD)	MDD Total (MGD)	SFE[1]
2025	123,865	16.8	1.7	18.5	31.0	3.1	34.1	74,904
2030	133,155	18.1	1.8	19.9	33.3	3.3	36.6	81,355
2035	143,142	19.5	1.9	21.4	35.8	3.6	39.4	88,341
2040	153,877	20.9	2.1	23.0	38.5	3.8	42.3	95,906
2045	165,418	22.5	2.2	24.7	41.4	4.1	45.5	104,098

Notes:
[1]Based on projected ADD with reserve capacity and a value of 250 gpd/SFE as discussed in Section 3.7

Figure 4.3 and Figure 4.4 show the historical consumption and the projected ADD and MDD through 2045. Projections through the year 2045 will be used for the purpose of the capital improvement plan (CIP) development. The projections through buildout will be determined based off the land use capacity of the service area and will be used to determine sizing.

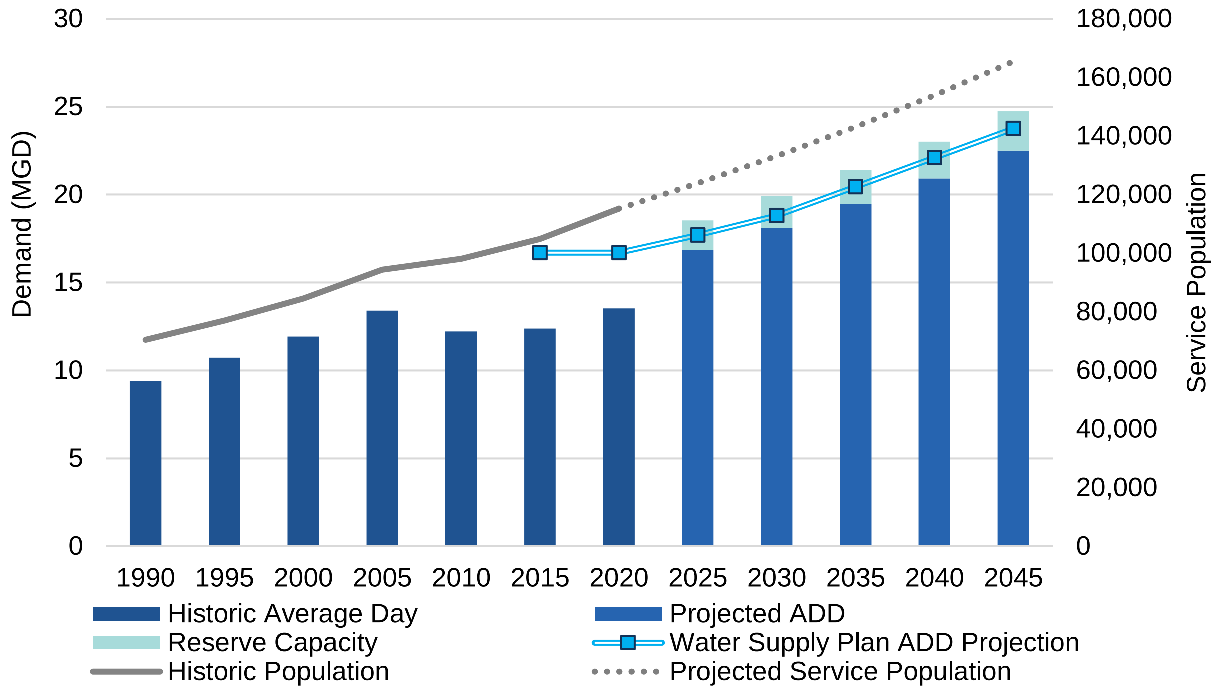


Figure 4.3: Historical and Projected Average Day Demand

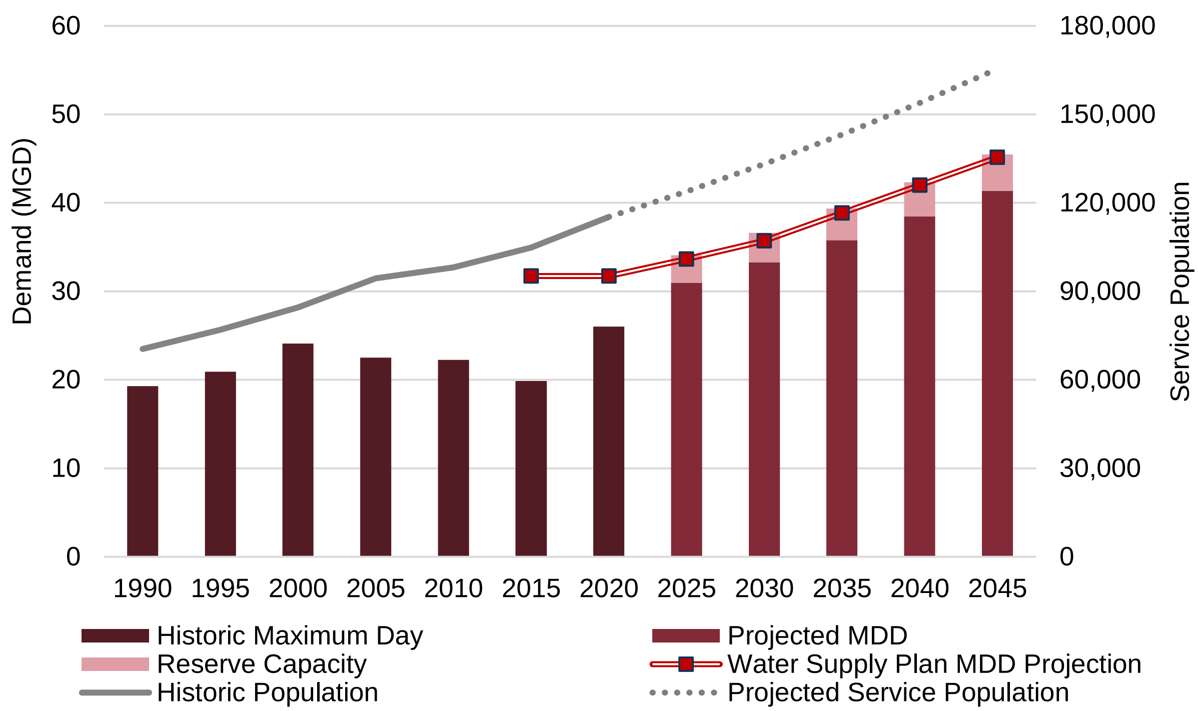


Figure 4.4: Historical and Projected Maximum Day Demand

5.0 Water Quality

Garver reviewed the following historical water quality data provided by NUA and downloaded from the Oklahoma Drinking Water Watch database to gain a better understanding of the current system and identify current system challenges:

- Disinfectant Residual
- Bacteriological
- Nitrite
- Disinfection Byproducts (DBPs)
- Lead and Copper

5.1 Disinfectant Residual

Disinfectant residuals serve as a surrogate for the potential for or presence of microbial activity. Disinfectant residuals are measured as total chlorine in chloraminated systems and are typically lowest in areas with high water age or with sediment, corrosion products, biofilm, or other sources of disinfectant demand, or where undisinfected groundwater enters the distribution system. Figure 5.1 summarizes disinfectant residual data provided by NUA from the regulatory compliance sampling conducted from 2021 to 2023. Average total chlorine residuals for the entire system, denoted by "x" symbols, ranged from 1.1 to 2.9 milligrams per liter (mg/L).

Oklahoma Department of Environmental Quality (ODEQ) regulations require a minimum total chlorine residual of 1.0 mg/L throughout the water distribution system. The regulatory minimum total chlorine residual is shown as a dashed red line on Figure 5.1. Several total chlorine residual samples, denoted by "o" symbols, were below 1.0 mg/L in the data provided. Finished water leaving the Vernon Campbell Water Treatment Plant typically has a total chlorine residual of at least 3.0 mg/L. However, undisinfected groundwater is pumped directly into the distribution system at multiple well sites, which is likely contributing to low total chlorine residuals at some locations. A new centralized groundwater blending and disinfection facility that will address this issue is currently in the design phase. Because nitrification can also contribute to low disinfectant residuals, the total chlorine residuals will be evaluated in comparison to hydraulic model results (source trace) as part of the upcoming Distribution System Hydraulic Model Update Technical Memorandum to identify any low residuals unlikely to have been associated with groundwater.

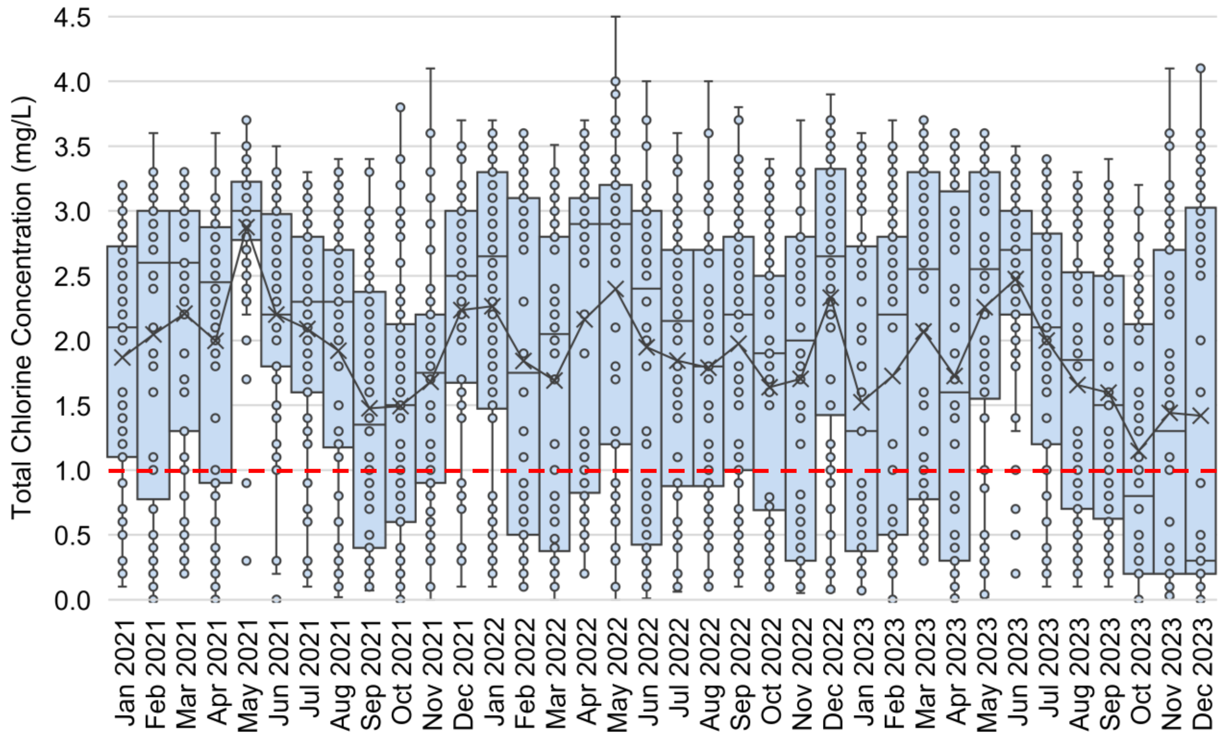


Figure 5.1: Total Chlorine Residual Box Plots by Month for 2021–2023

5.2 Total Coliform and *E. coli*

The Revised Total Coliform Rule (RTCR) requires monitoring of total coliform and *E. coli* according to a sample siting plan and schedule specific to each water system. According to the Oklahoma Drinking Water Watch database, NUA is currently required to sample 100 sites per month. A Level 1 Assessment to find sanitary defects is triggered when 5% of routine/repeat samples in the same month are total coliform-positive.

Bacteriological sample results were obtained from the Oklahoma Drinking Water Watch database for 2020 through 2023. According to these sample results, 5% of the samples during the months of October 2023 and May 2022 were total coliform-positive. No samples from 2020 through 2023 tested positive for *E. coli*.

5.3 Nitrification

Nitrification is the microbial process by which ammonia is oxidized to nitrite and nitrate. It occurs in chloraminated systems due to the presence of free ammonia from the decay of chloramines, excess ammonia addition during the formation of chloramines, or possibly from source water. Nitrification typically begins in areas with low disinfectant residuals and can lead to additional disinfectant residual loss, excessive microbial activity, and a drop in pH which can lead to corrosion. Nitrification is typically identified based on total chlorine, monochloramine, free ammonia, nitrite, and nitrate measurements.

NUA currently collects two samples daily to monitor nitrite in the water distribution system, rotating through 14 different sampling locations throughout the system. Figure 5.2 summarizes nitrite data provided by NUA for 2021 to 2023. Average nitrite for the entire system, denoted by "x" symbols, increased during the last summer months of each year, reaching as high as 0.3 mg/L-N in 2021. The locations with high nitrite concentrations will be evaluated in comparison to hydraulic model results as part of the upcoming Distribution System Hydraulic Model Update Technical Memorandum.

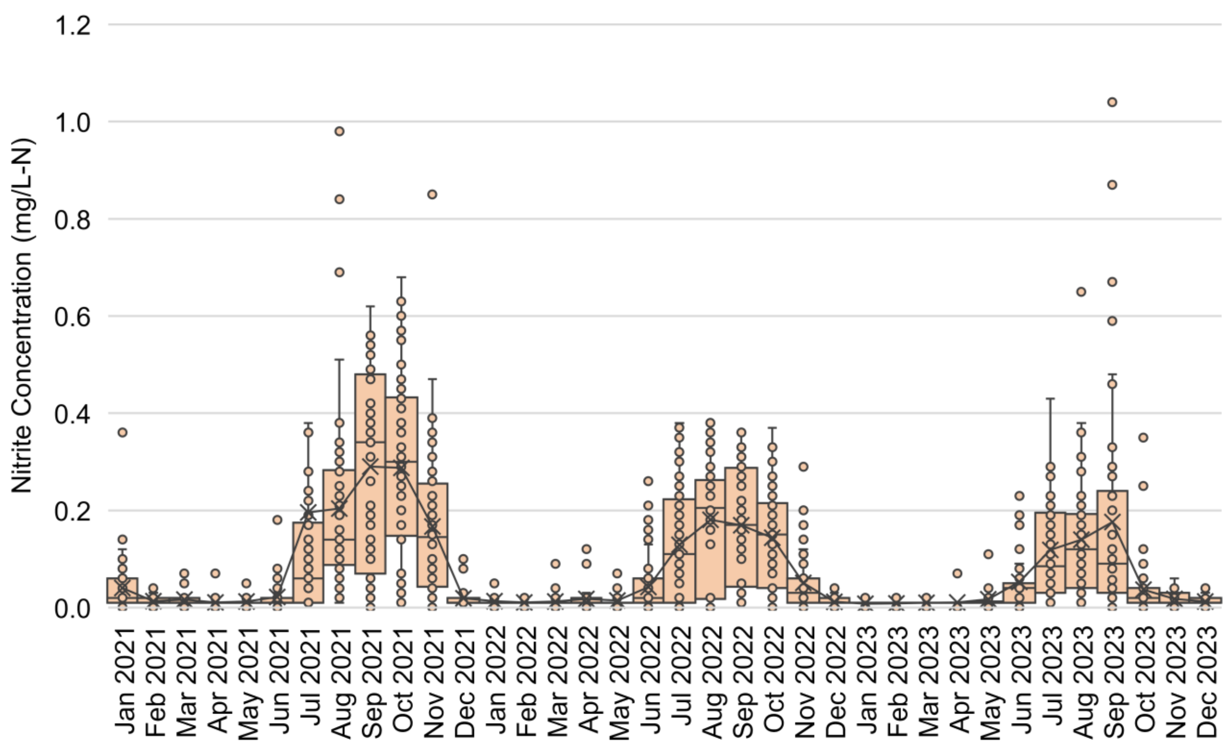


Figure 5.2: Nitrite Box Plots by Month for 2021–2023

5.4 Disinfection Byproducts

Disinfection byproducts (DBPs) can form when a disinfectant reacts with natural organic matter (NOM). Some DBPs are associated with negative impacts on human health and have maximum contaminant levels (MCLs) based on locational running annual averages (LRAAs) under the Stage 2 Disinfectants/DBP Rule. Two groups of regulated DBPs are measured in NUA's distribution system:

- Haloacetic acid (HAA5), with an MCL of 60 micrograms per liter (µg/L)
- Total trihalomethanes (TTHM), with an MCL of 80 µg/L

NUA provided quarterly sampling results for HAA5 and TTHM at four sampling locations for 2021 through 2023. All individual HAA5 and TTHM samples were below 60 µg/L and 80 µg/L, respectively. The maximum HAA5 and TTHM detected concentrations for 2023 were 10.1 µg/L and 14.9 µg/L, respectively.

5.5 Lead and Copper

Lead and copper typically enter drinking water via release from service line and premise plumbing materials. Lead is associated with negative human health outcomes even at low levels. Copper is primarily associated with aesthetic complaints but could have health impacts at high levels.

The Lead and Copper Rule (LCR) sets action levels for copper and lead at 1.3 milligrams per liter (mg/L) and 0.015 mg/L, respectively, based on the 90^{th} percentile tap sample collected during each monitoring period. If the 90^{th} percentile sample exceeds an action level, the water system must take steps to reduce lead or copper release, such as service line replacement or optimization of corrosion control treatment.

NUA provided lead and copper sample results from tap sampling in the distribution system from 2010 to 2023. Table 5.1. summarizes lead and copper data for 2010–2023. The 90^{th} percentile samples for both copper and lead are well below their action levels. No individual samples have been above the copper action level since at least 2010 and only one sample has been above the lead action level since 2010.

The proposed Lead and Copper Rule Improvements (LCRI), which is expected to be finalized in 2024 and have a compliance date in 2027, will require water systems to revise their sampling sites to preferentially sample from sites with known lead service lines or lead premise plumbing. At present, NUA collects lead and copper samples that are known or expected to have lead service lines or lead premise plumbing. NUA will need to confirm the service line and/or premise plumbing materials at sites that are currently only expected to have lead.

The LCRI also will require water systems to revise their sampling sites to preferentially sample from sites with known lead service lines or lead premise plumbing. At present, NUA collects lead and copper samples that are known or expected to have lead service lines or lead premise plumbing. NUA will need to confirm the service line and/or premise plumbing materials at sites that are currently only expected to have lead. Should new sites be needed, it is possible that the measured lead levels will increase.

Table 5.1: 90th Percentile Lead and Copper Concentrations for 2010–2023

Monitoring Period	Copper		Lead		
	90th Percentile Concentration (mg/L)	Number of Samples Exceeding 1.3 mg/L Action Level	90th Percentile Concentration (mg/L)	Number of Samples Exceeding 0.015 mg/L Current Action Level	Number of Samples Exceeding 0.010 mg/L Future Action Level
07/01/2010 - 12/31/2010	0.0259	0	0	1	1
01/01/2011 - 06/30/2011	0.0224	0	0	0	0
01/01/2012 - 06/30/2012	0.0167	0	0	0	0
07/01/2012 - 12/31/2012	0.0144	0	0	0	0
01/01/2013 - 12/31/2013	0.0922	0	0.000634	0	0
01/01/2018 - 12/31/2018	0.078	0	0	0	0
01/01/2019 - 12/31/2019	0.07	0	0	0	0
01/01/2020 - 06/30/2020	0.109	0	0	0	1
07/01/2020 - 12/31/2020	0.086	0	0	0	0
01/01/2021 - 12/31/2021	0.066	0	0	0	0
01/01/2022 - 12/31/2022	0.177	0	0.000365	0	0
01/01/2023 - 12/31/2023	0.155	0	0.00072	0	0

6.0 Water System Evaluation Criteria

Design criteria and regulatory requirements from a variety of sources were assembled to develop the evaluation criteria for analysis of the distribution system. Specifically, documents from the following sources were reviewed:

- Oklahoma Department of Environmental Quality (ODEQ)
- International Fire Code (IFC)

- City of Norman 2023 Engineering Design Criteria and Standard Specifications (Norman EDC)
- American Water Works Association (AWWA) Manuals

Table 6.1 summarizes the evaluation criteria that will be used to evaluate the water system's performance and identify potential capital improvement projects.

Table 6.1: Water System Evaluation Criteria

Criteria	Limiting Source	Description
Supply	ODEQ	ODEQ requires documentation demonstrating an adequate quantity of water will be available and that water will meet or exceed current drinking water standards.
Water Lines	Norman EDC	All water lines along section lines and arterial streets must be at least 12-inch diameter. All water lines along half-section lines and all collector streets should be a minimum of 8-inch diameter. All other lines shall be minimum 6-inch diameter
Pumping	ODEQ	All pumping stations shall have a minimum of two pumping units. With any pump out of service the remaining pump(s) shall be capable of providing the maximum pumping demand of the system.
Storage	ODEQ	System must be able to maintain sufficient storage capacity to meet domestic demands and fire flow demands over a 24-hour period while maintaining 25 psi throughout distribution system.
Minimum Pressure	ODEQ	A minimum pressure of 25 pounds per square inch (psi) shall be maintained, including during fire flow events. .
	NUA target level of service (2018 Modeling Update Report)	A minimum pressure of 40 pounds per square inch shall be maintained if possible.
Fire Flow	IFC	The City enforces the International Fire Code (IFC), 2018 edition. A system-wide minimum pressure criteria of 25 psi is used to determine available fire flow.
	NUA target level of service (2018 Modeling Update Report)	A minimum available fire flow of 1,500 gpm at 25 psi residual pressure, if possible.
Maximum Flow Velocity	AWWA (guideline)	Water distribution lines should not experience a maximum flow velocity of 6 ft/s. (Note: Guideline is not a regulatory requirement and will be used to identify water lines for potential replacement)
Maximum Head Loss Gradient	AWWA (guideline)	The maximum head loss gradient for smaller pipes (diameter < 16 inches) should not exceed 7 ft/1,000 ft. The maximum head loss gradient for larger pipes (diameter ≥ 16 inches) should not exceed 3 ft/1,000 ft. (Note: Guideline is not a regulatory requirement and will be used to identify water lines for potential replacement)

7.0 Future Work

The City's population projections and future land use plan are being developed in parallel with the baseline development for the water system. Once the future land use plan is finalized, Garver will update the water baseline development presented in this TM and move forward with the following future water system evaluations:

- Distribution System Hydraulic Model Update
- Hydraulic Model Evaluation
- Water Supply Plan Review
- Capital Improvement Program

Each evaluation will be documented in an upcoming TM that will be incorporated in the Water Master Plan Report.