City of Sycamore

2019 Water Master Plan

Continuity • Collaboration • Commitment

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Glossary of Terms

Term	Definition
ACS	American Community Survey
ADD	Average Day Demand
AFF	Available Fire Flow
avg	Average
BAT	Best available technology
C	Celsius
cf	Cubic feet
CMAP	Chicago Metropolitan Agency for Planning
DAF	Daily Average Flow
Diurnal Pattern	Variation over the course of a day
DNR	Department of Natural Resources
EcoCAT	Ecological Compliance Assessment Tool
EPA	Environmental Protection Agency
F	Fahrenheit
Firm Capacity	Capacity with one pump out of service
FPA	Facility Planning Area
fps	Feet per second
ft	Feet
FY	Fiscal year
gal	Gallons
gcd	Gallons per capita per day
GIS	Geographical Information System
gpd	Gallons per day
gpm	Gallons per minute
HDPE	High density polyethylene
HGL	Hydraulic gradeline
HMO	Hydrous manganese oxide
HP	Horsepower
hr	Hour
HZ	Hertz
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency

IEX	Ion-exchange
IHPA	Illinois Historical Preservation Agency
in	Inch
ISO	International Organization for Standards
L	Liter
l.f.	Lineal feet
lbs	Pounds
max	Maximum
MCC	Motor control center
MCL	Maximum Contaminant Level
MDD	Maximum Daily Demand
MG	Million gallons
mg/L	Milligrams per liter
MGD	Million gallons per day
min	Minimum or minute
mL	Milliliter
NFF	Needed Fire Flows
NRW	Non-revenue water
NPDES	National Pollutant Discharge Elimination System
PE	Population Equivalent
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
pCi	Picocuries
RO	Reverse osmosis
SCADA	Supervisory Control and Data Acquisition
sf	Square Feet
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
WRT	Water Remediation Technologies, LLC.
WTP	Water Treatment Plant
yr	Year

SECTION 1

INTRODUCTION AND BACKGROUND

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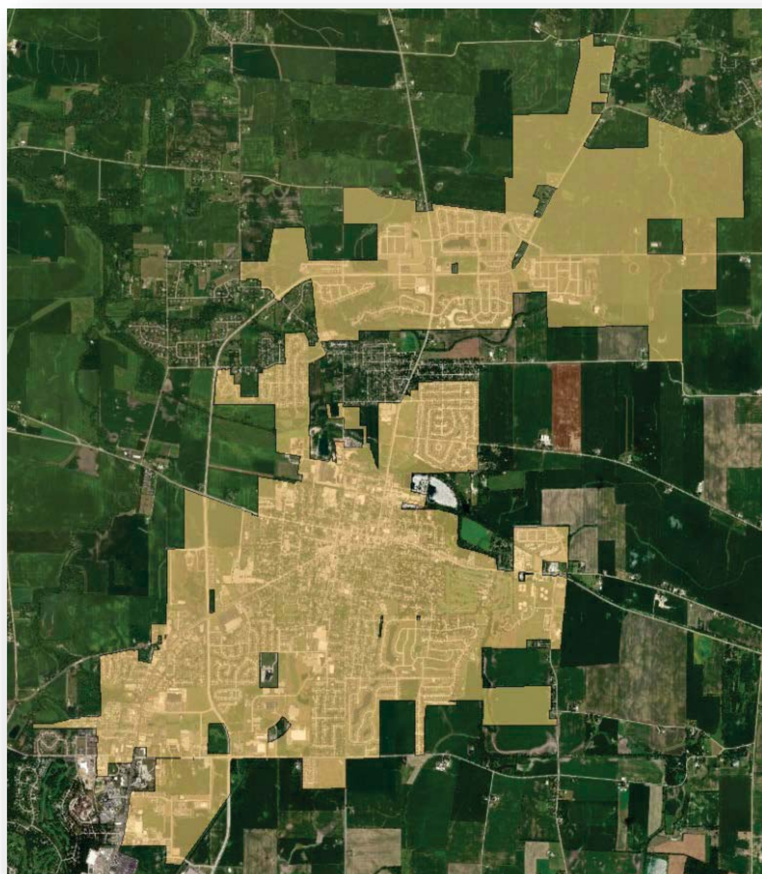
1. INTRODUCTION AND BACKGROUND

1.1. GENERAL BACKGROUND

The City of Sycamore was incorporated as a Village in 1858 and established as a City in 1869. Located in DeKalb County, Illinois, the City covers approximately 6,424 acres or 10 square miles of land surrounding the intersection of Route 64 and Route 23. Outlined in the exhibit below is the City's corporate boundary. In 1888, the City developed its first public water supply and to this day still owns and maintains a well-operated water system that spans throughout the City's boundary, serving the community's residents as well as commercial, industrial, and municipal users.

The most recent study of the City's water distribution system was conducted in 2007, which was a complete water system Master Plan. At the time of the previous report, the resident population was estimated at 17,214. According to the American Community Service survey, the population grew with an annual growth rate of approximately 0.3% to 17,712 in 2017, and the estimated population for 2019 is 17,897. The residential water billing for the community in FY2019 was 971,560 gallons per day, while the non-residential (commercial, industrial, and municipal) usage was approximately 467,027 gallons per day. This equates to an average daily billing for the City of approximately 1.43 MGD across the entire service area, with an average pumpage throughout the City of 1.85 MGD. The difference between the two numbers, billing and water pumpage, is largely due to water loss and/or unmetered water usage.

City of Sycamore Corporate Boundary



In 2014, the City's Comprehensive Plan was updated, including prospective future improvements and developments. The City plans to ultimately expand land use by 23,000 acres, which includes additions of various residential and commercial areas, however majority will be slated for agricultural purposes.

1.2. Existing Distribution System

The City of Sycamore maintains roughly 115 miles of water main serving the community's 7,000 connected users. The Sycamore Public Works Water Division has adopted proactive water main maintenance, flushing, and rehabilitation programs to sustain the level of service provided to the community. The goal for the City after completion of this report is to coordinate the water main rehabilitation program with the City's future Capital Improvement's Program for street rehabilitation and reconstruction to minimize costs.

The City commissioned a computerized water model to be developed in 2007 to evaluate a number of system scenarios. Since that time, the model has become outdated and is has not been operational in years. As such, the City requested that Trotter and Associates develop a new hydraulic model utilizing Bentley WaterCAD® V8i based on the City's existing GIS databases. The model is a valuable tool for evaluating the impact of potential development, as well as to measure the benefits received from capital improvement and rehabilitation projects. The WaterCAD® model is used to reflect the distribution system's capabilities under Maximum Day Demand (MDD), Fire Flow conditions, and has been developed to include data for all hydrants throughout the service area.

1.3. Existing Treatment and Storage Infrastructure

The City of Sycamore water supply and storage consists of five deep groundwater wells (one inactive), four radium removal treatment facilities, a 750,000-gallon water tower, and a 1.5 MG water tower. Each of the City's wells draw water from deep sandstone aquifers and have a combined design pumping capacity of approximately 6.8 MGD.

Water from these aquifers have been observed to have high concentrations of radium that are above the USEPA Maximum Contaminant Level of 5 piC/L. In order to meet this standard, the City of Sycamore signed an agreement with Water Remediation Technology, LLC (WRT) in 2005 for the implementation of radium removal facilities at Well #6, 8, and 9 and again in 2012 for a facility at Well #10. The systems use an adsorptive media to remove radium from the source water. In addition to implementing the facilities, WRT is also responsible for maintaining them, providing the WRT media for each of the systems, and the removal and disposal of old or spent media to a licensed facility. The City renewed the contract for Well #6, 8, 9, and 10 in 2017 which ends in 2027.

As with most municipal water supplies, the existing infrastructure has been constructed over several decades and the components within the system vary in age. The City of Sycamore has made an effort to perform routine maintenance for the Wells and Treatment Facilities to keep them in good operational order. However, City will need to do the same for the distribution system and towers in the future.

Two elevated storage towers provide the City with a combined 2.25 MG capacity of water for the system. The distribution system operates off of the two towers to provide consistent pressures and hydraulic grade line within the system. As tower levels fall, the SCADA system will start wells to recover, following a lead/lag cycle.

1.4. Water System Typical Operation

The City's SCADA system works in conjunction with experienced operational staff to handle non-routine events as well as perform continual modifications to optimize water quality. In general, the water system operates based on the elevated storage tank levels.

The City's water system operates through alternating the wells in operation based on a set cycle. The City's existing SCADA system assigns a number to each well, which is typically 1-5. However, since one well is out of service (Well #7), the range is 1-4. The well identified as #1 will be the first to kick on based on the tower setpoints. If the towers continue to drop, well #2, 3, and 4 will kick on to supplement as required. As the towers recover, the wells kick off in the same fashion, however it is in reverse order. Well #4 kicks off first, then 3, 2, and ultimately 1. This lead/lag system can be altered by SCADA to rotate each well through each of the different positions so equal run times are obtained.

The levels of the two tanks dictates when wells run and is shown in the tables below. Each table identifies the hydraulic grade lines for when each additional well kicks on. Each of the elevated storage tanks are strategically located throughout the system to maintain as consistent a pressure throughout the water system as possible. The hydraulic grade line (HGL) represents total pressure supplied relative to sea level.

The City maintains an HGL of approximately 991 feet within service area. Therefore, if the ground elevation at a point in the system is 880 feet above sea level (near Tower #1), the water pressure at this location would equate to 48 psi (991 HGL – 880 ft Elevation = 111 ft ÷ 2.31 ft/psi).

Tank 1 Settings		Tank 2 Settings	
Lead Start	Lead Stop	Lead Start	Lead Stop
990.93	995.93	986.31	990.81
Lag Start	Lag Stop	Lag Start	Lag Stop
989.93	996.93	984.81	990.61
3rd Start	3rd Stop	3rd Start	3rd Stop
988.93	993.93	982.81	987.81
4th Start	4th Stop	4th Start	4th Stop
987.93	990.93	979.81	982.81
5th Start	5th Stop	5th Start	5th Stop
984.93	988.93	975.81	979.81

1.5. Purpose and Scope

A Water Master Plan is a management and planning document used to identify, evaluate, and plan required water distribution and facility improvements. It provides an assessment of the distribution, storage, and supply system's abilities to meet both current and future demands and regulatory requirements and provides critical information for improvements to correct current or anticipated deficiencies.

Master Plans are typically updated every five to 10 years, or when significant changes in growth or regulatory requirements have occurred or are expected. An approved Master Plan is also needed to secure IEPA Funding. The City of Sycamore's most recent Water Master Plan was prepared in 2007 and is now more than ten years old. Since the 2007 update, the City has implemented a number of the recommendations including the installation of new and replaced water main, construction of the 1.5 MG water tower, and the implementation of the Well #6, 8, 9, 10 WRT treatment facilities. During the timeframe the City also found it necessary to shut down Well #7 due to high radium levels. In an effort to be proactive the City is seeking to update the Master Plan to develop a single document which includes a Capital Improvements Plan to assist in budgeting for necessary improvements and to provide a guide for future improvements, such as a cost-effective solution to rehabilitating Well #7, and a review of the WRT systems and costs.

The ultimate goal of this plan is to establish the community's current and future water production and infrastructure needs and develop an implementation plan to meet those needs. This plan will provide the blueprint for future improvements, expansion phasing, and capital improvement projects. In addition, the master plan can also be used to assist the City with the procurement of an IEPA low interest loan funding. Throughout development of the Water System Master Plan, the City's staff and Trotter and Associates have worked together closely to determine the City's needs and evaluate alternative solutions. These meetings were essential to ensure the proposed implementation plan satisfies the City's expectations and regulatory requirements.

A significant portion of the planning effort is dedicated to the analysis of the existing distribution system. Therefore, the City's WaterCAD model was rebuilt to reflect the distribution system's current capabilities under Maximum Day Demand (MDD) and Fire Flow conditions. Water supply requirements were evaluated based on updated population projections, and limitations within the distribution system.

1.6. Summary

The following sections will provide a detailed analysis of the City of Sycamore long-term needs and a selection of alternatives, cost estimates and schedule for implementation of the recommended improvements to the distribution system and water supply, storage, and treatment infrastructure.

- Section 2 – Community Needs
- Section 3 – Existing Distribution System Evaluation
- Section 4 – Analysis for Distribution System Alternatives
- Section 5 – Evaluation of Existing Water Supply, Treatment & Storage Facilities
- Section 6 – Analysis of Water Supply, Treatment, and Storage Alternatives
- Section 7 – Recommendations and Summary

SECTION 2

COMMUNITY NEEDS

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2. COMMUNITY NEEDS

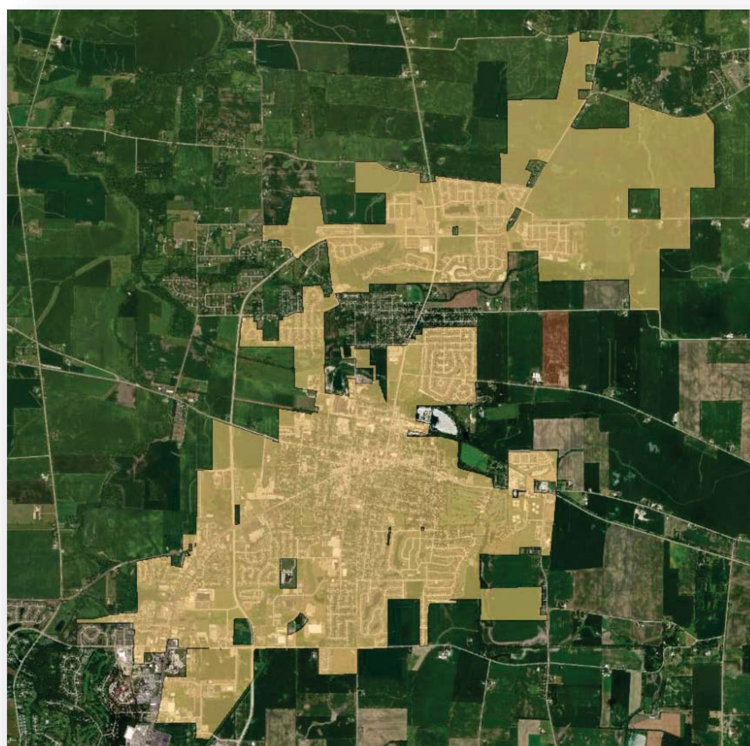
This section includes a discussion of the City's water service planning area, current and future population projections, water usage, and regulatory considerations in order to provide a complete evaluation of the City's drinking water needs. While the City did not experience the growth that was projected in the 2007 Water Master Plan, projecting for future water demands will again be critical to the City's long-term planning.

2.1 GENERAL BACKGROUND

The City of Sycamore is located in DeKalb County, 58 miles west of Chicago and roughly 29 miles southeast of Rockford. The City's planning area extends from the intersection of Route 64 and Route 23, covering about 6,424 acres or 10 square miles of land. The population has grown from a community of 10,058 in 1990, to 14,750 people in 2005, and an estimated 17,712 people in 2017 according to the American Community Survey. In 2007, when the previous Water Master Plan was written, the 2021 population projection was 29,694. This utilized a 4.0% annual growth rate stemming from a spike in residential construction between 2002 and 2006. However, the actual annual growth rate since that report has been approximately 1.7%.

In 2014, the City commissioned an update to the Comprehensive Plan that outlines the goals and objectives for the City's future improvements and developments throughout a specific geographic planning area. Historically, the City's planning area includes the entire Sycamore corporate limits as well as the land within a mile and a half radius of these limits. The Comprehensive Plan proposes an increase of land use by 23,000 acres, and although 80% of the proposed land use will be slated for agricultural purposes, the planned residential, commercial, and industrial developments are predicted to nearly double in size, and thus, have a significant impact on the overall demand of the City's water system, and utilities as a whole. At the time of the writing of this report, the City was in the process of developing an update to the existing Comprehensive Plan. As such, the best available information was used in the development of this report.

Figure 2-1: City of Sycamore Facility Planning Area (FPA)



2.2 EXISTING CONDITIONS

Most communities contain both residential and non-residential land uses. Analysis of current and future water usage often utilizes "population equivalents", or P.E., which provide a common basis for residential and non-residential demands to be analyzed. One P.E. is equivalent to the water consumed by one resident, as determined by historic data. This can then be applied to non-residential water usage to obtain a total equivalent population for the City's service area.

2.2.1 Resident Population

In fiscal year 2019, the City had a total customer base (including residential and non-residential) of 7,247 accounts. However, this cannot necessarily be correlated with the total population served. In order to determine the total PE within the City's Service Area, the residential population is established as the first step. The City's population from the 2017 American Community Survey (ACS) can be found in Table 2-1. The ACS is a yearly survey executed by the U.S. Census Bureau which contacts over 3.5 million households. This data is used to provide updated community estimates in the 10 years between nationwide censuses. The table also identifies the anticipated 2040 population based on three different annual growth rates.

The Chicago Metropolitan Agency for Planning (CMAP) conducts a Socioeconomic Forecast study for the northeastern counties of Illinois for regional planning purposes. Although the City of Sycamore lies just outside the primary CMAP subregion, Dekalb County was still included in the forecast as part of the Illinois Outer Counties subregion. The total population including all counties in this subregion are projected to have an annual growth rate of 0.52% forecasted to 2050. The second projected growth rate was presented in the 2018 Dekalb County Comprehensive Economic Development Strategy. This document stated an expected growth total rate of 6.2% from 2016-2025, equating to a 0.69% growth per year.

These low growth rates were calculated for the County as a whole, and while the population growth for the entire county has decreased, the City of Sycamore has experienced otherwise. The City of Sycamore has experienced consistent annual increases of single- and multi-family residential units, approximately 50 and 15 new units per year, respectively. These developments result in an approximate 1.16% annual growth rate. However, The City is expecting a steeper growth rate due to increasing upcoming residential developments of an estimated 75 single-family homes per year, equating to a 1.64% annual growth rate. By utilizing the 2017 American Community Survey (ACS) in conjunction with the City's specific historical growth, a more accurate representation of the 2020 population could be achieved. This Master Plan will utilize the expected annual growth rate of 1.64% for a conservative approach on further calculations.

Table 2-1: Population Projections to 2040

	Projected Annual Growth Rate	2017 ACS Population	2020 Population Forecast	2040 Population Forecast
CMAP	0.52%	17,712	17,990	19,956
Dekalb County CEDS	0.69%	17,712	18,081	20,747
City of Sycamore	1.16%	17,712	18,248	22,267
	1.64%	**17,712**	**18,598**	**25,748**

2.2.2 Total Population Equivalents

The table below illustrates the breakdown between residential and non-residential water billing throughout the City over the past five full fiscal years. The non-residential water billing includes commercial, industrial, non-profit, and any billed-municipal water usage.

The residential water usage remained relatively consistent between FY2015-2019 with year-over variations of no more than 1.5%. Non-residential water usage has slowly increased over the past years with the largest percent increase of 3% from FY2017 to FY2018. As shown above, the residential water usage in the City accounts for over 68% of billings, though it represents more than 90% of total accounts. This annual water billed does not represent the total water metered (or pumped) for the City, which would help quantify the water loss and non-revenue water of the system. Water loss and non-revenue water is discussed further in the following section.

Table 2-2: Total Water Billed (FY2015-2019)

Fiscal Year	Total (GPD)	Residential (GPD)	Non-Residential (GPD)
FY2015	1,426,957	989,108	437,848
FY2016	1,423,739	977,595	446,144
FY2017	1,417,913	968,701	449,212
FY2018	1,446,757	982,585	464,172
FY2019	1,438,586	971,560	467,027
5-Year Average:	**1,430,790**	**977,910**	**452,881**
	100%	**68.30%**	**31.70%**

The residential population equivalents were calculated by dividing the residential water sold by the total number of residents within the Service Area. The 2017 population estimate of 17,712 based on the ACS projection was utilized for this estimate as it follows the approximations used by the City. In order to estimate the population in 2020, a projected compound annual growth rate of 1.64% was used. The per capita water billed equates to 52.6 gpd/capita, which was then used to determine the equivalent population of the non-residential water billing. This resulted in an estimated 8,610 PE of non-residential use to be served by the City's water distribution system, for a total of 27,208 PE.

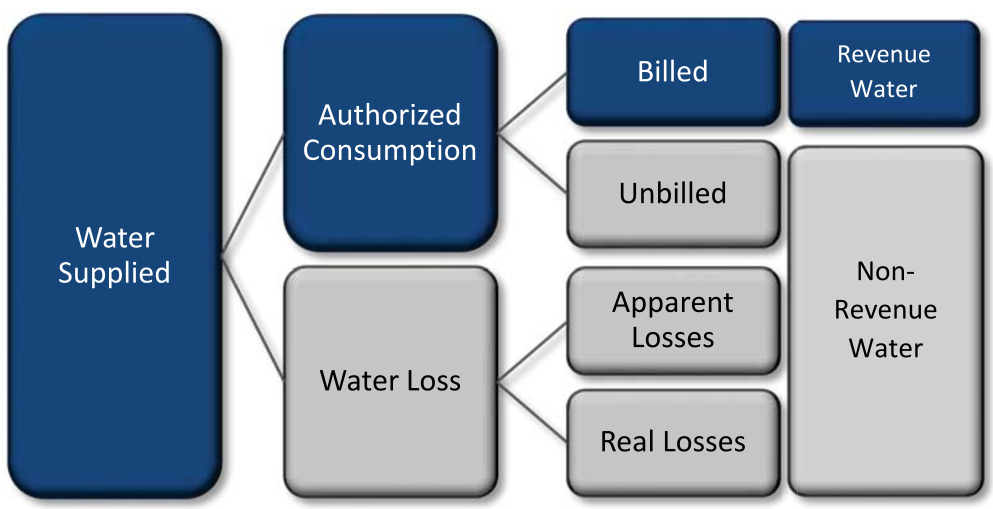
Table 2-3: Current Total Population Equivalent

Description	Total
5-Year Average Residential Water Billed (GPD)	977,910
2020 Residential PE	18,598
Residential Per Capita Water Billed (GPD)	52.6
Non-Residential Water Billed (GPD)	452,881
Non-Residential PE (at 52.6 GPD/PE)	8,610
Total 2020 (Current) PE	**27,208**

2.2.3 Water Loss

While the City must meet the system water demand on a daily basis, not all of the supplied water can be metered or billed. Water supplied is the total amount of water that is pumped by the wells into the distribution system. From being pumped, water supplied can be broken down into two separate categories, authorized consumption and water loss. Authorized consumption describes all water that is approved by the water utility for use. This category consists of billed authorized consumption and unbilled authorized consumption. Billed consumption includes all the accounts of water within a customer billing system and is the source of revenue for the water utility. Unbilled consumption is water that is consumed but not charged to an account and can include water used for firefighting, flushing, street cleaning, and usage for the municipality itself. A simplified graphic of this concept is shown below.

Water loss can be broken down into two categories: real losses and apparent losses. Real losses are the physical and primary source of losses, consisting of leakage from distribution mains and service connections, and leakage and overflows of storage tanks. This results in water systems requiring an increased volume of water to be extracted, larger infrastructure capacity than needed, and excessive energy usage to meet the demands of the community.



Apparent losses account for the nonphysical losses in a water system which occur from inefficiencies in measurement, recording, and archiving water volumes in a the system. The main sources of apparent losses are from meter inaccuracies, systematic data handling errors, and unauthorized consumption. Unauthorized consumption water loss is due to water theft or meter tampering. Apparent losses impact water system management by skewing the quantification of water demand in a community and causing water utilities to suffer a loss of potential revenue. The sum of unbilled authorized consumption and water loss equates to Non-Revenue Water (NRW). Typically, the majority of NRW is due to inefficiencies to the water distribution system, water loss.

Table 2-4: Average Non-Revenue Water

Fiscal Year	Pumped (MGD)	Billed (MGD)	NRW (%)
FY2015	1.68	1.43	14.88%
FY2016	1.72	1.42	17.07%
FY2017	1.97	1.42	28.03%
FY2018	2.11	1.45	31.30%
FY2019	1.90	1.44	24.45%
Average:	**1.88**	**1.43**	**23.18%**

The average non-revenue water of systems in the United States is approximately 16%, according to the USEPA. The City of Sycamore's 5-year average non-revenue water equates to approximately 23%. This is likely related to both metering discrepancies and large quantities of unbilled usage (e.g. auto-flushers). This is further discussed in Section 4 relating to the City's meter replacement program.

Additionally, while the gallons billed per capita was found to be 52.6 gpd/PE, the water usage is higher due to this water loss. The average daily water pumped of 1.90 MGD divided among the 27,208 PE equates to 69.8 gpd/PE pumped. However, as the City replaces water meters throughout the system the total non-revenue water should decrease over time due to the more accurate readings, and net revenues should increase. EPA studies indicate that aging meters may contribute to an apparent loss of 1.5-2.0% of total water produced. Replacement of these older, less accurate meters should result in long term benefits in reducing non-revenue water.

2.3 Future Population Projections

In order to estimate the future water demand that the City must be able to provide, four growth categories were developed and analyzed. Future population equivalents were established by reviewing the City's expected residential lots, approved non-residential development plans, and the City's Future Land Use Plan. Ultimately four different population equivalents were developed; 2020, 2025, 2030, and 2040. These effectively represent the current, five, 10, and 20-year estimates. They were determined as identified below, and are described in further detail on the following pages:

- ***2020 (Current)*** *– This represents the existing population estimates as described in Section 2.2.2.*
- ***2025*** *– This includes all developments that are considered "Final Platted Lots" for single-, two- and multi-family homes, as well as 1/3 of identified future Non-Residential Development.*
- ***2030*** *– This includes 33% of developments that are considered "Preliminary Platted Lots" for single-, two- and multi-family homes, as well as 33% of the remaining (2/3) identified Non-Residential Development.*
- ***2040*** *– This includes the remaining 67% of developments that are considered "Preliminary Platted Lots" for single-, two- and multi-family homes, as well as 67% of the remaining identified (2/3) Non-Residential Development.*

The City maintains a database that outlines the development of residential areas. While keeping track of lots already built-out, the City also designates platted and vacant lots to either single-family, two-family, or multi-family homes in existing and new neighborhood establishments. The City identifies these residential developments as either Final Platted Lots or Preliminary Platted Lots. Final Platted Lots are already annexed and are ready for construction. While the Preliminary Platted Lots are located, they are not as far into the development process, and would not be considered "shovel ready."

The City's future non-residential growth was evaluated from open space areas planned for commercial, industrial, and other business developments. Open space acreage was calculated from the Land Use Map within the Comprehensive Plan, shown in Figure 2-2, on the following page. This boundary includes both vacant residential lots as well as non-residential uses. Areas illustrated in red and purple (business and industrial areas) identify non-residential open spaces, and is approximately 350 acres in total size. Both the database and acreage data will be used in the following sections for future population projects.

2.3.1 2025 Population Projection

The 2025 population projection utilized is the sum of all Final Platted Lots for single-, two- and multi-family homes described in the City's database. A total of 783 lots were identified as "Final Platted Lots" by the City, and it is expected that these will be developed within the next five years. For calculation purposes, it is assumed there will be three houses/lots per acre, with 3.5 residents per home for single- and two-family and 2.5 residents per home for multi-family. The three residential categories were also multiplied by open space density factors which takes into consideration land dedicated to roads, utilities and green space. The calculated PE values are represented in

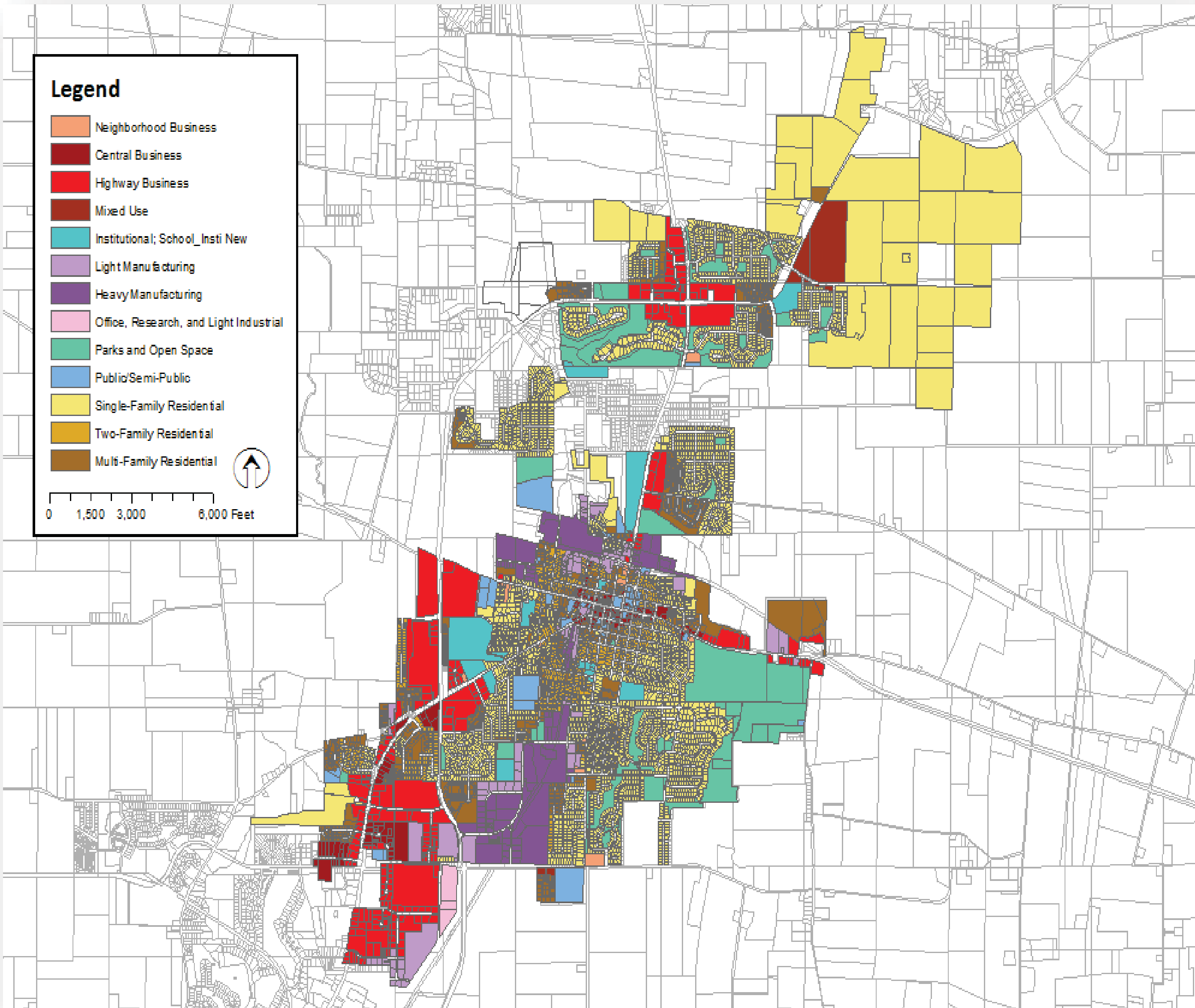
Table 2-5 on the following page, and equate to a total of 2,164 PE of residential growth by 2025.

For the non-residential PE projection, about one-third (1/3) of the 350 acres of available open space is expected to be constructed by 2025, including the development of a new Meijer in the western zone of the City off Peace Road. The remaining 2/3 of the open space acreage is anticipated to develop between 2025-2040. This resulting 117 acres (350 ÷ 3) was then multiplied by 9.0 PE/acre for a total of 1,050 non-residential PE by 2025. The 9.0 PE/acre was calculated using a sample non-residential area of the City, correlated to the respective water usage within that area. This generally tracks with density usage of other communities and is further described in Section 2.3.3. Over the next five years, the City can expect total population equivalent growth of roughly 3,214 PE, which equates to an annual growth rate of 2.36%.

Table 2-5: 2025 Residential and Non-Residential PE Growth

Land Use	Lots	Area (Acres)	Percent	PE
Single-Family Residential (3 lots/acre, 3.5 PE/unit, 10% open space)	487	162	48.39%	1,534
Two-Family Residential (3 lots/acre, 3.5 PE/unit, 20% open space)	106	35	10.53%	297
Multi-Family Residential (3 lots/acre, 2.5 PE/unit, 30% open space)	190	21	6.29%	333
Non-Residential Open Area	-	117	34.78%	1,050
Total PE Growth	**783**	**569**	**100.00%**	**3,214**

Figure 2-2: Current Land Use



2.3.2 2030 Population Projections

The 2030 PE projections were calculated similarly to the 2025 projection. The City has identified several locations as "Preliminary Platted Lots" which are expected to develop in the 15 years following the 2025 benchmark (2025-2040). The City expects to build out a total of 2,165 lots for single-family residential homes, 288 two-family lots, and 152 multi-family lots. The same factors used previously were multiplied by the designated residential lots to obtain a total residential PE growth of 7,892 in the 2025-2040 period.

In addition to the "Preliminary Platted Lots", the remaining 2/3 of non-residential open areas (as previously discussed) are predicted to build out consistently between 2025 and 2040, equating to an additional 2,100 PE. The total residential and non-residential growth rate from 2025 to 2040 was calculated as 2.2%, and results in a total PE growth of 9,992, and are illustrated in Table 2-6 below.

Table 2-6: Preliminary Platted PE Growth (2025-2040)

Land Use	Lots	Area (Acres)	Percent	PE
Single-Family Residential (3 lots/acre, 3.5 PE/unit, 10% open space)	2,165	722	65.51%	6,820
Two-Family Residential (3 lots/acre, 3.5 PE/unit, 20% open space)	288	96	8.71%	806
Multi-Family Residential (3 lots/acre, 2.5 PE/unit, 40% open space)	152	51	4.60%	266
Non-Residential Open Area	-	233	21.18%	2,100
Total	**2,605**	**1,218**	**100.00%**	**9,992**

In order to delineate a population projection for 2030, a linear interpolation was performed. Every five years, the City can expect to grow 33% of the total 9,992 PE, or about 3,331 PE. Therefore, by adding 33% of the estimate to the 2025 PE, the City obtains a 2030 population estimate, shown in the table below. The expected population equivalent in 2030 is 33,241 PE.

$$\frac{9{,}992\ PE}{15\ Years} = 666\frac{PE}{Year} \qquad 666\frac{PE}{Year} \times 5\ Years = 3{,}331\ PE$$

	2020 (Current)	2025 (5-Year)	2030 (10-Year)
Current P.E.	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544
Total P.E.	**26,697**	**29,911**	**33,241**

2.3.3 2040 Population Projections

The 2040 population projections are a continuation of the 2030 calculation. As previously stated, the City has identified several locations throughout town as “Preliminary Platted Lots”, as well as the remaining open areas that could be developed as non-residential.

The City expects to build out a total of 2,165 lots for residential homes, 288 two-family lots, and 152 multi-family lots by 2040 with a total residential PE growth of 7,892. In addition to the “Preliminary Platted Lots”, the remaining 2/3 of non-residential open areas (as previously discussed) are predicted to be built out by 2040, equating to an additional 2,100 PE. This equates to an addition growth if 9,992 PE from 2025 to 2040. The table below identifies the population equivalent for 2040, estimated at 39,903 PE.

	2020 (Current)	2025 (5-Year)	2030 (10-Year)	2040 (20-Year)
Current P.E.	26,697	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544	13,206
Total P.E.	**26,697**	**29,911**	**33,241**	**39,903**

2.3.3 Build-Out Population Projection

In addition to the 20-year planning PE, a Build-Out population projection was calculated based on the City’s Future Land Use Plan. Build-Out population will occur when all available lots have been developed within their existing zoning designation.

Table 2-7 on the following page outlines the variety of proposed land uses that are outlined in the City’s 2014 Comprehensive Plan. According to this Plan, the City’s residential and non-residential land use will nearly double in size and almost half of the new land will be devoted to parks, open space, and green buffers. These areas will not contribute a significant increase to the projected PE growth. However, the future population projection calculation is highly dependent on the new residential, commercial, and industrial areas.

About 30% of the proposed land will go to residential development according to the Plan. These areas were split into three categories: rural, neighborhood, and multi-family. The rural residential areas are anticipated to be exclusively on well/septic and will not require City water service. Like the previous calculations, neighborhood residential areas will have three lots per acre, 3.5 residents per home, and 20% of the area will be dedicated to open space. Multi-family residential areas were multiplied by 9.0 units per acre, 2.5 PE/unit, and 20% open space based on feedback from the City.

Table 2-7 on the following page represents these estimated values.

Commercial development makes up about 4.85% of the proposed land use. The PE growth from these areas were calculated from the current commercial land use and water billing data. The total commercial water billing was divided by the current total commercial acreage (described in the Comprehensive Plan). The current commercial areas are using approximately 475 GPD/acre. The water billed per PE for the City was estimated at 52.6 GPD/PE, and therefore the existing commercial PE per acre can be calculated to be 9.0 PE/Acre. It is anticipated that all future commercial developments will reflect the same water usage.

A similar process was utilized to evaluate Mixed Use, Industrial, and Office locations. The mixed-use PE contribution was calculated by using the City's current Land Use Map. A small area that contained a variety of businesses was calculated and divided by the water usage of those developments. This equated to about 460 GPD/acre and approximately 9 PE/acre. It is anticipated that all future commercial developments will reflect the same water usage. The sample that was used for the Mixed Use analysis was representative of several other land use types, and therefore the same value was also used for office, research and light industrial land uses.

Based on this identified potential growth, the build-out population projection for the City of Sycamore is an additional 21,571 PE. Although this PE has been identified as potential, it is not anticipated that it will occur within the next 20 years, or within the planning period of this report. It is recommended that this additional PE be reviewed and reevaluated at the point that the comprehensive plan is updated, as well as when the Water Master Plan is updated. Therefore, future water demands should not be based on this conservative estimate.

Table 2-7: Ultimate Build-Out PE Growth (Beyond 2040)

Land Use	Area in Acres	Percent	PE
Rural Residential	369	7.22%	0
Neighborhood Residential (3 lots/acre, 3.5 PE/unit, 0.2 open space)	575	11.25%	4,830
Multi-Family Residential (9 lots/acre, 2.5 PE/unit, 0.2 open space)	282	5.52%	4,442
Park/Open Space/Green Buffer	2,545	49.80%	0
Commercial	248	4.85%	2,480
Mixed Use	230	4.50%	2,070
Industrial	314	6.14%	2,826
Office, Research, Light Industrial	547	10.70%	4,923
Total	**5,110**	**100.00%**	**21,571**

2.3.4 Future Population Projection Summary

The future population equivalents were established by reviewing the City's detailed water billing records, approved development plans, plat tracking spreadsheets, as well as the City's Comprehensive Plan and Future Land Use Plan. Analysis of the projected land use was the basis for developing future population projections. These growth estimates are summarized below in Table 2-8 below.

Table 2-8: Future Population Projection Summary

	2020 (Current)	2025 (5-Year)	2030 (10-Year)	2040 (20-Year)	Ultimate Build-Out
Current P.E.	26,697	26,697	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544	13,206	34,776
Total P.E.	**26,697**	**29,911**	**33,241**	**39,903**	**61,473**

2.4 Capacity Requirements

As discussed in Section 1, the average daily demand and maximum day demand are defined using historic information based on the City's billing and pumpage data throughout each year. The average daily usage and maximum day usage are the criteria used by the Illinois EPA to evaluate the water systems production needs. In accordance with Title 35, Subtitle F, Part 654.202, the Illinois EPA requires the public water supply to have enough capacity to meet the average daily usage with the largest producing well out service and meet the maximum day usage with all of the wells in production. These criteria are the minimum requirements, and communities often plan for more conservative circumstances.

Systems with multiple wells are typically designed to meet the maximum daily demand with the largest well out of production. This design allows the municipality to meet the needs of the residents and businesses while performing routine maintenance on the wells. Without this redundancy, the work must be performed in off-peak periods, which restricts and increases the cost of the maintenance activities.

2.4.1 Historic Water System Demands

In order to determine the adequacy of the existing supply and distribution system, historical peak day and month consumption data was reviewed. The 10-year average daily water usage was calculated to be 1.82 MGD. The variation between water supplied and water sold is attributed to the various forms of water loss. Table 2-9 illustrates the highest two days of pumpage for each of the past 10 years. The numbers shown reflect the maximum amount of water supplied by the City, not the water billed to customers.

Average	MGD
1-Year	1.93
5-Year	1.86
10-Year	1.82

Table 2-9: Historic Water System Maximum Day Demands

Year	1st Largest (MG)	2nd Largest (MG)
2007	3.09	2.97
2008	2.78	2.48
2009	2.96	2.96
2010	2.60	2.58
2011	2.79	2.64
2012	3.14	3.06
2013	3.23	3.23
2014	2.78	2.47
2015	2.71	2.49
2016	3.09	2.90
2017	3.84	3.46
2018	2.95	2.94

The maximum day demand (MDD) over the previous 10-year period was 3.84 MGD, which occurred on September 16th, 2017. The second highest recorded rate was 3.46 MGD and occurred on June 10th of the same year. The third highest consumption occurred in 2013 with a value of 3.23 MGD. To further analyze the historical water usage, maximum day peaking factors (PF) were calculated. These factors are the ratio of the maximum day demand observed over a certain time span, compared to the average daily usage during the same time period.

Peaking Factor (Based on 3.84 MGD MDD)	
5-Year	2.07
10-Year	2.11

The ultimate peaking factor is calculated as the ratio of the maximum day to either the 5-year or 10-year daily average usage. This provides a more conservative approach to planning and is used in hydraulic modeling. As seen in the table above, this corresponded to peaking factors of 2.07 and 2.11, respectively.

A peaking factor of 1.8-2.2 is considered typical and is highly dependent on the types of commercial and industrial users that a community has. The peaks observed by the City appear to be within reason, and therefore don't create any uncertainty in the data. However, due to the close values of the 5 and 10-year peaking factors, the 2.11 peaking factor will be utilized for planning and hydraulic modeling.

2.4.2 Overall System Capacity

Historically, the City has had adequate supply to serve its planning area under all circumstances. During extremely high-water usages, the City has been required to put additional wells into service to cover the peak, however at no point was the system in jeopardy of not meeting demands from a supply standpoint. This means that the wells currently in operation are anticipated to have sufficient capacity to meet existing demands, but that downstream components may limit the ability of the system to handle extreme demands. The distribution system's capacity to convey the required flows is reviewed and discussed in Sections 3.

Future Water Demands

Water usage has generally decreased over the past decade as a result of higher efficiency water fixtures, watering restrictions, and a public effort to reduce unnecessary water consumption. While the City should not depend on a decrease in demand, this trend is seen in most communities and represents a national shift rather than a local anomaly. For the City of Sycamore, it is unlikely that the water demands will vary significantly unless a substantial drought is experienced in the area. The City has experienced relatively consistent demands, and there is no reason to expect that this would change.

Section 2.3 of this Plan identified population growth projections for 5-year, 10-year, and 20-year planning periods. Associated increases in water demand for each of these phases was developed by extrapolating current water usage per PE. For example, at the calculated 69.8 gallons per PE/day of water pumped, the 2025 population estimate of 29,911 equates to a total average daily demand of approximately 2.1 MGD. The table below includes the extrapolated demands based on population projects.

Table 2-10: Future Water Demands

	2020 (Current)	2025 (5-Year)	2030 (10-Year)	2040 (20-Year)	Ultimate Build-Out
Current P.E.	26,697	26,697	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544	13,206	34,776
Total P.E.	26,697	29,911	33,241	39,903	61,473
ADD (MGD)	1.9	2.1	2.3	2.8	4.3
MDD (MGD)	3.93	4.41	4.90	5.88	8.83
Firm Capacity Required	**4.0**	**4.5**	**5.0**	**6.0**	**9.0**

The firm capacity that is recommended is the minimum amount of well production available with the largest well out of service (Well #9). With a current maximum day demand of 3.93, based on historical data, the recommended current firm capacity is 4.0 MGD. The tables above illustrate the maximum day demand increasing proportionally to the average demand based on population growth. While the maximum day demand may not follow a linear relationship, this provides a conservative estimate for water supply planning.

The City has a total well design capacity of 8.6 MGD and a firm capacity of 6.7 MGD. However, due to the age and condition of the wells, the production capacity is currently limited to a firm capacity of approximately 4.9 MGD. This assumes Well #7 is offline indefinitely due to radium levels, and Well #9 is removed from service as the largest remaining production well.

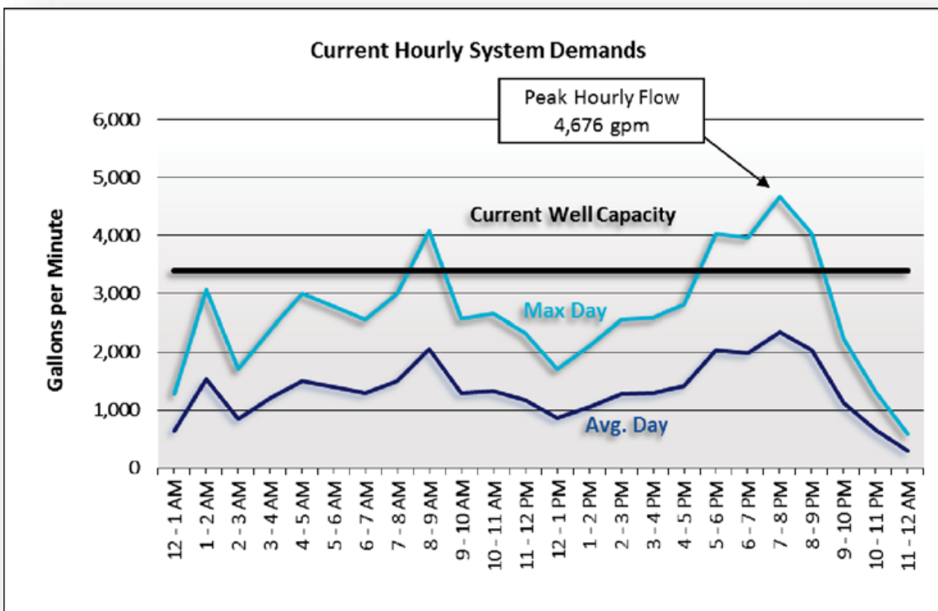
The City has capacity to provide the average daily demand throughout the four planning horizons. However, the maximum day demand for 2030 (5.0 MGD) exceeds what is currently available. Therefore, Well #7 would need to be back online at that time. Once all wells are operational, the City will be able to meet both estimated ADD and MDD through the 20-year planning period.

Ability to Meet Current Peak Hourly Demands

The maximum day usage was identified as 3.84 MGD in 2017. To determine the system's ability to meet the maximum day demand, the diurnal peak of the maximum day is reviewed. The diurnal curve represents the water usage across a typical 24-hour day. For example, water usage at 2:00 am is minimal, and is represented with a 0.5 multiplier of the day's total usage. Similarly, a community such as Sycamore with a commercial base may see a maximum hour usage at 9:00 am when both residential and commercial operations are using water, and a multiplier of 1.5 – 2.0 may be observed.

The Peak Hourly Flow is defined as the maximum hourly flow, often occurring on the maximum day. To evaluate the system's ability to meet this flow, trending of the actual diurnal flows seen by the City was performed. These diurnal factors were then applied to the average daily demand and maximum day demand to create the chart below. The peak hourly flow would be anticipated to occur at 7:00 PM on the maximum day with an hourly flow rate of 4,676 gpm.

Figure 2-3: Current Peak Hourly System Demands



The 'current well capacity' line in the graph above represents the 4.90 MGD (3,403 gpm) well production firm capacity. This firm capacity includes Well 9, the largest capacity well, out of service to meet the required redundancy. Well 7 is also not in service, as this well is currently offline. The hourly flow exceeds this production capacity several times throughout the day, which would require flow into the system from the elevated storage tanks. The total supplemental volume required on this maximum day is approximately 185,995 gallons. Currently, the City has this storage capacity available, and the system will be able to adequately refill the water towers during off-peak hours. However, the system may not be able to sufficiently meet peak demands in the future as demand increases with growth. This issue and potential solutions are evaluated in Section 5 and Section 6 of this report.

Ability to Meet Future Peak Hourly Demands

Utilizing the 2040 Maximum Day Demand of 5.88 MGD, the ability of the system to meet the peak hourly demand through the planning horizon was evaluated. As shown in Figure 2-7 below, the peak hourly flow at this future maximum day condition is approximately 7,000 gpm. Assuming the system remains at the same 3,403 gpm capacity (that is, Well #7 has not been returned to service), this scenario would require excess of 1.1 MG to be supplied by storage. While the City does maintain 2.25 MG of elevated storage, typically only one-third of this volume is allocated to operational storage. Further, the net deficit of water produced vs. consumed across this day is 860,000, meaning that the towers will not refill in off-peak periods. A second consecutive high flow day would further stress the system.

Figure 2-4: Future Peak Hourly System Demands (Well #7 Offline)

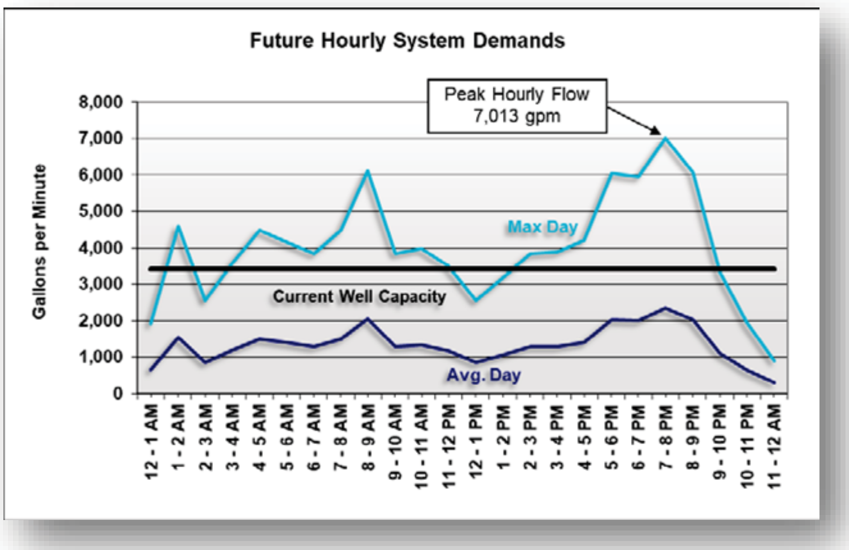
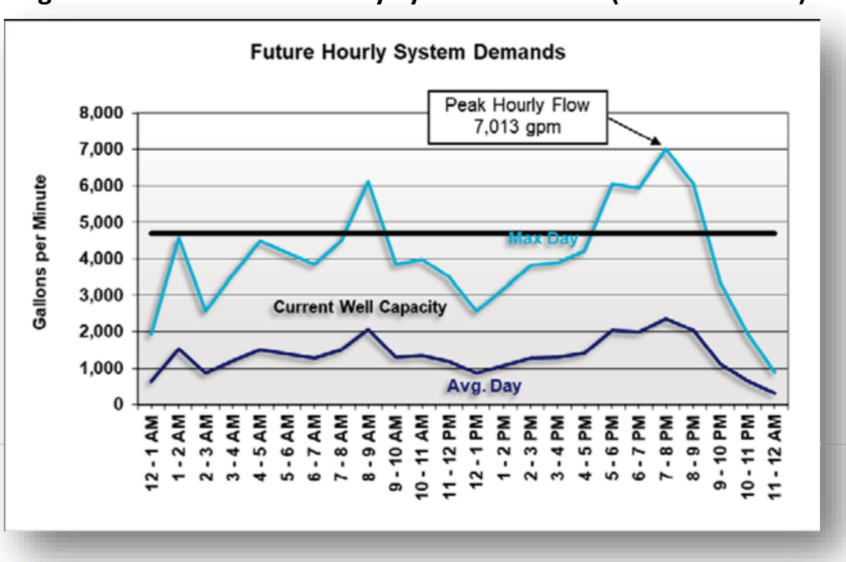


Figure 2-8 below represents the future peak hourly demands with Well #7 brought back online. This scenario still requires the use of operational storage from the elevated tanks, however only approximately 375,000 gallons would be required, and the system would recover during off-peak periods. This will be further reviewed within Sections 5 and 6, however the population growth projections reviewed within this section indicate that returning Well #7 to service would be recommended.

Figure 2-5: Future Peak Hourly System Demands (Well #7 Online)



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SECTION 3

EXISTING DISTRIBUTION SYSTEM EVALUATION

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3. EXISTING DISTRIBUTION SYSTEM EVALUATION

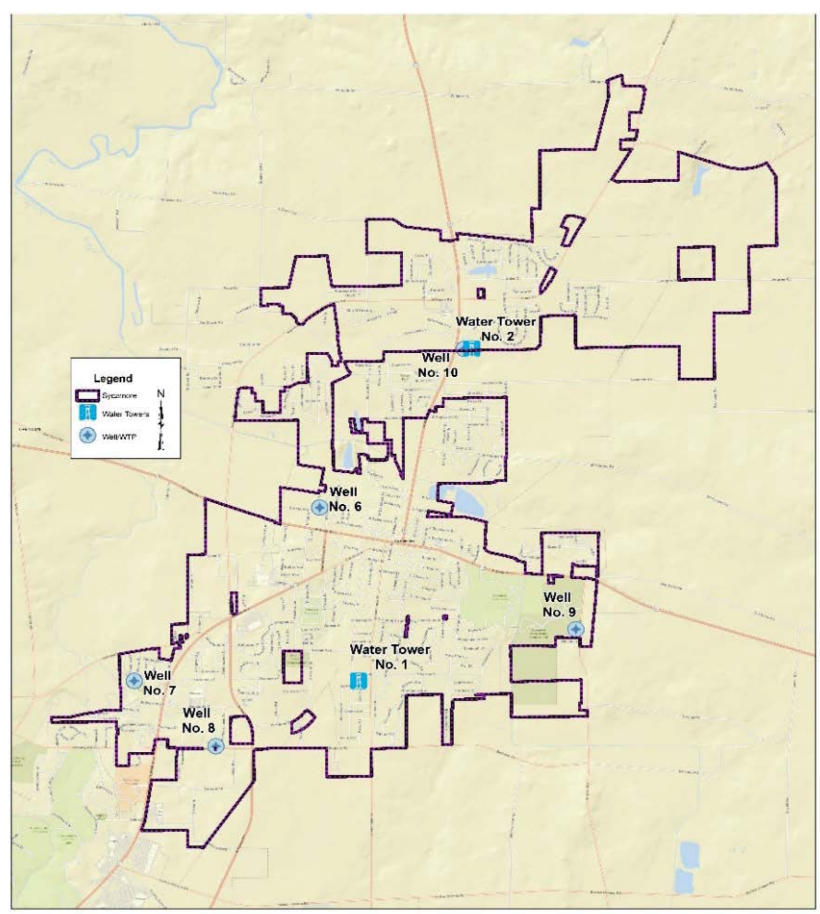
This section describes the current conditions, limitations, and maintenance issues related to the City's water distribution system. A hydraulic analysis of the City's distribution system was performed in order to identify restrictions within the existing distribution system and develop recommendations for future improvement projects. Alternatives for improvements will be reviewed in Section 4.

3.1 GENERAL BACKGROUND

The City provides an average of approximately 1.88 MGD to its residential, commercial, and industrial customers. The distribution system consists of a single pressure zone and experiences minimal elevation change throughout the system. Water is supplied to the City via five wells, Wells # 6, 7, 8, 9, and 10. However, at this time, Well #7 has been removed from service due to radium level concerns. The City of Sycamore owns and maintains roughly 115 miles of water main of varying sizes, ages, and conditions throughout the system and approximately 1,465 fire hydrants.

Figure 3-1 provides a basic layout of the City's service area, as well as identifies the locations of the City's two elevated storage towers, four active wells (#6, 8 ,9, 10), and one inactive well (#7). The oldest parts of the distribution system are generally in the center of the City, near Well #6 and the downtown area. The northern and southern ends of town have been subject to recent development over the last two decades and are constructed of newer materials/larger main.

Figure 3-1: Water System Zone and Structure Map



As a whole, the City of Sycamore is only about 50% built-out at this time, with a large amount of development that can occur within the next 20 years. Development will consist of new residential homes, commercial and industrial buildings, as well as redevelopment or vertical development.

The City of Sycamore's Water Division has adopted a water main maintenance and flushing programs to sustain the level of service provided to the community. The City of Sycamore has made an effort to perform routine maintenance for the wells and treatment facilities to keep them in good operational order.

3.2 DISTRIBUTION SYSTEM EVALUATION

As stated previously, the City's water distribution system includes roughly 115 miles of water main, and 1,465 fire hydrants. For planning purposes, the value of water main and other system components can be estimated to project a total distribution system asset value. As shown in the table below, the existing City of Sycamore water distribution system infrastructure value is estimated at approximately $90.7 million including system valves and hydrants, prior to depreciation. The total replacement cost for the water system, estimated at approximately $135.95 million, was calculated by adding 50% the unit asset value to account for surface restoration, contingencies, project management, design and administration.

Table 3-1: Distribution System Asset Value & Replacement Cost

System Asset	Quantity	Unit Value	Total Asset Value ($ Million)	Total Replacement Cost ($ Million)
≤4-Inch Main	50,478	$120	$6.06	$9.09
6-Inch Main	162,500	$120	$19.50	$29.25
8-Inch Main	135,565	$120	$16.27	$24.41
10-Inch Main	259,286	$130	$33.71	$50.57
12-Inch Main	1,257	$140	$0.18	$0.26
14-Inch Main	279	$150	$0.04	$0.06
16-Inch Main	97	$175	$0.02	$0.03
System Valves	1,513	$4,500	$6.81	$10.22
Hydrants	1,465	$5,500	$8.06	$12.09
Total:	-	-	**$90.65**	**$135.95**

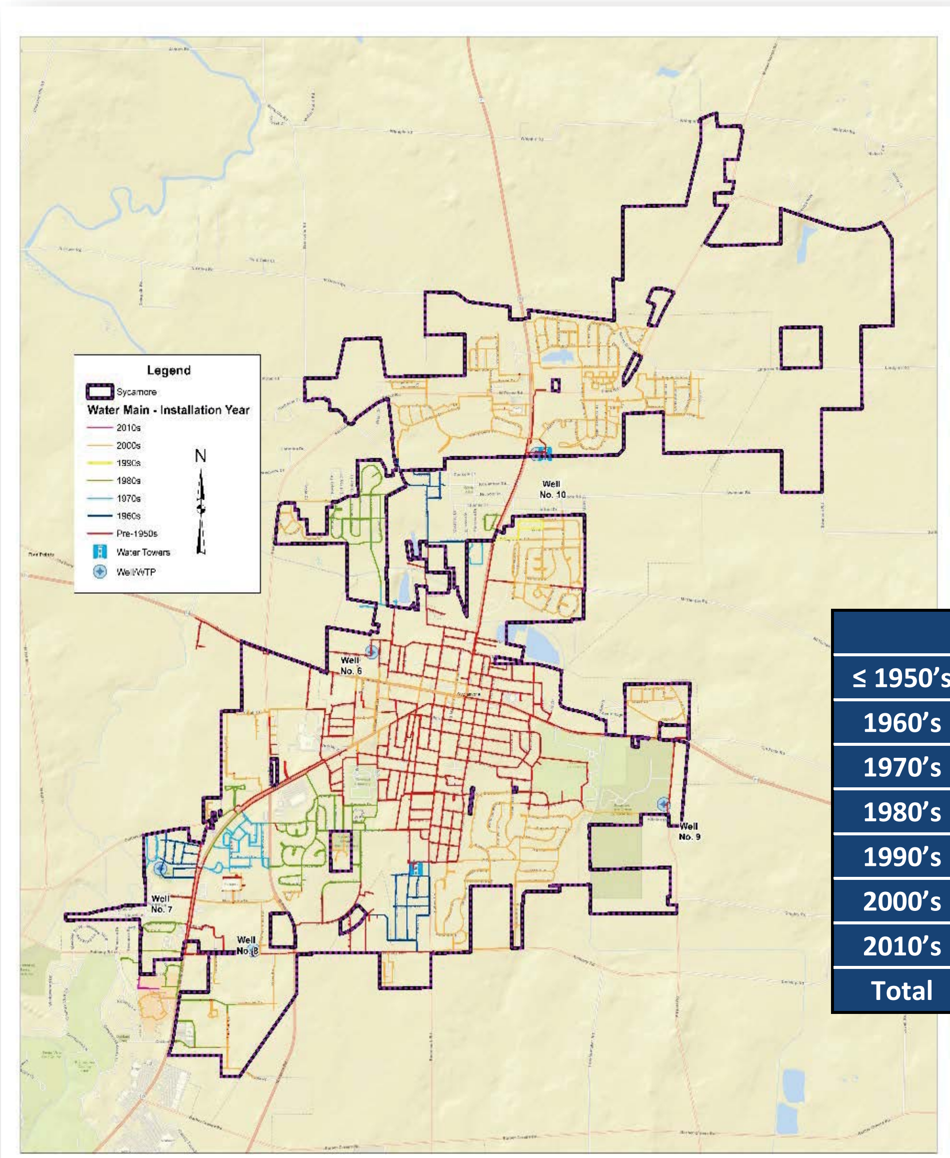
Based on straight-line depreciation and a 75-year service life for this infrastructure, an average of $1.81 Million would need to be budgeted annually in order to replace all of the existing distribution system by the year 2095. This budgetary amount would need to be increased by the Construction Cost Index (CCI) each year, which has averaged 2.92% over the past decade. This annual reinvestment should be prioritized based on a number of criteria including available fire flow, main age, break frequency, soil conditions, and the presence of lead services, among others. These criteria will be discussed within this section, with recommended alternatives for rehabilitation and upgrade of the distribution system in Section 4.

3.2.1 Water Main Age

Shown below is the water main installation date for the City of Sycamore. Water main in red represents pipe installed in the 1950's or earlier, dark blue within the1960's, light blue 1970's, green 1980's, yellow 1990's, orange 2000's, and magenta is 2010's. The table below identifies the breakdown of the water main age by decade within the City. As shown in the table, the largest percentages of the water main system were either installed in the "during or before the 1950's" (38%) or "during the 2000's" (41%) eras.

According to the AWWA's "Buried No Longer" study performed in 2012, the lifespan of water main depends primarily on material and installation region. For the Midwest region, PVC main can be expected to last approximately 55 years, ductile iron between 50-100 years, and cast iron 85-120 years (in the absence of pressure and operational issues). From a replacement standpoint, water main is anticipated to last up to 75 years if properly installed. More than 45% of the City's distribution system is 50 years or older. Therefore, during capital planning, the City should include age as a metric for prioritization.

Figure 3-2: Water Main Installation Year



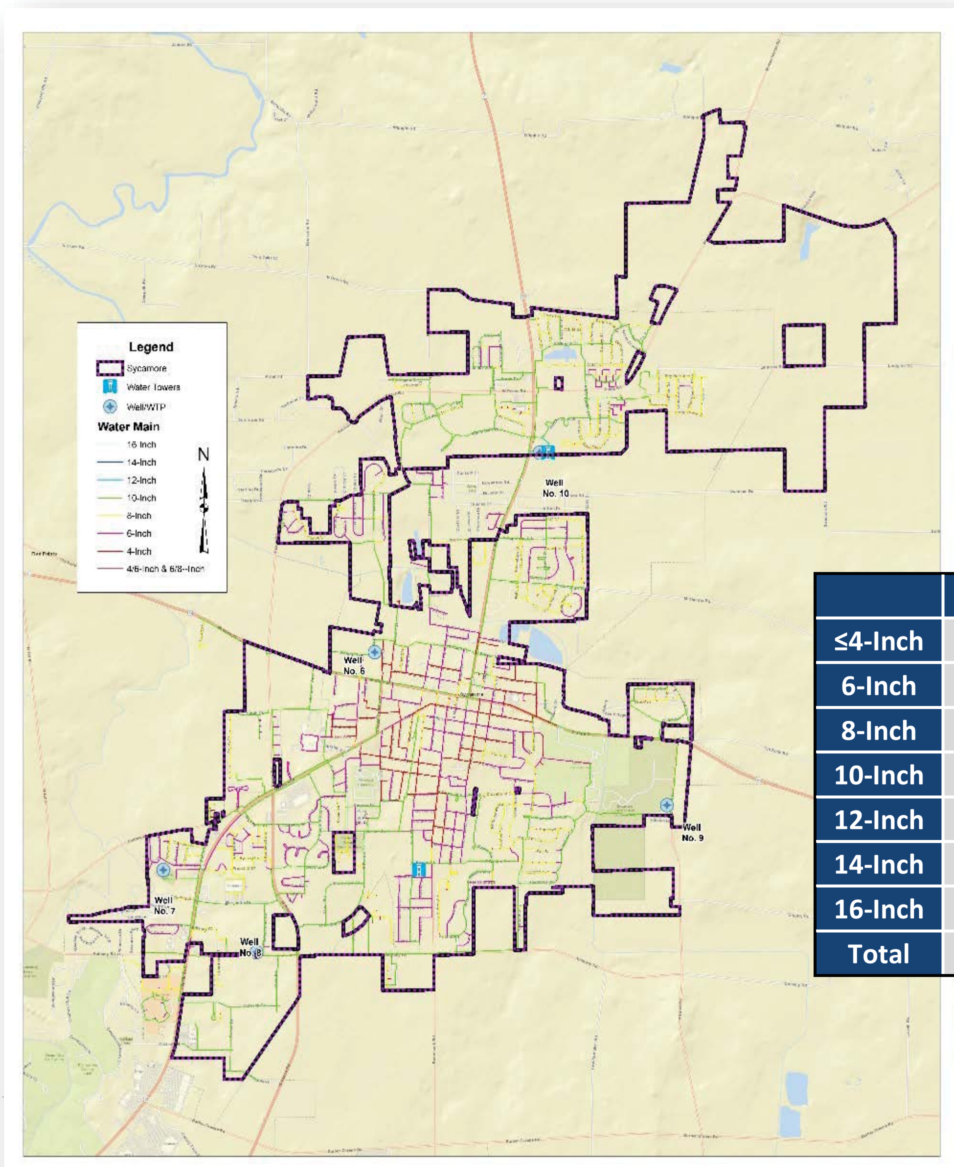
	Feet	Miles	%
≤ 1950's	231,590	43.86	38.00%
1960's	30,918	5.86	5.07%
1970's	20,653	3.91	3.40%
1980's	69,186	13.1	11.35%
1990's	3,532	0.67	0.58%
2000's	251,714	47.67	41.30%
2010's	1,869	0.35	0.30%
Total	**609,462**	**115.4**	**100.00%**

3.2.2 Water Main Size

Shown below is the water main sizing within the City of Sycamore. Water main in red represents 4-inch, pink 6-inch, yellow 8-inch, green 10-inch, teal 12-inch, dark blue 14-inch, and light blue 16-inch. The table below identifies the breakdown of the water main sizing within the City. As shown in the table, the majority of the water main in the community is 10-inch and 6-inch, with downtown areas generally smaller diameter, the majority being 4 and 6-inch.

Current accepted practice is installation only of 8-inch and larger diameter water main. This includes both residential and commercial applications. Historically, mains as small as 4-inch were installed in residential areas. Increasing fire flow requirements have led to a need for larger main. About 8% of the City's system is comprised of 4-inch, isolated primarily in the downtown residential area. Industry standard for many years was to utilize 6-inch for residential areas, and as such makes up more than 26% of the City's system. While this provides adequate fire protection in some areas, it may be insufficient in neighborhoods with large homes requiring commercial-grade fire protection or older homes more susceptible to fire damage.

Figure 3-3: Water Main Size



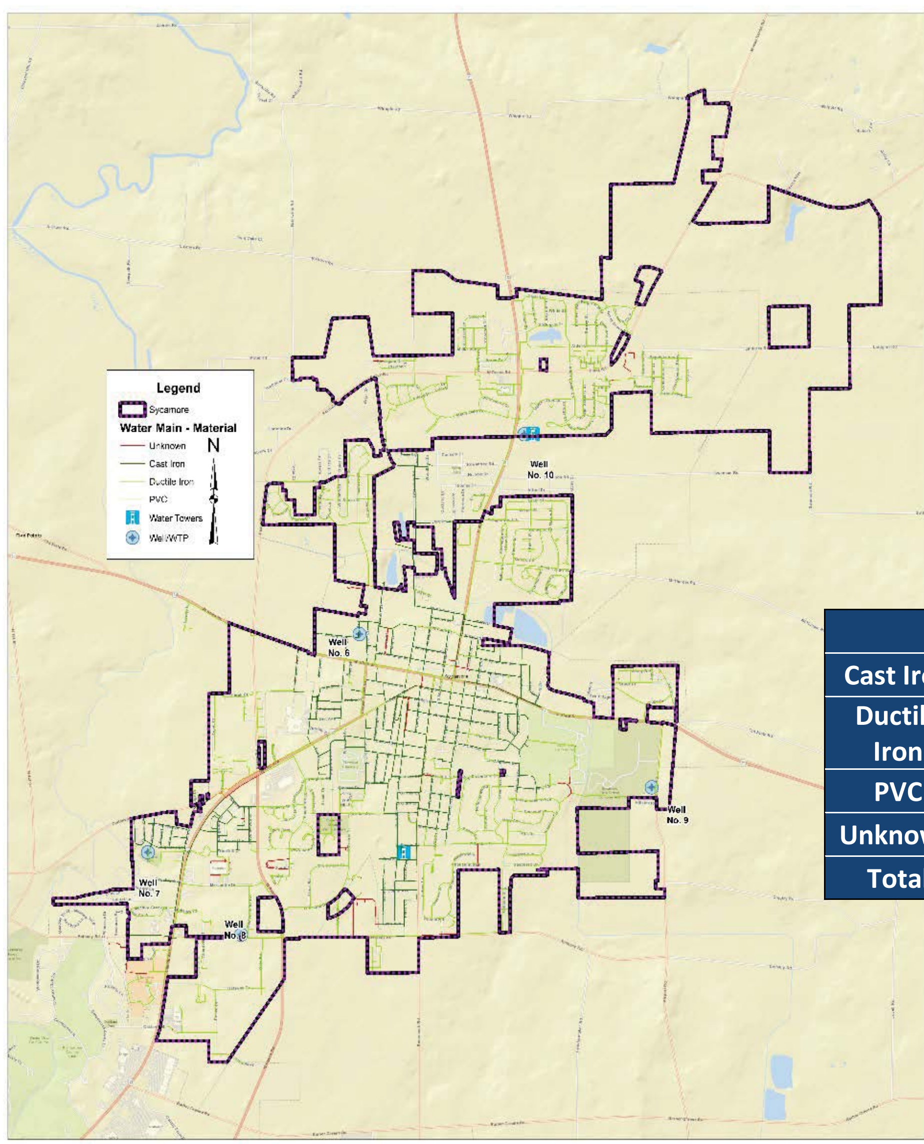
	Feet	Miles	%
≤4-Inch	50,478	9.56	8.30%
6-Inch	162,500	30.78	26.70%
8-Inch	135,565	25.68	22.20%
10-Inch	259,286	49.11	42.50%
12-Inch	1,257	0.24	2.10%
14-Inch	279	0.05	<0.1%
16-Inch	97	0.02	<0.1%
Total	**609,462**	**115.4**	**100.00%**

3.2.3 Water Main Material

Shown below is the water main construction material for the City of Sycamore's distribution system. Water main in orange represents PVC, light green ductile iron, and dark green cast iron. The table below identifies the breakdown of the water main material. As shown in the table, the majority of the water main (98%) is either cast or ductile iron. The remaining 2% of the system is either PVC or unknown.

Corresponding to the era in which the City's distribution system was constructed, much of the pipe is either cast iron or ductile iron. According to the AWWA, cast iron was predominantly used from the early 1900s through the 1950s. In the 1960s ductile iron and pre-stressed concrete pipe became the most commonly used materials. Polyvinyl chloride was commercially available in the late 1940s but did not become widely used until the mid-1970s. The City's distribution system follows this historic trend, with the first installations in the service area in the early 1900s being cast iron, and the remaining consisting of ductile iron, with a recent transition to PVC. With the exception of portions of unincorporated areas, the City largely ceased installation of cast iron and has migrated to ductile iron and PVC. These materials are less brittle and are more widely accepted as an industry standard at present when compared to cast iron.

Figure 3-4: Water Main Material



	Feet	Miles	%
Cast Iron	202,874	38.4	33.29%
Ductile Iron	393,471	74.5	64.56%
PVC	3,006	0.6	0.49%
Unknown	10,112	1.9	1.66%
Total	**609,462**	**115.4**	**100.00%**

3.2.4 Water Main Breaks

The City of Sycamore's water distribution system has been in operation since the early 1900's, and the rate of deterioration of water mains exceeds the rate of replacement. The majority of rehabilitation work performed within the system has been in response to leakage or water main breaks.

The system has been identified as relatively fragile due to the age of the water main piping and the materials that much of it was constructed using (e.g. cast iron). The City should work to replace the older and deteriorated sections of water main with piping manufactured of non-corrosive materials such as PVC, HDPE, or wrapped ductile iron, as the majority of the City contains corrosive soils.

The following map identifies the City's water distribution system with main break locations throughout the City limits. These failures could be a result of a combination of several factors including insufficient construction materials or techniques or "hot" soils which can be the cause of increased pipe deteriorating. In addition, many of the breaks are localized within the downtown area, where the water main has likely reached the end of its anticipated service life.

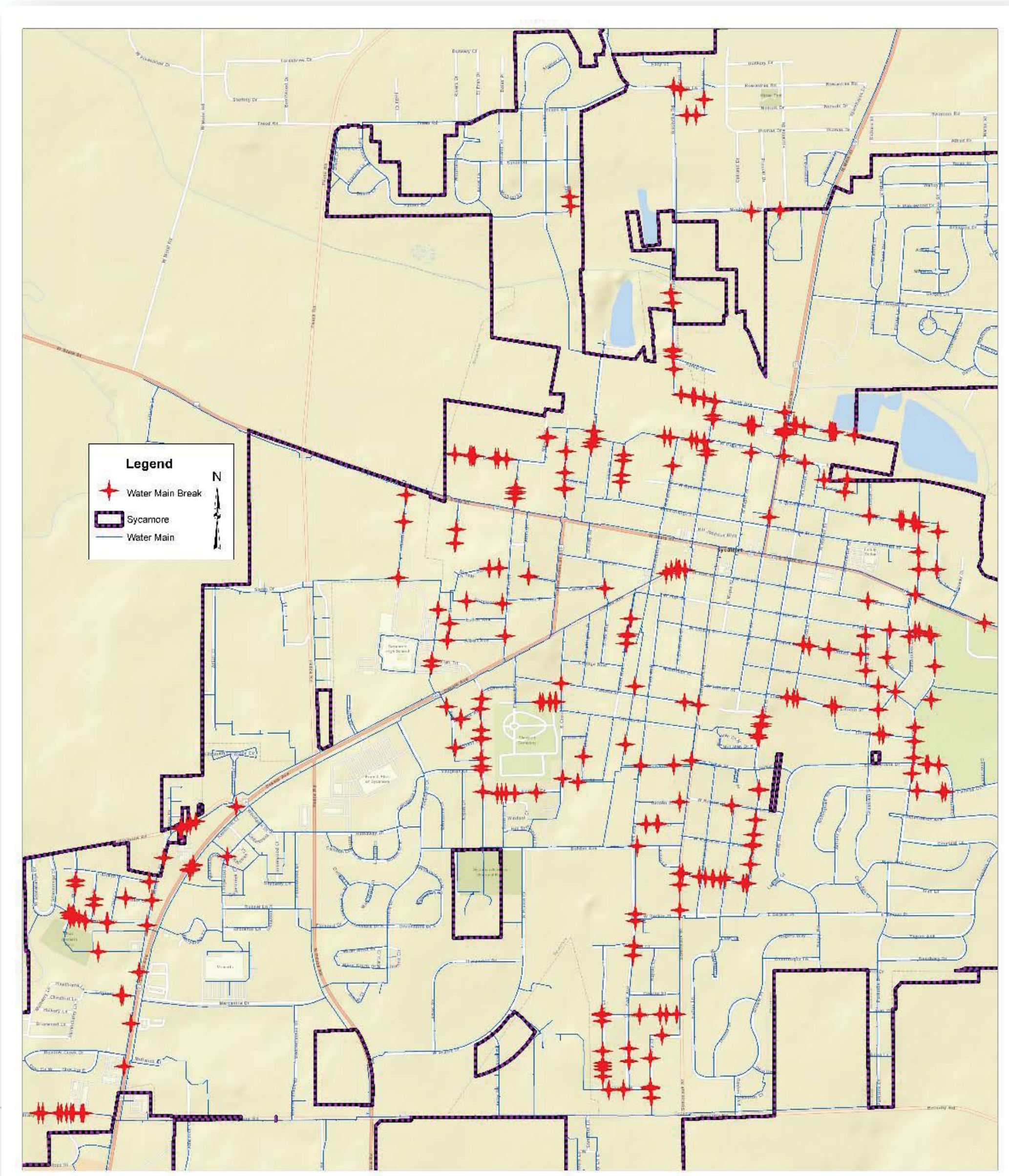


Figure 3-5: Water Main Break History

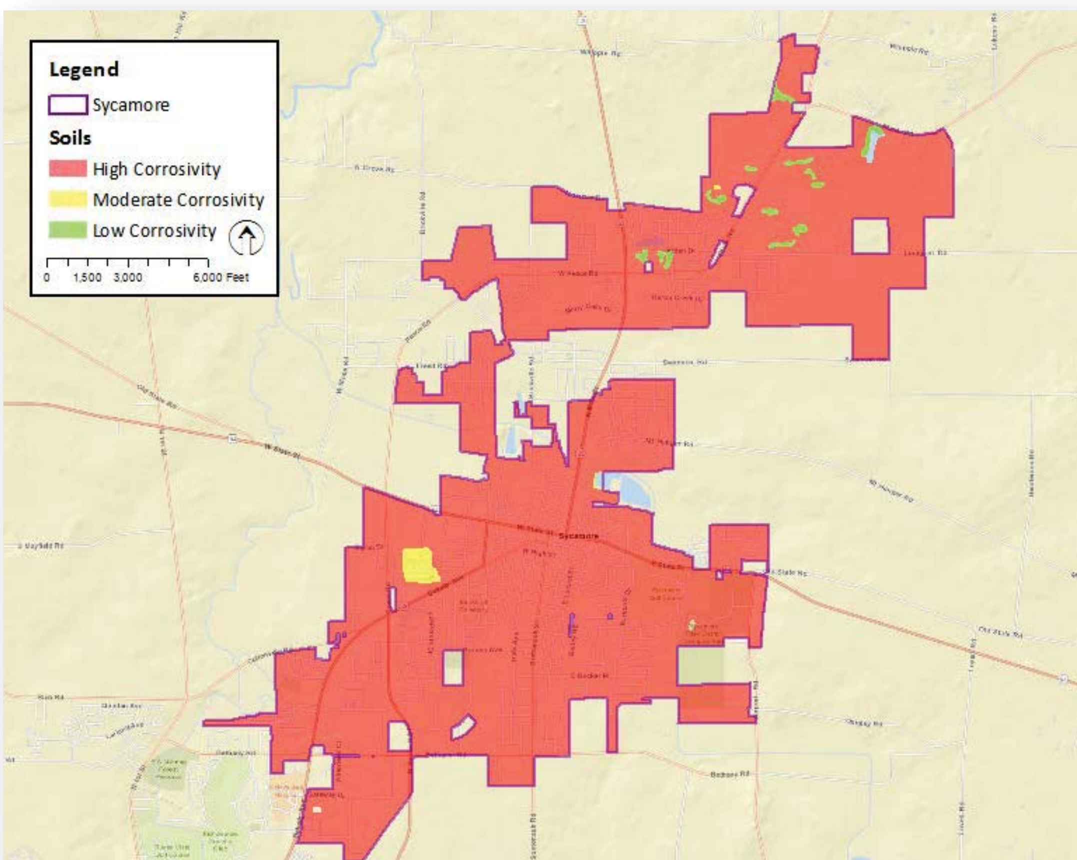
3.2.5 Corrosive Soils

The City of Sycamore has experienced a significant number of water main breaks throughout the distribution system. One of the affecting factors of water main breaks could be attributed to corrosive soils. Over time, as water main is exposed to corrosive soils, the pipe and fittings begin to deteriorate both internally and externally, shown in the images to the right. As a result of this decay the service life of the water main is significantly reduced, much of this is due to the reduced wall thickness of the water main itself.

The graphic below illustrates the corrosivity levels of soils within the City, as mapped by the US Department of Agriculture (USDA). Green represents low soil corrosivity, yellow moderate, and red high. Unfortunately, approximately 98% of the City of Sycamore's service area falls within the 'high' corrosivity soil areas. This is entirely within the expected range for towns in northeastern Illinois, where highly corrosive soils are widespread.

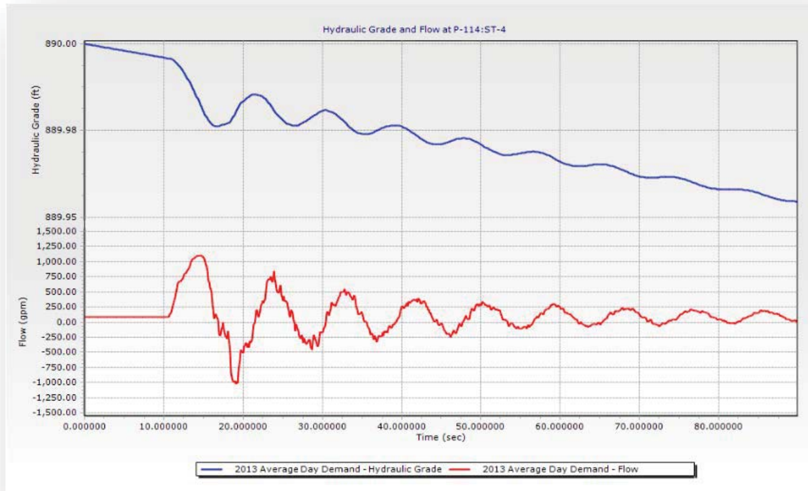
The City should work to replace the older and deteriorated sections of water main pipe with piping manufactured of non-corrosive materials such as PVC. If ductile-iron pipe is going to be utilized, it should be wrapped in polyethylene given the damage that the aggressive soils in the area have caused to the existing iron-based piping.

Figure 3-6: Corrosive Soil Locations



3.2.6 Water Hammer

Water hammer can be a nuisance to customers, as well as cause serious damage to the water distribution system such as water main breaks or pump damage. Water hammer results during transient conditions in the piping system. The longitudinal transient wave that moves throughout the system causes pressures to oscillate repeatedly between alternating peaks and valleys while the transient conditions persists and then gradually subsides. The duration and magnitude of the transient condition are dependent on the dynamics, geometry, and operation of the system.



Severe transient conditions, such as those that can occur when a pump is shut down rapidly following a loss of power, can pull a vacuum during the drop-in pressure that occurs as the transient pressure wave moves away from the pump, only to be followed by a rapid climb to pressures far in excess of normal operating pressures. The arrival of the return longitudinal wave is marked by the water hammer sound as the wave rebounds and reverses.

In many communities, transients have caused unwanted discharge of RPZ backflow preventers, and there are few operational adjustments that can be made to control the water hammer that is experienced. The transients result from the configuration of the distribution system and usually a result of areas remote from the nearest open-air water surface (water tower). This is often the case with communities that have undersized or distant elevated storage tanks.

The City has previously only experienced water hammer in areas near well site when these wells were suddenly shut off. This was most prevalent in the Electric Park neighborhood outside of Well #7, though this well is currently inactive. Small diameter water main and a lower elevation at the well may have contributed to these conditions, resulting in multiple main breaks in the area. At other well sites, installation of Variable Frequency Drives (VFDs) has remediated the effect of water hammer. Water hammer issues will need to be considered when evaluating alternatives for making Well #7 active in the future, discussed in Section 6.

3.2.7 Lead Service Survey

Lead and Copper Rule Background

In response to the 1986 amendment to the Safe Drinking Water Act, the Environmental Protection Agency (EPA) adopted the Lead and Copper Rule (LCR) in 1991. The LCR requires water suppliers to deliver water that is minimally corrosive, thereby reducing the likelihood that lead and copper will be introduced into the drinking water from the corrosion of customer lead and copper plumbing materials. Prior to the LCR inception, the previous standard was to measure lead at the entry point to the distribution system and report issue when levels exceeded 50 parts per billions (ppb). While the old system was easier to test and enforce, most of the lead and copper reaching the taps of customers was (and still is) already within the system in the form of lead solder and the lining of old piping. In accordance to the new rule, testing must be done at the tap of customers on a six (6) month, year, or triennial schedule (smaller districts with a history of low results may only need to test every 9 years).

Over the years, the LCR has seen a few adaptations. Namely, in January of 2000, municipalities were required to install the "best available corrosion control mechanisms" and to continue to observe water levels even after the implementation of corrosion control. In 2004 and 2006, revisions and minor additions to the rule were implemented, in 2007 the EPA enhanced implementation in the areas of monitoring, treatment, customer awareness, and service line replacement. And in 2016 the EPA published additional options that may further revise the rule in the future.

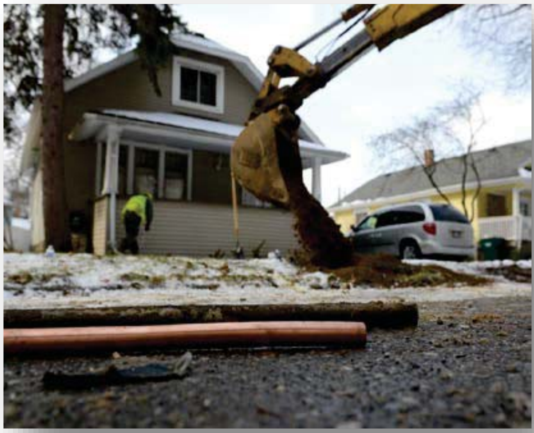
In its current state, the LCR still requires testing at the customer's tap. If 10% of the tested taps exceed a concentration of 15 ppb for lead, or copper concentrations exceed 1300 ppb further action is required to minimize corrosion. Please note, municipalities are only in violation if they report concentrations greater than those noted and do nothing to fix the issue within a predetermined period of time. These fixes may include replacement of piping, fixtures and fittings within the system, or it may be more cost effective to change the corrosivity of the water within the system to prevent pickup of the unwanted chemicals.

The City of Sycamore Lead Service Survey

The City of Sycamore has been working over the last several years to improve their water service material estimates that are reported to the IEPA. They City has leveraged its existing data, as well as the meter replacement program to continually update the service material inventory. Out of a total of 7,182 services, 1,346 sites have the service material identified, while 21 were identified as unknown but not lead, and the remaining 5,815 services were identified as unknown. Table 3-2 summarizes the service material throughout the distribution system, and as they were reported to the IEPA for 2019.

Table 3-2: Service Material

Service Material	Number of Services
Lead	111
Copper/Non-Lead Solder	1,204
Galvanized	2
Plastic	26
Cast/Ductile Iron or Transite	3
Unknown Not Lead	21
Unknown	**5,815**
Total	**7,182**



DAVE WASINGER/LANSING

Of the known service materials, 2% are estimated to be lead at this time, and 17% is copper, with the largest portion being unknown at 81%. It is recommended that the City continue to inspect, and document the water main services throughout the system. The City is currently updating their data through the meter replacement program and noting service material at the time of replacement.

Currently, the State is only requiring replacement of lead services if they are on a water main which is also being replaced. The permitting process is being utilized for enforcement at this point as well, however it is anticipated that lead service replacement requirements will continue to develop over the next 12-18 months. Cost for replacement vary greatly depending on length of service, location of City's water main, and restoration (pavement, driveway, sidewalk, etc.). It should be noted that the City is governed under "Home Rule" and the City only owns water main and doesn't own the services to the b-box or meter. Depending on the IEPA's ruling this could greatly increase or decrease the capital requirements for lead service replacement throughout the City.

Meter Replacement Program

ci.waitepark.mn.us

Currently the City has over 7,500 meters that are in service, and consist of three separate reading systems (Orion, ensus, and Trace). Many of these meters are well past their anticipated service life and are in need of replacement. In an effort to reduce non-revenue water, and improve overall service to its customers, the City implemented a meter replacement program throughout the service area beginning in 2016. The program was slated to be completed over a 4-5-year period, with approximately 2,100 meters remaining to be replaced at the time of this report. City staff has indicated that they expect this program to be completed by 2022-2023.

The new replacement meters have an expected 20-year service and battery life, and instead of being a "walk-up" manual reading, each meter sends the readings through radio frequency to a handheld or mobile device. This will reduce the overall investment of time and resources required by the City by simplifying the metering reading process. Each of the new meters are also more accurate than their predecessors, as the meter technology has advanced, and meters are now able to obtain more accurate readings for a wider range of flows. Through these improvements the City is hoping to help reduce the amount of apparent losses within the system.

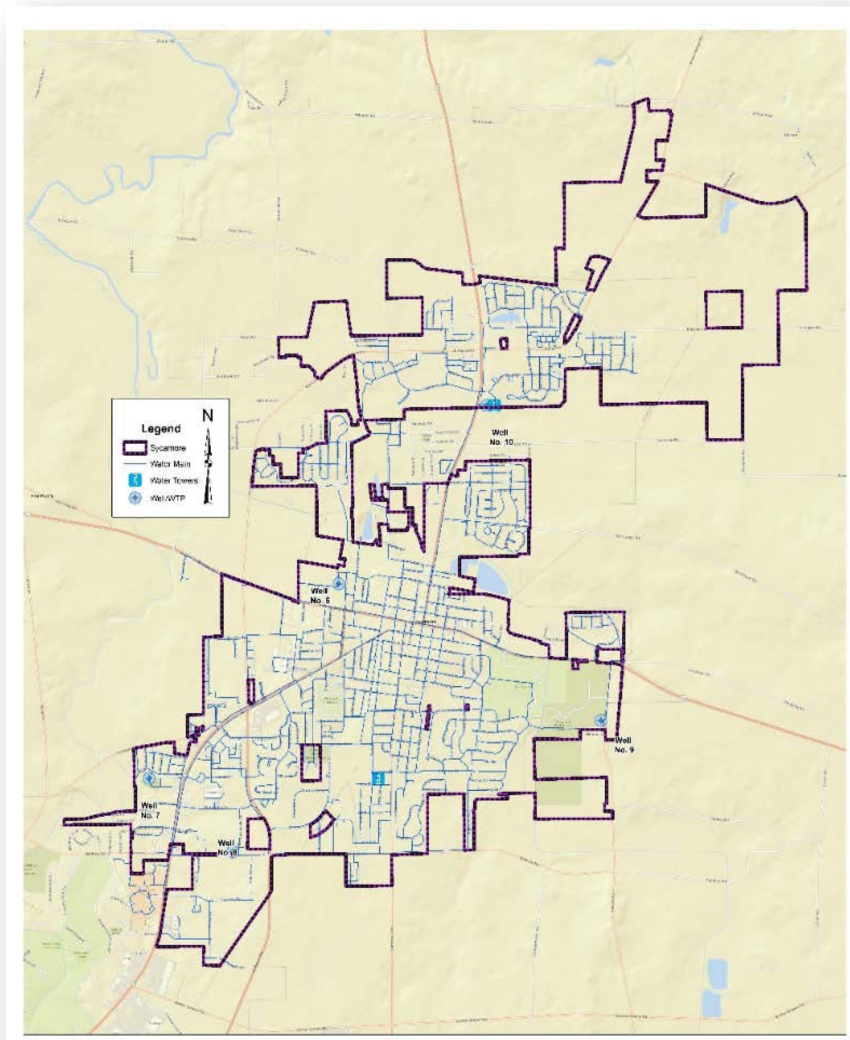
The City has elected to prioritize the replacement of the Trace system first due to the large amount of resources that it is currently tying up within the department, as well as a growing number of meters falling out of calibration due to age. The Trace system is the only system that requires a manual reading each billing period. City staff must move street to street collecting meter readings, a time-consuming process that can be phased out with improved technology.

3.3 WATER DISTRIBUTION SYSTEM MODELING

The City's WaterCAD hydraulic model was last updated to represent the distribution system in 2007. Trotter and Associates and the City have worked together to develop a hydraulic model in the upgraded WaterGEMs software using information from the City's latest GIS database. The model is a valuable tool for assessing potential capital improvement projects and system rehabilitation needs, while also evaluating the impact of potential new developments.

A water distribution model has been created for the City utilizing Bentley's WaterGEMs Connect software. The Connect software has the capability to evaluate multiple data points simultaneously and therefore reach a higher degree of calibration than previous versions. The City elected to rebuild the model from the the latest GIS database. This database was developed through careful analysis and validation of system updates since 2007 by City staff. The model was then calibrated through fire flow testing. Upon calibration of the hydraulic model, multiple scenarios and analyses were performed.

Figure 3-7: WaterCAD Water System Map



The features in the model include wells, elevated storage/towers, hydrants, valves, and the distribution system. Each feature's characteristics are simulated within the model, including pipe sizes and lengths, storage reservoir characteristics, pump performance curves and ground elevations. The purpose of the model was to analyze the existing distribution system, to identify capacity issues and to evaluate the impacts of proposed improvements. The accuracy of the current model is sufficient to evaluate existing conditions and to make future recommendations for upgrade of the City's distribution system based on future projected demands. Figure 3-7 shows the existing system as modeled in WaterCAD V8i. However, as the City performs improvements, it is recommended that the water model be updated regularly.

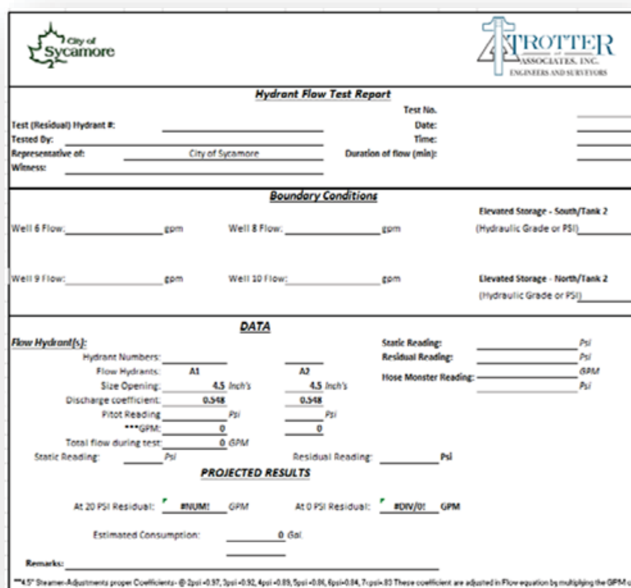
3.3.1 Water Model Assumptions and Limitations

The following assumptions were utilized to most accurately analyze the water system for the Master Plan. The available fire flows and pressures reported represent instantaneously available capacities at the water main and fire hydrants listed throughout. Assumptions were made in regard to future water usage/daily demands for the City, as necessary. Per the Joint Committee on Administrative Rules – Tile 35, Appendix B: Commonly Used Quantities of sewage flows from Miscellaneous Type Facilities was also used when existing data was not available.

3.3.2 Water Model Calibration

Once the model was updated to include modifications since the 2007 update, it was necessary to verify that the conditions of the model accurately represent the actual operations of the distribution system. To do this, the City performed multiple hydrant tests throughout the service area and the entire distribution system. Hydrant testing is critical for distribution modeling and requires a specific operating procedure. The City utilized a Hose Monster® unit during all testing. The Hose Monster allowed the City to obtain accurate and consistent results for all hydrant tests.

In addition to utilizing the Hose Monster, the City was provided a specific data sheet outlining all data to be collected during the hydrant tests. For example, the data sheet identified the test and flow hydrants, time of day, flow received, and both residual and static pressures. The City also provided information in regard to all boundary conditions during testing identifying the tower levels and Well pumps in operation/running.



City of Sycamore
TROTTER ASSOCIATES, INC. ENGINEERS AND SURVEYORS

Hydrant Flow Test Report

Test (Residual) Hydrant #: ____ Test No. ____
Tested By: ____ Date: ____
Representative of: City of Sycamore Time: ____
Witness: ____ Duration of flow (min): ____

Boundary Conditions

Well 6 Flow: ____ gpm Well 8 Flow: ____ gpm Elevated Storage - South/Tank 2 (Hydraulic Grade or PSI) ____
Well 9 Flow: ____ gpm Well 10 Flow: ____ gpm Elevated Storage - North/Tank 2 (Hydraulic Grade or PSI) ____

DATA

Flow Hydrant(s):
Hydrant Numbers: ____ ____
Flow Hydrants: A1 A2
Size Opening: 4.5 *Inch's* 4.5 *Inch's*
Discharge coefficient: 0.548 0.548
Pitot Reading ____ *Psi* ____ *Psi*
***GPM: 0 0
Total flow during test: 0 *GPM*
Static Reading: ____ *Psi* Residual Reading: ____ Psi

Static Reading: ____ *Psi*
Residual Reading: ____ *Psi*
Hose Monster Reading: ____ *GPM* ____ *Psi*

PROJECTED RESULTS

At 20 PSI Residual: #NUM! *GPM* At 0 PSI Residual: #DIV/0! GPM

Estimated Consumption: 0 *Gal.*

Remarks: ____

***4.5" Steamer-Adjustments proper Coefficients- @ 2psi =0.97, 3psi =0.92, 4psi =0.89, 5psi =0.86, 6psi=0.84, 7+psi=.83 These coefficient are adjusted in Flow equation by multiplying the GPM of each hydrant. Example GPM X (Adjusting coefficients)

In total, 23 fire flow tests were completed throughout the distribution system. Four of these tests were later identified as faulty due to incorrect recording and were performed again to ensure accurate data. Upon retesting these locations each test was brought into calibration. The results were used to calibrate the distribution model to reflect the field observations.

Creation and calibration of the hydraulic model was performed in accordance with the recommendations of the American Water Works Association's "Computer Modeling of Water Distribution Systems" Manual (AWWA M-32). Each flow test was input individually by setting the time of day, supply pressure and flows, and water tower elevations. During the initial evaluation, the static pressures were verified, and minor adjustments made to obtain a minimal margin of error. The observed fire flow in the field was simulated in the model as a point demand, and the model was run to verify that the residual pressure recorded in the field closely match those projected by the model.

Calibration is an iterative task and requires that most of the points be revisited two to three times to ensure that the modifications that were made didn't affect other tests. Calibration began with hydrants near connection points to water supplies (wells), and moved outward, away from supply sources. For accurate results it was necessary to have the hydraulic model correctly depict pipe diameters, lengths, pumps, controls, etc., the model relies largely on the Hazen-Williams roughness coefficients or C-Factors.

The model relies largely on the Hazen-Williams roughness coefficients or C-Factors. C-Factors were adjusted from 130 (new, smooth pipe) to 70 (old, rough pipe). Newer areas of town were first set at the higher value and modifications occurred as needed to adjust the model to reflect the field conditions Table 3-3. below identify the starting values that were used for the water main to begin the calibration process. These values were then adjusted to calibrate the model to the results found within the field.

Table 3-3: C-Factor Starting Value

	1960	1970	1980	1990	2000	2010
UNK	100	100	100	100	100	100
PVC	125	125	130	130	135	135
HDP	125	125	130	130	130	130
DI	95	95	100	105	105	110
CI	95	95	100	100	100	100

With an average deviation of 1.23% (static) and 2.81% (residual) for the entire system, the WaterCAD model is considered to be very accurate and capable of producing real-time fire flow and pressure data for evaluation and analysis purposes. The results of the fire flow testing and calibration can be found on the following page.

		Hydrants			WaterCAD Results					
		Flow	Static	Residual	Static			Residual		
Test No.	Location	GPM	psi	psi	psi	Difference psi	Difference %	psi	Difference psi	Difference %
1	Albert Ave/Fair St	950	53	42	52.0	-1.0	-1.89%	45.0	3.0	7.14%
2	Dekalb Ave/Stark Ave	1,375	58	54	57.0	-1.0	-1.72%	54.0	0.0	0.00%
3	Ellen St/Exchange St	1,600	68	54	68.0	0.0	0.00%	57.0	3.0	5.56%
4	Page St/Maple St	1,525	64	61	64.0	0.0	0.00%	62.0	1.0	1.64%
5	State St/Locust St	1,560	50	45	51.0	1.0	2.00%	48.0	3.0	6.67%
6	Airport Rd/State St	1,725	68	55	70.0	2.0	2.94%	55.0	0.0	0.00%
7	Main St/Home St	1,150	51	40	51.0	0.0	0.00%	43.0	3.0	7.50%
8	Anjali Ct/Sarah Dr	1,675	65	54	66.0	1.0	1.54%	52.0	-2.0	-3.70%
9	State St/Liberty Ln	1,400	68	40	70.0	2.0	2.94%	41.0	1.0	2.50%
10	Bristol Dr/Hathaway Dr	1,300	48	40	51.0	3.0	6.25%	40.0	0.0	0.00%
11	Oak Ln/Fairland Dr	1,700	66	58	66.0	0.0	0.00%	57.0	-1.0	-1.72%
12	Dekalb Ave/Oakland Dr	1,425	53	42	53.0	0.0	0.00%	41.0	-1.0	-2.38%
13	Bethany Rd/Klein Rd	1,350	45	42	46.0	1.0	2.22%	43.0	1.0	2.38%
14	Borden Ave/Park Ave	1,625	52	48	52.0	0.0	0.00%	50.0	2.0	4.17%
15	Fulton Ln	1,500	56	46	57.0	1.0	1.79%	45.0	-1.0	-2.17%
16	Sandberg Dr/Parkside Dr	1,725	62	58	63.0	1.0	1.61%	58.0	0.0	0.00%
17	Maplewood Dr/Main St	1,700	66	60	66.0	0.0	0.00%	59.0	-1.0	-1.67%
18	Brian St/Arneita St	1,650	64	52	64.0	0.0	0.00%	51.0	-1.0	-1.92%
19	Freed Rd/Williams St	1,775	65	56	65.0	0.0	0.00%	54.0	-2.0	-3.57%
20	Frantum Rd/Stonegate Dr	1,625	61	52	61.0	0.0	0.00%	53.0	1.0	1.92%
21	Coley Pl	1,775	62	54	62.0	0.0	0.00%	53.0	-1.0	-1.85%
22	Luther Lowell Ln/Alden Dr	1,600	58	52	56.0	-2.0	-3.45%	50.0	-2.0	-3.85%
23	Republic Ave/National St	1,475	55	44	55.0	0.0	0.00%	43.0	-1.0	-2.27%

3.3.3 Fire Flow Requirements

Per the 2012 International Fire Code, the fire-flow duration for commercial properties is two hours for Needed Fire Flows (NFF_i) up to 3,000 gpm and three hours for needed Fire Flows up to 4,000 gpm. Properties requiring greater than 4,000 gpm fire flows require a flow duration of four hours. The needed fire-flow duration for 1-and 2-family dwellings with an effective area of 3,600 square feet or less is one hour, and dwellings larger than 3,600 square feet is two hours. Buildings other than one and two-family dwellings require fire flows per table B105.1 (minimum required fire-flow and flow durations for buildings) within Appendix B of the IFC.

In general, commercial, municipal, and industrial properties require a minimum of 3,000 gpm of available fire flow. Residential properties generally require a minimum of 1,000 gpm of fire flow capacity. Both of these guidelines vary by square footage, building density, construction materials, and other factors.

Figure 3-8: 2015 IFC Fire Flow Requirements –

TABLE B105.1(2)
REFERENCE TABLE FOR TABLES B105.1(1) AND B105.2

FIRE-FLOW CALCULATION AREA (square feet)					FIRE-FLOW (gallons per minute)[b]	FLOW DURATION (hours)
Type IA and IB[a]	Type IIA and IIIA[a]	Type IV and V-A[a]	Type IIB and IIIB[a]	Type V-B[a]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
—	—	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
—	—	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
—	—	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
—	—	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
—	—	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
—	—	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
—	—	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
—	—	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.
a. Types of construction are based on the *International Building Code*.
b. Measured at 20 psi residual pressure.

3.4 WaterCAD Model Hydraulic Analysis & Results

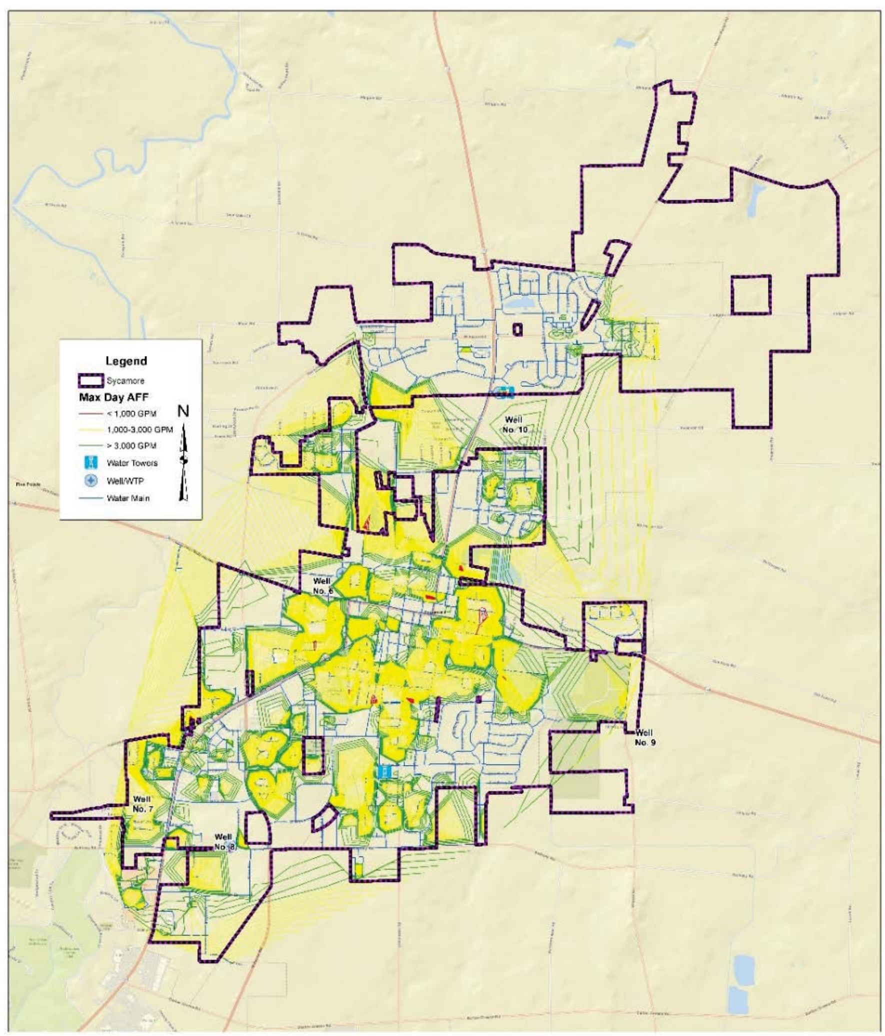
The City's distribution system was analyzed to see the flows available through the service area, as well as the static and residual pressures. During this analysis, the model was run under maximum daily demand (MDD) conditions to provide a conservative analysis of the system. A peaking factor of 2.11 was used to establish the demand for the maximum day conditions, which was substantiated by historical flow data provided by the City. The following sections provide an analysis of the water distribution system based on both available fire flows, and pressure. Additionally, a number of scenarios have been modeled, reflecting real-world occurrences to illustrate how the system would respond. This includes removing elevated tanks from service (for cleaning or recoating), and loss of critical transmission mains.

Present Day Available Fire Flows

The WaterCAD computer modelling software was used to identify the available fire flow capacity throughout the City of Sycamore water distribution system, defined as the maximum deliverable flow from a single hydrant, while maintaining residual pressures no less than 20 psi. An extended period analysis provided a comprehensive overview of the system's status over a 24-hour period including peak demand conditions.

The results from the simulation were then used to generate an available fire flow contour map. The fire flow contour map to the right has identified the available fire flows throughout the City, and each contour is defined as less than or equal to the value presented. The fire flow contour map below identifies areas of insufficient fire flow, flow less than 1,000 gpm, in red, potentially insufficient areas of fire flow between 1,000 and 3,000 gpm in yellow and areas of sufficient fire flow greater than 3,000 gpm in green. Each of the areas of concern was analyzed, the cause determined, and recommended improvements developed to alleviate the situation.

Figure 3-9: Available Fire Flows

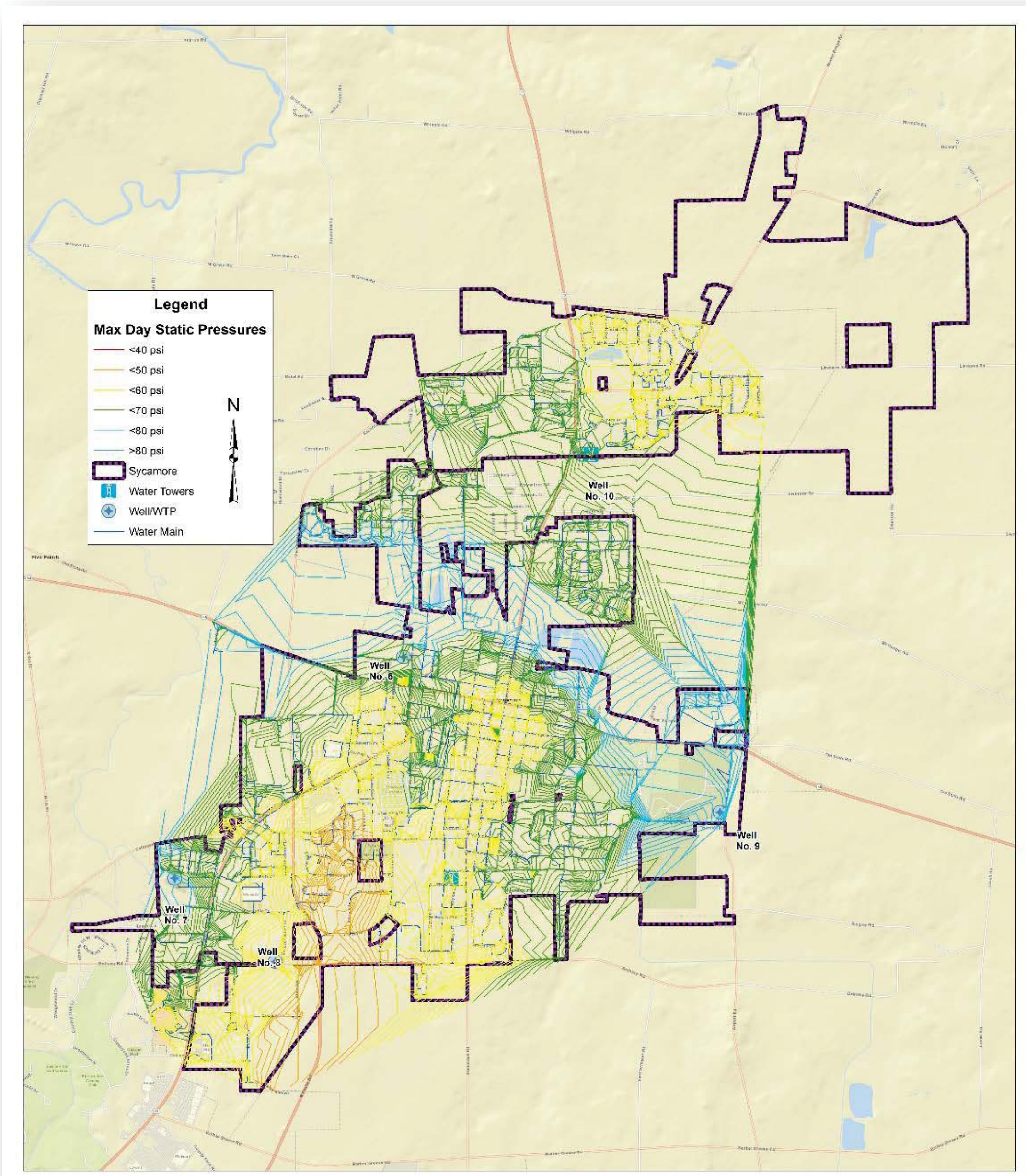


Present Day Pressure Contour Map

In addition to fire flow, the WaterCAD computer modelling software was used to identify the available pressures throughout the City of Sycamore's water distribution system. An extended period analysis provided a comprehensive overview over a 24-hour period including peak demand conditions.

The pressure contour map below has identified areas of low pressure, defined as less than or equal to 40 psi, in red and areas less than 50 psi are in orange, less than 60 psi are in yellow, less than 70 psi are in green, less than 80 psi in light blue, and greater than 80 psi are in dark blue. The areas of low pressure identified during the analysis were due to high ground elevation in comparison with the hydraulic grade-line of the distribution system. Overall, static pressures throughout the distribution system are generally between 60-80 psi, with very few areas falling below 50 psi.

Figure 3-10: Pressure Contour Map



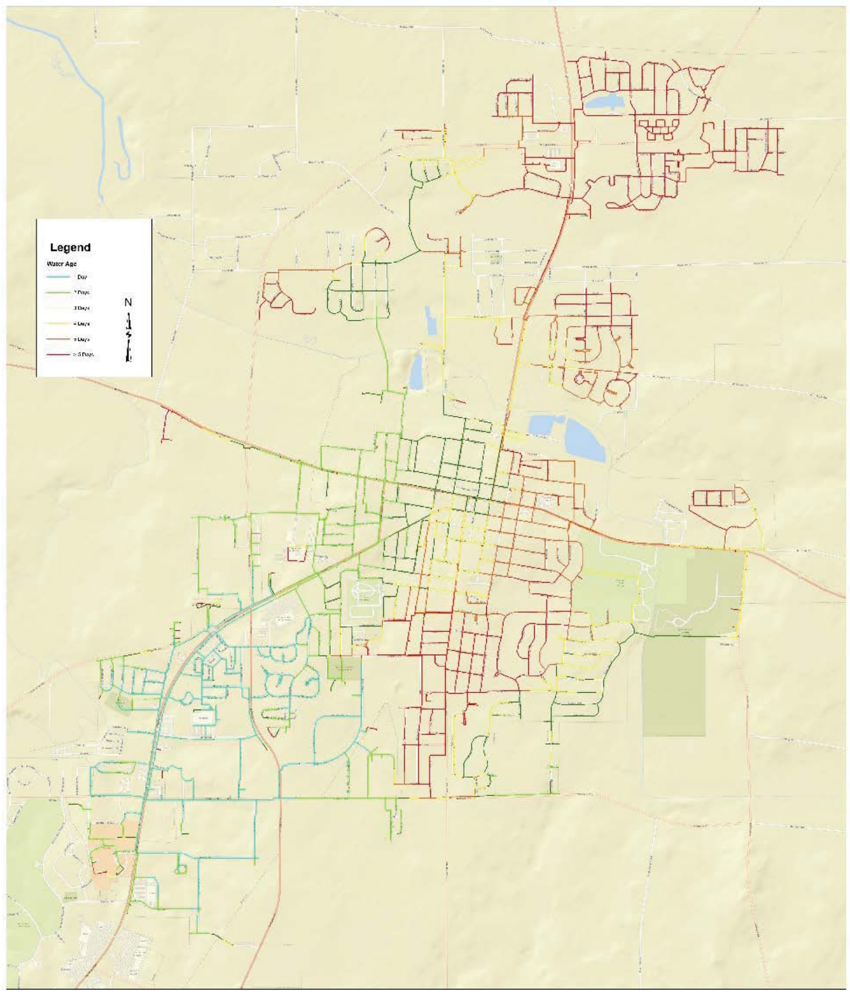
Water Age

Water age, the duration that water is in the distribution system before being delivered to the consumer, is a strong indicator of overall water quality. Water age can be affected by several different factors, which include water system demands, well run time, elevated storage capacity, water main layout, water main size, etc. Increased water age can result in loss of chlorine residual, odors, and potential color changes. In general, anything less than three days age is considered 'very good', while above five days is where residual degradation may occur.

Figure 3-11 shows the water age within each. Teal identifies areas of water age of less than one day, light green represents age up to two days, dark green represents up to three days, yellow represents up to four days, orange represents up to five days, and red represents over five days. On average the City's system has a water age of three to six days. The area of longer-duration ages is typically found in the northeast portion of the system and is likely related to the 1.5 MG elevated storage tank in this region. This tower is needed as it provides storage and improves water pressure throughout the City, providing net benefits.

Areas such as the east side of downtown have been noted as displaying occasional water quality concerns, which is corroborated by the water age displayed in the model exceeding five days.

Figure 3-11: Water Age



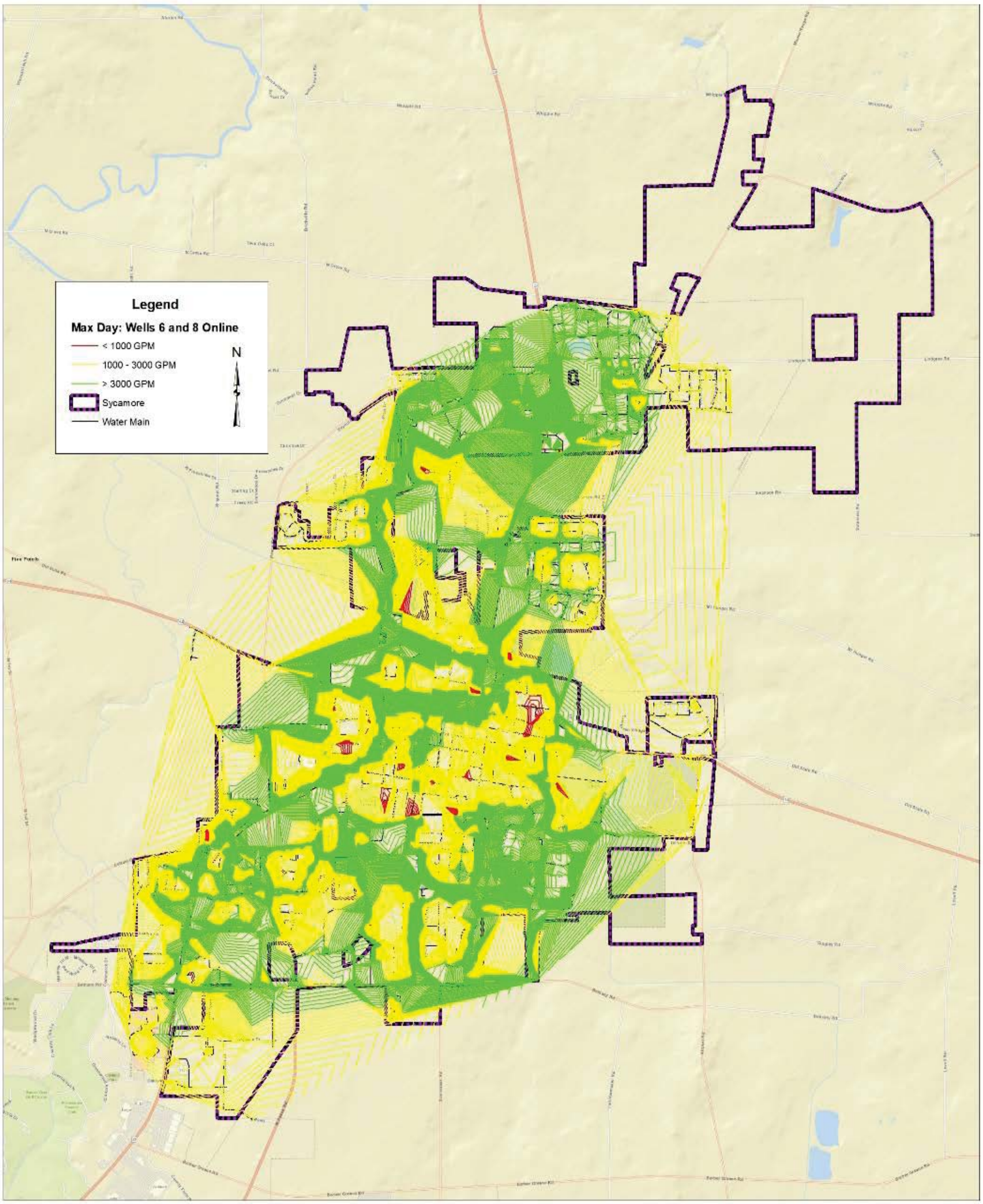
Modeling of Select Scenarios

The City of Sycamore's system can be dynamically affected throughout the day by varying water usage, elevated storage levels, and the wells available for production. Wells may be temporarily unavailable due to maintenance or replacement of WRT media. Additionally, wells operate on a SCADA-controlled rotation in order to promote equal wear on each well. As these features fluctuate, the model responds differently. Therefore, several scenarios were identified to be hydraulically modeled. These scenarios represent scheduled occurrences (e.g. water towers being offline for painting, WRT systems offline for media exchange) as well as less likely occurrences (loss of a production well). As a result, there were three key scenarios that were outlined to be evaluated, with several sub-scenarios including:

- Alternative No. 1 – Tower #1 Offline
  - Alternative No. 1A – Well 6 & 8 Online
  - Alternative No. 1B – Wells 6, 8 & 9 Online
  - Alternative No. 1C – Return Well 7 to Service
- Alternative No. 2 – Tower #2 Offline
  - Alternative No. 2A – Well 6 Online
  - Alternative No. 2B – Well 6 & 9 Online
  - Alternative No. 2C – Wells 6, 9 & 10 Online
- Alternative No. 3 – Loss of Route 23 Transmission Line
  - Alternative No. 3A – Well 6 & 10 Online
  - Alternative No. 3B – Well 6, 8 & 10 Online
- Alternative No. 4 – Returning Well 7 to Service

The following sections identify the results of the hydraulic model during fire flow conditions for each of the scenarios. In addition, a brief synopsis of the ramifications of the scenario is described, and ultimately provides insight on the critical items throughout the City's water distribution system. One of the goals of modeling these scenarios is to identify the most critical components of the water system and provide solutions for how they can be minimized. This also will allow the City to prioritize improvements, upgrades, and rehabilitation efforts. Shown in Figure 3-11 on the following page is the "Base Model" illustrating the available fire flows throughout the system during maximum day demand, with all water infrastructure in service.

Figure 3-12: Max Day Fire Flow - Wells 6 and 8 Online

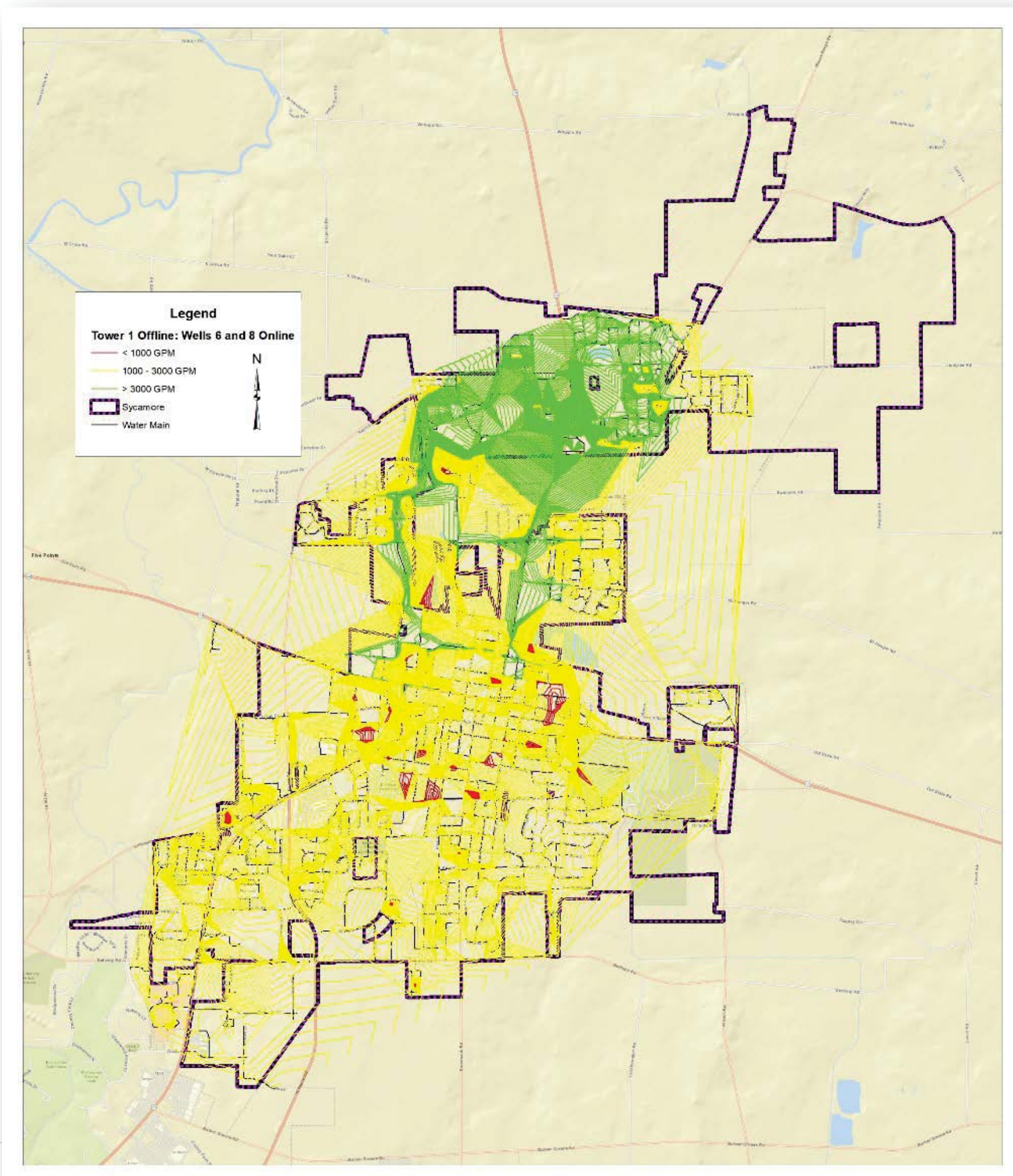


3.4.1 Alternative No. 1 – Tower #1 (Downtown) Offline

Alternative No. 1A – Well 6 & 8 Running

The removal of an elevated storage tank from service is likely to occur due to tower painting (which typcically requires around three months of down time) or routine maintenance, or loss of a riser due to freezing in the winter. This would result in a loss of the City's storage capacity due to the absence of ground storage reservoirs. The pumps in service would then need to be capable of providing flow for all users in the area local to the elevated storage tank. Serving the southern region of the system, Tower #1 has a volume of 750,000 gallons and is primarily filled by Wells 6, 8, and 9. As shown in Figure 3-12, utilization of only Wells 6 and 8 with Tower #1 offline will result in available fire flows throughout the south and central regions of town providing flows in the range of 1,000 to 3,000 gallons per minute, while areas that currently receive available fire flows below 1,000 gallons per minute are slightly decreased. In general, all commercial fire protection (≥3,000 gpm) is lost south of Route 64.

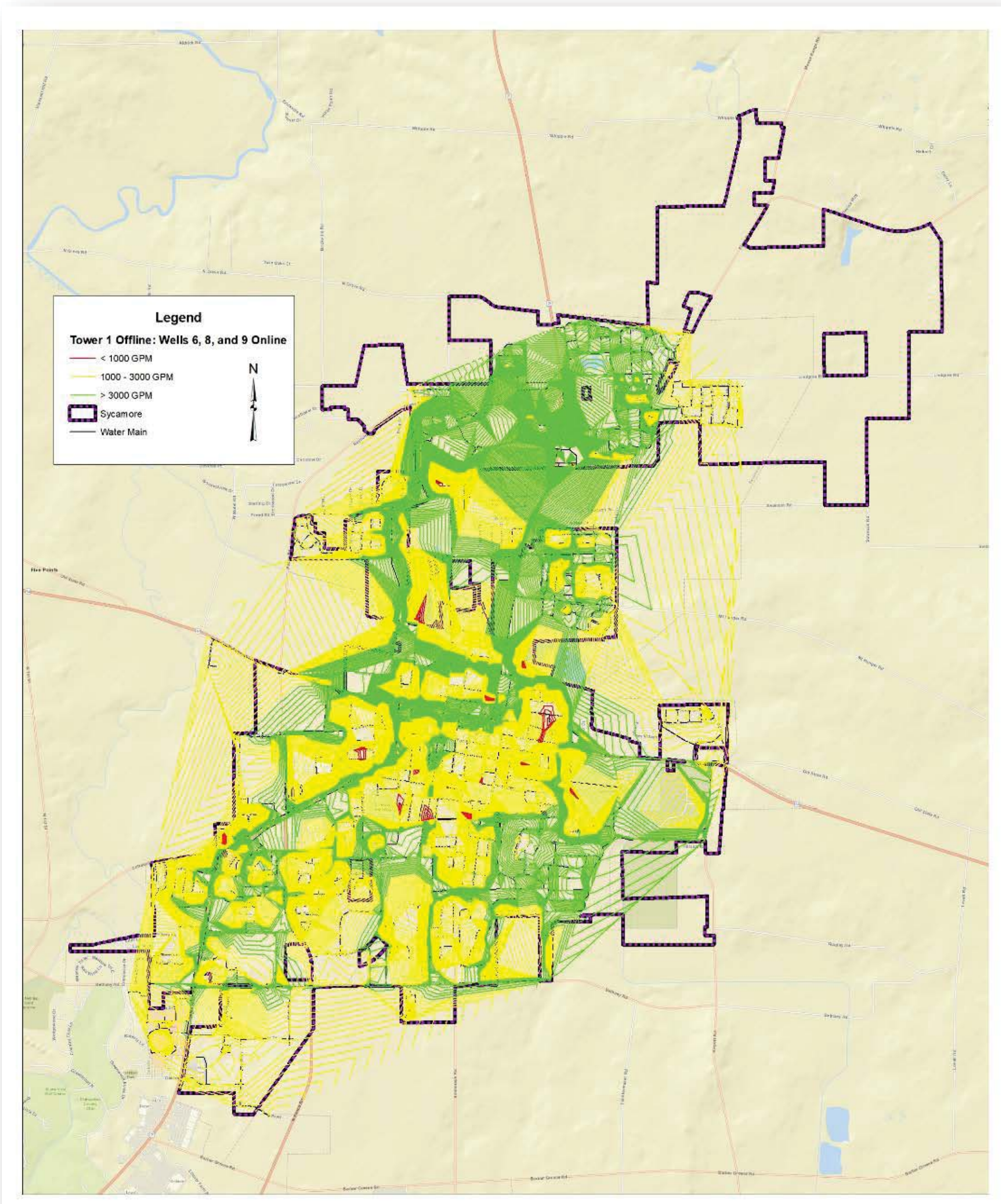
Figure 3-13: Tower #1 Offline - Wells 6 & 8 Running



Alternative No. 1B – Wells 6, 8 & 9 Running

In order to maximize the available flows in the south and central regions of town with Tower #1 offline, it is recommended that the City operate Wells 6, 8 and 9 during a fire flow or other high flow event. This scenario will result in fire flow exceeding 3,000 gallons per minute to be provided to commercial regions along Bethany Road, Peace Road, and DeKalb Avenue. This protection also extends to much of the downtown area, though the total available fire flow is below those seen with Tower #1 online. Additionally, the scenario displayed below would occur if the tower is in service but is fully drained. This is notable in that the City experiences reduced resiliency directly following an extreme demand event as the tower will need to be refilled.

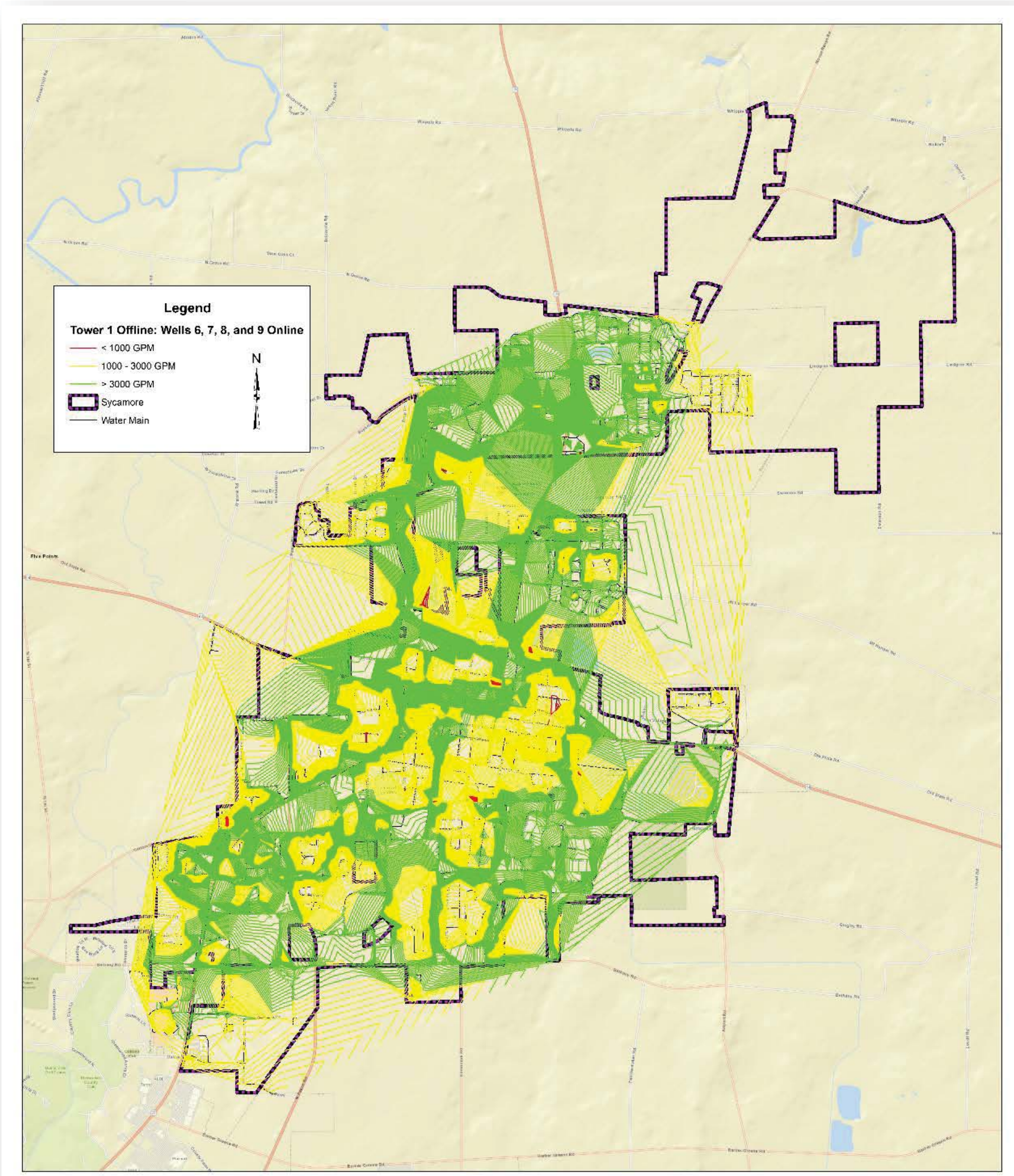
Figure 3-14: Tower #1 Offline - Wells 6, 8 & 9 Running



Alternative No. 1C – Returning Well 7 to Service

While Well 7 is currently offline indefinitely, flows in the downtown area would likely be increased if this supply point was returned to service. This is further analyzed in Alternative No. 4, however returning Well 7 to service would also positively impact the City's ability to provide fire flow with Tower #1 offline. Shown below is the available fire flow with all wells running/available and Tower #1 offline, with Well 7 returned to service. Available fire flows throughout the southern portion of the distribution system increase, however few areas below commercial fire protection increase over the threshold to provide 3,000+ gpm. This indicates that while returning Well 7 does appreciably increase available fire flows, improvements to the distribution system would still be recommended to properly convey this flow throughout the system.

Figure 3-15: Tower #1 Offline – Well 6, 7, 8 & 9 Running

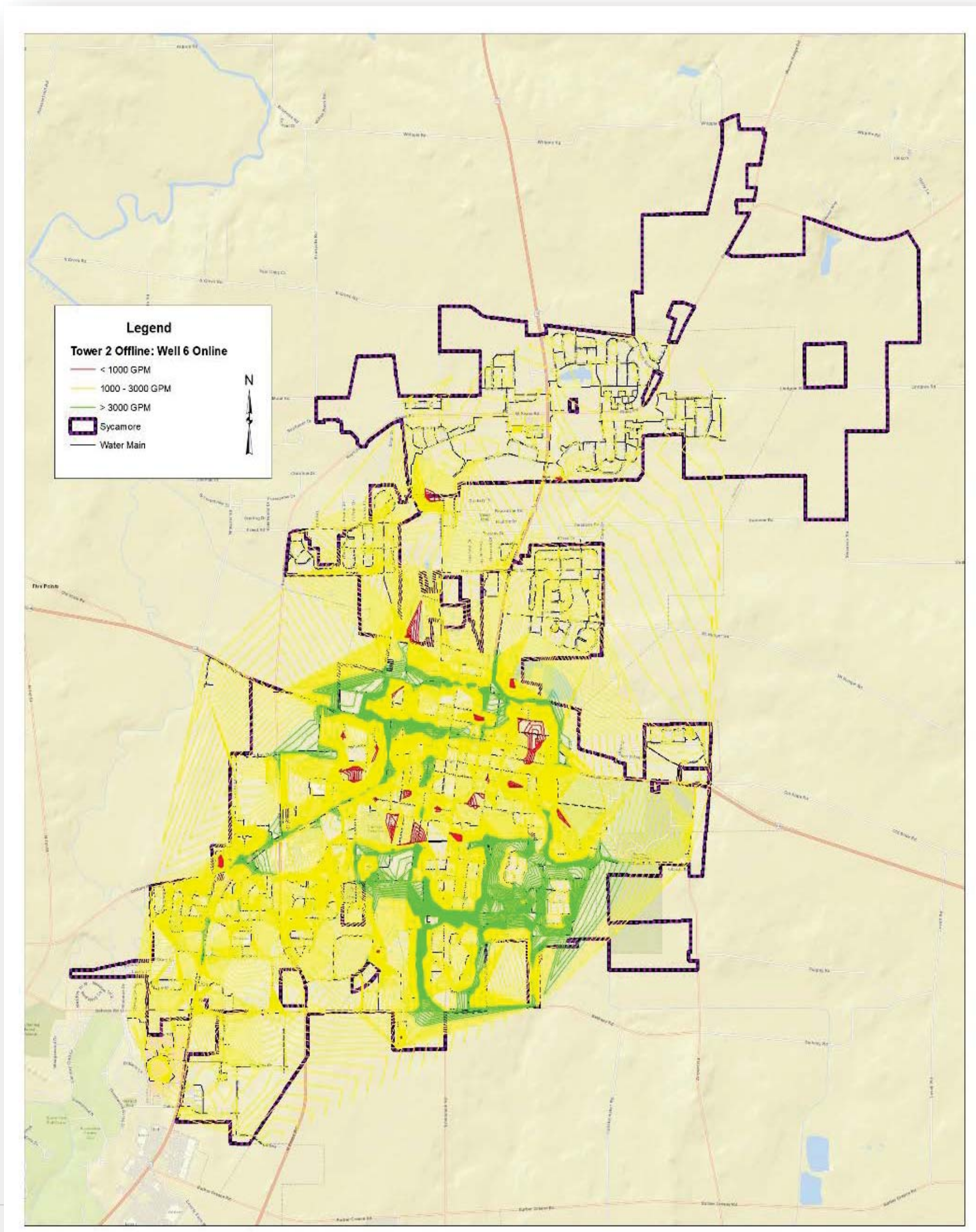


3.4.2 Alternative No. 2 – Tower #2 Offline

Alternative No. 2A – Well 6 Running

Tower #2, constructed in 2009, will likely not require removal from service for maintenance or painting as soon as Tower #1. In addition, the presence of Well 10 adjacent to Tower #2 will provide flow to the north section of the City in the event that the tower is taken offline. With only Well 6, located in the central-south area of the City active, the region around Tower #2 receives consitent fire fows between 1,000 and 3,000 gallons per minute. This will be sufficient for the residential population around the area, though will not reach the targetted 3,000 gallons per minute for commercial properties and schools located in this area.

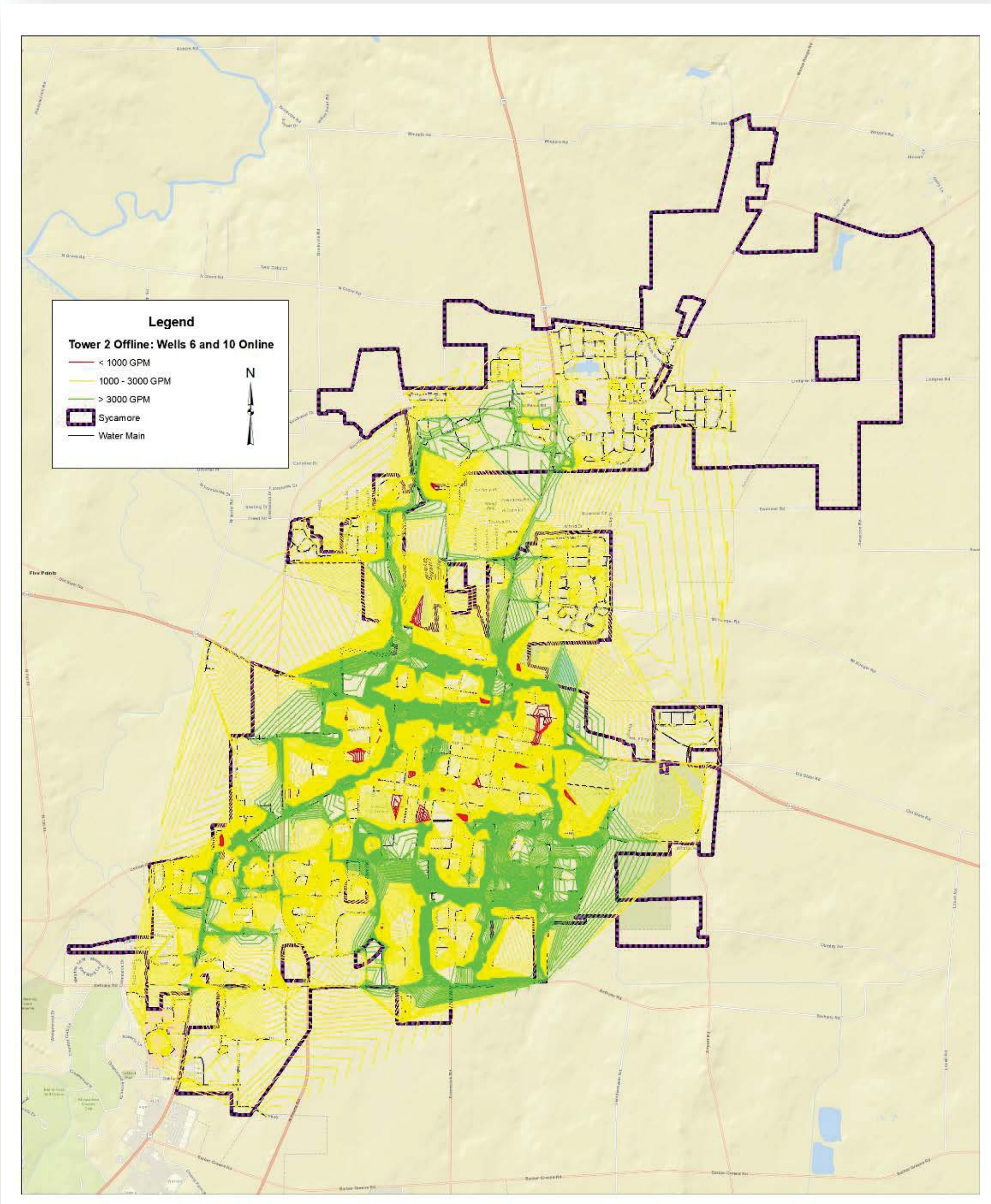
Figure 3-16: Tower #2 Offline - Well 6 Running



Alternative No. 2B – Well 6 & 10 Running

Utilizing Wells 6 and 10 to provide flow while Tower #2 is offline, the City would be able to provide expanded commercial fire flow to properties located along 10-inch mains throughout the north region of the City. These primary mains along Rt. 23 and Plank Road provide a strong backbone to convey flow, though areas in the northeast corner of the system, including North Grove Elementary School continue to receive flows below 3,000 gallons per minute with the north tower offline.

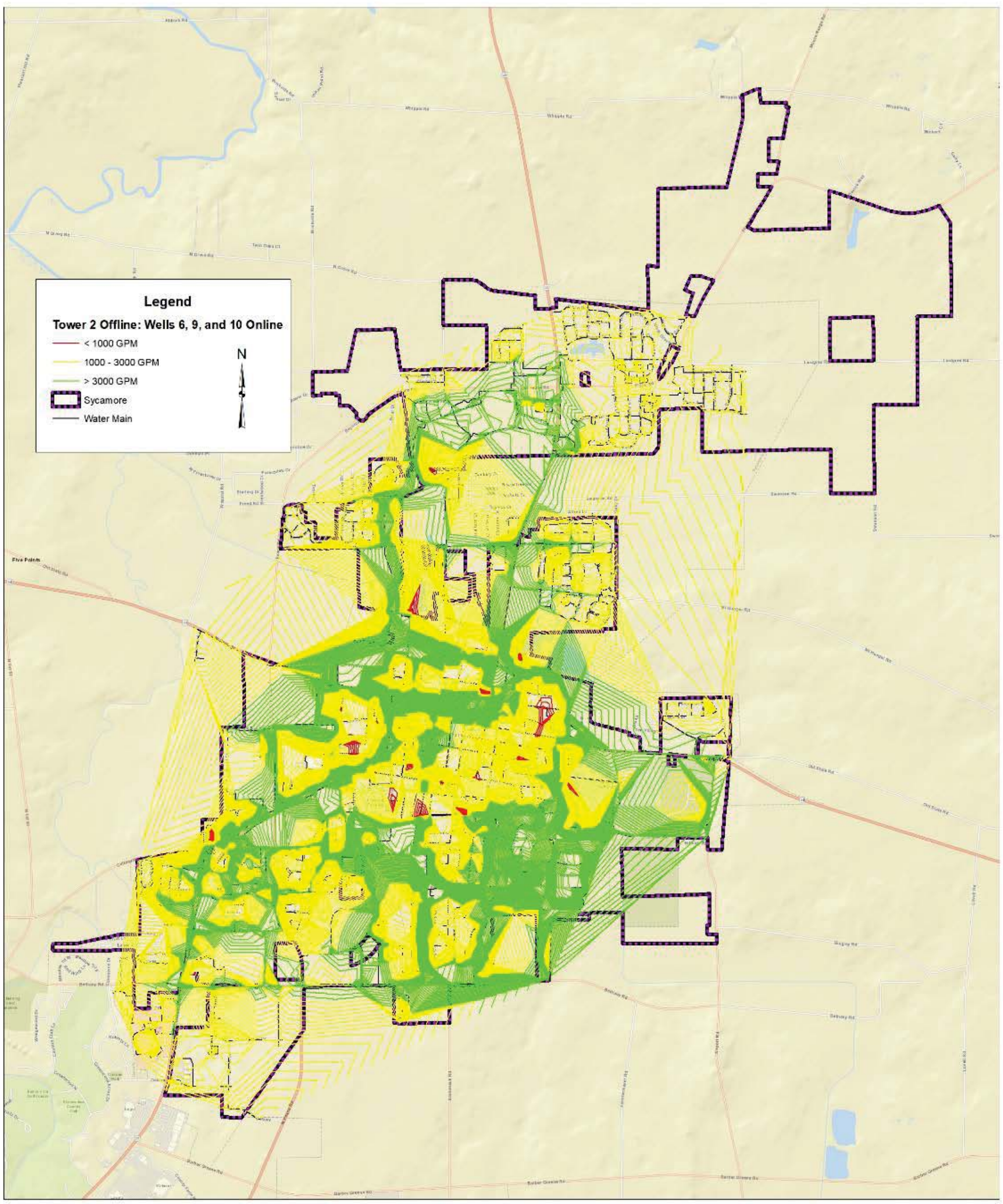
Figure 3-17: Tower #2 Offline - Wells 6 & 10 Running



Alternative No. 2C – Wells 6, 9 & 10 online

Available fire flow with Wells 6, 9 and 10 running is slightly improved from the scenario described in Alternative No. 2B, with just Wells 6 and 10 online. With three wells running and the north tower offline, the far edges of the north and south sides of the system receive improved fire flow above 3,000 gallons per minute. This is especially notable around the intersections of Bethany Road and Rt. 23 on the south side, and north of the intersection of Rt. 23 and Plank Road. However, the improved flows do not stretch east of the intersection of Rt. 23 and Plank Road, leaving this area between 1,000 gallons per minute and 3,000 gallons per minute of available flow.

Figure 3-18: Tower #2 Offline - Wells 6, 9 & 10 Running

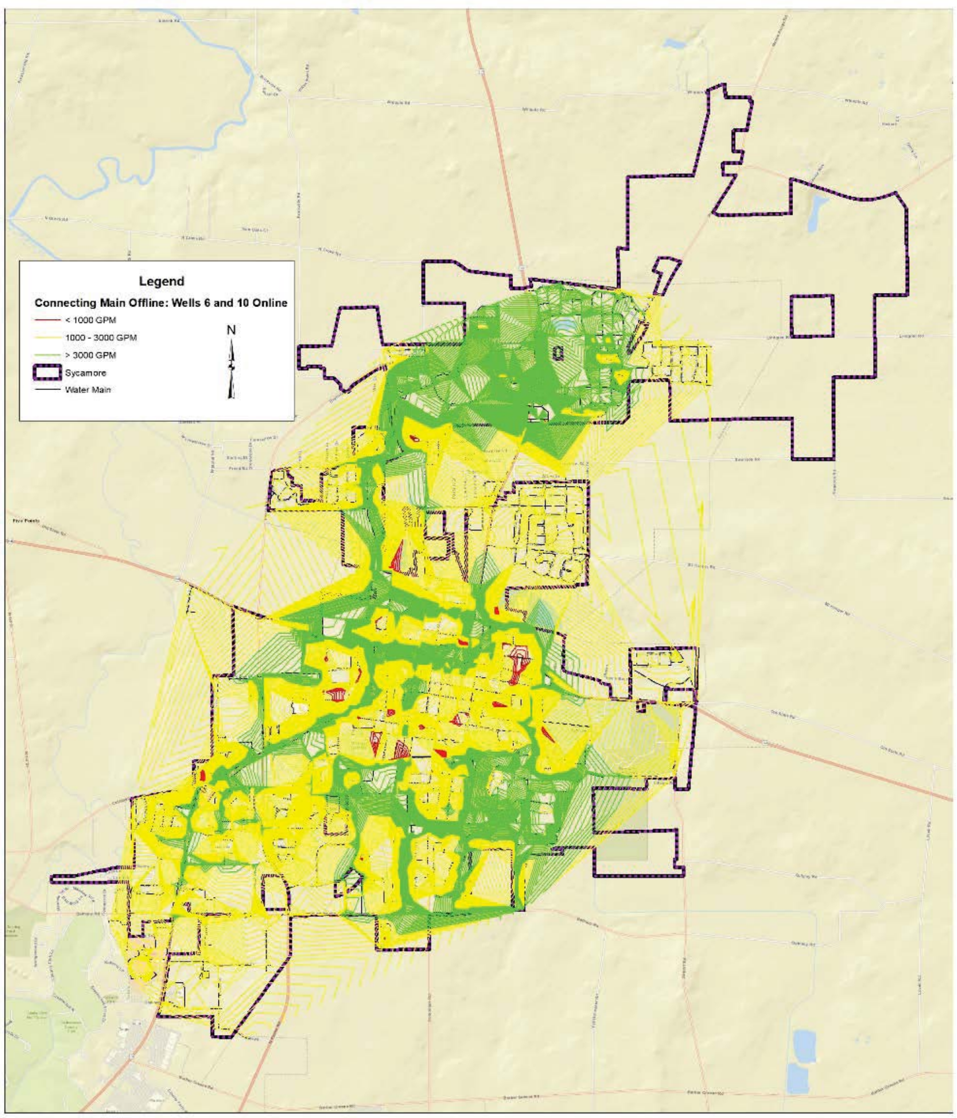


3.4.3 Alternative No. 3 – Loss of Route 23 Transmission Line

Alternative No. 3A – Well 6 & 10 Running

The 10-inch water main located along Route 23 between Maplewood Drive and Route 64 provides a significant portion of the flow conveyance between the north and south regions of the City's distribution system. Loss of this main as a result of a significant break could result in a large separation between the sides of the City, though there are two additional 10-inch mains further west that also connect the areas. In this event, the system was simulated with one well active on the north side and one well running on the south side. Additionally, both water towers are active to provide storage and additional flow in the event of an emergency. With the water main along Route 23 inactive, the north portion of the City suffers minimal impact, as flow is provided by Tower #2 and Well 10. However, the southwest corner of the system suffers a reduction in the area to which it can provide commercial fire flow. This area is centered around the intersection of Bethany Road and DeKalb Avenue, and is a result of the headloss associated with Well 6 supplying this area alone.

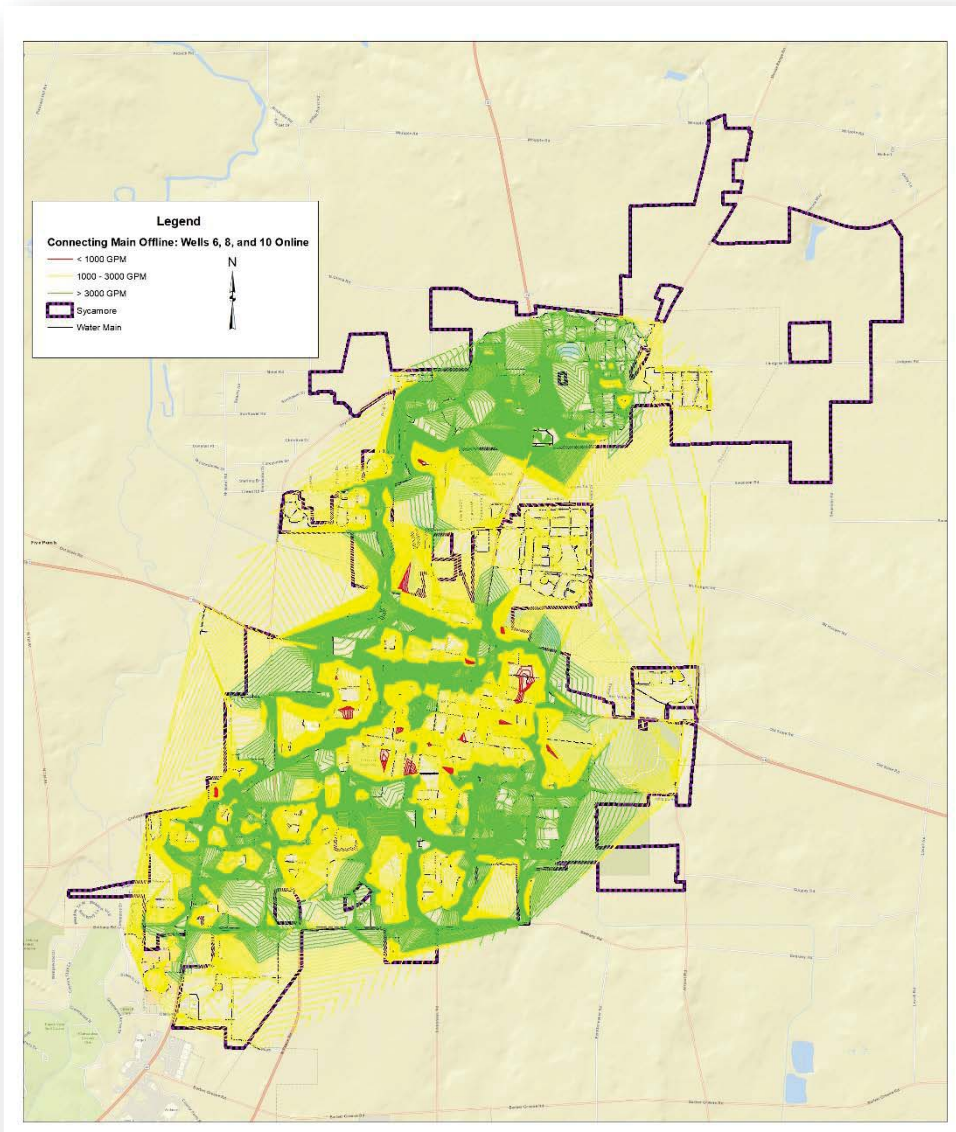
Figure 3-19: Connecting Main Offline - Wells 6 & 10 Running



Alternative No. 3B – Well 6, 8 & 10 online

With the crosstown 10-inch main inactive, it is important to provide both sections of town with sufficient flow independent of each other. Tower #2 and Well 10 provide all required flow to the north side of town without additional flow from the south. In this emergency scenario, the south section of town will require flow coming out of Tower No. 1 as well as two of the three wells in the area to meet the available fire flow protection that is seen with the north/south connecting main online. Utilization of Wells 6 and 8 restore sufficient commercial fire protection to the the southwest region of the City. As such, it is recommended to operate Well 10 and two wells in the south half of the City if the connecting main were to be removed from service and a fire flow event occurred.

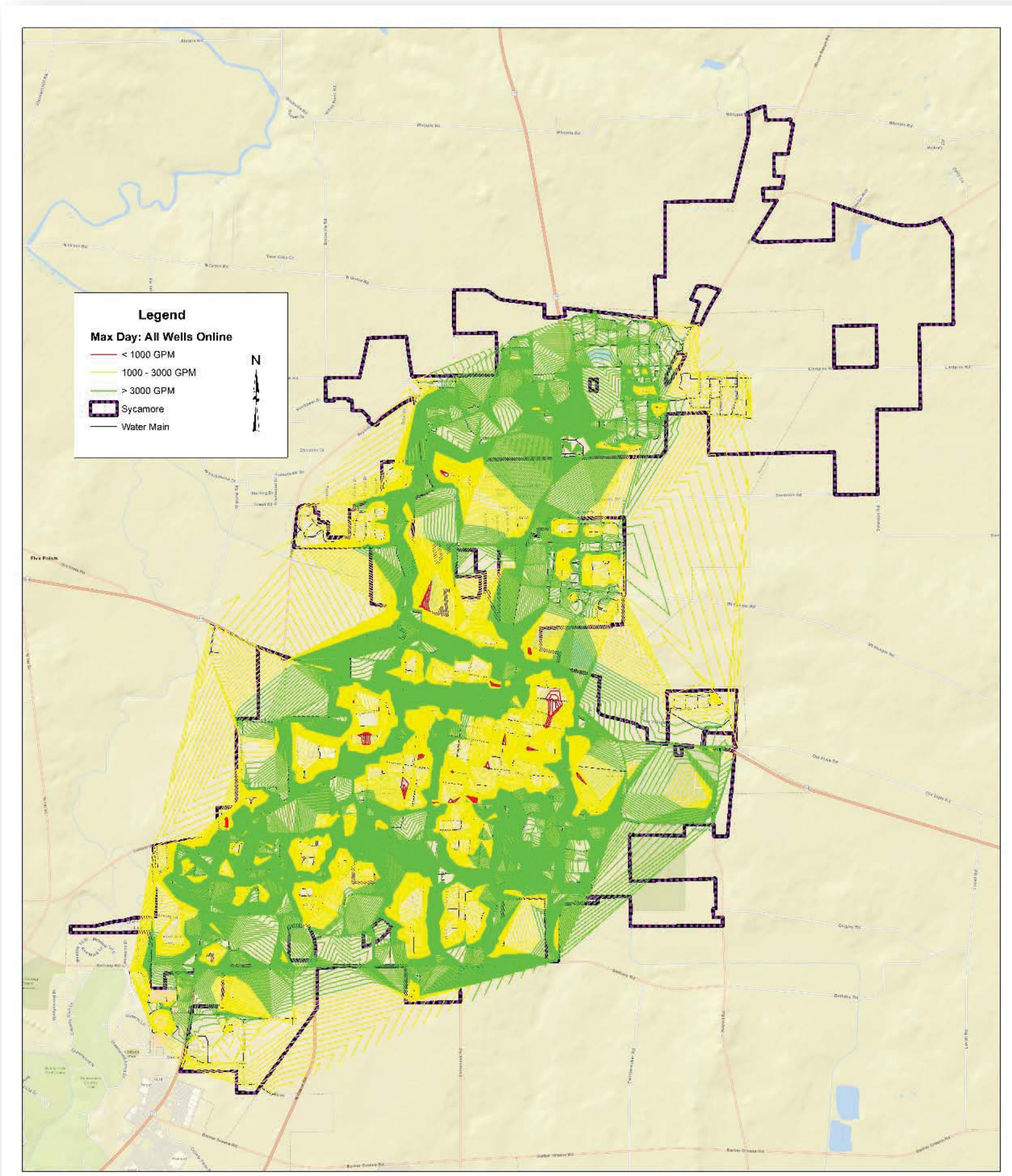
Figure 3-20: Route 23 Main Offline - Wells 6, 8 & 10 Running



3.4.4 Alternative No 4 – Return Well 7 to Service

Currently, Well 7 has been removed from service indefinitely due to radium limit exceedances. Alternatives for bringing this well back into service are reviewed in further detail within Section 5. This analysis assumes Well 7 has been brought back into service, whether that be through blending with a shallow well or treatment of radium, but at the previous 1,250 gpm of capacity. Shown below is the resulting available fire flow with Well 7 returned to service, both towers online, and all wells running. This represents the maximum amount of fire flow in the system following Well 7 being brought back online. While available fire flows are increased throughout the southern half of the distribution system, no areas of low fire flow are resolved exclusively with brining Well 7 back online.

Figure 3-21: Maximum Available Fire Flows – All Towers and Wells Online



3.5 DISTRIBUTION SYSTEM SUMMARY

The City of Sycamore water distribution system is over 115 miles of water main piping, valves, fire hydrants, and service connections. The total asset value of the distribution system is approximately $91M, with a $136M replacement cost, as identified in the table below. Based on a 75-year service life for the buried water infrastructure, the City would need to be investing approximately $1.81 million annually into replacement of the system. Throughout northeastern Illinois, communities are experiencing rapidly increasing numbers of main breaks and degradation of installed mains. As such, they are budgeting to increase routine annual water main replacement. Not properly funding water main repair and replacement will lead to increased strain on City staff and budgets due to future emergency repairs, as well as decreased system resiliency due to increased tuberculation on older pipes.

System Asset	Quantity	Unit Value	Total Asset Value ($ Million)	Total Replacement Cost ($ Million)
≤4-Inch Main	50,478	$120	$6.06	$9.09
6-Inch Main	162,500	$120	$19.50	$29.25
8-Inch Main	135,565	$120	$16.27	$24.41
10-Inch Main	259,286	$130	$33.71	$50.57
12-Inch Main	1,257	$140	$0.18	$0.26
14-Inch Main	279	$150	$0.04	$0.06
16-Inch Main	97	$175	$0.02	$0.03
System Valves	1,513	$4,500	$6.81	$10.22
Hydrants	1,465	$5,500	$8.06	$12.09
Total:	-	-	**$90.65**	**$135.95**

It is recommended that the City not only budget for the annual replacement program, but also prioritize specific projects through the service area. Section 4 outlines several specific projects that address available fire flows throughout the City and consist of both rehabilitation and upgrade of the distribution system as well. The prioritization of these projects will be discussed in Section 4. Each project is rated based on criteria such as main age, material, available fire flows, break frequency, and public safety. This prioritization is utilized for the development of the Capital Improvements Program and Implementation Schedule within Section 8.

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SECTION 4

ANALYSIS FOR DISTRIBUTION SYSTEM ALTERNATIVES

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4. Analysis for Distribution System Alternatives

4.1 Recommended Distribution System Capital Improvement Projects

Through work sessions with City staff, a number of capital improvement projects were identified to rehabilitate and upgrade the distribution system. As discussed in Section 3, the water system has been constructed throughout the last century. As a result of the age of the system, many of the components are at or beyond their anticipated service life and will require rehabilitation or replacement.

Through review of water main age, size, material, break history, and available fire flows detailed in Section 3, 10 priority rehabilitation areas within the distribution system were identified. These areas may exhibit low available fire flow (AFF), a high frequency of main breaks, or a combination of issues. Each of these areas are discussed in further detail in the following pages, with prioritization of the improvements reviewed at the end of this section. The projects are numbered by orientation and do not represent prioritization. Full line item cost estimates for each project can be found in Appendix A.

A. California, Brickville, and North
B. Sycamore High School
C. Lincoln & Locust
D. Elm Street & DeKalb Avenue
E. Sabin & Exchange
F. North Grove School Connection
G. Somonauk Road
H. Electric Park
I. Mercantile & Prairie Connection
J. Bethany Rd. (Rt. 23 to Health Club)

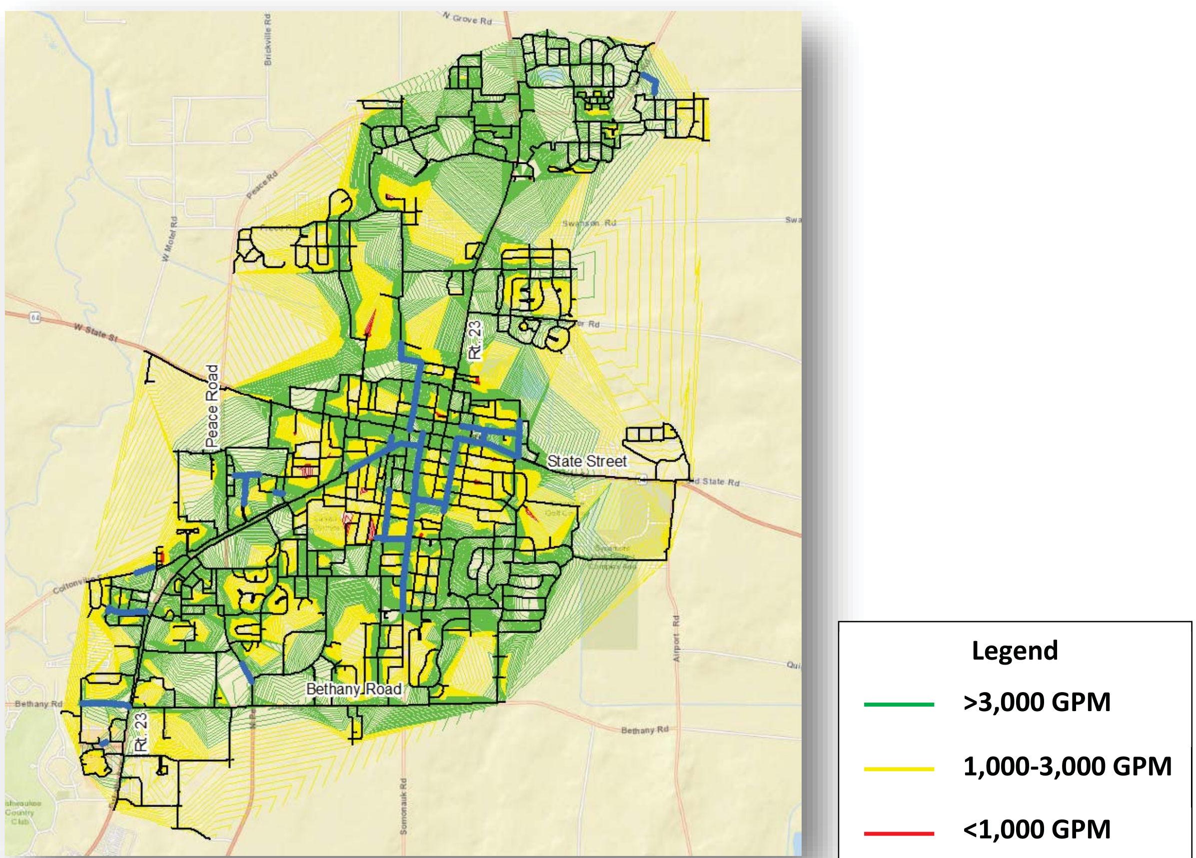
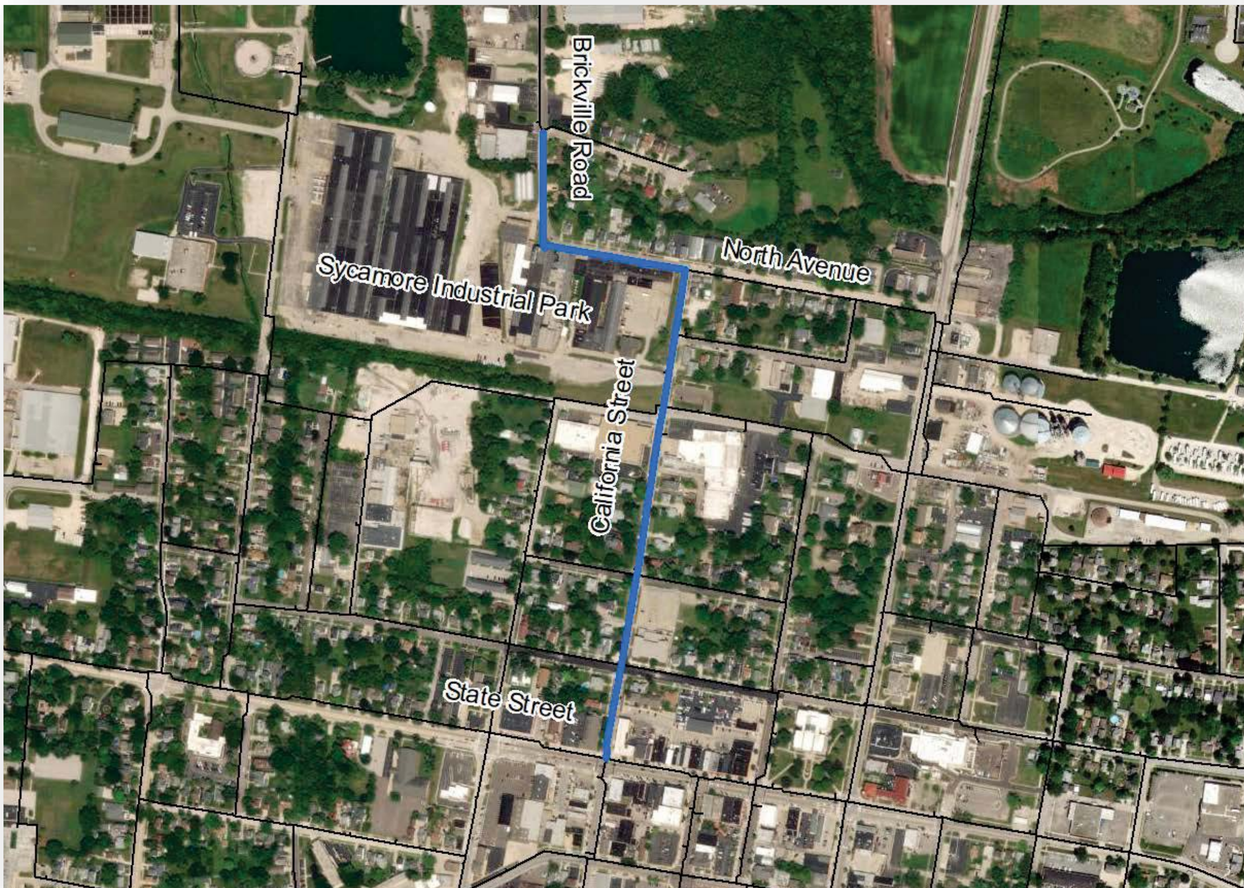


Figure 4-1: Available Fire Flows - Projects Completed

4.1.1 California/Brickville/Main – 10-inch Main

Tower 2 and Well 10, located adjacent to the DeKalb County History Museum in the north side of the City's distribution system, are capable of providing sufficient flow and pressure to meet all demand throughout this region. Tower 1 and Wells 6, 8, and 9 are likewise capable of meeting the maximum day demands of the southern portion of the City. In emergency scenarios, the City may rely on a handful of critical mains with 10-inch diameters to transfer large volumes of water between these areas.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Brickville Road	6	10	475
North Avenue	6	8	600
California Street	6/8	10	2,000
Total	**-**	**-**	**3,075**

Currently, two 10-inch water mains provide conveyance between the north and south sections of the City. These are located along Rt. 23 to the east and Cross Street to the west. There is also a 10-inch water main running along Brickville Road, though this main constricts to a 6-inch diameter around Parker Street. Increasing this main's diameter to 10-inches, along with segments of North Avenue and California Street, will allow for a third path for water to flow. The southern terminus of this installation is the 10-inch water main along State Street.

The primary benefit of this improvement project is allowing more water to flow south from Tower 2 in the event of the emergency, such as a fire or major main break. Current system operation may lead to Well 10 filling Tower 2 while these two structures fulfill the demands in the north side of town, rather than contributing to demands on the south side. Additionally, the stretch of North Avenue that would be replaced through this project has experienced a very high rate of main breaks over its service life. This project could be completed with the redevelopment of the adjacent Sycamore Industrial Park.

Project #1 - California, Brickville, and North				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,036,437
			Construction Sub-Total	$1,036,437
			Contingency @ 20%	$207,287
			PROBABLE CONSTRUCTION COST:	$1,243,725
			ENGINEERING & ADMIN (15%)	$186,559
			PROBABLE PROJECT COST:	**$1,430,284**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 6"	3,111	FT	$13	$40,443
Abandonment of Existing Water Main - 8"	54	FT	$15	$810
Parking Lot Rehab	280	SQ YD	$48	$13,440
Hot-Mix Asphalt Class D Patch	80	SQ YD	$48	$3,840
HMA Driveway Pavement, 2", Remove & Replace	90	SQ YD	$34	$3,038
PCC Curb & Gutter, Remove & Replace	633	FT	$45	$28,485
Trench Backfill, Patch	354	CU YD	$65	$23,039
Trench Backfill, Driveway	100	CU YD	$65	$6,500
Trench Backfill, Bedding & Over Pipe	938	CU YD	$65	$60,956
Backfill	2,018	CU YD	$40	$80,733
Parkway Restoration	1,730	SQ YD	$10	$17,300
Ductile Iron Water Main, Class 52, 10" w/ testing	3,165	FT	$100	$316,500
Gate Valve in Vault, 10"	11	EA	$5,500	$60,500
Fire Hydrant, Complete	11	EA	$5,500	$60,500
Water Service Connection, Short	14	EA	$2,500	$35,000
Water Service Connection, Long	25	EA	$3,500	$87,500
Adjust Existing Sanitary Services	39	EA	$1,500	$58,500
Connections to Existing System	12	EA	$7,500	$90,000
Traffic Control: 5% of Project Cost				$49,354
TOTAL WATER MAIN IMPROVEMENTS:				**$1,036,437**

4.1.2 Sycamore High School – 8-inch Main

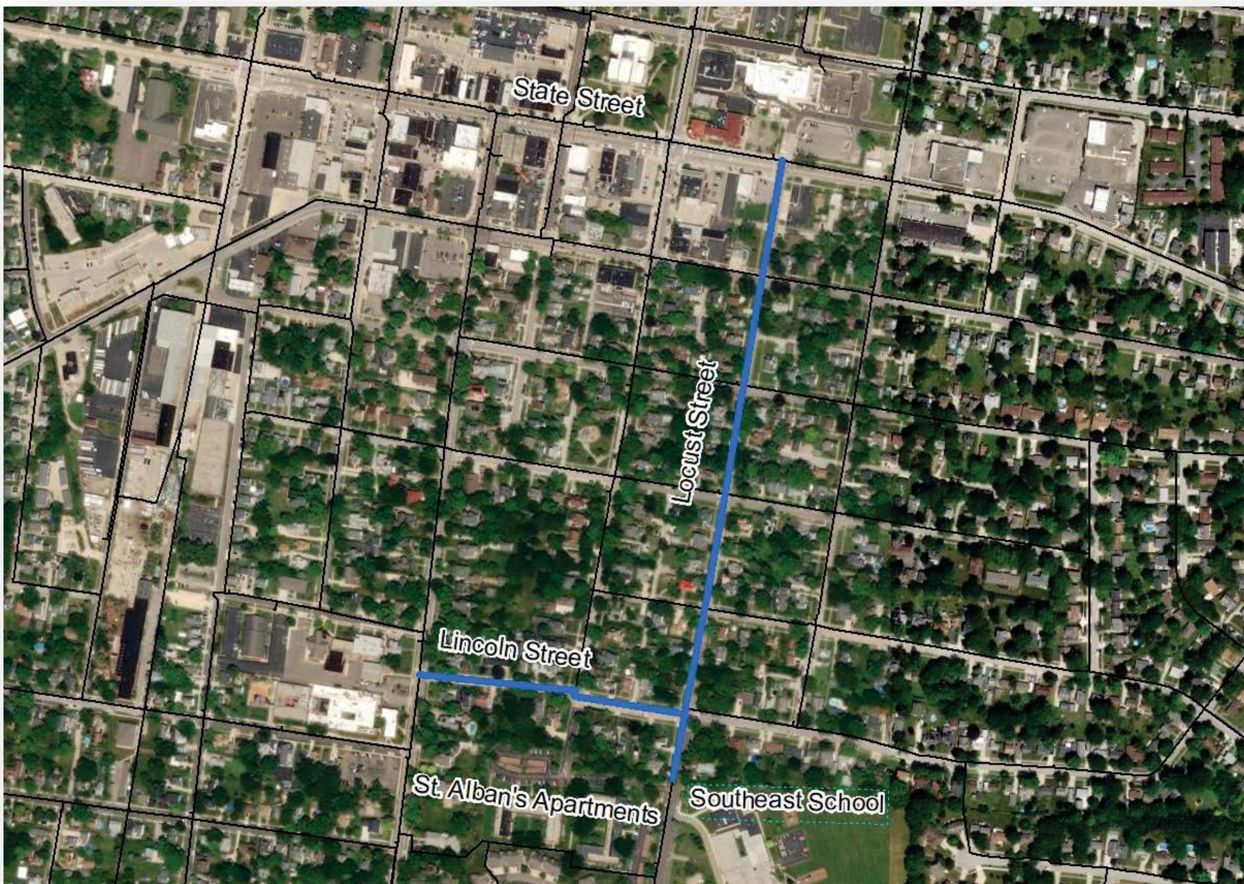
Sycamore High School is centrally located within the City's distribution system and serves approximately 1,400 staff and students. Currently, the high school is served by a 6-inch loop of water main that stems from West Street to the northeast. In order to improve both fire flow and service redundancy, it is recommended to increase the number of water lines that access the high school. The high school currently receives approximately 1,500 gallons per minute of Available Fire Flow. It is recommended that the City install an 8-inch line to the southeast of the school that will connect to the parallel 10-inch water main.

In addition, an 8-inch main should be installed from the northwest of the existing loop, near where the service connection is, through the fields to the west of the school. This main would connect to the existing water main that runs through the access road of the Fox Briar Apartments. Lastly, an 8-inch connection would be made to the south to the Plaza Drive cul de sac to provide additional looping and resiliency. These improvements will increase the Available Fire Flow at the high school to approximately 3,500 gallons per minute, above the recommended 3,000 gallons per minute. As these improvements through open space are unlikely to disturb traffic or water supply during construction, much of the work could be completed by Public Works staff. This will reduce the total contracted labor cost of the project.

Project #2 - Sycamore High School				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$493,581
Construction Sub-Total				$493,581
Contingency @ 20%				$98,716
PROBABLE CONSTRUCTION COST:				$592,297
ENGINEERING & ADMIN (15%)				$88,845
PROBABLE PROJECT COST:				**$681,142**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	64	SQ YD	$48	$3,072
PCC Curb & Gutter, Remove & Replace	400	FT	$45	$18,000
Trench Backfill, Patch	78	CU YD	$65	$5,084
Trench Backfill, Bedding & Over Pipe	593	CU YD	$65	$38,519
Backfill	1,481	CU YD	$40	$59,236
Parkway Restoration	1,778	SQ YD	$15	$26,667
Ductile Iron Water Main, Class 52, 8" w/ Testing	2,000	FT	$80	$160,000
Gate Valve in Vault, 8"	7	EA	$4,500	$31,500
Fire Hydrant, Complete	7	EA	$5,500	$38,500
Water Service Connection, Short	3	EA	$2,500	$7,500
Water Service Connection, Long	5	EA	$3,500	$17,500
Adjust Existing Sanitary Services	8	EA	$1,500	$12,000
Connections to Existing System	7	EA	$7,500	$52,500
Traffic Control: 5% of Project Cost				$23,504
TOTAL WATER MAIN IMPROVEMENTS:				**$493,581**

4.1.3 Lincoln & Locust – 8-inch Main

Upsizing of water main along Lincoln Street and Locust Street will work in conjunction with the previously discussed project along Somonauk Street. These projects will significantly improve the distribution system's ability to provide sufficient flow to the downtown residential and commercial areas. With the Somonauk project providing flow to move north and south between Tower 1 and State Street, improvements along Lincoln and Locust Streets will provide resiliency while also improving fire flows to older homes in the region. This project will benefit the area that was impacted by the July 2019 fire at the St. Albans Apartments, as well as improving protection for the Southeast School.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Lincoln Street	4	8	1,000
Locust Street	4	8	2,200
Total	**-**	**-**	**3,200**

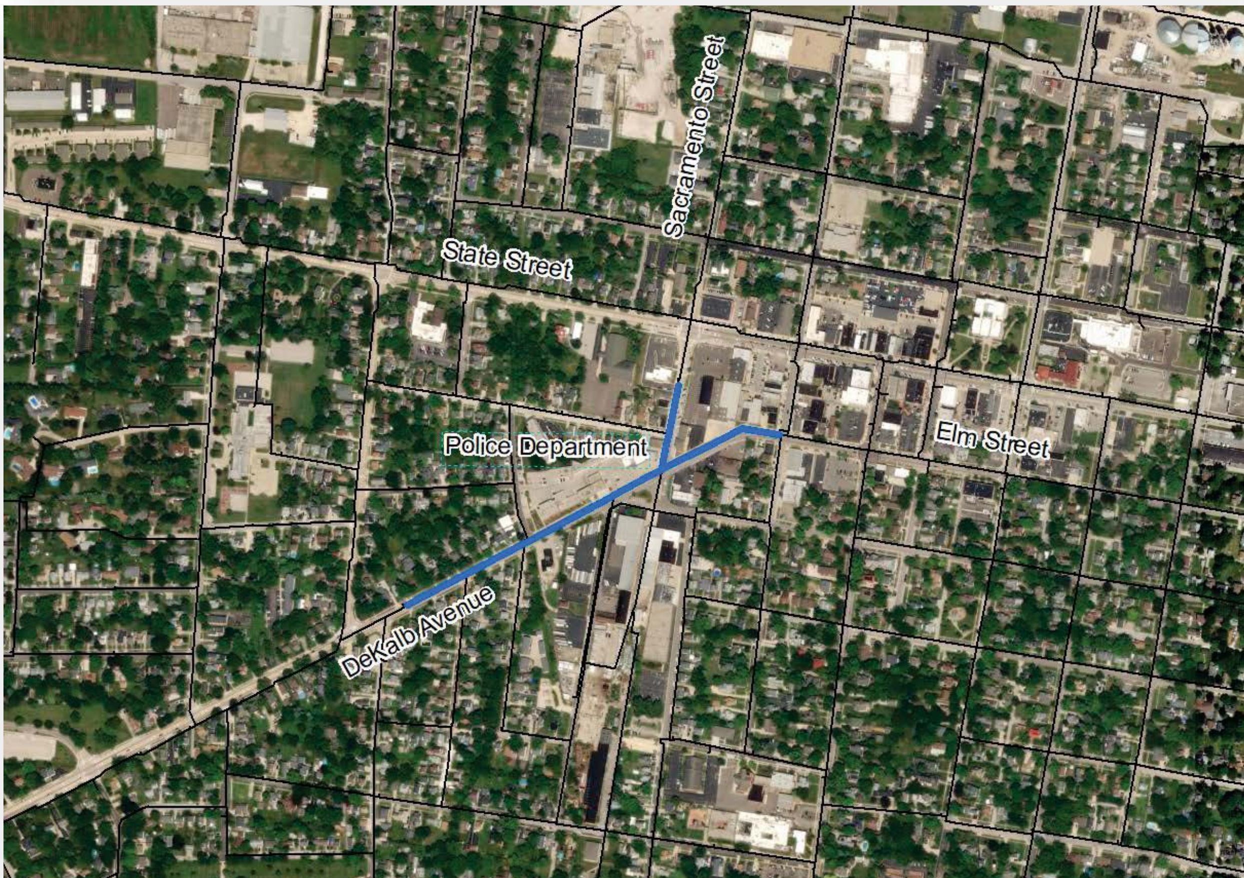
The extents of the project include upsizing 4 and 6-inch main along Lincoln Street from Somonauk Street to Locust Street, and along Locust Street from just south of Lincoln Street to State Street. In total, this will include over 3,200 feet of new 8-inch water main. This project will result in Available Fire Flow at Southeast school increasing from 1,500 gallons per minute to 3,500 gallons per minute.

With the removal of the 10-inch alleyway water main near Blumen Gardens, the project along Lincoln and Locust will work in the coordination with Somonauk Street and Park Avenue to provide three avenues of water main above 6-inches for flow to travel between Tower 1 and State Street.

Project #3 - Lincoln & Locust				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,015,983
Construction Sub-Total				$1,015,983
Contingency @ 20%				$203,197
PROBABLE CONSTRUCTION COST:				$1,219,179
ENGINEERING & ADMIN (15%)				$182,877
PROBABLE PROJECT COST:				**$1,402,056**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 4"	3,243	FT	$11	$35,673
Parking Lot Rehab	89	SQ YD	$48	$4,267
Hot-Mix Asphalt Class D Patch	144	SQ YD	$48	$6,912
HMA Driveway Pavement, 2", Remove & Replace	210	SQ YD	$34	$7,088
PCC Curb & Gutter, Remove & Replace	649	FT	$45	$29,187
Trench Backfill, Patch	257	CU YD	$65	$16,736
Trench Backfill, Driveway	233	CU YD	$65	$15,167
Trench Backfill, Bedding & Over Pipe	961	CU YD	$65	$62,458
Backfill	2,032	CU YD	$40	$81,262
Parkway Restoration	1,741	SQ YD	$10	$17,413
Ductile Iron Water Main, Class 52, 8" w/ Testing	3,243	FT	$80	$259,440
Gate Valve in Vault, 8"	11	EA	$4,500	$49,500
Fire Hydrant, Complete	11	EA	$5,500	$60,500
Water Service Connection, Short	23	EA	$2,500	$57,500
Water Service Connection, Long	25	EA	$3,500	$87,500
Adjusting Existing Sanitary Services	48	EA	$1,500	$72,000
Connections to Existing System	14	EA	$7,500	$105,000
Traffic Control: 5% of Project Cost				$48,380
TOTAL WATER MAIN IMPROVEMENTS:				**$1,015,983**

4.1.4 Elm Street & DeKalb Avenue – 8-inch Main

Route 23 provides one of the main streetscapes of the City of Sycamore, and correspondingly often parallels some of the most significant water mains in the City. Near the primary downtown commercial area, Route 23 diverts north from DeKalb Avenue onto Center Cross Street. Water main along DeKalb Avenue decreases in diameter from 10-inch to 6-inch just past this intersection, before again reducing to 4-inch diameter.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Sacramento Street	6	8	200
Elm Street	4	8	175
DeKalb Avenue	4/6	8	1,725
Total	**-**	**-**	**2,100**

Upsizing water main along DeKalb Avenue after Center Cross Street to 8-inch diameter will improve east-west flow of water and allow more water to enter the downtown residential and commercial areas. Route 23 is eligible for DeKalb Sycamore Area Transportation Study (DSATS) Funding. As such, water main work should be coordinated with roadway work through this corridor to offset paving costs. Additionally, this project would replace a segment of water main the intersection of DeKalb Avenue and Elm Street that has historically presented a very high frequency of water main breaks. This will reduce overall demand on City staff over time for costly maintenance and repair.

The value derived from this project is increased by the high value locations that it will improve fire protection to; the Sycamore Fire Department, Sycamore Police Department, and DeKalb County Community Foundation are all located in close proximity along this stretch of DeKalb Avenue. Overall, this project will increase Available Fire Flow values in the region from 1,800 to 2,500 gallons per minute to well above the 3,000 gallon per minute requirement for commercial areas.

Project #4 – Elm Street and DeKalb Avenue	
Description	Total Probable Cost
SUMMARY	
SITEWORK	$710,934
Construction Sub-Total	$710,934
Contingency @ 20%	$142,187
PROBABLE CONSTRUCTION COST:	$853,121
ENGINEERING & ADMIN (15%)	$127,968
PROBABLE PROJECT COST:	**$981,089**

Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 4"	831	FT	$11	$9,141
Abandonment of Existing Water Main - 6"	1,294	FT	$13	$16,822
Parking Lot Rehab	267	SQ YD	$48	$12,800
Hot-Mix Asphalt Class D Patch	64	SQ YD	$48	$3,072
HMA Driveway Pavement, 2", Remove & Replace	140	SQ YD	$34	$4,725
PCC Curb & Gutter, Remove & Replace	425	FT	$45	$19,125
Trench Backfill, Patch	323	CU YD	$65	$20,973
Trench Backfill, Driveway	156	CU YD	$65	$10,111
Trench Backfill, Bedding & Over Pipe	630	CU YD	$65	$40,926
Backfill	1,181	CU YD	$40	$47,258
Parkway Restoration	1,013	SQ YD	$10	$10,127
Ductile Iron Water Main, Class 52, 8" w/ testing	2,125	FT	$80	$170,000
Gate Valve in Vault, 8"	8	EA	$4,500	$36,000
Fire Hydrant, Complete	8	EA	$5,500	$44,000
Water Service Connection, Short	18	EA	$2,500	$45,000
Water Service Connection, Long	17	EA	$3,500	$59,500
Adjust Existing Sanitary Services	35	EA	$1,500	$52,500
Connections to Existing System	10	EA	$7,500	$75,000
Traffic Control: 5% of Project Cost				$33,854
TOTAL WATER MAIN IMPROVEMENTS:				**$710,934**

4.1.5 Sabin & Exchange – 8/10-inch Main

Located to the east of the primary downtown stretch of the City, Sabin and Exchange streets are currently served by 4-inch water mains mostly installed in the 1950s and 1960s, with some lines dating back as far as the 1920s. Although the majority of State Street through the City is served by 10-inch water mains, the area between Sabin Street and Locust Street contains 4-inch water main. The infrastructure of 10-inch main heading to the central portion of town from Well 9 to the east stretches north around this region, connecting to Page Street. Installing continuous 10-inch water main along State Street may improve flow conveyance and reduce stagnation leading to water quality issues that are currently experienced within this region. The extents of the proposed project are highlighted in blue in Figure 4-2.

Figure 4-2: Sabin & Exchange

Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Sabin St.	4	8	1,050
Exchange St.	4/6	8	1,750
State St.	4/6	10	1,900
Governor St.	4	8	400
Total	**-**	**-**	**5,100**

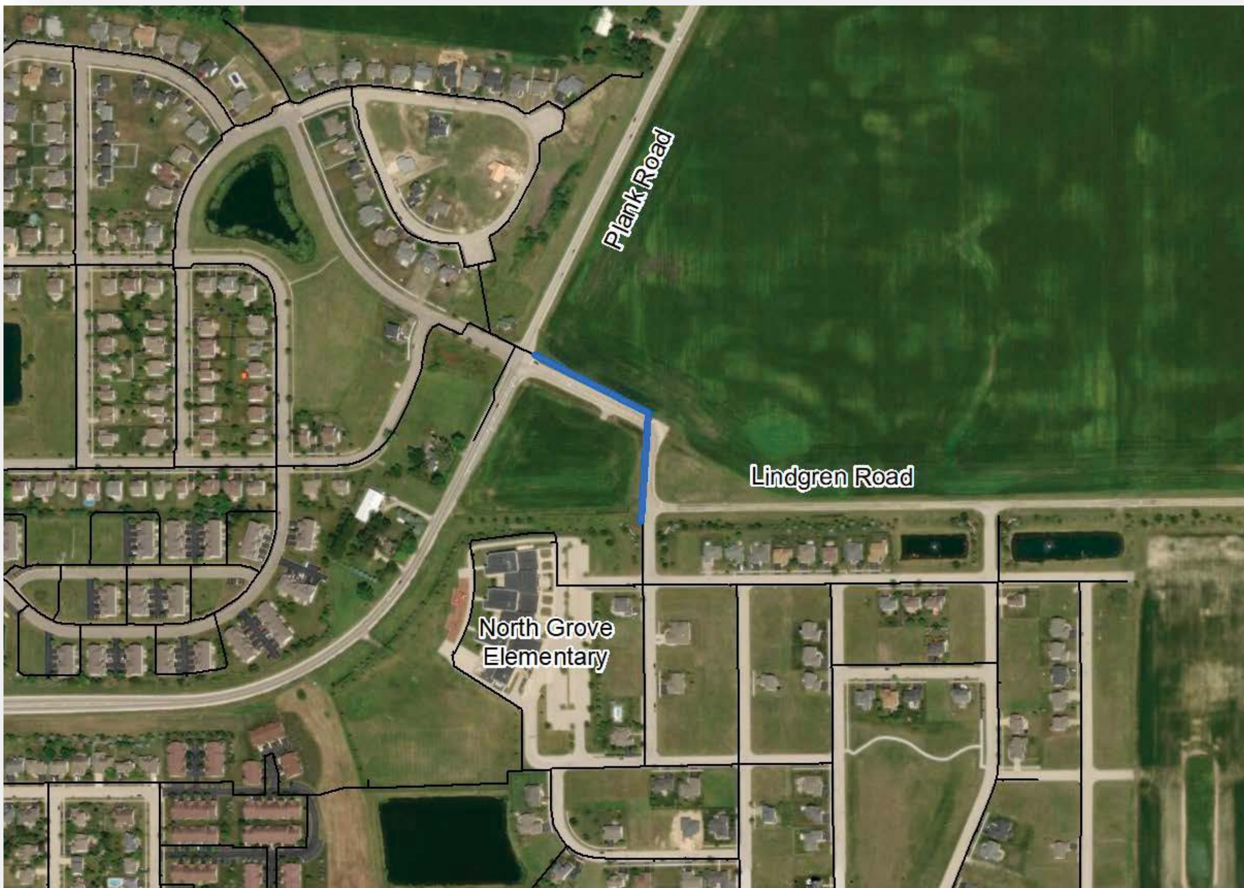
The Old School Condominiums, located along Exchange Street, currently receive Available Fire Flow values of approximately 750 gallons per minute under maximum day demand condition. Upsizing water main along Main Street to 10-inch diameter, as wells as water main along Sabin Street, Exchange Street, and Governor Street to 8-inch diameter should improve the Available Fire Flow received hydrants around this high-density residential community to in excess of 3,500 gallons per minute. The exhibit below left illustrates the currently available fire flows, while the below right illustrates the available flows anticipated following the improvement project outlined. Contours in red indicate AFF values below 1,000 gallons per minutes, yellow indicate values between 1,000 and 3,000 gallons per minute, and green indicate values above 3,000 gallons per minute.

The table below outlines the estimate of cost for execution of this project. A 20% contingency is included to account for any variations in bidding costs or unforeseen site conditions. Engineering and Administration is estimated at 15%, with 7.5% for design and 7.5% for construction. The City's Engineering Department is able to conduct some of this work in house, reducing overall costs.

Project #5 - Sabin/Exchange/Route 64				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$1,520,447
Construction Sub-Total				$1,520,447
Contingency @ 20%				$304,089
PROBABLE CONSTRUCTION COST:				$1,824,537
ENGINEERING & ADMIN (15%)				$273,680
PROBABLE PROJECT COST:				**$2,098,217**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 4"	3,948	FT	$11	$43,428
Abandonment of Existing Water Main - 6"	1,192	FT	$13	$15,496
Hot-Mix Asphalt Class D Patch	192	SQ YD	$48	$9,216
HMA Driveway Pavement, 2", Remove & Replace	290	SQ YD	$34	$9,788
PCC Curb & Gutter, Remove & Replace	1,031	FT	$45	$46,413
Trench Backfill, Patch	235	CU YD	$65	$15,253
Trench Backfill, Driveway	322	CU YD	$65	$20,944
Trench Backfill, Bedding & Over Pipe	1,528	CU YD	$65	$99,320
Backfill	3,449	CU YD	$40	$137,947
Parkway Restoration	2,956	SQ YD	$10	$29,560
Ductile Iron Water Main, Class 52, 8" w/ testing	3,251	FT	$80	$260,080
Ductile Iron Water Main, Class 52, 10" w/ testing	1,906	FT	$100	$190,600
Gate Valve in Vault, 8"	11	EA	$4,500	$49,500
Gate Valve in Vault, 10"	7	EA	$5,500	$38,500
Fire Hydrant, Complete	18	EA	$5,500	$99,000
Water Service Connection, Short	42	EA	$2,500	$105,000
Water Service Connection, Long	25	EA	$3,500	$87,500
Adjust Existing Sanitary Services	67	EA	$1,500	$100,500
Connections to Existing System	12	EA	$7,500	$90,000
Traffic Control: 5% of Project Cost:				$72,402
TOTAL WATER MAIN IMPROVEMENTS:				**$1,520,447**

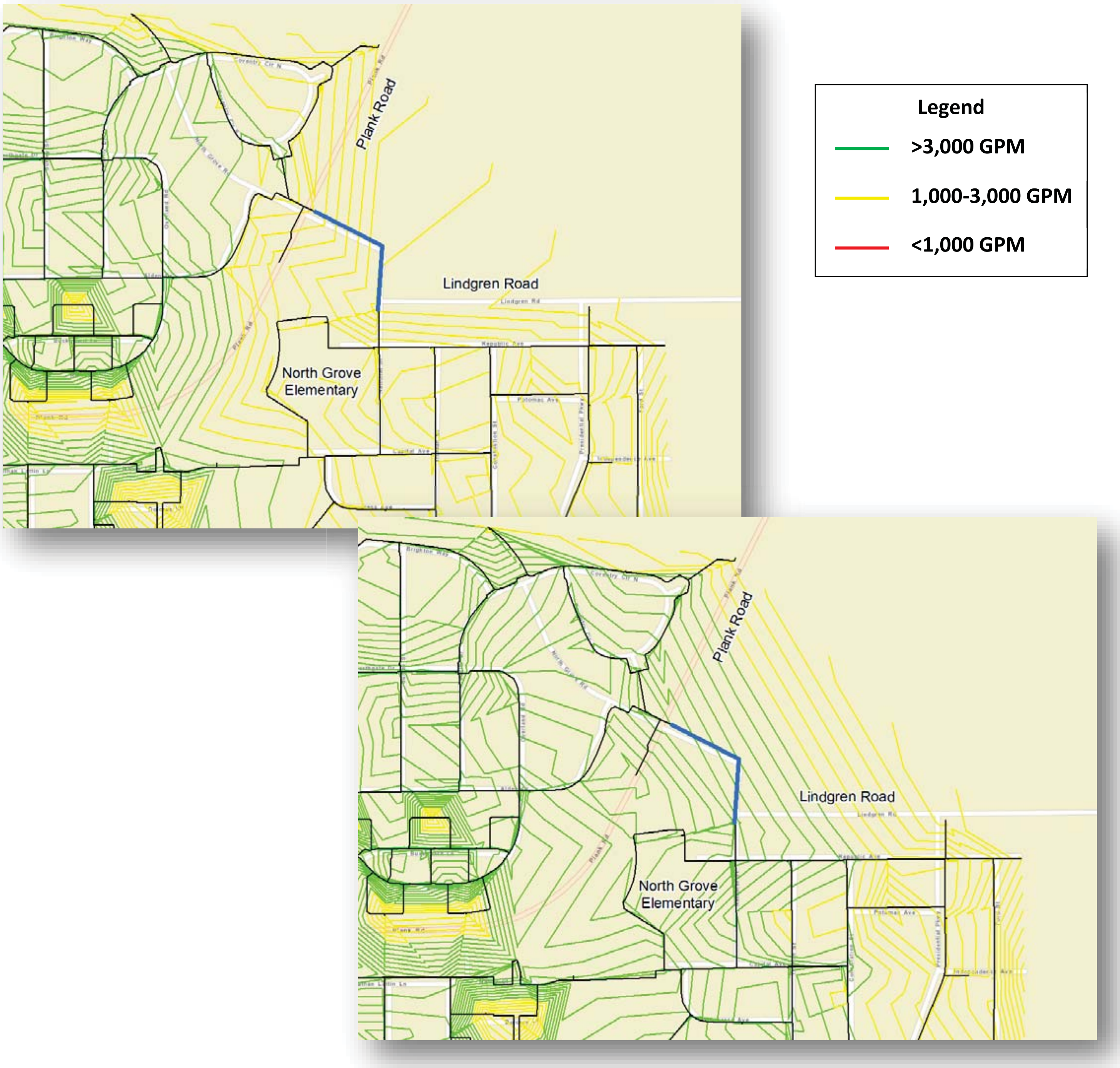
4.1.6 North Grove School Connection – 10-inch Main

Located in the northeast corner of the City, North Grove Elementary School opened in the late 2000s. The neighborhood around the Elementary School is still undergoing construction of new homes. There is 8-inch water main running throughout the neighborhood, as well as a 10-inch water main that circles around the west side of the school. Another 10-inch water main serves the adjacent neighborhood, across Plank Road. In order to maximize fire protection to the Elementary School, it is recommended to install a connecting 10-inch water main between the two neighborhoods that will cross Plank Road.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Lindgren Road	-	10	775
National Street	8	10	225
Total	**-**	**-**	**775**

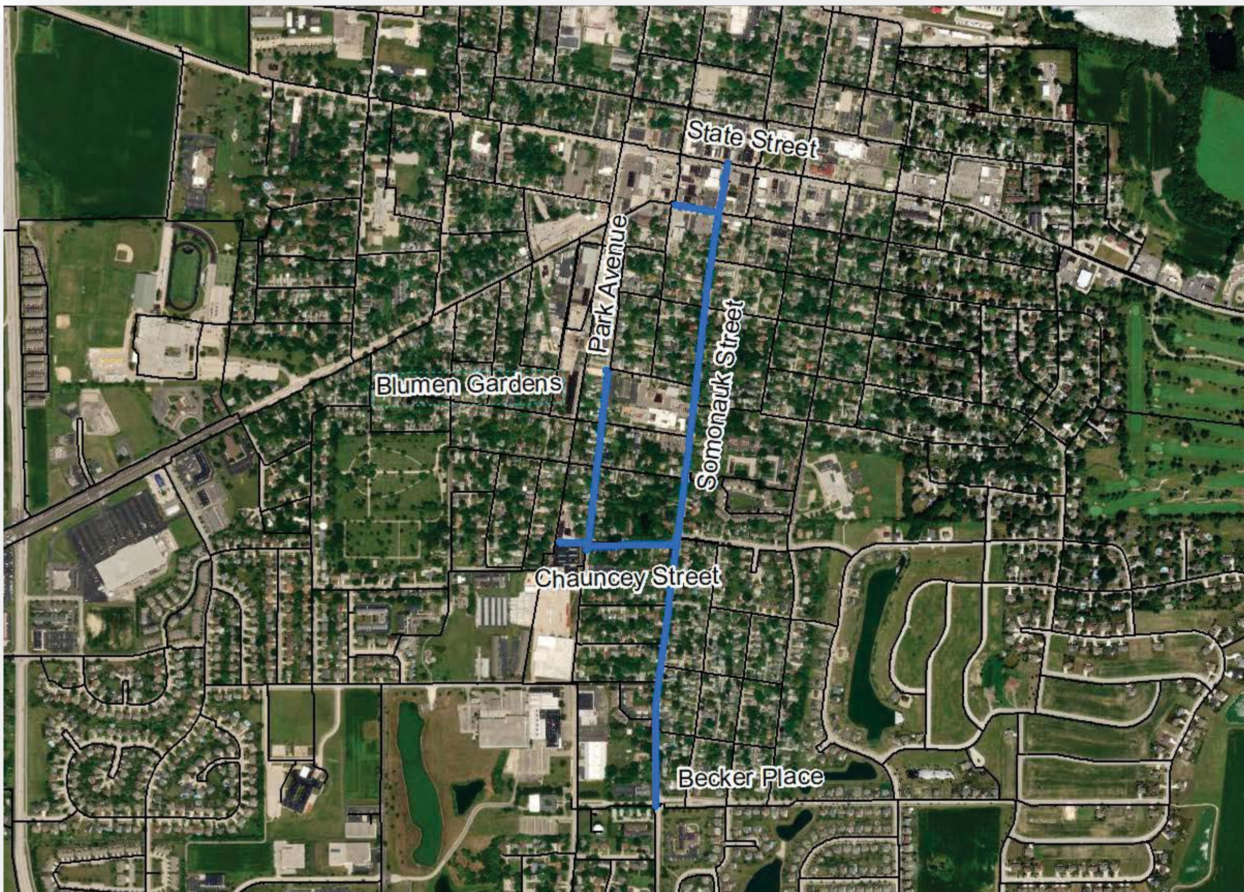
The existing distribution layout provides approximately 2,750 gallons per minute of Available Fire Flow to North Grove Elementary School, just shy of the recommended 3,000 gallons per minute. Upsizing a segment of 8-inch main along Lindgren Road and installing new 10-inch main to the intersection of Grove Road and Plank Road will allow the school to receive Available Fire Flows exceeding 3,400 gallons per minute.



Project #6 - North Grove School Connection				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$200,439
Construction Sub-Total				$200,439
Contingency @ 20%				$40,088
PROBABLE CONSTRUCTION COST:				$240,527
ENGINEERING & ADMIN (15%)				$36,079
PROBABLE PROJECT COST:				**$276,606**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	32	SQ YD	$48	$1,536
Trench Backfill, Patch	39	CU YD	$65	$2,542
Trench Backfill, Bedding & Over Pipe	237	CU YD	$65	$15,407
Backfill	585	CU YD	$40	$23,396
Parkway Restoration	501	SQ YD	$10	$5,013
Ductile Iron Water Main, Class 52, 10" w/ Testing	800	FT	$100	$80,000
Gate Valve in Vault, 10"	3	EA	$5,500	$16,500
Fire Hydrant, Complete	3	EA	$5,500	$16,500
Connections to Existing System	4	EA	$7,500	$30,000
Traffic Control: 5% of Project Cost				$9,545
TOTAL WATER MAIN IMPROVEMENTS:				**$200,439**

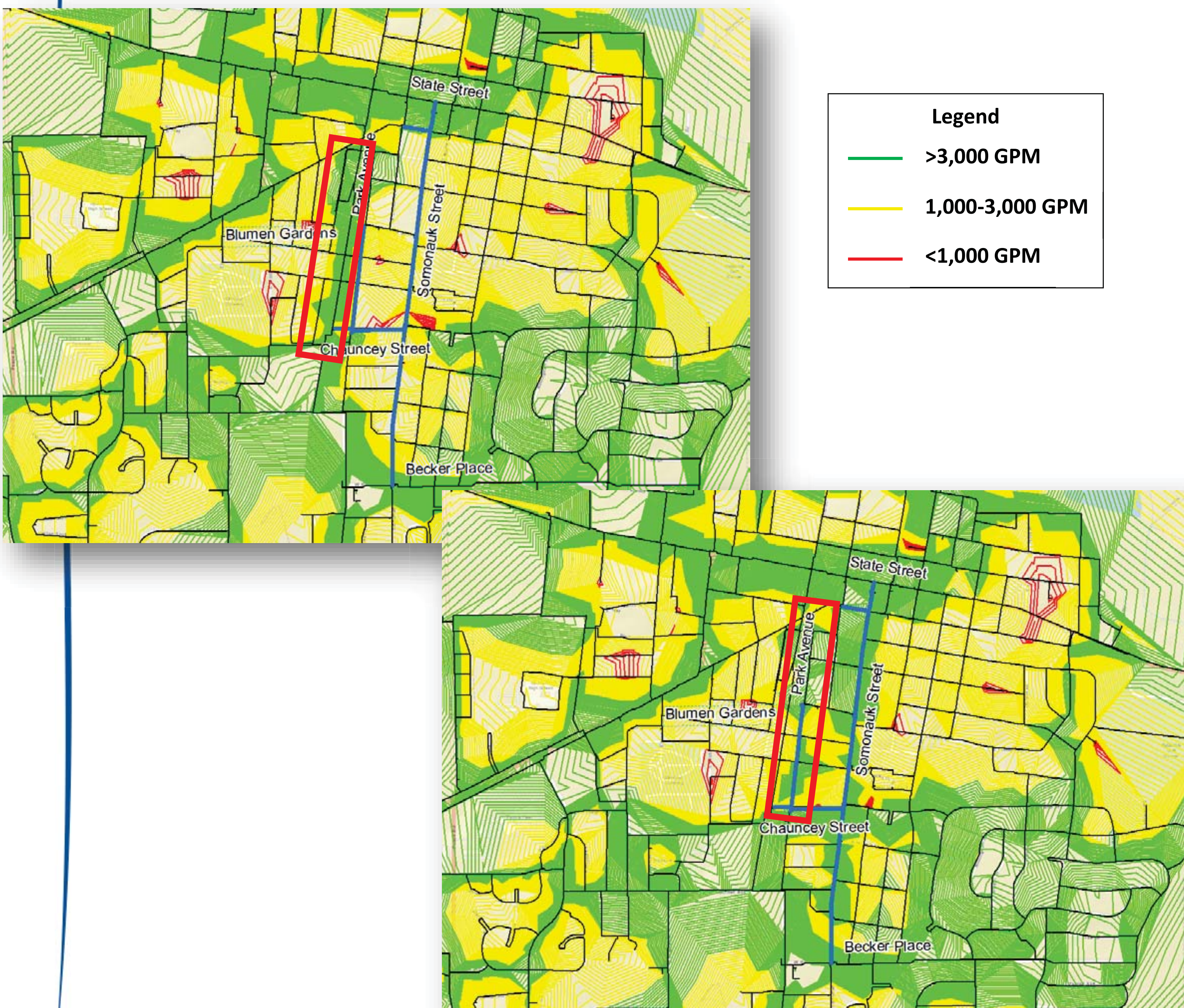
4.1.7 Somonauk Street – 8/10-inch Main

Existing infrastructure through the central portion of town consists primarily of water main over 60 years in age with a diameter of 4-inches or 6-inches, which represents the accepted design conventions during the time of installation. However, these smaller diameter mains are less capable of conveying significant amounts of flow north and south through downtown. Currently, the main that provides the greatest amount of flow from Tower 1 to the State Street commercial corridor, between Sacramento Street and Main Street, passes through an alleyway near Blumen Gardens. This alley, between Park and South Avenues, is not ideal for access to the deep main for repairs or replacement. Over time, the City indicates a preference to abandon this water main, opting for an alternative large diameter water main installation that would be easier to maintain.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Somonauk Street	4/6/8	10	5,450
Chauncey Street	4/6	8	1,300
High Street	6	10	400
Park Avenue	4	8	1,500
Total	**-**	**-**	**8,650**

In order to convey appreciable flow north from Tower 1, it is recommended to install a 10-inch water main along Somonauk Street from Becker Place to State Street. This will also create a more direct path for equalizing flow between Tower 1 and Tower 2. During high-demand events such as significant fires, the two towers will contribute the necessary flow more equally with a direct stretch of large-diameter main between them. Again, the below graphics indicate the current fire flow condition (left) and the available flows following the proposed improvements (right). The red box indicates the shift in coverage from the alleyway water main to Park Avenue with the improvements implemented.

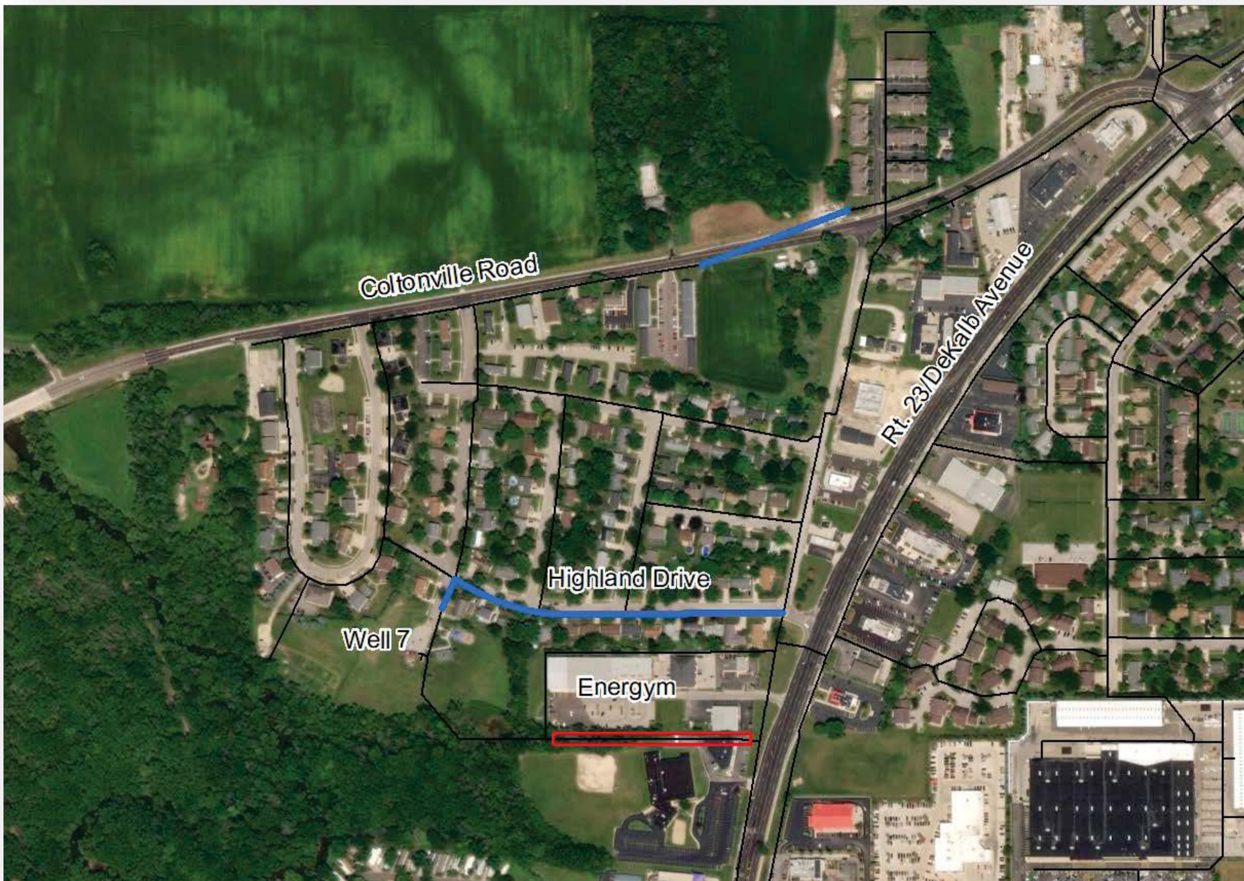


In order to abandon the 10-inch main that runs through an alleyway between Park and South Avenues, it is recommended that an alternative main be installed that can maintain commercial fire flow to properties in the area. It is recommended to upsize main on Chauncey Street between Park Avenue and Somonauk Street to 10-inches, and on Park Avenue from Chauncey Street to Waterman Street to 8-inches.

Project #7 - Somonauk Road				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$2,752,730
Construction Sub-Total				$2,752,730
Contingency @ 20%				$550,546
PROBABLE CONSTRUCTION COST:				$3,303,277
ENGINEERING & ADMIN (15%)				$495,491
PROBABLE PROJECT COST:				**$3,798,768**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 4"	3,666	FT	$11	$40,326
Abandonment of Existing Water Main - 6"	3,571	FT	$13	$46,423
Abandonment of Existing Water Main - 8"	571	FT	$15	$8,565
Abandonment of Existing Water Main - 10"	3,959	FT	$15	$59,385
Hot-Mix Asphalt Class D Patch	400	SQ YD	$48	$19,200
HMA Driveway Pavement, 2", Remove & Replace	500	SQ YD	$34	$16,875
PCC Curb & Gutter, Remove & Replace	1,540	FT	$45	$69,300
Trench Backfill, Patch	489	CU YD	$65	$31,778
Trench Backfill, Driveway	556	CU YD	$65	$36,111
Trench Backfill, Bedding & Over Pipe	2,281	CU YD	$65	$148,296
Backfill	4,939	CU YD	$40	$197,556
Parkway Restoration	4,233	SQ YD	$10	$42,333
Ductile Iron Water Main, Class 52, 8"	1,500	FT	$80	$120,000
Ductile Iron Water Main, Class 52, 10"	6,200	FT	$100	$620,000
Gate Valve in Vault, 8"	5	EA	$4,500	$22,500
Gate Valve in Vault, 10"	21	EA	$5,500	$115,500
Fire Hydrant, Complete	26	EA	$5,500	$143,000
Water Service Connection, Short	63	EA	$2,500	$157,500
Water Service Connection, Long	80	EA	$3,500	$280,000
Adjust Existing Sanitary Services	143	EA	$1,500	$214,500
Connections to Existing System	31	EA	$7,500	$232,500
Traffic Control: 5% of Project Cost				$131,082
TOTAL WATER MAIN IMPROVEMENTS:				**$2,752,730**

4.1.8 Electric Park – 8/10-inch Main

As will be discussed in Section 5 of this report, restoration of Well 7 would improve the City's resiliency and the overall ability of the distribution system to respond to adverse conditions. Through conversation with City staff, TAI learned that startup of Well 7 in the past has led to main breaks throughout the Electric Park neighborhood due to transient pressure waves. Transient waves occur when there is a sudden change in the supply of water, creating a pocket of built up pressure that then propagates back toward the point that has changed the water supply. This creates a drastic swing on the pressure exerted on the water main. Water main in this area typically exceeds 50 years in age and has displayed an increasing frequency of breaks even without Well 7 in operation. Upsizing of water main and replacing old segments will reduce main breaks by subjecting older mains to less pressure variation.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Willow Street	8	10	100
Coltonville Road	-	8	525
Backyard Main Abandonment (red)	-	-	725
Highland Drive	6	10	1,100
Total	**-**	**-**	**1,725**

The proposed water main rehabilitation project that will maximize the benefit of bringing Well 7 online includes upsizing of water main along Willow Street and Highland Drive from the well to the 10-inch water main along DeKalb Avenue. This continuous stretch of 10-inch main would be the primary path of flow leaving the well. This would also allow the City to abandon the 10-inch water main that currently runs south of the well, along the back side of what is currently Energym Gymnastics. The main is highlighted in red in the associated exhibits. This backyard water main has previously broken and is difficult for the City to maintain as it runs through a forested area. It is also recommended to clear trees and brush away in the area to improve access for main breaks.

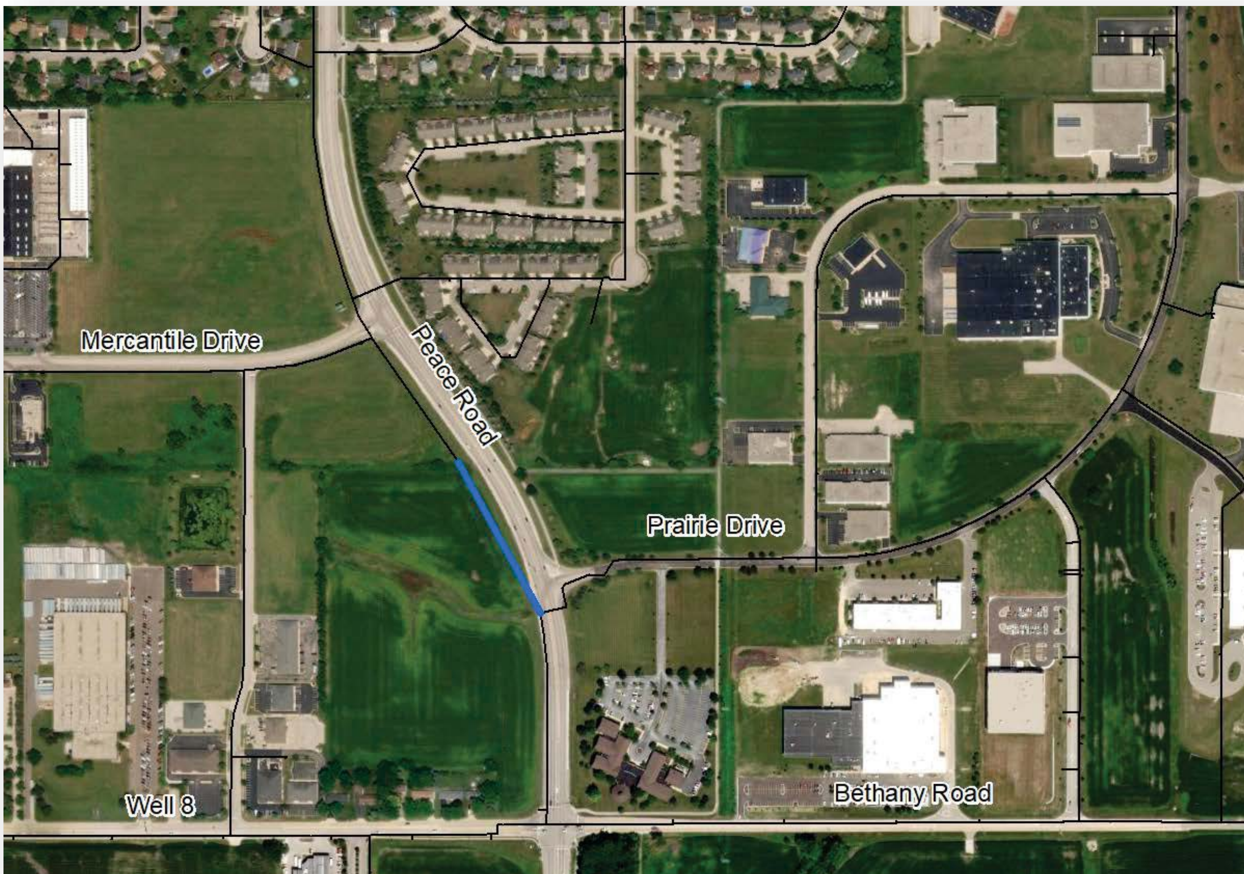
Along with water main along Willow Street and Highland Drive, TAI recommends installing a connecting water main along Coltonville Road. There is currently a gap in the water main from the Richport apartments to Ridge Drive. Installing a continuous 8-inch water main here would eliminate two dead ends and help to reduce the risk of main breaks due to transient waves when Well 7 is in operation.

Project #8 - Electric Park	
Description	Total Probable Cost
SUMMARY	
SITEWORK	$624,467
Construction Sub-Total	$624,467
Contingency @ 20%	$124,893
PROBABLE CONSTRUCTION COST:	$749,361
ENGINEERING & ADMIN (15%)	$112,404
PROBABLE PROJECT COST:	**$861,765**

Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 6"	1,136	FT	$13	$14,768
Abandonment of Existing Water Main - 8"	107	FT	$15	$1,605
Hot-Mix Asphalt Class D Patch	144	SQ YD	$48	$6,912
HMA Driveway Pavement, 2", Remove & Replace	170	SQ YD	$34	$5,738
PCC Curb & Gutter, Remove & Replace	355	FT	$45	$15,957
Trench Backfill, Patch	176	CU YD	$65	$11,440
Trench Backfill, Driveway	189	CU YD	$65	$12,278
Trench Backfill, Bedding & Over Pipe	525	CU YD	$65	$34,147
Backfill	1,013	CU YD	$40	$40,507
Parkway Restoration	868	SQ YD	$10	$8,680
Ductile Iron Water Main, Class 52, 8" w/ Testing	530	FT	$80	$42,400
Ductile Iron Water Main, Class 52, 10" w/ Testing	1,243	FT	$100	$124,300
Gate Valve in Vault, 8"	2	EA	$4,500	$9,000
Gate Valve in Vault, 10"	5	EA	$5,500	$27,500
Fire Hydrant, Complete	6	EA	$5,500	$33,000
Water Service Connection, Short	16	EA	$2,500	$40,000
Water Service Connection, Long	12	EA	$3,500	$42,000
Adjust Existing Sanitary Services	28	EA	$1,500	$42,000
Connections to Existing System	11	EA	$7,500	$82,500
Traffic Control: 5% of Project Cost				$29,737
TOTAL WATER MAIN IMPROVEMENTS:				**$624,467**

4.1.9 Mercantile to Prairie Connection – 10-inch Main

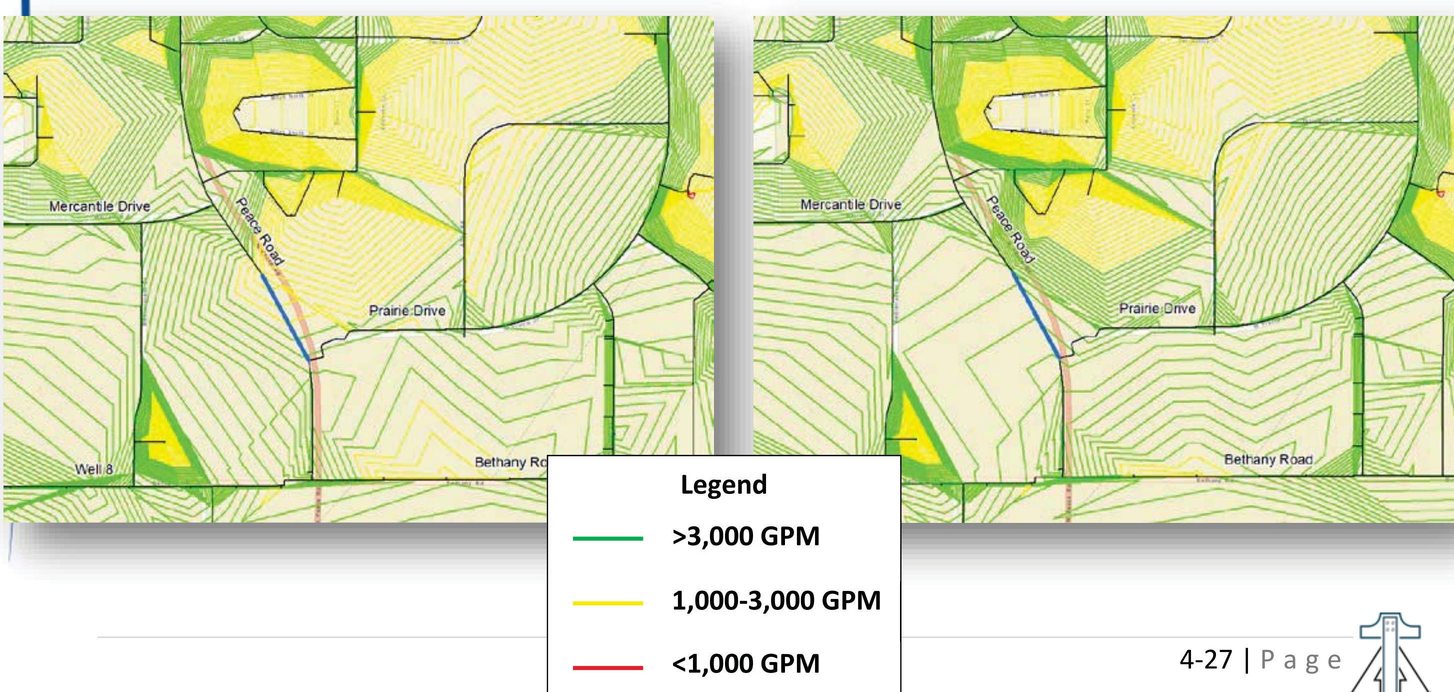
In the existing distribution system, there is a gap of approximately 700 feet between two 10-inch water main segments along Peace Road. The northern end appears to have been stubbed to allow for this connection in the past, south of the intersection of Mercantile Drive and Peace Road. To the south, the 10-inch main turns east at the intersection of Peace Road and Prairie Drive. Installing a continuous 10-inch water main through the area would allow for a second path for water to flow north directly from Well 8, which is located just west of the intersection of Bethany Road and Mediterranean Drive. A 10-inch main currently runs along Mediterranean Drive but connecting the water mains along Peace Road will allow for redundancy and better looping through the area.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Peace Road	-	10	700
Total	**-**	**-**	**700**

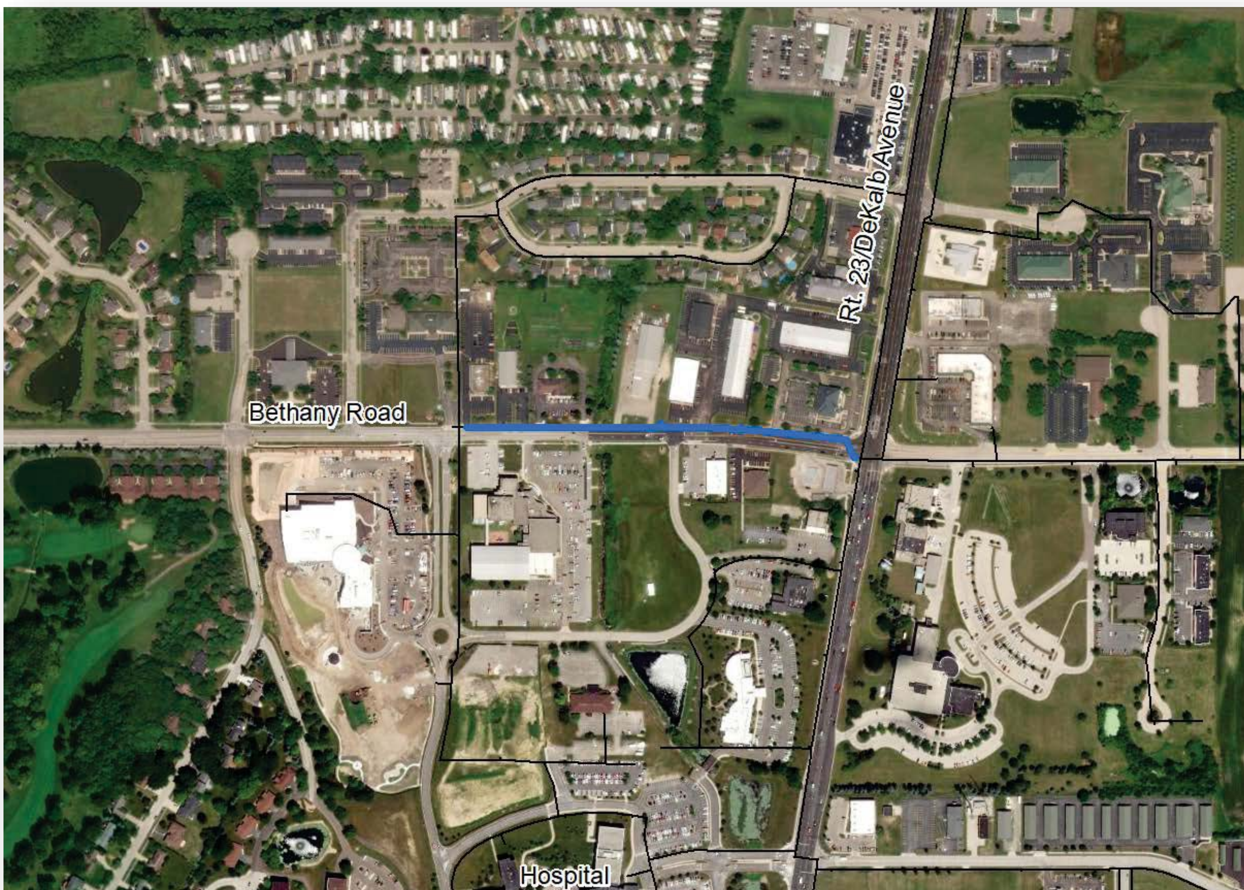
Project #9 - Mercantile to Prairie Connection	
Description	Total Probable Cost
SUMMARY	
SITEWORK	$181,501
Construction Sub-Total	$181,501
Contingency @ 20%	$36,300
PROBABLE CONSTRUCTION COST:	$217,802
ENGINEERING & ADMIN (15%)	$32,670
PROBABLE PROJECT COST:	**$250,472**

Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Hot-Mix Asphalt Class D Patch	16	SQ YD	$48	$768
PCC Curb & Gutter, Remove & Replace	140	FT	$45	$6,300
Trench Backfill, Patch	20	CU YD	$65	$1,271
Trench Backfill, Bedding & Over Pipe	207	CU YD	$65	$13,481
Backfill	526	CU YD	$40	$21,031
Parkway Restoration	451	SQ YD	$10	$4,507
Ductile Iron Water Main, Class 52, 10" w/ Testing	700	FT	$100	$70,000
Gate Valve in Vault, 10"	3	EA	$5,500	$16,500
Fire Hydrant, Complete	3	EA	$5,500	$16,500
Connections to Existing System	3	EA	$7,500	$22,500
Traffic Control: 5% of Project Cost				$8,643
TOTAL WATER MAIN IMPROVEMENTS:				**$181,501**



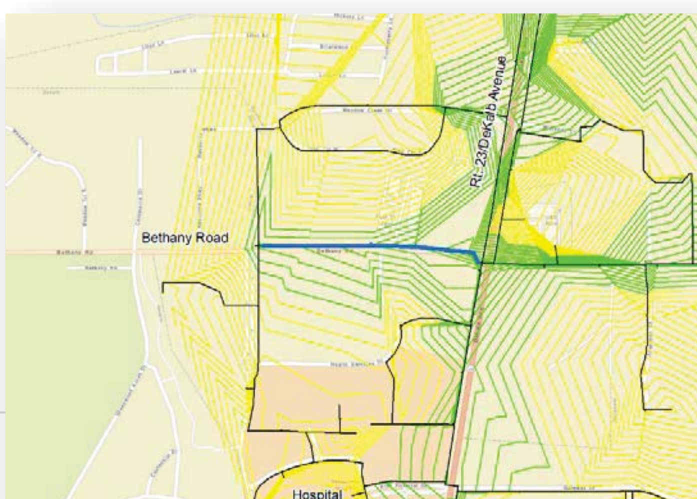
4.1.10 Bethany Rd. (Rt. 23 to Health Club) – 10-inch Main

The 10-inch water main along Bethany Road, west of the intersection with Route 23, has displayed a high frequency of main breaks in recent years. This water main provides flow to the north end of the Northwestern Medicine Kishwaukee Hospital complex. Replacing this water main should reduce the frequency of water main breaks along this stretch. This will allow for consistent supply of the maximum level of fire protection to the fire from Well 8 and Tower 1 to the east. TAI recommends replacing the existing 10-inch main with the same diameter main. This will minimally affect fire flows through the region, as the older pipe is likely tuberculated and buildup may be contributing to head loss along the length of the pipe. However, these differences are not expected to be appreciable, and the water main in the area is capable of provided the recommended 3,000 gallons per minute of commercial Available Fire Flow. This project should be targeted for completion when the maintenance costs and service outages exceed the cost of the project.



Street Name	Current Diameter (in.)	Updated Diameter (in.)	Length (ft.)
Bethany Road	10	10	1,500
Total	**-**	**-**	**1,500**

Project #10 - Bethany from Rt. 23 to Health Club				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$414,344
Construction Sub-Total				$414,344
Contingency @ 20%				$82,869
PROBABLE CONSTRUCTION COST:				$497,212
ENGINEERING & ADMIN (15%)				$74,582
PROBABLE PROJECT COST:				**$571,794**
Description	Quantity	Unit	Unit Price	Total Cost
SITEWORK				
Abandonment of Existing Water Main - 10"	1,450	FT	$17	$24,650
Hot-Mix Asphalt Class D Patch	32	SQ YD	$48	$1,536
HMA Driveway Pavement, 2", Remove & Replace	80	SQ YD	$34	$2,700
PCC Curb & Gutter, Remove & Replace	290	FT	$45	$13,050
Trench Backfill, Patch	39	CU YD	$65	$2,542
Trench Backfill, Driveway	89	CU YD	$65	$5,778
Trench Backfill, Bedding & Over Pipe	430	CU YD	$65	$27,926
Backfill	997	CU YD	$40	$39,884
Parkway Restoration	855	SQ YD	$10	$8,547
Ductile Iron Water Main, Class 52, 10" w/ Testing	1,450	FT	$100	$145,000
Gate Valve in Vault, 10"	5	EA	$5,500	$27,500
Fire Hydrant, Complete	5	EA	$5,500	$27,500
Water Service Connection, Short	7	EA	$2,500	$17,500
Water Service Connection, Long	5	EA	$3,500	$17,500
Adjust Existing Sanitary Services	12	EA	$1,500	$18,000
Connections to Existing System	2	EA	$7,500	$15,000
Traffic Control: 5% of Project Cost				$19,731
TOTAL WATER MAIN IMPROVEMENTS:				**$414,344**



Legend

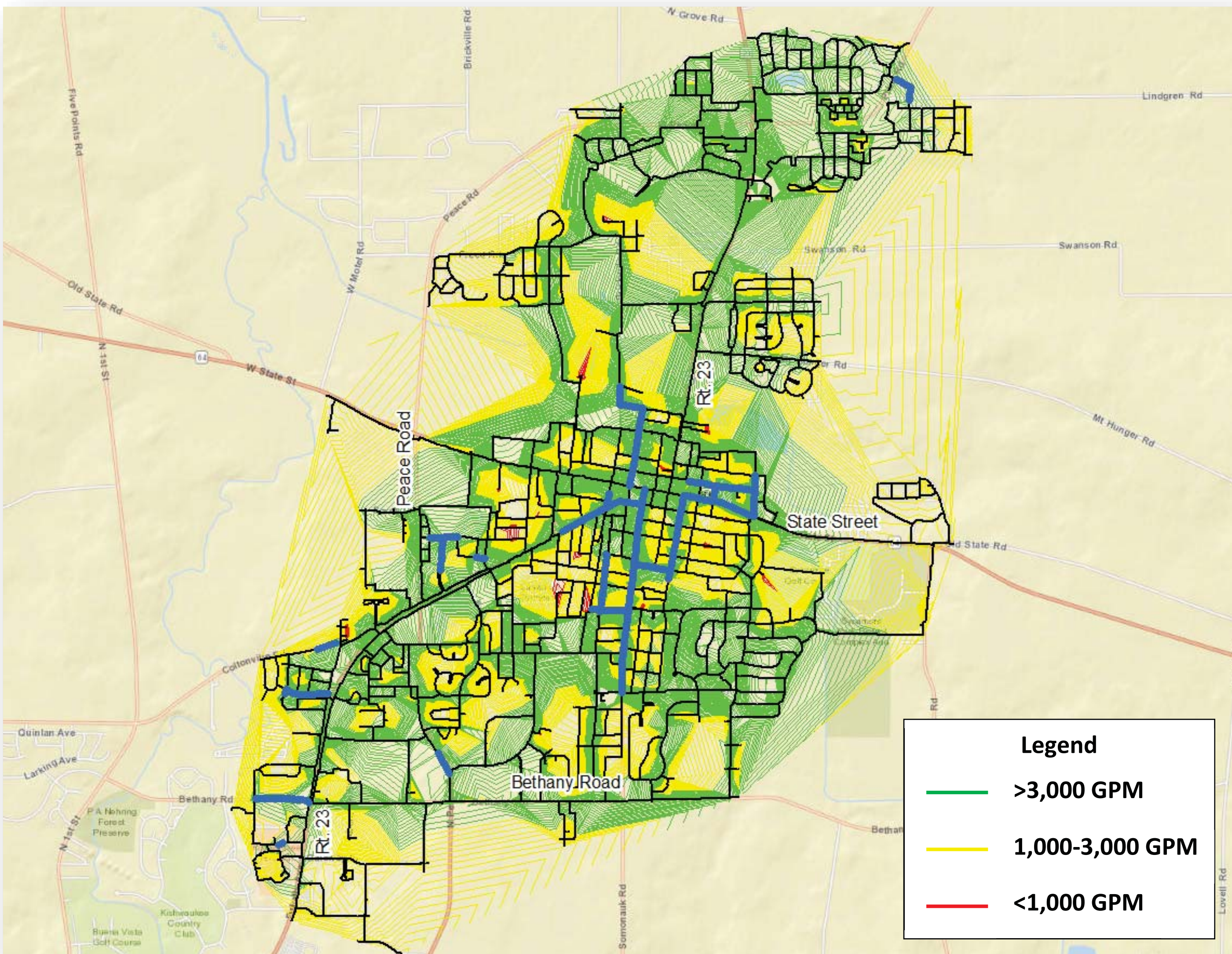
- >3,000 GPM
- 1,000-3,000 GPM
- <1,000 GPM

Summary of Water Main Fire Flow Improvements

If the above identified improvements were completed, the resulting fire flow map would be as shown below. The outlined project locations are highlighted in blue.

As indicated the majority of the areas with less than 1,000 gpm (red) of available fire flow have been eliminated with negligible areas remaining. Additionally, most of the downtown and outlying commercial areas have been increased to over 3,000 gpm of available fire flow.

Figure 4-3: Available Fire Flows - Projects Completed



Impacts of Upsizing Water Mains Throughout the System

The City has adopted minimum fire flow requirements of generally 1,000 gpm in residential neighborhoods and 3,000 gpm in commercial/industrial/institutional areas and are set through the Insurance Services office (ISO) fire standards. Currently the City has adopted the 2015 ISO Fire Standards. The majority of residential areas in the heart of the downtown area have sufficient fire flow protection in excess of 1,200 gpm. The ISO provides this information through the Public Protection Classification (PPC) program. The PPC program provides classification for the overall water system ranging for 1-10. Class 1 generally represents excellent fire protection, and Class 10 indicates that the area's fire-suppression program doesn't meet ISO's minimum certification criteria. The City has participated in the ISO evaluation for several years. In an effort to continue the improvement of the overall water system the City is anticipating regularly updating the water distribution model.

The water mains in these older residential areas were constructed with 4-inch and 6-inch diameter pipes. The distribution system includes roughly 6 miles of 4-inch diameter and 30 miles of 6-inch diameter water main. Not only are these mains of inadequate size, but for the most part also have reached the end of their useful service life; their replacement should be planned.

Figure 4-5 illustrates the impact on fire flows throughout the City's water distribution system of replacing all 4-inch and 6-inch water mains with larger 8-inch piping. Upon completion, the water system would have capacity to provide all residential areas with fire flows in excess of 1,500 gpm, and most all commercial locations with over 3,000 gpm.

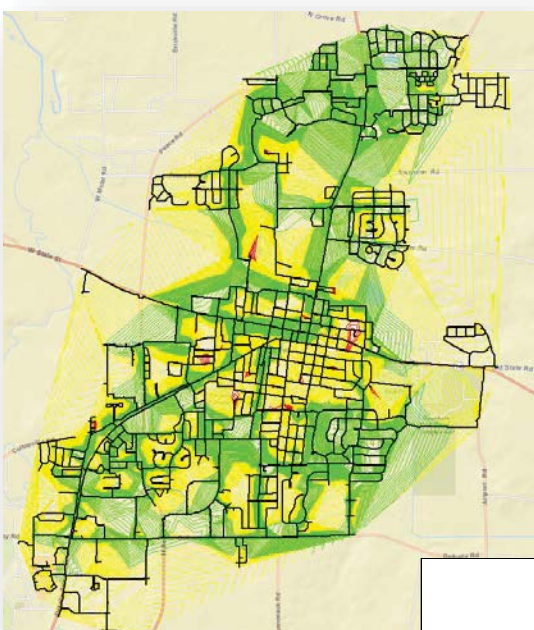
Prioritization of the capital improvements projects should be based upon the City's knowledge and understanding of the age and condition of the undersized pipe segments. The WaterCAD model in indicates that within areas of undersized water main, available flows are primarily uniform but deficient to convey necessary fire flows. No one particular area seems to contain a particularly restrictive hydraulic condition. For this reason, additional criterion such as corrosive soils, high-capacity users, and potential need for emergency services should be used to prioritize projects.

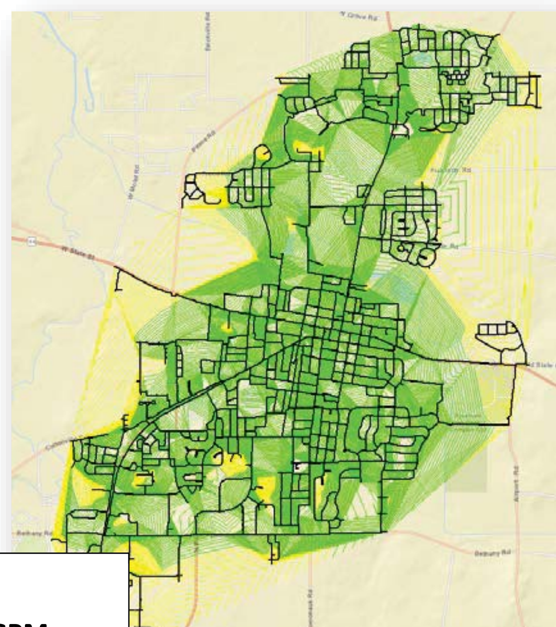
There exists approximately 190,000 lineal feet of 4-inch and 6-inch water main in the system. The replacement cost for the 4-inch and 6-inch water main is listed in total to be $47 million. The replacement cost for fire hydrants and water valves in these areas is estimated at $6 million for a total program cost of $53 million. The most cost-effective way to complete these projects is to coordinate them with other capital improvement projects such as roadway construction or development, reducing overall pavement restoration costs incurred by the City. Other cost saving options include inhouse design/construction or coordination with proposed developments.

Utilizing the $1.91 million annual investment to maintain all infrastructure components within a 75-year service life described in Section 3, it's estimated that the $53 million project cost of replacing 4-inch and 6-inch water main would be completed over the first 28 years, approximately. This date range may be shifted due to prioritization of other significant projects, such as those described throughout Section 4 of this report. The 28-year plan to replace the pipes would include the replacement of 6,800 l.f. per year.

Probable capital costs for an example annual water main replacement project are presented in the table on the following page.

Upsize 4 & 6-inch Water Main Improvements				
Description				Total Probable Cost
SUMMARY				
SITEWORK				$38,819,557
SUBTOTAL CONSTRUCTION				$38,819,557
CONTINGENCY @ 20%				$7,763,911
ENGINEERING @ 15%				$5,822,934
CONSTRUCTION TOTAL				**$52,406,402**
Description	Quantity	Unit	Unit Price	Total Probable Cost
SITEWORK				
Abandonment of Existing Water Main - 4"	32867	FT	$11	$361,537
Abandonment of Existing Water Main - 6"	157979	FT	$13	$2,053,727
Ductile Iron Water Main, Class 52, 8"	190846	L.F.	$100	$19,084,600
Gate Valve in Vault, 8"	637	EA	$4,500	$2,866,500
Fire Hydrant, Complete	637	EA	$5,500	$3,503,500
Trench Backfill	56575	C.Y.	$65	$3,677,390
Pavement Removal and Replacement	63615	S.Y.	$100	$6,361,533
Landscape Restoration	84820	S.Y.	$15	$1,272,307
PROJECT TOTAL				$38,819,557





Legend

>3,000 GPM

1,000-3,000 GPM

<1,000 GPM

4.2 Prioritization of Distribution System Improvement Projects

In order to objectively rank the identified distribution system capital improvement projects, the below prioritization matrix was created. Through work sessions with City staff, the following ten criteria were identified as most important when selecting a project:

1. Public Safety/Available Fire Flow – The relative ability of the existing water main to supply the needed Available Fire Flow.
2. Right of Way/Legal Access – Whether or not the City currently has access to the route outlined in the improvement proposal.
3. Water Quality – Replacement of main associated with water quality complaints.
4. Water Main Age – With main installed in the 1960's approaching the end of its service life.
5. Main Break Frequency – Replacement of main breaking often reduces staff labor and expense.
6. Road Program – Ranked higher if the project corresponds with a project on the City's roadway rehabilitation program.
7. System Benefit – The overall benefit that the project will have on, not just surrounding areas, but the system as a whole.
8. Public Benefit (Value) – The impact of the proposed project when compared to the overall cost of implementation.
9. Public Benefit (Population) – Weighted in comparison to the population within the City that will derive a benefit from completion of the project.
10. Construction Offsets – The ability to complete work with Public Works crews or to offset costs using redevelopment connection costs. This will reduce total cost but may require schedule adjustment.

Each of these criteria were then weighted with a 1-10 factor (as indicated in the list above), with the higher number indicating the greater weight. The 10 projects were then given a score from 1-5 for each of the criteria, which were then multiplied by the weight factor and added together to arrive at a total score or "Criticality Index."

As illustrated in the table on the following page, the projects ranged in criticality from 77 to 217, with the three highest projects being the California and Brickville, Sycamore High School, and Lincoln & Locust. The estimated project costs for these three projects are $1.43 Million, $0.68 Million, and $1.40 Million, respectively.

The City should look to budget for each of the 10 projects to be implemented as part of a total capital improvement plan. The larger projects could be broken into multiple phases in order to make them financially manageable.

The prioritization table listed on the next page represents the 10 projects identified for implementation but can also be used as a guideline for identifying future projects. The listed criteria can be applied for other areas of concern in the future to assist with further project scheduling.

	Project Description	Capital Cost	Project Selection Criteria										Total Score	Ranking
			Public Safety/AFF	Easement/ROW/Legal Access	Water Quality	Water Main Age	Main Break Frequency	Road Program	System Benefit	Public Benefit (Value)	Public Benefit (Pop.)	Construction Offsets		
			10	1	2	6	4	7	8	9	3	5		
1	California/Brickville/North	$1,430,000	3	5	3	4	5	4	5	5	3	2	217	1
2	Sycamore HS	$680,000	4	5	3	5	3	1	4	5	4	5	214	2
3	Lincoln/Locust	$1,400,000	5	5	3	5	2	2	5	3	4	1	197	3
4	Elm Street/Police Department	$980,000	2	5	4	4	4	4	4	4	5	1	189	4
5	Sabin/Exchange	$2,100,000	5	5	5	4	3	4	2	3	3	1	186	5
6	North Grove School 10" Connection	$280,000	5	3	2	1	1	1	3	5	5	5	183	6
7	Somonauk Rd	$3,800,000	2	5	3	5	2	2	5	5	3	1	182	7
8	Electric Park	$860,000	2	3	5	3	4	1	4	4	4	1	159	8
9	Mercantile to Prairie Connection	$250,000	1	4	1	1	1	1	2	1	1	4	81	9
10	Bethany from 23 to Health Club	$570,000	1	5	1	1	4	1	1	1	3	1	77	10
		$12,350,000												

SECTION 5

EVALUATION OF WATER SUPPLY, TREATMENT, AND STORAGE FACILITIES

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5. Evaluation of Existing Water Supply, Treatment & Storage Facilities

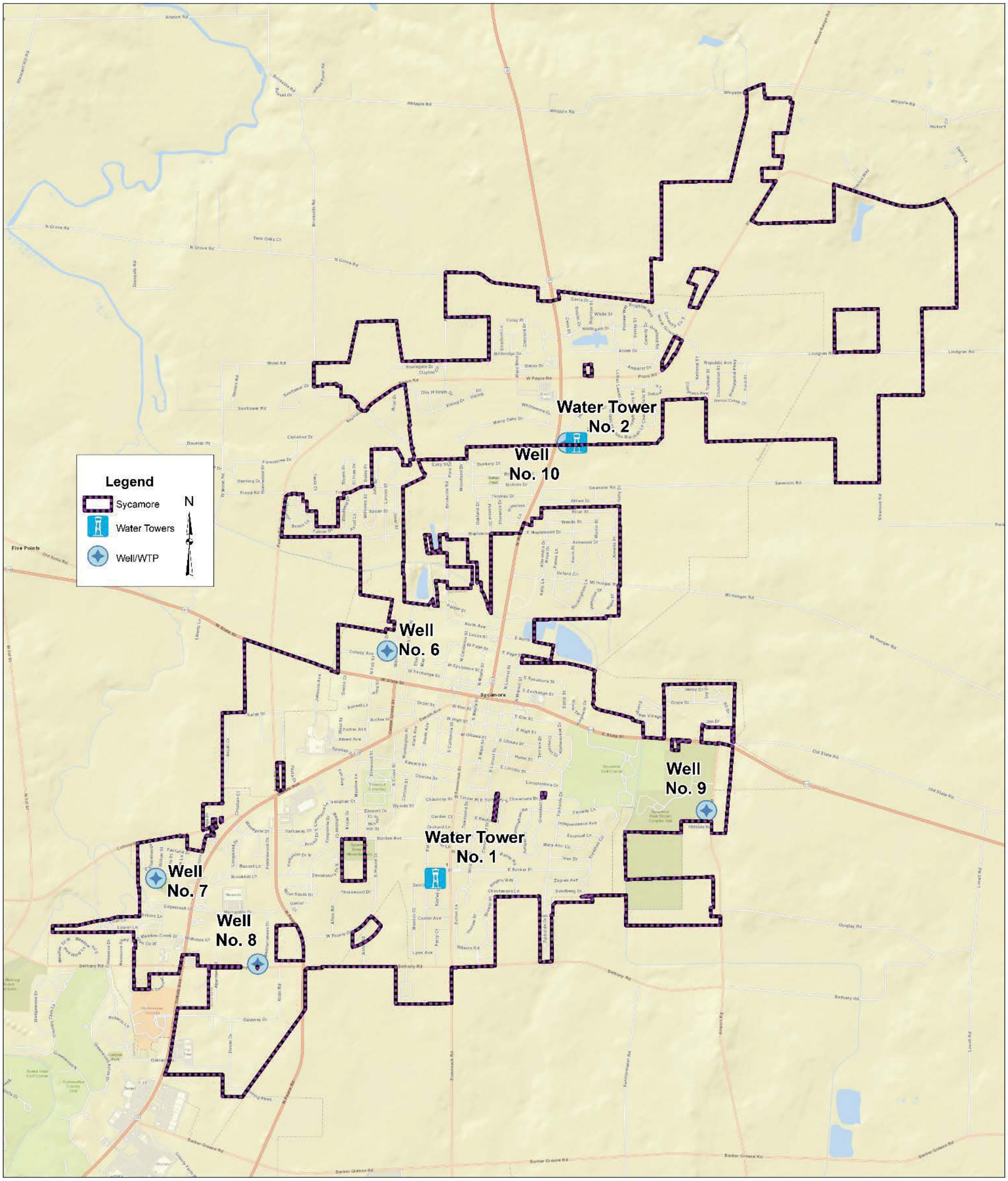
5.1 General Water System Information

The City of Sycamore's water supply, treatment and storage system consists of five wells, of which four wells are currently in service, four water treatment facilities, a 0.75 MG multi-column water tower, and a 1.5 MG spheroid water tower. As with most municipal water supplies, the existing infrastructure has been constructed over several decades and the components within the system vary in age.

The source water from all of the City's wells meets all regulatory requirements set by the EPA for drinking water, with the exception of radium concentration. The City's raw water was previously found to contain radium levels above the USEPA Maximum Contaminant Level (MCL) of 5 pCi/L. This resulted in the implementation of four radium removal treatment facilities, provided and maintained by Water Remediation Technology, LLC (WRT). After flowing through the WRT treatment units, the water from each well is also disinfected, dosed with fluoride, and phosphate before it is distributed.

Overall, the City's five wells and two water towers have been strategically placed throughout the City's service area and many improvements were made since the previous water study was conducted in 2007. At the time, the treatment facilities were in construction, Well #5, 6, 7, 8, and 9 supplied the City's water system, and only the 0.75 MG tower existed. The previous plan projected future populations to grow at an annual rate of 4.1% and recommended the construction of a new 800-1,300 gpm well along with a new 1.0 MG elevated storage tank. The City experienced a lower annual growth rate of about 1.7%, and since then, Well #5 was removed from service due to repeated issues with sand, and the inability to rehabilitated it, as a result a new 1,200 gpm well (Well #10) was constructed, and the 1.5 MG spheroid tower was built. Section 5.4.3 of this report will identify alternatives for future water storage capacity needs.

The exhibit on the following page shows the current, active sites of each well and elevated storage towers. At this time, Well #7 is currently offline due to elevated radium concentration. At the time the WRT systems were installed, Well #7 was operating under the 5 pCi/L limit, and since the installation of the WRT treatment systems, it could not meet IEPA MCL limits. Section 6 of this report will identify alternatives for returning Well #7 to service.


Legend
Sycamore
Water Towers
Well/WTP
N
Water Tower No. 2
Well No. 10
Well No. 6
Well No. 9
Water Tower No. 1
Well No. 7
Well No. 8

5.2 WATER SYSTEM CAPACITIES

5.2.1 Current Well Capacities

Each of the active wells in the City of Sycamore are currently being operated near or at the original design point. As stated previously, Well #7 is out of operation due to elevated radium levels. The current active well capacities under existing conditions are indicated in Table 5-1 below. The system's current design capacity equates to 6.84 MGD, while the system's firm capacity equates to 4.9 MGD with Well #9 offline. The recommended firm capacity is the minimum amount of well production available with the largest well out of service (Well #9).

Section 2.3 of this report outlines the current average daily demand and maximum day demand for the City to be 1.9 MGD and 3.93 MGD, respectively. With respect to the maximum day demand of 3.93 MGD, the recommended firm capacity for the City is 4.0 MGD. Even with Well #7 and 9 out of service, the City can provide adequate water supply to their consumers, easily satisfying the average daily demands. To determine if the system capacity is sufficient for maximum day demands, a diurnal peak curve is used, which is discussed later in this Section.

Although the current system capacity is sufficient for the City's current customers, the City must also evaluate the capacity for increased demands in the future. This evaluation is included in Section 5.2.2.

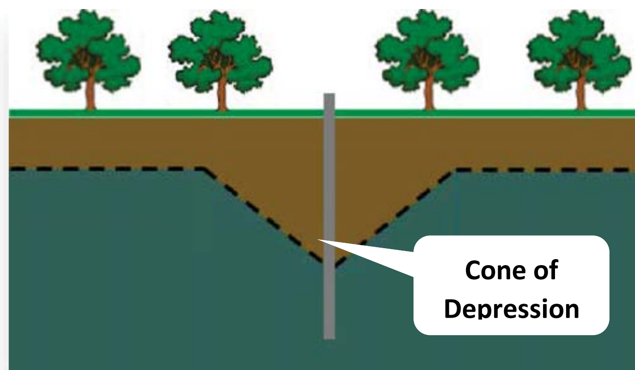
Each of the WRT systems have been designed to exceed the existing well capacity for each location, with the exception of Well #9. Therefore, the limiting factor for water production is limited to the well, and not the WRT system.

Table 5-1: Current Well Capacity

Well	Well Design Capacity (GPM)	Well Design Capacity (MGD)	WRT Design Capacity (GPM)	WRT Design Capacity (MGD)	System Firm Capacity (GPM)	System Firm Capacity (MGD)
6	1,000	1.44	1,000	1.44	1,000	1.44
7	-	-	-	-	-	-
8	1,200	1.73	1,350	1.94	1,200	1.73
9	1,350	1.94	1,300	1.87	-	-
10	1,200	1.73	1,300	1.87	1,200	1.73
Total	**4,750**	**6.84**	**4,950**	**7.12**	**3,400**	**4.90**

18-Hour Run Time Capacity

Figure 5-1: Cone of Depression



Traditionally, a community's firm system capacity is a function of the capacity remaining with the largest well out of service and is based on a 24-hour run time for each well. During this period the community must be capable of meeting the maximum day demand. Peak hour demands are typically met by drawing from elevated storage.

When running a well for a long duration (days), the aquifer can be stressed and start to create a **cone of depression** (see figure to the right). A cone of depression occurs when the aquifer water surface elevation begins to drop near the well due to the inability to recharge adequately. When a system experiences a depressed aquifer, it can result in lower pumping capacities. Therefore, this evaluation will also consider well capacity on an 18-hour run time basis in addition to the traditional 24-hour cycle. While the City of Sycamore has not experienced significant capacity reductions during periods of extended pumping, it should still be recognized during planning efforts.

The table below illustrates the well capacities updated to reflect a maximum 18-hour run time. Additionally, the far-right column represents the production capacity with the largest well out of service (firm capacity).

Table 5-2: 18-Hour Run Time Capacity

Well	Capacity (GPM)	Capacity (MGD)	18 Hour Run Capacity	Firm 18 Hour Run Capacity
6	1,000	1.44	1.08	1.08
7	-	-	-	-
8	1,200	1.73	1.30	1.30
9	1,350	1.87	1.40	-
10	1,200	1.73	1.30	1.30
Total	**4,750**	**6.77**	**5.08**	**3.68**

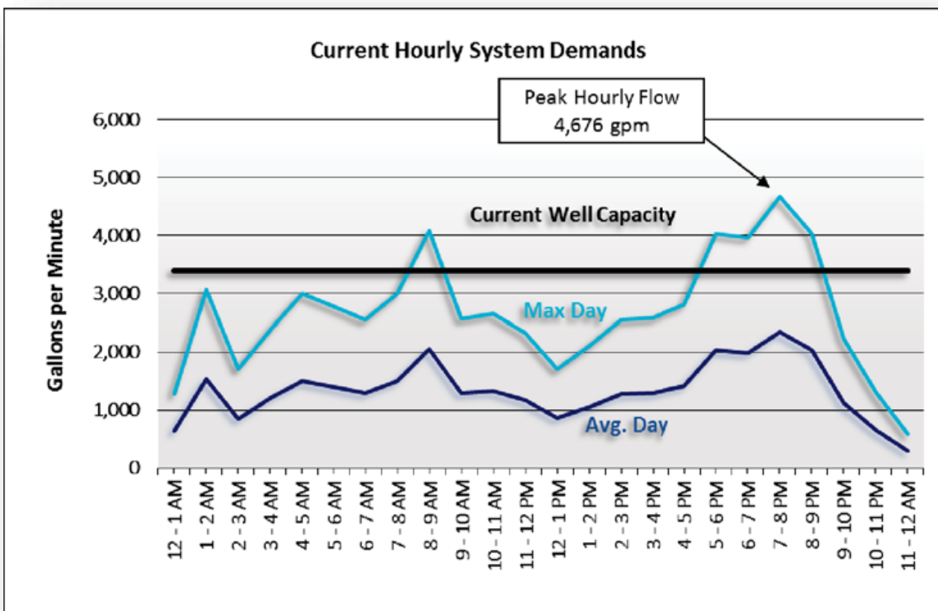
With the City's well pump time reduced to 18-hours per day, the firm capacity is reduced to 3.68 MGD for the entire system. These numbers can be used for evaluating the system's ability to meet average day demands, however they are not intended to be used for maximum demand scenarios when wells will be pumping as much as necessary to meet demand.

Ability to Meet Current Peak Hourly Demands

To determine the system's ability to meet the maximum day demand of 3.84 MGD, the diurnal peak of the maximum day is reviewed. The diurnal curve represents the water usage across a typical 24-hour day. For example, water usage at 2:00 am is minimal, and is represented with a 0.5 multiplier of the day's total usage. Similarly, a community such as Sycamore with a commercial base may see a maximum hour usage at 9:00 am when both residential and commercial operations are using water, and a multiplier of 1.5 – 2.0 may be observed.

The Peak Hourly Flow is defined as the maximum hourly flow, often occurring on the maximum day. To evaluate the system's ability to meet this flow, trending of the actual diurnal flows seen by the City was performed. These diurnal factors were then applied to the average daily demand and maximum day demand to create the chart below. The peak hourly flow would be anticipated to occur at 7:00 PM on the maximum day with an hourly flow rate of 4,676 gpm.

Figure 5-2: Current Peak Hourly System Demands



The Current Well Capacity line in the graph above represents the 4.90 MGD (3,403 gpm) well production firm capacity (with Well #9 and #7 out of service). The hourly flow exceeds this production capacity several times throughout the day, which would require flow into the system from the elevated storage tanks. The total supplemental volume required on this maximum day is approximately 185,995 gallons. Currently, the City has this storage capacity available, and the system will be able to adequately refill the water towers during off-peak hours. However, the system may not be able to sufficiently meet peak demands in the future as demand increases with growth. This issue is evaluated in the next subsection, and potential solutions to address future demands are evaluated in Section 6 of this report.

5.2.2 Future Well Capacity Requirements

Section 2.3 of this Plan identified population growth projections for 5-year, 10-year, and 20-year planning periods. Associated increases in water demand for each of these horizons were developed by extrapolating current usage per PE, as identified in Section 2.3.4. For example, at the calculated 69.8 gallons per PE/day of water pumped, the 2025 population estimate of 29,911 equates to an average daily demand of approximately 2.1 MGD. Table 5-3: Future Water Demands below includes the extrapolated demands based on population projections.

Table 5-3: Future Water Demands

	2020 (Current)	2025 (5-Year)	2030 (10-Year)	2040 (20-Year)	Ultimate Build-Out
Current P.E.	26,697	26,697	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544	13,206	34,776
Total P.E.	26,697	29,911	33,241	39,903	61,473
ADD (MGD)	1.9	2.1	2.3	2.8	4.3
MDD (MGD)	3.93	4.41	4.90	5.88	8.83
Firm Capacity Required	**4.0**	**4.5**	**5.0**	**6.0**	**9.0**

The table illustrates the maximum day demand increasing proportionally to the average demand based on population growth. While the maximum day demand may not follow a linear relationship, this provides a conservative estimate for water supply planning. The Firm Capacity Required is simply a rounding of the extrapolated maximum day demands for planning purposes.

The City has the supply capacity to provide the average daily demand throughout the four planning horizons. However, the maximum day demand for 2030 (5.0 MGD) exceeds the 4.9 MGD that is currently available. Therefore, Well #7 would need to be back online prior to that 2030 requirement. **Once all wells are operational, the City will be able to meet both estimated ADD and MDD through the 20-year planning period.** Below are the City's well design capacities with Well #7 being returned to service, which will allow the City to meet the projected 2030 and 2040 demands. Each of the WRT systems have been designed to exceed the existing well capacity for each location, with the exception of Well #9. Therefore, the limiting factor for water production is limited to the well, and not the WRT system. With Well #7 back online, the system firm capacity would be 6.70 MGD.

Table 5-4: Future Well Capacities

Well	Well Design Capacity (GPM)	Well Design Capacity (MGD)	WRT Design Capacity (GPM)	WRT Design Capacity (MGD)	System Firm Capacity (GPM)	System Firm Capacity (MGD)
6	1,000	1.44	1,000	1.44	1,000	1.44
7	1,250	1.80	1,250	1.80	1,250	1.80
8	1,200	1.73	1,350	1.94	1,200	1.73
9	1,350	1.94	1,300	1.87	-	-
10	1,200	1.73	1,300	1.87	1,200	1.73
Total	**6,000**	**8.64**	**6,200**	**8.93**	**4,650**	**6.70**

Ability to Meet Future Peak Hourly Demands

Utilizing the 2040 Maximum Day Demand of 5.88 MGD, the ability of the system to meet the peak hourly demand through the planning horizon was evaluated. As shown in Figure 2-7 below, the peak hourly flow at this future maximum day condition is approximately 7,000 gpm. Assuming the system remains at the same 3,403 gpm capacity (that is, Well #7 has not been returned to service), this scenario would require excess of 1.1 MG to be supplied by storage. While the City does maintain 2.25 MG of elevated storage, typically only one quarter of this volume is allocated to operational storage. Further, the net deficit of water produced vs. consumed across this day is 860,000, meaning that the towers will not refill in off-peak periods. A second consecutive high flow day would further stress the system.

Through interpolation, it is estimated that by 2033 Well #7 would need to be returned to service. The net deficit of water produced vs. consumed across this day is 570,000, meaning that the towers will not refill in off-peak periods.

Figure 5-3: Future Peak Hourly System Demands (Well #7 Offline)

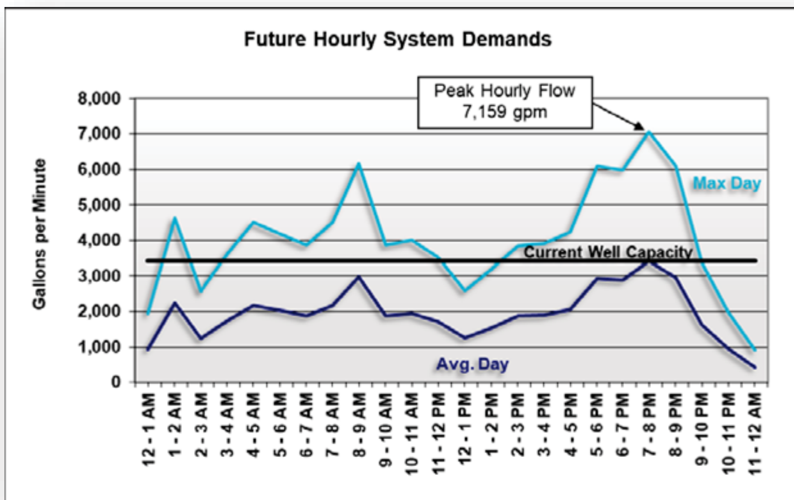
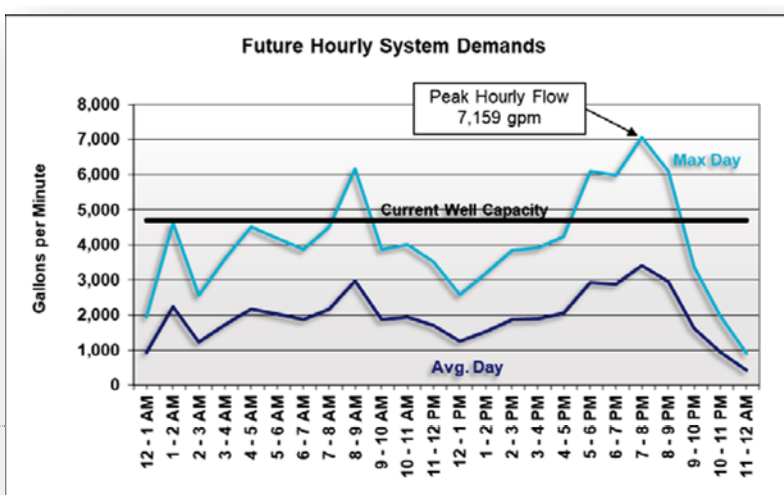


Figure 2-8 below represents the future peak hourly demands with Well #7 brought back online. This scenario still requires the use of operational storage from the elevated tanks, however only approximately 375,000 gallons would be required, and the system would recover during off-peak periods. This will be further reviewed within Sections 5 and 6, however the population growth projections reviewed within this section indicate that returning Well #7 to service would be recommended.

Figure 5-4: Future Peak Hourly System Demands (Well #7 Online)



5.3 Water Supply and Treatment Evaluation

As previously mentioned, the City of Sycamore's water distribution system is supplied by five deep, underground wells. Each of the wells have drilled depths that range from 1,200 feet to 1,300 and pump source water from the Mt. Simon sandstone aquifer. This raw water pumped from each of the wells have experienced increasing amounts of radium and barium, leading to the City commissioning the construction of radium removal facilities at each operating well. The City works actively to ensure the residents of the service area are provided with ample and safe water. An evaluation of the system's supply and treatment processes is described in the succeeding sections.

5.3.1 Water Quality

The City of Sycamore is committed to supplying a safe, reliable and economical potable water supply to all residents and businesses within the City's service area. Overall, the City of Sycamore's source water meets all regulatory requirements for all contaminants that are monitored by the EPA, with the exception of barium and radium. Many of these contaminants are not detected in the City's raw water during laboratory testing, which include all volatile and synthetic organic compounds. Other water quality characteristics are identified as taste, odor, color, hardness, etc. Although most of these are also monitored by the IEPA, these are the most predominant concerns amongst residents/consumers.

Hardness

While the existing water supply is safe, it also contains high levels of the minerals calcium and magnesium, commonly referred to as hardness. Hard water is common in water systems that use groundwater as their source. As groundwater travels through the aquifer it dissolves minerals such as calcium and magnesium. The City of Sycamore has a hardness range of 289-314 parts per million, which is defined as hard to very hard water, as seen in the following AWWA Hardness Classification Scale table.

Table 5-5. AWWA Hardness Classification Scale

Hardness Classification	Grains per Gallon (gpg)	Parts per Million or mg/l
Soft	0 to 4.3	0 to 75
Moderately Hard	4.3 to 8.8	75 to 150
Hard	8.8 to 17.1	150 to 300
Very Hard	17.1 and above	300 and above

The EPA does not have a drinking water regulation for hardness as it does not present any health concerns. The concerns associated with hardness levels are related to aesthetics, such as mineral deposits, soap consumption, and service life of appliances. The City may need to consider implementing water softening treatment if complaints of these issues arise. However, the City does actively monitor this contaminant which allows for potential water softening alternatives to be investigated in the future.

	Hardness (mg/L)
Well #6	289
Well #7	-
Well #8	267
Well #9	283
Well #10	314

Barium Concentration

	MCL Limit (ppb)	Barium (ppb)
Well #6	2,000	1,150
Well #7		1,020
Well #8		1,810
Well #9		1,310
Well #10		1,710

Barium is a naturally occurring alkaline earth metal that is commonly found in the Midwest. It is present in brines/fluids associated with oil and gas development, landfill leachate, coal waste, and high-octane fuels. Barium is also used to make electrical components, dyes, fireworks, ceramics and glass, but dissolves into water resources through drilling waste discharges, copper smelting, and motor vehicle manufacturing.

Health effects of different barium compounds vary with how well the compound dissolves into water. Compounds with low solubility are typically not harmful but ingesting high levels of barium compounds that have high solubility in water can cause gastrointestinal issues, muscle weakness, high blood pressure, and problems with the nervous and circulatory systems.

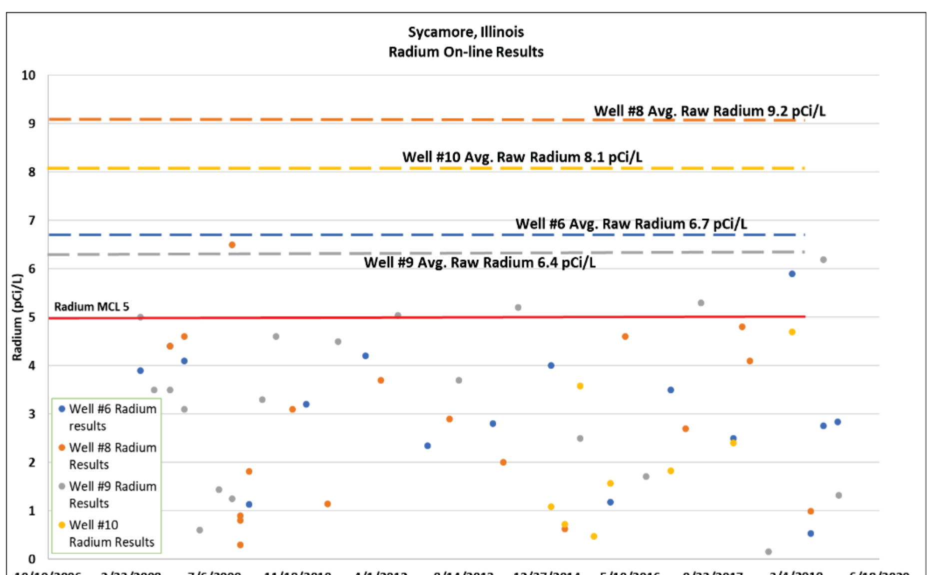
These adverse health effects led the EPA to set the MCL for barium to 2.0 mg/L or 2000 ppb. The City of Sycamore does not have any issues with meeting this requirement, but it is noted that Well #8 and 10 have values approaching the EPA standard. Even so, it is important for the City to monitor contaminant concentrations that have the potential of exceeding these requirements.

Radium Concentration

Radium is a naturally occurring radioactive metal that exists in rocks, soil, and groundwater. In Northern Illinois, it is fairly common for groundwater supplies to contain varying concentrations of radium. The radium is embedded in the bedrock that surrounds the aquifer, and thus can be transferred into the surrounding water. This can become an issue when the water is extracted by wells for drinking water. When water that contains high levels radium is consumed, it acts similarly to calcium and is adsorbed into bone tissues. These deposits can deteriorate the surrounding tissues and increase the risk of bone cancer.

Radium and other radioactive elements are measured in units called "curies" (Ci) which equates to one gram of radium. When evaluating levels in water, units of one trillion curies per liter of water or picocuries per liter (pCi/L) is used. Under the Safe Drinking Water Act, the U.S. Environmental Protection Agency (USEPA) set the Maximum Contaminant Level (MCL) for the combined radium isotopes Ra-226 and Ra-228 in drinking water to 5 pCi/L.

The City of Sycamore's wells draw source water that contains concentrations ranging from approximately 6-10 pCi/L. These values are above the MCL, and required the City to seek out available options for treatment. The graph to the right shows the average initial feed concentrations of radium at each well and discharge concentrations, showing that all wells meet the requirement after treatment.



WRT Radium Removal Treatment Facilities

In 2007, the City of Sycamore entered an agreement with Water Remediation Technology, LLC (WRT) for radium removal facilities at each of the operating wells, Well #6, 8, 9, and 10. The City made a capital outlay towards the installation of the systems, and pays a monthly fee for the rental of equipment and operation. The systems for Well #6, 8 and 9 were leased with a 10-year contract in 2007, while the Well #10 system was sold to the City in 2014. In 2017, the City elected to renew the contract for an additional 10-year term to 2027.

The City utilizes four WRT Radium Removal Systems with their Z-88® adsorptive media which attracts radium and removes it from the source water as it flows through. As a result, the system process does not produce wastewater and thus, does not affect the local wastewater treatment plant. The contracts with WRT include maintenance of each system as well as removal, replacement, and disposal of spent media as needed to a licensed nuclear waste facility.

Before the treatment systems were installed, the raw source water contained radium levels ranged from approximately 6-10 ppc and were above the USEPA MCL of 5 pCi/L. Within the agreement between WRT and the City, an Agreed Radium Concentration for each well is established. This value represents the maximum amount radium that should be present in the raw well water to be treated. If levels in the raw water exceed this concentration, WRT charges the City to compensate the excess treatment that is necessary to reduce the radium concentration to meet the MCL.

The combined radium 226/228 concentration range of the finished water is documented in the City's Annual Consumer Confidence Reports and the values over the past three years are represented in the table below. With these facilities, radium levels are reduced from the Agreed Radium Concentration range to a range that satisfies the USEPA standards for drinking water, ensuring safe, potable water distributed to all service consumers.

Consumer Confidence Report	MCL (pCi/L)	WRT Agreed Concentration Range (pCi/L)	Treated Water Range Detected (pCi/L)
2016	5.0	6.40-9.20	1.18-5.20
2017	5.0	6.40-9.20	1.82-5.30
2018	5.0	6.40-9.20	0.16-4.80

5.3.2 Well #6

Well #6 is the oldest operating Well in the system and is located on Maertz Drive, near the center of the City and just north of the intersection of Center Cross Street and State Street. Originally drilled in 1970, Well #6 had a depth of 1,214 feet into the Mt. Simon sandstone aquifer. However in 1997 the well was plugged to a depth of 800 feet due to address the elevated barium levels. The well operates with a drawdown of 235 feet below grade and pressure of 64 psi, with a design capacity of 1,000 gpm. Well #6 along with all the other well sites have installed backup diesel generators, which run weekly and sends out an alarm to notify the City when they are being used.

The WRT system at Well #6 was leased and installed in 2007. Well #6 pumps water to the system first through two WRT treatment vessels, one after the other, but also has a bypass that can allow flow directly into the distribution system if needed. In addition to WRT treatment, raw water from Well #6 is also treated with fluoride, phosphate, and chlorine. According to the WRT contract with the City, the Agreed Radium Concentration of the source water supplied by Well #6 is 6.7 pCi/L, and after treatment this concentration is reduced to or under the MCL. Of the contaminants that are monitored by the City as well as the EPA for drinking water regulations, the finished water from this well does not violate any water quality standards, shown in the table to the below.

Well #6	Influent	MCL
Radium (piC/L)	6.70	5.00
Barium (mg/L)	1.15	2.00
Hardness (mg/L)	289	N/A
Iron (mg/L)	0.17	0.30
Fluoride (mg/L)	0.47	2.00

The last media replacement at the Well #6 site occurred in March of 2019, and the most recent motor adjustment was made in July of 2019. Recently, the well has had a decrease in pumping capacity and raw water has been observed to contain bronze shavings. In August of 2019, the City approved a maintenance inspection for Well #6 as the issues indicate a problem with the bowl assembly or pump. The project included pulling of the column pipe and pump as well as the reinstallation after the necessary repairs. Well #6 was recently pulled, and the City is in the process of replacing the existing pump. This work is anticipated to be completed in December 2019/January 2020.

5.3.3 Well #7

Well #7 is located on Willow Street, just east of Dekalb Avenue and south of Highland Drive. With a depth of 1,233 feet below the ground surface into the Mt. Simon aquifer, Well #7 has a design capacity of 1,300 gpm. The well was taken offline in the summer of 2015 due to increasing concentrations of radium in the source water. The historic raw water radium concentration found in water samples from Well #7 are presented in **Table 5-5** below. Although concentration values commonly fluctuate, it is shown that levels started increasing over the MCL in 2014 and into 2015. Instead of implementing another WRT treatment facility, the City found it best to deactivate the well.

Table 5-5: Well #7 Historic Radium Concentration

Collection Date	Radium 226 (pCi/L)	Radium 228 (pCi/L)	Combined Radium (pCi/L)
10/9/2013	2.6	1.6	4.2
2/5/2014	2.8	1.3	4.1
10/6/2014	3.7	3.6	7.3
1/20/2015	2.8	1.4	4.2
4/14/2015	3.2	5.5	8.7
5/28/2015	2.5	2.9	5.4
7/16/2015	2.5	4.2	6.7

As the City plans for increasing development and future population projections are on the rise, the City must explore options to meet the projected short- and long-term water demand. Thus, this Master Plan evaluates the existing Well #7 as well as provides alternative solutions for bringing the well back online which are assessed in Section 6. The table below outlines the increased design and firm capacity of the City's system if Well #7 is back in operation.

Table 5-6: Total System Capacity with Well #7

	Design Capacity (GPM)	Design Capacity (MGD)	Firm Capacity (GPM)	Firm Capacity (MGD)
Current Capacity	4,750	6.84	3,400	4.90
Well #7 Capacity	1,250	1.80	1,250	1.80
Total System Capacity	**6,000**	**8.64**	**4,650**	**6.70**

5.3.4 Well #8

In the southeast region of the City, Well #8 is located near the intersection of Bethany Road and Mediterranean Drive, just west of Peace Road. The well was drilled at a 1,300 foot depth in 1987 with the backup generator installed in 1988. The pump setting for this well is at 620 feet below grade, and static water level of 280 feet below grade or 340 feet above the pump. Well #8 has a design capacity of 1,200 gpm but normally runs at 1,160 gpm. The current pump was originally installed in 1987 and is a Johnston 12GMC model with a U.S. WP-1 250V motor.

The WRT system at this site is under the same contract as the one at Well #6. The WRT equipment was leased to the City and installed in 2007 with two treatment columns in series. Well #8 has an established Agreed Radium Concentration 9.2 pCi/L, the highest out of all the wells. However, with the existing radium removal facility, levels are able to meet the MCL standard of 5 pCi/L. In addition, all other monitored and regulated contaminants are below the maximum contaminant level. The last WRT Media replacement was done in April of 2019.

Well #8	Influent	MCL
Radium (piC/L)	9.20	5.00
Barium (mg/L)	1.81	2.00
Hardness (mg/L)	267	N/A
Iron (mg/L)	0.12	1.00
Fluoride (mg/L)	0.65	2.00

5.3.5 Well #9

Well #9 is located in the far eastern part of town, west of Airport Road, and just north of Hillside Road and adjacent to the Park District's Community Center. The well was drilled 1,285 feet into the Mt. Simon Aquifer in 2004. Having the largest capacity out of all the four wells, Well #9 operates with a pump setting of 600 feet below grade, static level of 265 feet below grade, and has the ability of supplying 1.94 MGD.

The Agreed Radium Concentration of Well #9 is 6.4 pCi/L, the lowest out of the four wells. The WRT systems were installed under the same contract as Well #6 and 8 and also operates with two treatment columns. The most recent WRT media replacement at this site occurred in September of 2019, with the previous replacement completed in July of 2018. Alike the other systems, the finished water quality meets all standards for contaminants monitored by the City and the EPA, shown in the table to the left.

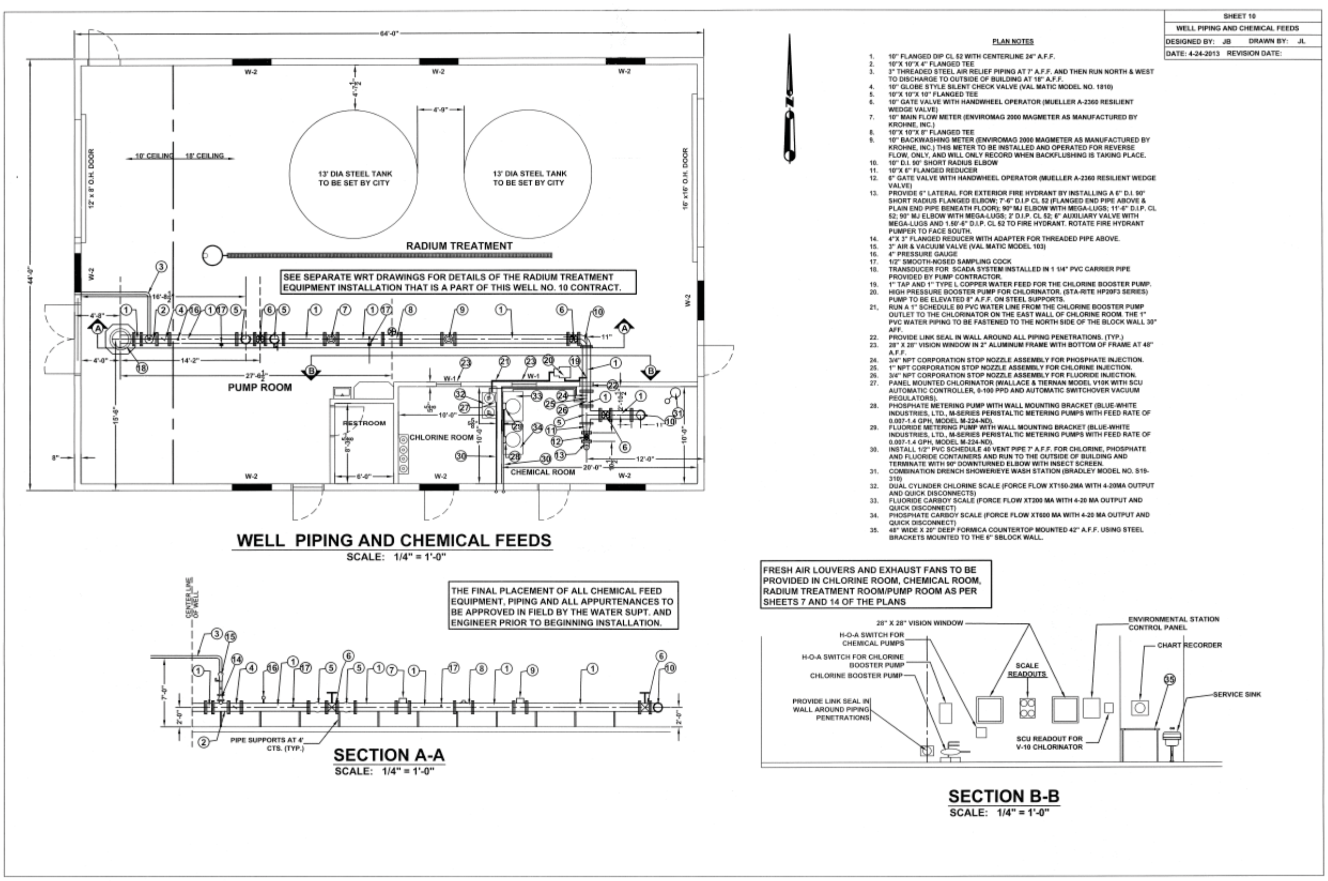
Well #9	Influent	MCL
Radium (piC/L)	6.40	5.00
Barium (mg/L)	1.31	2.00
Hardness	283	N/A
Iron (mg/L)	0.22	1.00
Fluoride (mg/L)	0.64	2.00

5.3.6 Well #10

Well #10 was constructed alongside Tower #2 in the northern region of the City just east of Main Street and south of Heron Creek Drive. The well is the most recently activated well, originally drilled in 2010. At a 1,325-foot depth, the pump setting for Well #10 is at 590 feet below grade, and a static level of 203.5 feet below grade or 386.5 feet above the pump.

Because the well was drilled after the original WRT contract was signed for Wells #6, 8, and 9, the WRT system Well #10 was originally under its own contract. The City was able to renew both contracts together in 2017 and the last media replacement was conducted in March of 2017. As seen in the water quality table to the right, Well #10 has an Agreed Radium Concentration of 8.1 pCi/L, and all other contaminants meet the EPA MCL standards.

Well #10	Influent	MCL
Radium (piC/L)	8.10	5.00
Barium (mg/L)	1.71	2.00
Hardness (mg/L)	314	N/A
Iron (mg/L)	0.31	1.00
Fluoride (mg/L)	0.71	2.00

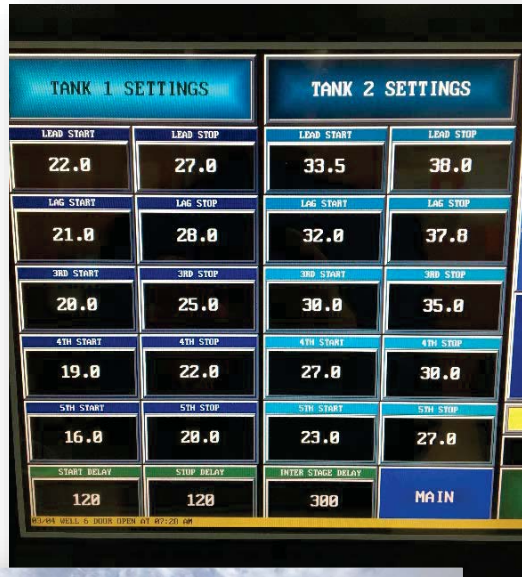


5.3.7 Infrastructure Condition Assessment Tables

Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Service Life	Replacement Year
Well No. 6						
Well No. 6 Pump	Layne/Aurora	12RKBH 7 Stage	Poor Condition (Out of Service)	1970	50	2020
Well No. 6 Motor	U.S. Motor				20	-
Globe Style Silent Check Valve	Val-Matic		Good Condition	2007	20	2027
WRT Vessels	Silvan Industries	06-M-02	Good Condition	2007	20	2027
WRT Cartidge Filter	VAF/Evoqua	V-1000	Good Condition	2007	25	2032
WRT Bag Filter			Good Condition	2007	25	2032
Chlorinator					20	-
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Fair Condition	2007	15	2022
Chemical Feed Scales	Force Flow		Good Condition	2007	20	2027
Fluoride Feed Pump	LMI			2007	15	2022
Phosphate Feed Pump	LMI			2007	15	2022
Well No. 6 VFD	ABB		Fair Condition	2007	15	2022
Well No. 6 MDP	Square D Company		Good Condition	2007	30	2037
Transfer Switch	Emerson	ASCO 7000 Series	Fair Condition	2007	30	2037
SCADA Control Panel	Metropolitan Industries	-			15	
Generator	Caterpillar	(300 kW)	Good Condition	2007	30	2037
Well No. 7						
Well No. 7 Pump	Johnston Pump Company		Fair Condition	1978	50	2028
Well No. 7 Motor	U.S. Motor	(200 HP) RUS1 Frame: H445TPA	Good Condition		20	-
Chlorinator					20	-
Chlorine Booster Pump	Pentair/STA-RITE	HP20F3-02	Good Condition	2007	25	2032
Chemical Feed Scales	Force Flow				20	-
Fluoride Feed Pumps	LMI		Poor Condition		15	-
Phosphate Feed Pump	LMI		Poor Condition		15	-
Well No. 7 VFD	ABB		Fair Condition		15	-
Well No. 7 MCC	Cregier/Anixter		Fair Condition		30	-
Transfer Switch	Powertron		Fair Condition		30	-
SCADA Control Panel		-	Good Condition		15	-
Generator	Kohler		Fair Condition		30	-
Well No. 8						
Well No. 8 Pump	Johnston Pump Company	12GMC 10 Stage	Good Condition	1987	50	2037
Well No. 8 Motor	U.S. Motor	(250 HP) WP-1 Frame: 445TPA	Good Condition	2007	20	2027
Globe Style Silent Check Valve	Val-Matic		Good Condition	2007	20	2027
WRT Vessels	Silvan Industries	08-M-01	Good Condition	2006	30	2036
WRT Cartidge Filter	VAF/Evoqua	V-1500	Fair Condition	2007	25	2032
WRT Bag Filter			Good Condition	2007	25	2032
Chlorinator					20	-
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Good Condition	2007	15	2022
Chemical Feed Scales	Force Flow		Good Condition	2007	20	2027
Fluoride Feed Pump	Blue-White	ProSeries-M2		2007	15	2022
Phosphate Feed Pump	Blue-White	ProSeries-M2		2007	15	2022
Well No. 8 VFD	ABB		Good Condition	2007	15	2022
Well No. 8 MCC	Square D Company	Model 5	Fair Condition	1987	30	2017
Transfer Switch	ASCO		Fair Condition	1988	30	2018
SCADA Control Panel	Metropolitan Industries	-			15	-
Generator	Kohler Power Systems	Cummins Engine NTA855G3	Fair Condition	1988	30	2018

Equipment	Manufacturer	Model	Condition	Installation/ Rebuild Year	Service Life	Replacement Year
Well No. 9						
Well No. 9 Pump	Byron-Jackson	12EHM 10 Stage	Good Condition	2005	50	2055
Well No. 9 Motor	Byron-Jackson	(250 HP) BJ 480V 14" H	Good Condition	2005	20	2025
WRT Vessels	Silvan Industries	09-M-02	Good Condition	2006	30	2036
WRT Cartidge Filter	VAF/Evoqua	V-1500	Good Condition	2006	25	2031
WRT Bag Filter			Good Condition	2006	25	2031
Automatic Control Valve	OCV Fluid Solutions		Good Condition	2005	15	2020
Chlorinator					20	-
Chlorine Booster Pump	STA-RITE	Signature 2000	Good Condition	2005	15	2020
Chemical Feed Scales	Force Flow		Good Condition	2005	20	2025
Fluoride Feed Pump	LMI			2005	15	2020
Phosphate Feed Pump	LMI			2005	15	2020
Well No. 9 VFD	ABB		Fair Condition	2005	15	2020
Well No. 9 MCC	Square D Company	Model 6	Good Condition	2005	30	2035
Transfer Switch	Emerson	ASCO Series 300	Good Condition	2005	30	2035
SCADA Control Panel	Metropolitan Industries	-	Fair Condition	2005	15	2020
Generator	Kohler Power Systems	(275 kW) 35DREDZV	Good Condition	2005	30	2035
Well No. 10						
Well No. 10 Pump	American Marsh	12HCRA 9 Stage	Good Condition	2014	50	2064
Well No. 10 Motor	U.S. Motor	(250 HP) DN14 Frame: H445TPA	Good Condition	2014	20	2034
Globe Style Silent Check Valve	Val-Matic		Good Condition	2014	20	2034
WRT Vessels	Universal Tank & Fabrication	S/N: 732401 & 732402	Good Condition	2014	30	2044
WRT Cartidge Filter	Fil-Trek Corporation		Good Condition	2014	25	2039
Automatic Control Valve	OCV Fluid Solutions		Good Condition	2014	15	2029
Magnetic Flow Meter	Krohne Flow Instruments		Good Condition	2014	15	2029
Chlorinator	Wallace & Tiernan	Model V10K	Good Condition	2014	20	2034
Chemical Scales	Force Flow	XT-200MA/XT-600MA/XT-150MA	Good Condition	2014	20	2034
Fluoride Feed Pump	Blue-White	ProSeries-M2	Good Condition	2014	15	2029
Phosphate Feed Pump	Blue-White	ProSeries-M2	Good Condition	2014	15	2029
Chlorine Booster Pump	Pentair/STA-RITE	HP20P3-02	Good Condition	2014	25	2039
Well No. 10 VFD	ABB		Good Condition	2014	10	2024
Well No. 10 MCC	Square D Company		Good Condition	2014	30	2044
Transfer Switch	Emerson	ASCO 7000 Series	Good Condition	2014	30	2044
SCADA Control Panel	Metropolitan Industries	-	Good Condition	2014	20	2034
Generator	Kohler Power Systems		Good Condition	2014	30	2044

5.4 Evaluation of Elevated Storage

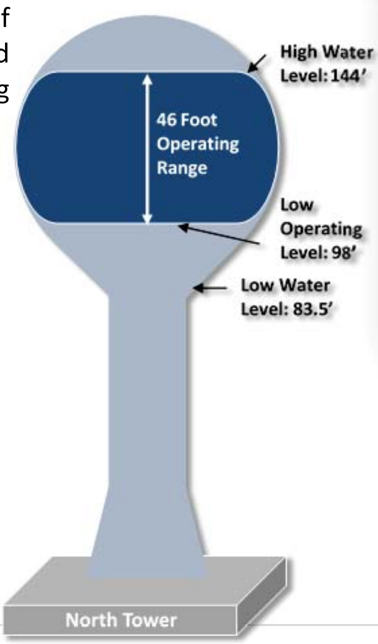


This section describes the current and future storage capacity requirements while Section 6 will describe alternatives to meet these requirements. The City owns and maintains two elevated storage tanks (water towers) with a combined storage of 2,250,000 gallons. This storage capacity contains reserved water that is crucial for fire flows and maximum day demands as well as operating the City's distribution system.

Both of the towers are strategically placed throughout the service area in order to maintain consistent water system pressures. The City's wells operate off of the elevated storage tower levels, pumping on and off as the hydraulic grade line of the towers change. The well supply functions with a lead/lag operation, meaning as the Tower levels drop to their low setpoints, the wells will kick on to supplement as required. Once the Tower reaches the high setpoints, the wells will kick off.

5.4.1 Tower #1 – South Tower

Tower #1, or the South Tower, is located on the southwest corner of Park Avenue and Becker Place. This multi-column tower was the only existing storage tank when the City's 2007 Master Water Plan was developed and it is located at the same site as the deactivated Well #5. Constructed in 1962, the 9-column tower has a 750,000-gallon capacity with an elevation of 879 feet, height of 120 feet, and overlow elevation of 999 feet. The existing tower was last coated in 1987, and is in need of inspection and recoating. The operating head range of the tower is 30 feet. The City is expecting to repaint and rehabilitate Tower #1 within the 10-year planning period.



5.4.2 Tower #2 – North Tower

Tower #2, or the North Tower, was built in 2014 and was constructed at the same site as Well #10, near the intersection of Main Street and Heron Creek Drive. This 1,500,000-gallon spheroid tower has an elevation of 855 feet and height of 144 feet, equating to an overflow elevation of 999 feet. The North Tower has an operating head range of 46 feet, as shown in the diagram to the right.

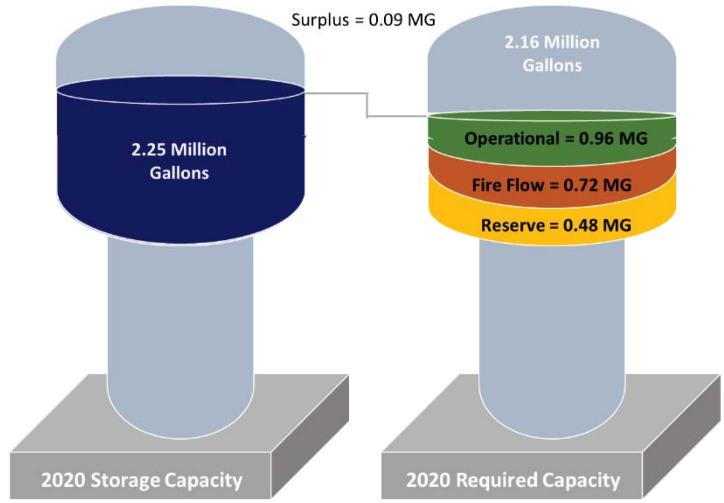
5.4.3 Water Storage Capacity Evaluation

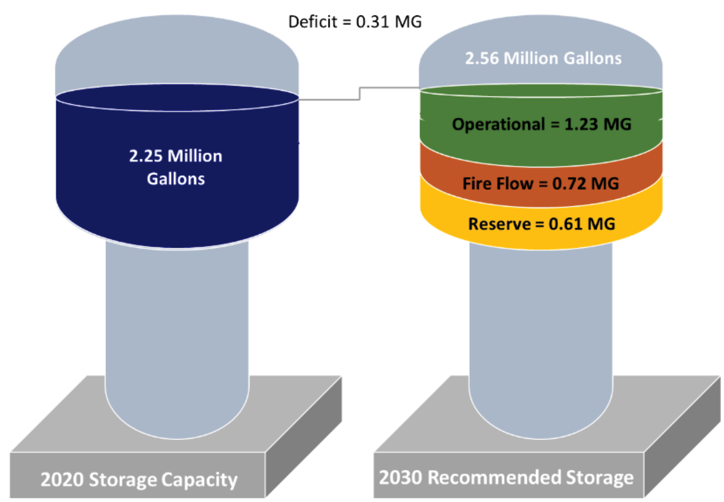
Recommended water storage volumes consists of three components; fire flow, operational, and reserve storage. Fire flow requires 3,000 gallons per minute for four hours, or 720,000 gallons of storage. Operational storage is equivalent to 25% of the maximum day demand (3.84 MG), or 960,000 gallons. Lastly, the City should maintain 12.5% of the maximum day demand, 480,000 gallons in reserve storage. Combining these components gives a recommended 2020 Storage of 2.16 MG.

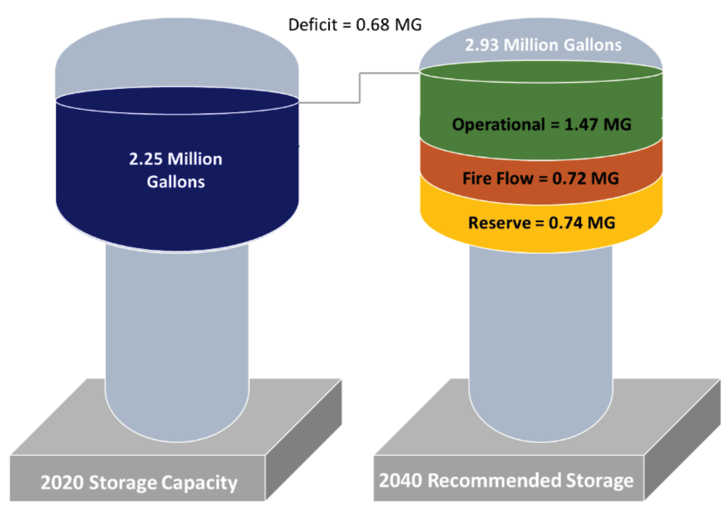
As described in Section 2.4, the City will have an average daily water demand of 2.3 MG and a maximum daily water demand of 4.90 MG in 2030. Using this future maximum day demand and the same calculation above, the recommended storage for the City for the 10-year planning period was determined to be approximately 2.56 million gallons. The same evaluation was done for the 20-year planning period using the estimated 2040 maximum day demand of 5.88 MG, equating to a recommended storage of 2.93 million gallons.

The exhibits to the right display the current storage capacity for the City of Sycamore, as well as the 2030 and 2040 storage recommendations for the three components detailed above. As shown in the exhibits, the City currently has a storage surplus of 90,000 gallons but may see a deficit of approximately 310,000 gallons by 2030, and 680,000 gallons by 2040.

As the City of Sycamore plans for future population and capital development growth over the next 20 years, they will also need to plan for increasing required storage capacity. It is recommended that the City construct additional storage during the 10-year planning period that can also satisfy the capacity needed for the 20-year planning period, approximately 700,000 gallons. In addition, maintenance and rehabilitation of Tower #1 is expected to occur within the next ten years, and reconstruction of the tower could include the necessary additional storage. These are further discussed in Section 6.







SECTION 6

ANALYSIS OF WATER SUPPLY, TREATMENT, AND STORAGE ALTERNATIVES

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6. Analysis of Water Storage, Supply and Treatment Alternatives

Section 5 of this study reviewed the current condition and capacity of the City's water storage infrastructure, supply sources, and treatment facilities. This section will review options for additional water supply, alternatives for radium removal treatment, and possible solutions for bringing Well #7 back into service.

6.1 Water Storage Alternatives

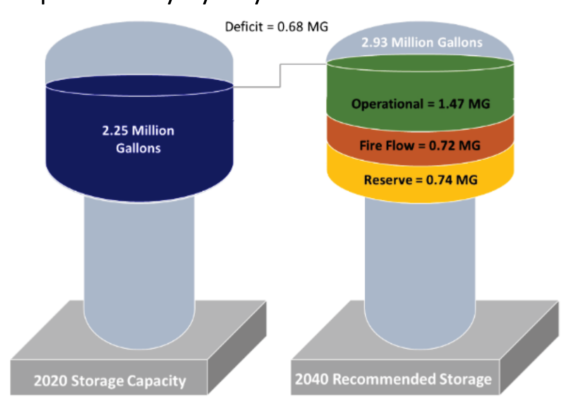
6.1.1 Tower #1 Rehabilitation

The City has two existing water towers, Tower #1 and #2 which vary widely in age. Tower #2 was constructed in 2014 and is in very good condition. However, based on input from City Staff, Tower #1 has not been recoated in 32 years. As a result, Tower #1 is in significant need of re-coating and likely minor repairs to the steel tank. Due to the proximity of this tower to the surrounding neighborhood, it is anticipated that a full enclosure shroud with negative pressure system may be required for re-coating. The cost for recoating this multi-leg tower is estimated to range from $900,000 to $1,100,000 and is dependent on the structural repairs that are required.

Tower #1 is 57 years old, and a recoating may be expected to provide an additional 20-30 years of service life. Alternatively, the City could replace Tower #1 rather than reinvest into its rehabilitation. Replacement of this elevated storage with a 1.0 MG spheroid has an estimated capital cost ranging from $3.2 - $3.7M. As discussed in Section 5, due to the projected population growth the City may need additional elevated storage within the 20-year horizon. Therefore, based on the potential for additional elevated storage within the planning period, as well as the number of capital projects required over the next 10 years, it is recommended that the City plan for re-coating of Tower #1 rather than replacement at this time. Based on the length of time between recoating, the City should contract with a tank inspection company to evaluate the structural integrity of the tank, identify required repairs, and test for potential lead paint. This inspection is estimated to cost approximately $20,000 and should be completed as soon as practical.

6.1.2 Additional Water Storage Analysis

The City currently has two existing water towers with a total of 2.25 million gallons of storage. However, at the rate that the City is growing, and based on the recommendation for water storage volumes, it is anticipated that by 2030 the City may have a deficit of approximately 300,000 gallons. By 2040 if population growth trends continue the City may see a deficit of 680,000 gallons. Therefore, it is recommended that locations for a potential third tower be reviewed periodically by City staff.

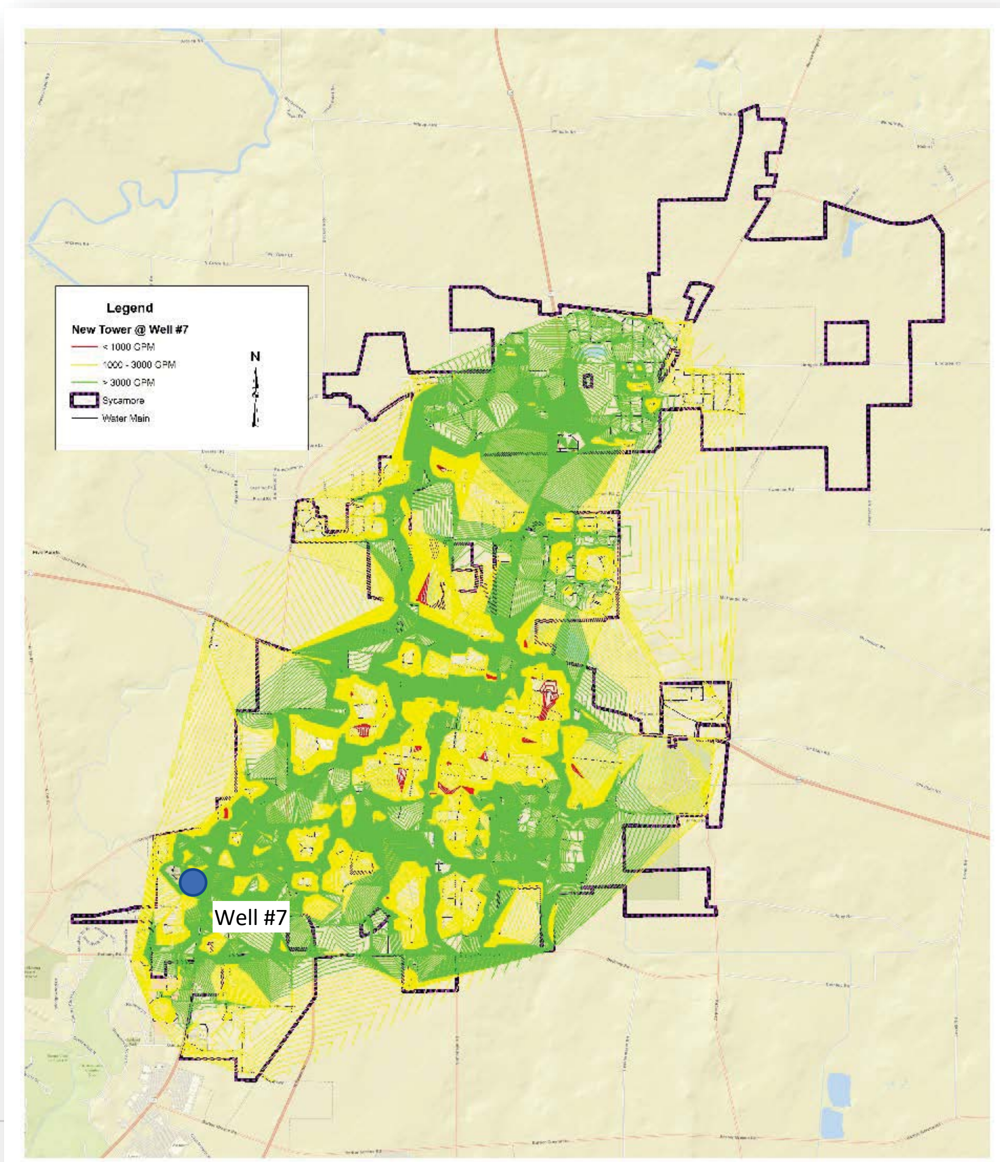


It is estimated that a third tower would be 1.0 MG, due to the projected need of 700,000-gallons in 2040. The analysis reviewed the potential of not only adding an additional tower, but also trying to identify whether Tower #1 could ultimately be permanently removed from service due to its age. It was determined as part of each analysis that the location of Tower #1 is critical to the system, and the additional tower would not eliminate the need for storage at the location of Tower #1, but rather would support the overall storage strategy with three towers in the future.

Additional 1.0 Million Gallon Tower at Well #7

The existing site for Well #7 was reviewed for locating a new 1.0 MG tower within the existing parcel. The existing site is large, and the proposed tower could be located behind the existing structure and generator. The exhibit below Identifies the max day fire flows with a new 1,000,000-gallon tower located at Well #7. The additional tower improves the system in the southwest corner and brings fire flows above 3,000 gpm in areas near commercial and industrial facilities.

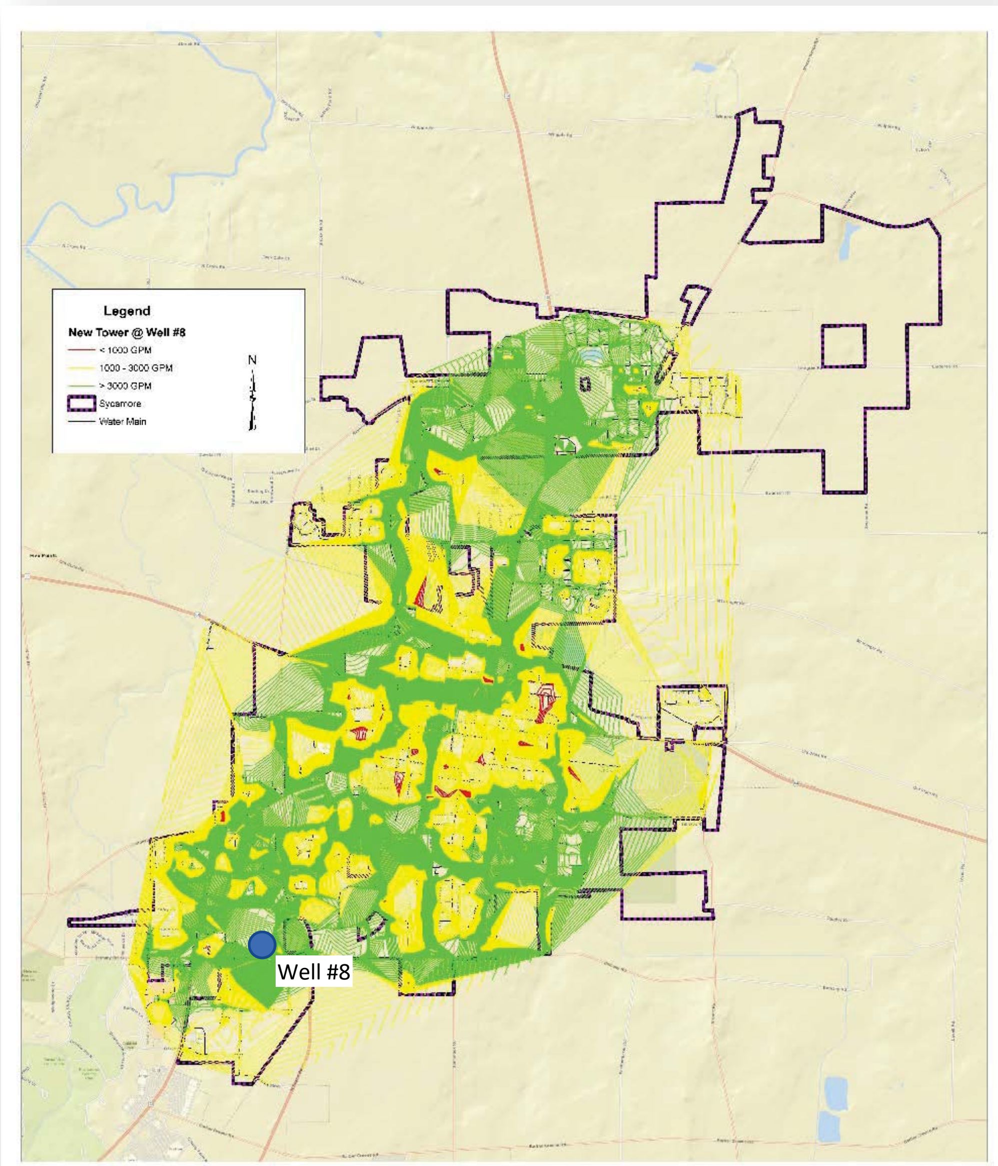
However, upon reviewing the existing site it was determined that the area directly south of the existing building is within the 100-year floodplain and construction of a tower within this area could be difficult to permit. In order to construct a tower on this site, the City would need to construct it on the east or west corner of the lot. This would be directly behind a residential development and within an existing park. The Well #7 site is also lower in elevation and would require the tower to be roughly 40 ft taller than Tower #1 to match the same hydraulic grade. The estimated construction cost for the 1.0 MG tower is $3.5M and the recommended project budget is $4.0M, which includes engineering and contingencies.



Additional 1.0 Million Gallon Tower at Well #8

The second site currently owned by the City that was reviewed was the Well #8 property. This site is relatively small, however, and there would likely not be enough open space to support an elevated tank. The area directly to the south of the existing well is largely undeveloped and a new tower and/or well facility could be located across the street through a property purchase.

Upon running the hydraulic model with the new 1.0 MG water tower at this location, it was clear that this location had the largest impact on the system of the three locations evaluated. Tower #3 provided a greater impact throughout the industrial and commercial areas on the south side of the City. In addition, the Tower on the south side of town would allow the City to remove Tower #1 from service to allow for maintenance/repair/replacement. Although Tower #3 at Well #8 doesn't completely replace the need for Tower #1, it does provide the means necessary for its maintenance/replacement. The estimated construction cost for the 1.0 MG tower is approximately $3.4M and the recommended project budget is $3.9, which includes land acquisition, engineering and contingencies.



Additional 1.0 Million Gallon Tower at Well #9

An additional 1,000,000-gallon water tower was also considered near the existing Well #9 site. However, the Well #9 location wouldn't allow the construction of a tower onsite and would require the City to purchase additional land adjacent to the Well. This area was reviewed with the hydraulic model and was identified as not being an ideal location for a new tower due to the proximity to the existing Tower #1, and the minimal impact to fire flows. The overall impact to the existing system was negligible and didn't allow Tower #1 to be taken offline for maintenance or repair. Therefore, it is not recommended that this location be evaluated any further.

6.1.3 Water Storage Recommendations

The City of Sycamore has several options in regards to Water Storage, and the prioritization of those options are critical. The recoating as well as making structural repairs and improvements to Tower #1 should be made a priority within the next several years. Although this tower is well into its service life, with the recoating of the tower the City can expect to get an additional 20-30 years from the existing structure.

Prior to recoating the tower, the City should budget $20-$30k for inspection services to identify the current state of the coating and tower, as well as to identify if the exiting coating contains lead. As this would likely attribute to a higher cost for the recoating of the tower. The City can obtain a quote for this inspection work from local tank inspection companies to incorporate into subsequent budgets. The estimated project cost for the recoating of Tower #1 is approximately $0.9M - $1.1M.

Upon getting Tower #1 recoated, due to the recommended water storage requirements as identified in Section 5, it is recommended that the City start to make steps in the direction of identifying the location of a new 1,000,000-gallon tower (Tower #3). The City has several options in regards to the location of the new water tower. It is recommended that the City pursue an option that is on the south side of town near the location of Well #8. The estimated construction cost for the 1.0 MG tower is approximately $3.4M and the recommended project budget is $3.9M. The City should continue to monitor population growth, as well as maximum day water demands which provides the basis for storage volume recommendations. If maximum day pumpage does not increase with population increase, the City may elect to reevaluate storage requirements within the next Water Master Plan.

At the time Tower #3 is in service, and Tower #1 is in need of full replacement, the City can evaluate decommissioning Tower #1 or demolishing and reconstructing Tower #1 in its existing location. It is recommended that Tower #1 stay in service at until Tower #3 is constructed due to the impacts of fire flows with it out of service, at a minimum.

6.2 Water System Supply Alternatives

As detailed in Section 2 Community Needs, the City is experiencing growth and it is expected to continue at 2.3% for the foreseeable future. Section 2.3 of this Plan identified population growth projections for 5-year, 10-year, and 20-year planning periods. Table 6-1: Future Water Demands below identifies the population projections, as well as the anticipated average and max day demands.

Table 6-1: Future Water Demands

	2020 (Current)	2025 (5-Year)	2030 (10-Year)	2040 (20-Year)	Ultimate Build-Out
Current P.E.	26,697	26,697	26,697	26,697	26,697
Growth P.E.	-	3,214	6,544	13,206	34,776
Total P.E.	26,697	29,911	33,241	39,903	61,473
ADD (MGD)	1.9	2.1	2.3	2.8	4.3
MDD (MGD)	3.93	4.41	4.90	5.88	8.83
Firm Capacity Required	**4.0**	**4.5**	**5.0**	**6.0**	**9.0**

The City has the supply capacity to provide the average daily demand throughout the four planning horizons. However, the maximum day demand for 2030 (5.0 MGD) exceeds the 4.9 MGD that is currently available. Therefore, Well #7 would need to be back online to meet supply requirements. Once all wells are operational, the City will be able to meet both the ADD and MDD through the 20-year planning period. Below are the City's well design capacities with Well #7 being returned to service, which will allow the City to meet the projected 2030 and 2040 demands. If additional sources are not identified and installed, the City may be required to curtail development or institute more stringent water use restrictions. Each of the WRT systems have been designed to exceed the existing well capacity for each location, with the exception of Well #9. Therefore, the limiting factor for water production is limited to the well, and not the WRT system. With Well #7 back online, the system firm capacity would be 6.70 MGD.

Table 6-2: Future Well Capacities

Well	Well Design Capacity (GPM)	Well Design Capacity (MGD)	WRT Design Capacity (GPM)	WRT Design Capacity (MGD)	System Firm Capacity (GPM)	System Firm Capacity (MGD)
6	1,000	1.44	1,000	1.44	1,000	1.44
7	1,250	1.80	1,250	1.80	1,250	1.80
8	1,200	1.73	1,350	1.94	1,200	1.73
9	1,350	1.94	1,300	1.87	-	-
10	1,200	1.73	1,300	1.87	1,200	1.73
Total	**6,000**	**8.64**	**6,200**	**8.93**	**4,650**	**6.70**

The following section reviews the three options that are available to the City for bringing Well #7 back online, and provides a review of several different radium removal technologies that are available beyond the use of the WRT systems. The City requested that the WRT systems be reviewed in regard to the capital cost to construct the new facility, as well as O&M costs to identify what treatment technology is the best option for the City moving forward within the planning horizon.

6.3 Water Treatment Alternatives

Depending on the groundwater source, additional treatment to the raw water may be necessary prior to distribution. At a minimum, chlorination and fluoridation of sources would be required. If this was the only treatment necessary, a standalone well house with chemical addition would likely be sufficient. There are two major sources of water, ground and surface water. Ground water can be broken into two categories, shallow and deep wells. If shallow wells are utilized, iron filtration may be necessary, and if deep wells are constructed, they may require radium removal treatment. As identified in Section 5, the City of Sycamore has deep wells, and has observed radium levels that exceed the 5 pCi/L MCL in their water supplies and as a result currently operates four radium removal treatment facilities.

6.3.1 Current Water Treatment Process - Water Remediation Technology, LLC

The City of Sycamore currently operates four radium removal treatment facilities provided by Water Remediation Technology, LLC (WRT) at each of their active wells to meet the MCL standard for radium. The first three systems were installed in 2007 at Well’s #6, 8, and 9. In 2014, the City constructed Well #10 and the associated WRT treatment facility, however the City purchased the treatment equipment outright, with WRT only providing maintenance and media exchanges.

The installed systems from WRT utilize adsorption technology to reduce the concentrations of radium in the City’s current water supply. Adsorption is the process wherein molecules of one substance attach to the surface of another, in this case radium is chemically attracted to the surface of a proprietary adsorptive media, Z-88®, which is a zeolite-based treatment media. This method requires the influent water to pass through the media with a series of upflow (or downflow in the case of Well #10) treatment vessels utilizing the pressure produced from the well pump. The radium atoms are absorbed into the material while the treated water flows out. The media is eventually loaded with the contaminant and are replaced and disposed at a licensed facility. As a result, wastewater treatment facilities in the City are not affected by additional waste products.

The adsorption method is not classified as a best available technology (BAT) as determined and identified by the EPA. To be a BAT, the treatment technology must meet several criteria such as having demonstrated consistent removal of the target contaminant under field conditions. Some of those criteria include: cost of achieving BAT effluent reductions; age of equipment and facilities involved; the processes employed by the industry and potential process changes; non-water quality environmental impacts, including energy requirements; as well as any other factors as EPA deems appropriate. Several WRT systems have been permitted and constructed throughout the United States, and the technology has been proven to reduce radium content to the MCL standards. However, due to the relative recent introduction to the market the EPA has yet identify it as a BAT. It is anticipated that as additional systems are permitted and installed, and as more data is provided it will also become a BAT.

This process does not require additional chemical usage or storage and therefore the system can operate unattended until replacement and disposal of exhausted media is needed, which is about every 2 years. In addition, media does not require backwashing and the system generally has low energy requirements.

WRT Lease Contracts

Each of the WRT systems that are currently installed within the community are leased on an annual basis from WRT, with the exception of Well #10, as equipment was purchased outright.

As part of the leasing contract from WRT, they provide a relatively complete contaminant removal solution. WRT's services include both operation and maintenance of the vessels at each location. WRT is responsible for reviewing the installed process equipment (sampling/monitoring), as well as a maintaining the radiation safety assurance program that provides all of the handling and transportation of radioactive treatment residuals. Each contract from WRT is setup in a cost per gallon treated basis, and typically is on a 5, 10, or 20-year cycle.

Beyond the sampling and monitoring, the lease from WRT also includes the disposal of material to licensed low-level radioactive waste facilities, installation of replacement media, provides a radioactive materials license for system operation and media handling for the term of the contract, as well as guaranteeing the City will meet the current MCL for radium within drinking water and process performance.

In 2007, the City of Sycamore entered into the original 10-year agreement with WRT during the initial installations at Well's #6, 8, and 9. During the initial 10-year lease period for the City of Sycamore, WRT was experiencing high operational costs for the installed vessels due to the frequent need for media replacements at each location. Near the end of the contract, water quality testing was performed at each location. The water quality testing indicated that in addition to the presence of radium, the City also had minor levels of barium within the source water. Due to the type of technology that WRT uses for radium removal, the vessels are also capable of treating the source water for barium. Since the raw water contained both contaminants, radium and barium, the vessels were treating both. This change in source water composition was causing the WRT media to reach the end of its service life more quickly and required replacement more frequently. This additional cost was absorbed by WRT, as it was not written into the original contract.

In 2017 the WRT contract for leasing the equipment to the City of Sycamore expired and was up for renewal. During the contract negotiations for the 2017-2027 contract, the overall cost for leasing the equipment increased significantly. Much of this was attributed to the presence of barium, and the additional costs for media replacement. Upon negotiations of new terms, the City entered into a new agreement with WRT, which expires in 2027. The City requested that an evaluation of the contract be included within the Water Master Plan, in order to determine the best path forward during the next contract renewal period.

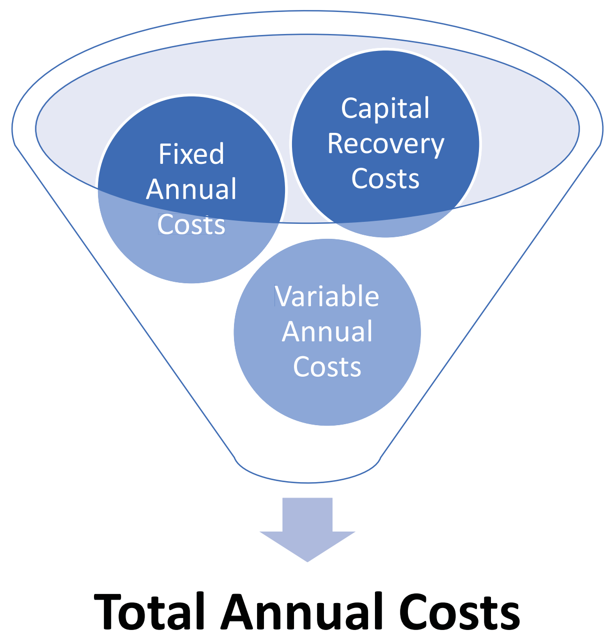
WRT Contract Analysis

As identified previously, in 2017 the City of Sycamore experienced a large increase in the overall leasing and annual costs for the operation of their installed WRT systems. As a result, the City requested a review of their contracts, as well as several other communities that have similar equipment installed. Within Northern Illinois, there are several WRT systems installed on deep wells similar to the City of Sycamore. The following analysis reviews the fees associated with the WRT systems for four other communities, with respect to the City of Sycamore's contract terms.

When reviewing each of the contracts for the WRT systems that were installed, in general, each of the contracts were broken down into three categories, capital recovery costs, annual costs (fixed/variable), as well as base volume charges. Each community that was evaluated entered into agreements with WRT in years ranging from 2005-2010. As a result, each of the fees/capital investments, and annual costs needed to be escalated first into present value or 2019 dollars. An inflation rate of 2% annually was used for this adjustment. This allows each community to be compared to one another in equivalent dollars.

Upon entering into a contract with WRT, most of the communities paid capital investment costs that ranged from $220,000 to $640,000 per well or location. However, this cost is a one-time fee. In order to identify the associated annual cost for this fee, the capital investment was broken down into a capital recovery, which assumed a 2% inflation rate, and a duration of 20 years. This amount for each community translated and ranged from approximately $20,000 to $60,000 per year and equates to the cost that the community would be responsible for if the capital cost was paid over a 20-year period through a loan.

The annual costs for each community within the WRT contracts are also broken into two sperate categories; fixed costs, and variable costs. The fixed costs are not subject to inflation rates and could be considered the lease payment for each of the units that are installed. The variable costs associated with the contracts are adjust due to inflation, as well as other factors such as water quality changes. For this analysis it was assumed that each of the variable costs were only subject to the inflation costs. Similar to the capital costs, both the fixed and variable costs were brought to 2019 dollars or present value.



Last, each contract also includes a base volume charge. This base volume charge is the additional costs to the community if water is utilized more than the identified base volume for the year. This cost is a surcharge for water used above and beyond the contract terms. The base volume charge is on a per 1,000-gallon basis. This value is not subject to inflation, and therefore can be compared between communities readily.

Due to the variability of the designs from a flow rate standpoint, the values obtained for each community were divided by the base volume and converted to a per 1,000-gallon value. Table 6-3 on the following page provides a comparison for each of the communities with respect to their WRT contract.

Table 6-3: WRT Contract Comparison

	Base Volume (Gallons)	Capital Recovery Per 1,000 Gal	Annual Cost Per 1,000 Gal	Total Cost Per 1,000 Gal	Base Volume Charge Per 1,000 Gal (1)
Community A	40,000,000	$1.28	$0.59	$1.87	$0.59
Community B	230,212,800	$0.25	$0.99	$1.24	$0.37
Community C	367,600,000	$0.06	$0.58	$0.64	$0.31
Community D	116,240,000	$0.65	$0.99	$1.64	$0.49
City of Sycamore	622,000,000	$0.26	$1.08	$1.34	$0.78

(1) The base volume charge is a surcharge for any water used above and beyond the total base volume allocated to the community.

Each community's costs were averaged amongst the wells that were in service. Based on the information provided in the table, the total capital recovery costs range from $0.06 to $1.28/ 1,000 gallons treated. In regard to the City of Sycamore, the capital recovery costs are in line with Community B and significantly lower than Communities A and D. There are several possible explanations for the variability among the capital costs realized by the communities, the most likely being a capital cost versus annual cost decision made by each community during contract negotiation. The City of Sycamore, for example, paid roughly $1.3M when entering into the 2007 Agreement, as a 'down payment or installation fee' that would have resulted in lower annual payments. Other communities may have elected not to pay as high an upfront fee but saw higher annual payments as a result. It should be noted that the annual costs reflected in Table 6-3 reflect the current 2017 contract rates. The 2007 annual costs were appreciably lower, likely a result of the upfront capital payment.

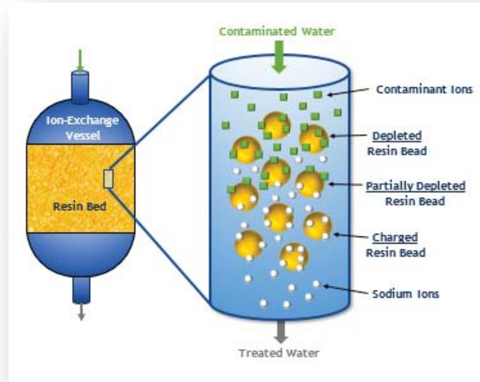
With regard to the annual costs, the City of Sycamore is one of the higher paying communities of the four reviewed. However, the differential is minimal per 1,000 gallons sold, at $0.09. Although there is a differential, it is anticipated that the other communities may be at the same rate or higher once their contracts are renewed, as many of them are still within their initial contract with WRT. Overall, when comparing the total cost per 1,000 gallons for each community, the City of Sycamore is paying a total of $1.34 and represents the median cost paid between the five communities.

The base volume charges for the City of Sycamore is on the high end of the spectrum, and by a significant margin, almost $0.20. It is anticipated that this is also attributed to the fact that many of the communities that were reviewed are still within their initial contract, and WRT has not had the opportunity to make any adjustments based on the operational & maintenance costs that were observed. During the renewal of the WRT system for Sycamore, the barium issue was brought to light and likely played a large role in both the annual cost and the base volume charge increase during contract renewal.

While each of the communities had significantly different terms within their WRT agreements, the total cost per 1,000 gallons treated represents the most comparative metric for this exercise. As previously stated, the City of Sycamore appears to be within the range of communities reviewed. As a result, it would not be expected that WRT rates during subsequent contracts would be appreciably lower and may increase based on cost indices alone. Therefore, it is recommended that the City evaluate alternatives for radium removal operated and maintained by the City. The following section reviews the different technologies that are available, as well as the potential for installation within the City's facilities.

Viable alternatives for radium removal in municipal water have developed rapidly over recent years and have resulted in several potential technologies with different removal efficiencies and characteristics. The following sections review the technology, and the feasibility for implementation for the City of Sycamore with regards to the replacement of the WRT systems.

6.3.2 Ion-Exchange Softening



Ion-exchange (IEX) resin technology is often used for water softening and the USEPA recognizes this technique as one of the best practices for radium removal. The process has the capability of removing 99 percent of the dissolved radium atoms and coincides with removing calcium and magnesium hardness. As shown in the diagram, influent water is passed through a vessel that holds a resin bed comprised of small beads that contain positively charged sodium ions bound to negative anion groups. The positively charged radium atoms, along with calcium and magnesium ions that are present in the water "exchange" places with the readily available sodium ions since they possess a higher affinity to the negative anions. This removes the contaminants from the source water and replaces them with sodium ions, resulting in an innocuous effluent solution.

Continuous cycles through the resin degrades the concentration of available sodium ions for ion-exchange which requires the resin to regularly go through regeneration, a process that includes backwashing. A brine with a high concentration of sodium chloride is used for backwashing and removes the contaminating ions and replaces them with new sodium ions. As backwashing and rinsing is completed, the effluent wastewater will have very high concentrations of radium, calcium, and magnesium ions that it has removed from the ion-exchange media as well as concentrated chlorides and will need to be directed to a treatment facility.

Not all unwanted ions will be washed out from the resin during regeneration. Eventually, aged and ineffective resin will become concentrated with radium and will need to be removed and replaced which will require disposal at a licensed facility. If the resin is not replaced at the proper time, an effect called chromatographic peaking can occur. When water passes through the highly concentrated resin, radium ions can leak into the influent, and the water leaving the system can become more concentrated. Even so, there are many reasons why the EPA approves this technology as one of the most beneficial radium removal techniques. In addition to the effectiveness of removal, the system has minimal chemical additives and requires only moderate operation. It is also one of the most common technologies for this purpose and can be generally inexpensive to implement.

One of the primary drawbacks from IEX includes the high amount of chlorides within the backwash water. Currently the City's WWTF has a chloride concentration of around 350 mg/L, and the current water quality standard is 500 mg/L. By converting the existing treatment facilities to IEX, influent wastewater may surpass 500 mg/L due to the chloride-rich backwash. Therefore, it is not recommended that the City move forward with IEX due to the potential for water quality violations at the WWTP.

6.3.3 Hydrous Manganese Oxide (HMO) Filtration

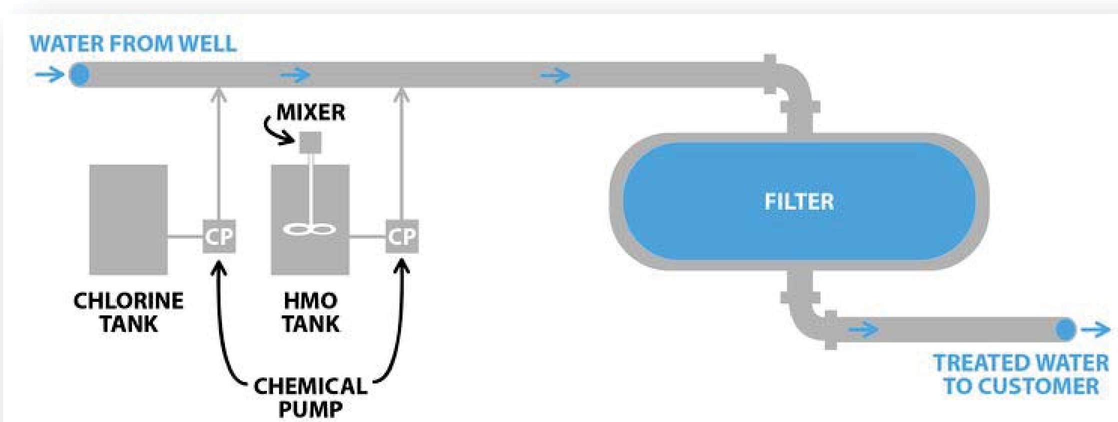
Manganese dioxide, often called Hydrous Manganese Oxide (HMO), is commonly used with conventional filtration to remove iron and manganese from water, but it has been proven under extensive research by the American Water Works Association (AWWA) to be an efficient method for radium removal as well. This process begins with a controlled dosage of HMO solution to the influent. The slurry can be purchased pre-formed or prepared at the treatment facility using a mixture of manganese sulfate, potassium permanganate, and water. The slurry will be added to the source water and due to its natural affinity, radium readily adsorbs onto the negatively charged surface of HMO molecules. Radium is then co-precipitated with HMO as a solid when the water passes through granular filtration.

The filtered water is then ready to be distributed while the contaminant is trapped in the filter media. Similar to ion-exchange, backwashing is required to clean the media of the accumulated contaminants. This will produce wastewater with high radium concentrations that must be treated at a wastewater treatment facility. In addition, the aged and ineffective media will eventually need replacement and appropriate disposal, typically every 7-10 years.

The effectiveness of HMO filtration depends on the quality of the raw water. High concentrations of iron can compete with radium ions and oxidization pretreatment with chlorine may be required. This process will also require intermediate operator skills as the HMO additions must be dosed cautiously. Excess HMO can clog the filter media while insufficient HMO will decrease removal efficiency. Although HMO filtration is not considered a BAT by the EPA, it still approves the technology for radium removal since it has shown to effectively reduce concentrations to meet the MCL standard. Utilizing HMO in addition to filtration can be up to 90% effective and is highly considered for facilities that already have a filtration system implemented where the HMO solution can easily be added to the process.

As part of the treatment process, approximately 4% of the forward flow is discharged as backwash. The backwash from the HMO process contains a small amount of the co-precipitated HMO slurry which contains the removed radionuclides. This will be treated by the WWTP and removed from the plant by the solids handling & dewatering process.

The HMO process is relatively simple, and only requires chemical addition and filtration. This process is also very similar to the technology implemented by WRT. It is recommended that the City consider HMO Filtration as one of the options for radium removal and water treatment. This process will be reviewed further in this section to identify feasibility, as well as capital and O&M costs for each well.



6.3.4 Lime-Soda Ash Softening for Radium Removal

The conventional single stage lime softening process that targets the removal of calcium and magnesium ions can also remove up to 80 percent of the concentration of radium. A more enhanced process, such as excess lime softening, can target up to 90 percent removal of radium and is considered one of the BATs. While ion-exchange works to chemically remove the contaminant through an aqueous solution, lime softening removes carbonate hardness along with radium by inducing solid precipitation.

In this process, limewater/calcium hydroxide ($Ca(OH)_2$) and soda ash/sodium carbonate (Na_2CO_3) are added to the source water. The addition of lime serves to raise the pH, which is crucial in encouraging precipitation of the calcium and magnesium ions. Soda ash is dissolved in the water to provide an ample source of carbonate ions (HCO_3^- , CO_3^{2-}) for calcium to react and precipitate with. The following equations show how calcium and magnesium ions precipitate as solids with the addition of lime and soda ash.

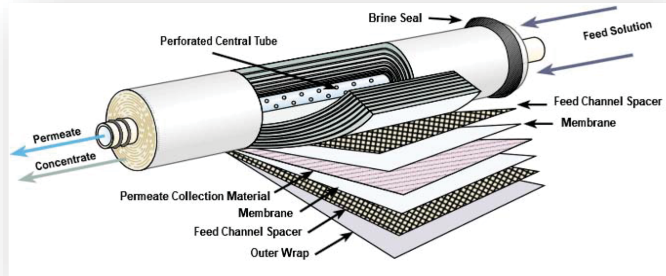
$$Ca^{2+} + 2HCO_3^- + Ca(OH)_2 \rightarrow 2CaCO_3(s) + 2H_2O$$
$$Mg^{2+} + 2HCO_3^- + 2Ca(OH)_2 \rightarrow 2CaCO_3(s) + Mg(OH)_2(s) + 2H_2O$$

The chemical dosages and steps in the process will vary depending on the concentrations of calcium, magnesium, carbonate hardness, and non-carbonate hardness in the raw water. However, in any of the processes, when the calcium and magnesium are precipitated out as solids, radium atoms are removed as well.

In an enhanced lime-soda softening system, a lime slurry will be added in excess to the source water. It will mix in a flocculation/clarification basin and raise the pH to 11 or higher which will precipitate calcium, magnesium, and radium ions. The solids are removed as waste sludge as the water is recarbonated with CO_2 to decrease the pH to about 10.6 and moves to a second basin where soda-ash is added to precipitate any excess lime. More waste sludge is removed from this basin while the treated water is recarbonated a second time. Lastly, the water flows through filtration media before it is distributed.

Lime-soda softening will require a larger footprint when compared to other alternatives discussed, as mixing and sedimentation basins and the final filter would need to be constructed. This softening method will also require extensive monitoring and careful dosing as excess final concentrations of lime could lead to corrosive water, which will increase labor hours. Lastly, the process generates large amounts of sludge and solids during recarbonation and will need to be transported and dewatered to be properly disposed. On the contrast, there are added health benefits to utilizing a lime-soda softening facility. This treatment can remove heavy metals, iron and manganese, turbidity and some organic compounds. It can also kill algae, bacteria and viruses. However, unless softening is needed along with radium removal, construction of this facility can be costly and unnecessary. Due to the large capital investment required for lime-softening, as well as the need for more centralized treatment facilities it is not recommended that the City move forward with consideration of lime-softening.

6.3.5 Reverse Osmosis



Reverse osmosis (RO) systems are commonly used to desalinate ocean or brackish water and is another EPA recognized BAT that can remove up to 99% of radium in groundwater. Opposed to the chemical processes that are used for ion-exchange and lime softening, reverse osmosis works using physical mechanisms where the influent water is forced through a semipermeable membrane at very high pressures. Water that passes through the membrane is called permeate and it is free of the targeted contaminants. Concentrate is the remaining water that exits the system with the unwanted solutes. There are a variety of reverse osmosis membranes that are engineered for certain permeation capabilities and reject characteristics for specific contaminant removal. The effectiveness of these membranes led the EPA to identify them as a BAT for many inorganic compounds.

RO is a continuous process that does not require backwashing, but the technology does require pretreatment and post-treatment. Fouling and scaling can occur when organic or inorganic particles and substances attach to the membrane. The deposits can block the membrane pores and decrease the efficiency of the process as well as increase the pressure drop which will degrade the membrane and increase energy costs. This can be prevented by using a more porous cartridge filter to pretreat the influent water and remove large particles. Post-treatment will also be necessary to adjust alkalinity and pH and remove dissolved gases in order to decrease corrosivity of the effluent water.

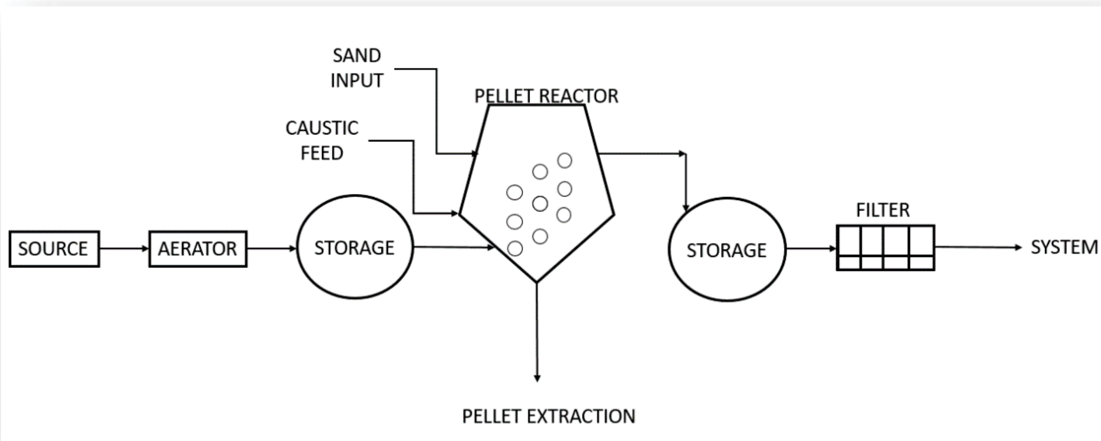
Membranes are commonly wound in a spiral around a central tube, as shown in the figure above. Water is then fed laterally through the spiral, and pressure will force the water through the membrane where it will enter the collection tube through an inner channel space. As the influent runs parallel to the membrane surface, water will carry away radium ions and other unwanted solutes from the membrane surface, preventing fouling. The contaminants will exit as a concentrated solution to be collected for wastewater treatment.

RO technologies can be advantageous due to their smaller footprints and high removal efficiencies. The process also requires much fewer chemical inputs than the other proposed techniques. In addition, the modular nature of membrane technologies mean that it is easy to add capacity to these systems. If the population of the community expands beyond current projections, the city would be able to add additional racks of membrane spirals as opposed to constructing larger facilities.

A significant challenge associated with reverse osmosis technology is the high level of reject water produced. Contemporary RO systems reject approximately 20% of treated water which will need to be treated, and the spent/used membranes will need to be disposed in an appropriate class of landfill. Energy also goes to waste during this process due to the large pressure drop of the concentrate. Due to these high operational costs, and high reject water tributary to the City's WWTP, it is not recommended that the City move forward with consideration of the reverse osmosis technology.

6.3.6 Pellet Reactor Softening

The name pellet softening is derived from the waste product that is created through the usage of this method. Whereas waste products from all other alternatives are liquids that would be treated at the wastewater treatment facility, palletization produces a small ball coated in calcium carbonate. Pelletization reactors consist of a bottom-fed tank filled with fine-grain sand. Raw water is injected into the base of the tank along with sodium hydroxide or lime to raise the pH and encourage reaction with charged sand particles. As the water level rises and calcium ions aggregate on sand particles, the heaviest particles settle toward the bottom of the tank while little particles rise and fluidize to react with more ions of hardness. Large, dense pellets are removed from the base of the tank and fresh sand is added to the reactor to maintain a consistent bed volume. Pellets have a residence time of around 100 days. After the pellet reactor, water is filtered to reduce the likelihood of pellets moving past the system. The figure below displays the system process for pellet softening.



One of the benefits of pellet softening includes radium removal. Radioactive cations may be removed as part of the pelletizing process through similar methods as the calcium carbonate. The radioactive cations will start to react with the sand at the increased pH levels that are present during the softening process. As a result, the radioactive cations may be removed as part of a pellet with the calcium. Therefore, the system could be used to obtain both radium removal as well as softer water within the community.

Pellet softening uses a small footprint and reduces the load on wastewater facilities when compared to other alternatives. The pellet waste product is largely innocuous, as it is primarily sand particles coated with limestone. This process also reduces chloride concentrations in influent water. This is ideal as other alternatives contribute to higher chloride concentrations in effluent water sent to wastewater facilities.

Although the overall pelletizing system is small in footprint, it is tall in size, and would not fit within any of the existing treatment facility buildings. In addition, this type of treatment method is similar to lime softening and is typically performed at centralized treatment facilities. Converting to pelletization for radium removal would require construction of all new treatment facilities, which presents a capital cost exceeding other viable alternatives. Therefore, it is not recommended that the City pursue this option.

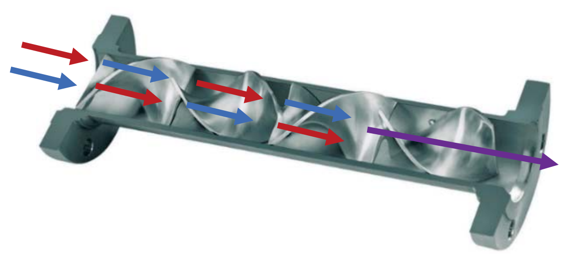
6.3.7 Blending Source Waters

Blending is technically a non-treatment method that decreases high levels of radium in one water source by diluting the concentration with another water source. The secondary source has little to no radium and is extracted from an existing or new surface water reservoir or groundwater aquifer. Water is pumped from both sources and control valves are used as the sources combine in a storage tank or common header. A mixing device in the storage tank blends the water completely where the diluted concentration of the water is decreased to meet the MCL standard.

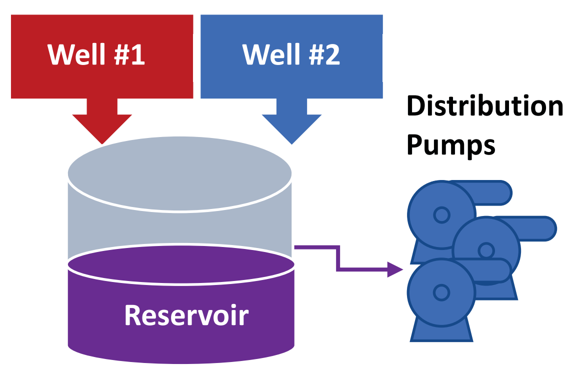
The USEPA highly encourages water utilities to first consider non-treatment options when deciding the best technique to decrease radium levels. The blending method would not require additional operator training. It will also reduce the amount of additional waste that is produced by treatment methods and in turn be more cost effective. Other non-treatment options include finding an alternative source or purchasing water that meets the EPA standards.

During recent discussions with the IEPA, and the feasibility of permitting and constructing a blending facility was reviewed. The IEPA has stated that the process of blending source water to obtain the MCL limit is plausible. However, the EPA expressed some concerns in permitting sources exceeding 6-7 pCi/L.

There are two methods for blending, one being a static mixer (shown to the right) between the two source waters, and the second being a reservoir with a booster station. A static mixer is the simplest way to achieve a blended flow. The two source waters are pumped to a common header with a static mixing device that disrupts flows and creates turbulence. The turbulent flow creates a mixing affect to achieve a homogenous mixture.



The second method consists of the two source waters or wells pumping to a reservoir where the two are mixed. The water is held in the reservoir until booster pumps are required and turn on to boost the water to the system. This method is equally effective, however the capital costs for this alternative are much more costly due to the added equipment, tanks, and pumps. In addition, the overall operational costs are higher due to pumping the produced water twice in order to get it into the distribution system.



Dynamic Mixing

It is recommended that if the City moves forward with the blending option, that the IEPA be contacted and the project be reviewed in its totality prior to moving forward with design and permitting. Blending raw water from Well #7 with a shallow well should be reviewed as a potential radium removal/mitigation technique and is discussed further within this section.

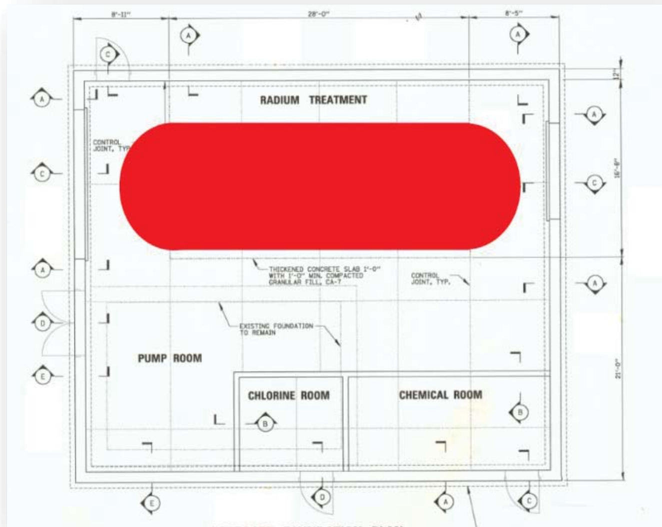
6.4 Radium Removal Alternatives – Existing Facilities

Due to the operational costs and the City's reliance on Water Remediation Technology for treatment, it was determined that each well should be reviewed for retrofitting/rehabilitation with a new radium removal technology. As identified in Section 6.3, although several options are available to the City, the recommended radium removal technology was found to be Hydrous Manganese Oxide (HMO) Filtration. This is primarily due to the simplicity of the system, and the fact that the technology could be installed in the existing buildings for most of the well sites. As part of the analysis, each well was reviewed in terms of space available for the new technology within the existing structure, as well as the costs associated with the equipment in terms of the initial capital investment and the 20-year O&M costs.

The following analysis and estimates are built around each of the WRT systems being decommissioned at the Well's #6, 8, 9, 10 and the construction of a new HMO treatment process at each location. In addition, Well #7 has been reviewed to be rehabilitated and brought back into service with the selected alterative. The new system would be owned and operated solely by the City of Sycamore. If the City elects to move forward with the decommissioning and removal of the WRT systems, each of the projects that have been identified would need to be online and operational by the end of service agreement from the 2017 WRT contract (2027).

The proposed systems have been preliminarily designed to meet the current IEPA regulations of maintaining a filter loading rate of 4 gpm/sf. However, as part of the treatment process, a cell within the proposed pressure vessel has the potential to go into backwash during regular operation. At that point, the effective surface area would be reduced, and the loading rate would increase. Therefore, it is recommended that the system be designed for 3.0 gpm/sf to account for the backwashing of the media and to maintain the 4gpm/sf loading rate during a backwash condition. This will ensure that the City is providing not only a high-quality product to its customers, but it will also ensure that each system is compliant with the outlined rules and regulations.

6.4.1 Well #6 - HMO Filtration



Well #6 is the oldest operating Well in the system and is located on Maertz Drive, near the center of the City, and was originally drilled in 1970. The existing well house has a large footprint, as well as large overhead doors and headroom for removal and replacement of equipment. Well #6 was evaluated for the installation of a new HMO filtration system that would be housed within the existing facility's structure.

The HMO system would consist of the addition of a single cylindrical horizontal pressure filter that is anticipated to be 12 ft in diameter and 32 ft long (shown in red). The existing building has a 14-foot overhead door that would allow for the new filter to be brought in without any modifications. In addition, the existing building is approximately 43 feet long, and therefore each side of the filter would have a minimum of 4 feet clear space around the entire system. This clear space would allow for influent and effluent piping to be installed, as well as space for typical operation and maintenance procedures.

Overall the existing treatment facility structure is in good condition, and only requires minor modifications and alterations. In addition to the HMO filter, the project also includes chemical feed equipment for the HMO process, electrical upgrades, as well as additional SCADA and Controls.

The overall estimated construction cost is approximately $1.7M and the recommended project budget is $2.0M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility and the potential improvements on the following page.

Well #6 Radium Removal - HMO	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$338,985
Site Work	$11,000
HMO Filter	$896,500
Electrical/SCADA/I&C	$156,000
Construction Sub-Total	**$1,402,485**
Contingency @ 20%	$280,497
Engineering & Administration @ 15%	$252,447
PROBABLE PROJECT COST:	**$1,935,429**

The operational costs of the HMO process are minimal, and only requires a small amount of chemical addition to the raw water. It is anticipated that the proposed facility would use approximately three gallons of a solution of manganese sulfate and potassium permanganate per day to create approximately 100 gallons of HMO slurry. There is also a minimal amount of additional power consumption for this equipment, which includes a blower for backwashing and the chemical feed pumps. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 10 hours per week.

The proposed HMO equipment also requires media exchanges throughout its service life, it is anticipated that this exchange would occur once every 10 years. It is anticipated that the cost per cubic yard for removal and replacement of the material is $200/cy, and the cost was spread out over 10-years. The waste stream generated would require treatment, which is quantified by applying the City's sewer rate for treatment of $6.07/1,000 gallons. This results in annual O&M of approximately $60,000, or $0.11 per 1,000 gallons produced. This O&M cost excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

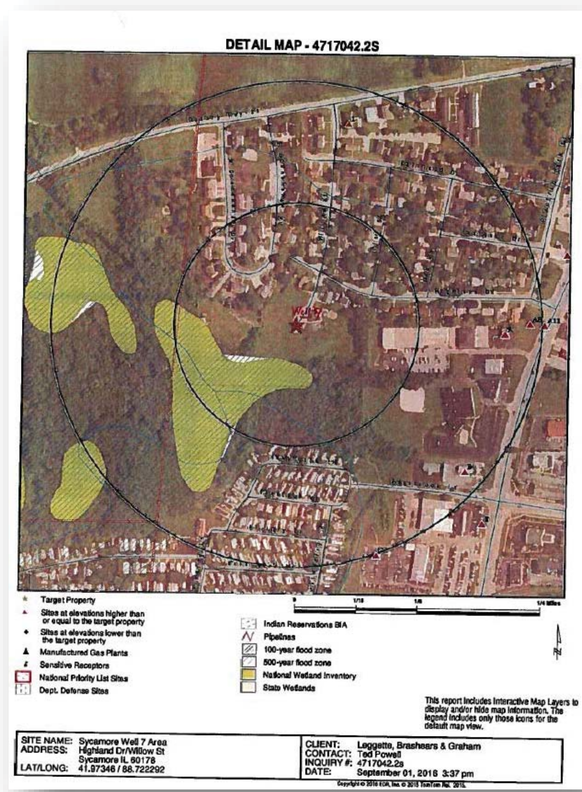
Well #6 HMO – Operation and Maintenance Costs						
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (20% Solution)	1.15	gallons	$	6.00	$	2,524.93
Potassium Permanganate (30% Solution)	1.15	gallons	$	5.00	$	2,104.11
Total Annual Chemical Cost:					$	4,629.03
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.07	$	3,658.11
Chem Feed Pump	1	kW	$	0.07	$	38.11
Total Annual Power Cost:					$	3,696.21
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	10	Hours	$	40.00	$	20,800.00
Total Annual Labor Cost:					$	20,800.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	148	CY	$	200.00	$	2,960.00
Total Media Waste Stream Cost:					$	2,960.00
Waste Stream	**Daily Production**		**Cost/1,000 Gal**		**Annual Cost**	
4% of Forward Flow	11,600	Gallons	$	6.07	$	25,700.38
Total Annual Waste Stream Cost:					$	25,700.38
Total Annual O&M Cost:					**$**	**57,785.63**
Cost per Thousand Gallons:					**$**	**0.11**

6.4.2 Well #7 – Alternative #1 Shallow Blending Well

As stated in Section 5, Well #7 has a design capacity of 1,250 gpm and was taken offline in 2015 due to the elevated radium levels within the raw water. Since being taken offline, the well has not been operated and is in need of minor rehabilitation. Currently there is no radium removal treatment installed at this location and therefore there is some flexibility moving forward with the available technology.

One of the simplest treatment alternatives that is available for Well #7 includes the installation of a shallow sand and gravel well. The proposed shallow well could be utilized to provide water to Well #7 that is low in radium, and which could then be used for blending with Well #7 water to reduce the overall radium concentration to a level below the 5 pCi/L. The overall design and target for the system would be a discharge concentration with a target of 3.5 pCi/L. The blending of shallow and deep wells does have its benefits through the reduction of radium, however there is the potential of precipitating out barium sulfate through this blending of source waters. Barium sulfate, a sulfate salt, can be a secondary reaction that occurs when the cation (barium) combines with the anion (sulfate), creating the sulfate salt. Typically, in groundwater sources, the barium is present in the deep wells (which is already present in Well #7), and the naturally occurring sulfates are typically present in the shallow wells (used for blending). As a result, this secondary reaction can deter many communities from blending source waters, as the barium sulfate can create scaling and other operational issues.

In 2016, Municipal Well & Pump performed a study which identified the feasibility of the installation of a shallow blending well at Well #7. As part of the study, a review of the existing Well #7 site, as well as other sites within the City were analyzed in regard to hydrogeologic, anthropogenic, and environmental conditions. This analysis identified that several areas surrounding Well #7 are favorable for a new sand and gravel blending well.



The overall recommendation Municipal Well & Pump identified included one of the first steps for the development of a shallow sand and gravel well includes drilling of a test boring on Well #7's existing site or within the adjacent park. This test boring would be utilized to determine if the sand and gravel deposits are suitable for a well. If the test boring on the Well #7 site indicate favorable results, and there is the potential of siting a new well, it was recommended that the City then move forward with developing the well into a test well to identify the potential pumping capacity. Based on correspondence from Municipal Well, the cost for this is anticipated to be around $90,000, and a budget of $100,000 should be utilized.

Overall, a shallow blending well (Well #11) located on the existing Well #7 site would be ideal as it would minimize the overall cost of the project. If the test boring at Well #7 doesn't indicate the potential for a shallow well, it is recommended that the City pursue other locations identified within the 2016 report.

	Full Well #7 Capacity (gpm)	Reduced Well #7 Capacity (gpm)
Well #7	1,250	550
Well #11	1,600	700
Combined 7/11	**2,850**	**1,250**

By combining the raw water from the existing well and blending with a new shallow well the City would be able to meet the radium removal requirements. Conservatively it is estimated that the existing facility's raw water is at approximately 8 pCi/L. With a finished water quality target of approximately 3.5 pCi/L it is estimated that the shallow well would need to produce around 1,600 gpm if the existing well was to produce the full 1,250 gpm design capacity of Well #7.

However, the City only needs a total of 1,250 gpm to be produced out of this well under future conditions. Therefore, it is recommended that the existing pump be pulled, and modified to discharge a target of around 500-600 gpm. This would only require the shallow well to produce approximately 700 gpm, with a similar blended discharge of 3.5 pCi/L.

Assuming that the additional well could be located onsite, the project would also include rehabilitation of the existing facility as well as a new well house for the additional well. The estimated construction cost is approximately $2.8M and the recommended project budget is $3.2M, which includes engineering and contingencies.

Well #7 – Alternative #1 Blending	
Description	Total Probable Cost
SUMMARY	
General Conditions	$488,205
Site Work	$149,875
Well #7 Rehabilitation	$633,050
New Shallow Well	$1,055,300
Construction Sub-Total	**$2,326,430**
Contingency @ 20%	$465,286
Engineering & Administration @ 15%	$418,757
PROBABLE PROJECT COST:	**$3,210,473**

The operational costs for blending the two wells is limited, and only requires minimal amount of additional power consumption for the new well pump. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 10 hours per week. This results in an annual O&M of approximately $45,000, or $0.08 per 1,000 gallons produced. This O&M cost excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

Well #7 Blending – Operation and Maintenance Costs				
Chemical	**Daily Usage**		**Cost/Unit**	**Annual Cost**
-	-	-	-	-
-	-	-	-	-
Total Annual Chemical Cost:				$ -
Power	**Daily Usage**		**Cost/Unit**	**Annual Cost**
Blending Well	895	kW	$ 0.07	$ 22,863.16
-	-	-	-	-
Total Annual Power Cost:				$ 22,863.16
Labor	**Hours per Week**		**Cost/Hour**	**Annual Cost**
Operations	10	Hours	$ 40.00	$ 20,800.00
Total Annual Labor Cost:				$ 20,800.00
Media Exchange	**Volume**		**Cost/Cy**	**Replacement Cost**
-	-	-	-	-
Total Media Waste Stream Cost:				$ -
Waste Stream	**Daily Production**		**Cost/1,000 Gal**	**Annual Cost**
-	-	-	-	-
Total Annual Waste Stream Cost:				$ -
Total Annual O&M Cost:				**$ 43,663.16**
Cost per Thousand Gallons:				**$ 0.08**

6.4.3 Well #7 – Alternative #2 HMO Filtration

In lieu of constructing a new shallow blending well, the City has a second alternative for radium removal at Well #7. This alterative includes the installation of an HMO pressure filtration system. Prior to the installation of the new technology, the existing site would require some rehabilitation and expansion. The existing facility is in fair condition; however, it was not designed to house additional treatment equipment.

Well #7 consists of an existing structure that is approximately 20 feet x 40 feet long. The western side of the facility houses the electrical and controls, as well as the well pump, while the eastern side contains a separate facility for chemical addition. The proposed improvements consist of a building addition alongside the back of the building on the south side, that is approximately 30 feet by 50 feet (shown in red). The new structure would house the additional equipment required for radium removal, which would be a single 12 ft in diameter, 38 ft long pressure filter with a loading rate of 3.0 gpm/sf. The filter has four interior cells, which operate independently. The new filter was designed similar to Well #6 where the filter would be sized sufficiently to provide full process treatment with one filter cell out of service.

In addition to the pressure filter, the project also includes a new chemical feed system for both the HMO system, as well as for treated water prior to being distributed. The existing MCC and control would also be replaced as part of this project due to them being part of the original construction and they have reached the end of their service life. As stated previously, the existing building is in fair condition, and only minor modifications are required. Therefore, the project includes minor tuckpointing, as well as a new HVAC, roof, and the existing generator being relocated.

It is anticipated that this facility could be constructed on the existing site and acquisition of additional land would be unnecessary. The estimated construction cost is approximately $3.4M and the recommended project budget is $3.5M, which includes engineering and contingencies. This results in an annual O&M of approximately $162,000, or $0.29 per 1,000 gallons produced. A conceptual cost estimate for construction of this facility is included on the following page.

Well #7 – Alternative #2 HMO Filtration	
Description	Total Probable Cost
SUMMARY	
General Conditions	$502,073
Site Work	$11,000
Well #7 Building Addition	$900,000
HMO Filter	$1,053,300
Construction Sub-Total	**$2,466,373**
Contingency @ 20%	$493,275
Engineering & Administration @ 15%	$443,947
PROBABLE PROJECT COST:	**$3,403,595**

For operational costs, it is anticipated that the facility would use approximately five gallons of chemical to produce the required 200 gallons of HMO slurry per day. There is a minimal amount of additional power consumption, which includes a blower for backwashing and the chemical feed pumps. Operational oversight is limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at 10 hours per week.

The equipment also requires media exchanges. The estimated cost per cubic yard for removal and replacement of the media is $200/cy, and the cost was spread out over 10-years. The waste stream generated would require treatment, which is quantified by applying the City's sewer rate for treatment of $6.07/1,000 gallons. This results in annual O&M cost of approximately $90,000, or $0.17 per 1,000 gallons produced. This O&M cost excludes the costs for chlorination, fluoride, and well pumping, etc. which are also associated with the WRT system and blending options.

Well #7 HMO – Operation and Maintenance Costs						
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (20% Solution)	2.39	gallons	$	6.00	$	5,223.99
Potassium Permanganate (30% Solution)	2.39	gallons	$	5.00	$	4,353.32
Total Annual Chemical Cost:					$	9,577.31
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.07	$	3,658.11
Chem Feed Pump	1	kW	$	0.07	$	38.11
Total Annual Power Cost:					$	3,696.21
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	10	Hours	$	40.00	$	20,800.00
Total Annual Labor Cost:					$	20,800.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	187	CY	$	200.00	$	3,733.33
Total Media Waste Stream Cost:					$	3,733.33
Waste Stream	**Daily Production**		**Cost/1,000 Gal**		**Annual Cost**	
4% of Forward Flow	24,000	Gallons	$	6.07	$	53,173.20
Total Annual Waste Stream Cost:					$	53,173.20
Total Annual O&M Cost:					**$**	**90,980.06**
Cost per Thousand Gallons:					**$**	**0.17**

6.4.4 Well #7 – Alternative #3 WRT System

The third and final alternative for Well #7 includes rehabilitating the existing building, as well as constructing the building addition on the south side of the existing wellhouse as identified within Alternative #2. The new structure would house a new WRT system similar to the existing facilities that are install at Well #6, 8, 9, and 10. The proposed system would be a similar two vessel design, and the City would be responsible for both providing an upfront capital investment, and fixed/variable fees on an annual basis as described in Section 6.3.

The WRT capital investment cost was estimated by taking the capital investment that was paid during the purchase of the Well #10 equipment and escalating them to 2019 dollars. It is anticipated that this cost would be around $1.0M. A similar approach was performed for the O&M costs (fixed, and variable costs).

The O&M costs for the WRT system installed at Well #7 is anticipated to the be similar to Well #8 due to the previously identified radium concentration. The O&M costs are broken down into two separate categories, fixed and variable costs. Due to the anticipation that the City would purchase the equipment versus lease it, there would be no fixed cost associated with the equipment. However, the City would still have an annual variable cost and it is expected that it would be similar to Well #10 due to the capacity and would be approximately $140,000/year. These O&M cost exclude the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the HMO systems.

Well #7 – Alternative #3 WRT System	
Description	Total Probable Cost
SUMMARY	
General Conditions	$494,876
Site Work	$11,000
Well #7 Building Addition	$900,000
WRT Equipment	$987,870
Construction Sub-Total	**$2,393,745**
Contingency @ 20%	$478,749
Engineering & Administration @ 15%	$430,874
PROBABLE PROJECT COST:	**$3,303,369**

6.4.5 Well #8 – HMO Filtration

In the southeast region of the City, Well #8 is located near the intersection of Bethany Road and Mediterranean Drive, just west of Peace Road. Within the existing site, there is a single building which incorporates the existing treatment facility, generator, as well as the Well, and chemical feed equipment. The existing facility is not sufficient in size for the addition of a new HMO pressure filter and therefore the building would need to be expanded. However, the existing site is likely too small (0.25 acres) and is bounded on all sides (shown in red).

In order to construct and install the improvements at Well #8, the City would need to purchase additional land and construct a new building and treatment facility at that location. Directly south of the existing facility, across Bethany Road is an open field that could be purchased (shown in blue). The additional land is 0.5 acres in size and could not only site the new water treatment facility for Well #8, but also could potentially site a new water tower as identified in Section 6.1.

This project includes the purchase and development of the land directly to the south of the existing site with a new treatment building. The new building would be approximately 40 feet by 60 feet long and would house a new HMO Pressure Filter that is 12 feet in diameter, and 38 feet long. The existing building would be maintained and would house all electrical gear, emergency power, as well as the existing well. The overall estimated construction cost is approximately $4.4M and the recommended project budget is $5.0M, which includes engineering and contingencies. This results in an annual O&M cost of approximately $158,000, or $0.29 per 1,000 gallons produced. A conceptual cost estimate for construction of this facility is included below.

Well #8 – HMO Filtration	
Description	Total Probable Cost
SUMMARY	
General Conditions	$617,348
Site Work	$233,750
Well #8 Addition	$1,540,000
HMO Filter	$1,022,500
Electrical/SCADA/I&C	$216,000
Construction Sub-Total	**$3,629,598**
Contingency @ 20%	$725,920
Engineering & Administration @ 15%	$653,328
PROBABLE PROJECT COST:	**$5,008,845**

The operational costs of the HMO process are minimal, and only requires a small amount of chemical addition to the raw water. It is anticipated that the facility would use approximately four gallons of chemical to produce the required 160 gallons of HMO slurry per day. There is also a minimal amount of additional power consumption for this equipment, which includes a blower for backwashing and the chemical feed pumps. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 10 hours per week.

The proposed HMO equipment also requires media exchanges throughout its service life, it is anticipated that this exchange would occur once every ten years. The cost per cubic yard for removal and replacement of the material is $200/cy, and was spread out over 10-years. The waste stream generated would require treatment, which is quantified by applying the City's sewer rate for treatment of $6.07/1,000 gallons. This results in annual O&M cost estimated at $80,000, or $0.15 per 1,000 gallons produced. This O&M excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

Well #8 HMO – Operation and Maintenance Costs						
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (20% Solution)	1.99	gallons	$	6.00	$	4,353.32
Potassium Permanganate (30% Solution)	1.99	gallons	$	5.00	$	3,627.77
Total Annual Chemical Cost:					$	7,981.09
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.07	$	3,658.11
Chem Feed Pump	1	kW	$	0.07	$	38.11
Total Annual Power Cost:					$	3,696.21
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	10	Hours	$	40.00	$	20,800.00
Total Annual Labor Cost:					$	20,800.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	178	CY	$	200.00	$	3,555.56
Total Media Waste Stream Cost:					$	3,555.56
Waste Stream	**Daily Production**		**Cost/1,000 Gal**		**Annual Cost**	
4% of Forward Flow	20,000	Gallons	$	6.07	$	44,311.00
Total Annual Waste Stream Cost:					$	44,311.00
Total Annual O&M Cost:					**$**	**80,343.86**
Cost per Thousand Gallons:					**$**	**0.15**

6.4.6 Well #9 – HMO Filtration

Well #9 is located in the far eastern part of town, west of Airport Road, and just north of Hillside Road, and has the largest capacity out of all the four wells. This facility was constructed in 2005, and is divided into two main areas, one with the WRT treatment equipment, and the other as a lab/electrical/control room. The existing well is located within the yard, on the north side of the facility.

The proposed improvements for Well #9 include converting the existing facility to the HMO process, which includes a vessel that is anticipated to be 12 feet in diameter and 38 feet in length. As part of the proposed project, the existing building would need to be modified to allow for the installation of the new equipment. A new 14-foot overhead door would need to be installed on the south side of the facility, within a small addition to allow for access around the proposed equipment. This clear space would allow for influent and effluent piping to be installed, as well as space for typical operation and maintenance procedures.

Overall the existing treatment facility structure is in good condition, and only requires minor modifications and alterations. In addition to the HMO filter, the project also includes chemical feed equipment for the HMO process, electrical upgrades, as well as additional SCADA and Controls.

The estimated construction cost is $2.5M and the recommended project budget is $2.9M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility is included below.

Well #9 – HMO Filtration	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$463,414
Site Work	$48,850
Building Modifications	$301,500
HMO Filter	$1,106,500
Electrical/SCADA/I&C	$156,000
Construction Sub-Total	**$2,076,264**
Contingency @ 20%	$415,253
Engineering & Administration @ 15%	$373,727
PROBABLE PROJECT COST:	**$2,865,244**

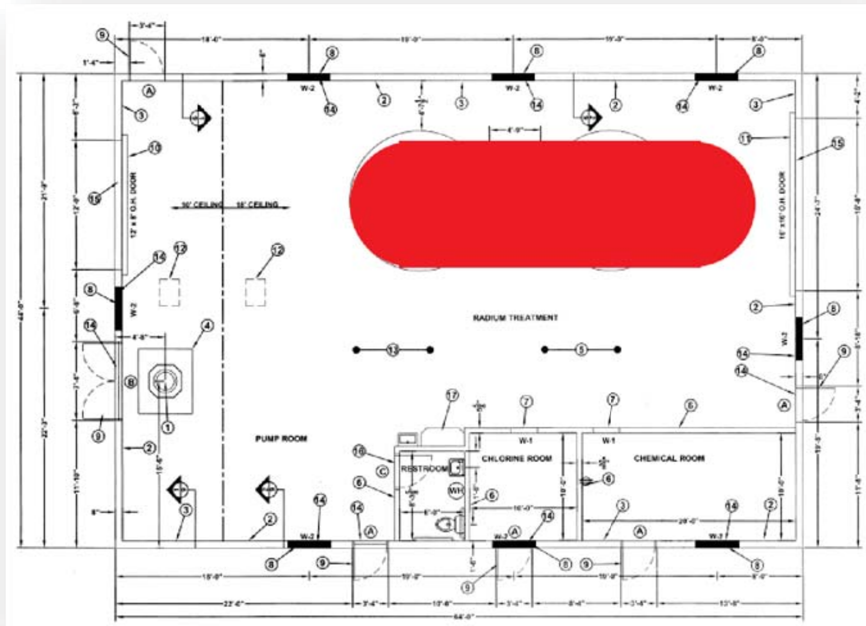
The operational costs of the HMO process are minimal, and only requires a small amount of chemical addition to the raw water. It is anticipated that the facility would use approximately four gallons of chemical to produce the required 160 gallons of HMO slurry per day. There is also a minimal amount of additional power consumption for this equipment, which includes a blower for backwashing and the chemical feed pumps. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 10 hours per week.

The proposed HMO equipment also requires media exchanges throughout its service life, it is anticipated that this exchange would occur once every 10 years. It is anticipated that the cost per cubic yard for removal and replacement of the material is $200/cy, and the cost was spread out over 10-years. The waste stream generated would require treatment, which is quantified by applying the City's sewer rate for treatment of $6.07/1,000 gallons. This results in annual O&M cost of approximately $85,000, or $0.15 per 1,000 gallons produced. This O&M excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

Well #9 HMO – Operation and Maintenance Costs						
Chemical	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Manganese Sulfate (20% Solution)	2.03	gallons	$	6.00	$	4,440.39
Potassium Permanganate (30% Solution)	2.03	gallons	$	5.00	$	3,700.33
Total Annual Chemical Cost:					$	8,140.72
Power	**Daily Usage**		**Cost/Unit**		**Annual Cost**	
Blowers	143	kW	$	0.07	$	3,658.11
Chem Feed Pump	1	kW	$	0.07	$	38.11
Total Annual Power Cost:					$	3,696.21
Labor	**Hours per Week**		**Cost/Hour**		**Annual Cost**	
Operations	10	Hours	$	40.00	$	20,800.00
Total Annual Labor Cost:					$	20,800.00
Media Exchange	**Volume**		**Cost/Cy**		**Annual Cost**	
HMO Media - 10-year Replacement	233	CY	$	200.00	$	4,666.67
Total Media Waste Stream Cost:					$	4,666.67
Waste Stream	**Daily Production**		**Cost/1,000 Gal**		**Annual Cost**	
4% of Forward Flow	20,400	Gallons	$	6.07	$	45,197.22
Total Annual Waste Stream Cost:					$	45,197.22
Total Annual O&M Cost:					**$**	**82,500.81**
Cost per Thousand Gallons:					**$**	**0.15**

6.4.7 Well #10 – HMO Filtration

Well #10 is the newest well and facility within the system and was constructed in 2014. The site includes a well, water treatment facility, as well as Tower #2. The existing facility is in very good condition and is roughly 64 feet by 44 feet. Due to the overall size, it is not anticipated that any modifications to the existing structure would be required to implement any future improvements or conversion to a new technology.



The proposed radium removal conversion consists of the installation on of a single HMO pressure filtration system. The vessel for Well #10 is estimated to be 12 feet in diameter and 38 feet in length (shown in red) and should fit within the footprint of the existing WRT equipment.

Well #10 has an existing 16 ft x 16 ft overhead door that could be utilized for installing the equipment and minimizing the overall construction duration period. The existing piping could be modified to connect to the HMO equipment, and this Well could be quickly modified, and started up seamlessly. In addition to the equipment and piping costs, the project also includes minor modifications to the electrical and controls for integration of the new technology.

The estimated construction cost is $1.9M and the recommended project budget is $2.2M, which includes engineering and contingencies. A conceptual cost estimate for construction of this facility is below.

Well #10 – HMO Filtration	
Description	Total Probable Cost
SUMMARY	
GENERAL CONDITIONS	$356,310
Site Work	$14,500
HMO Filter	$1,022,500
Electrical/SCADA/I&C	$184,000
Construction Sub-Total	**$1,577,310**
Contingency @ 20%	$315,462
Engineering & Administration @ 15%	$283,916
PROBABLE PROJECT COST:	**$2,176,688**

The operational costs of the HMO process are minimal, and only requires a small amount of chemical addition to the raw water. It is anticipated that the facility would use approximately three gallons of chemical to produce the required 130 gallons of HMO slurry per day. There is also a minimal amount of additional power consumption for this equipment, which includes a blower for backwashing and the chemical feed pumps. Operational oversight would be limited to personnel checking on the facility during rounds and some minor lab work and maintenance, anticipated at an additional 10 hours per week.

The proposed HMO equipment also requires media exchanges throughout its service life, it is anticipated that this exchange would occur once every 10 years. It is anticipated that the cost per cubic yard for removal and replacement of the material is $200/cy, and the cost was spread out over 10-years. The waste stream generated would require treatment, which is quantified by applying the City's sewer rate for treatment of $6.07/1,000 gallons. This results in annual O&M costs of approximately $67,000, or $0.12 per 1,000 gallons produced. This O&M excludes the costs for chlorination, fluoride, and well pumping, etc. as these costs would also be associated with the WRT system.

Well #10 HMO – Operation and Maintenance Costs				
Chemical	**Daily Usage**		**Cost/Unit**	**Annual Cost**
Manganese Sulfate (20% Solution)	1.47	gallons	$ 6.00	$ 3,221.46
Potassium Permanganate (30% Solution)	1.47	gallons	$ 5.00	$ 2,684.55
Total Annual Chemical Cost:				$ 5,906.01
Power	**Daily Usage**		**Cost/Unit**	**Annual Cost**
Blowers	143	kW	$ 0.07	$ 3,658.11
Chem Feed Pump	1	kW	$ 0.07	$ 38.11
Total Annual Power Cost:				$ 3,696.21
Labor	**Hours per Week**		**Cost/Hour**	**Annual Cost**
Operations	10	Hours	$ 40.00	$ 20,800.00
Total Annual Labor Cost:				$ 20,800.00
Media Exchange	**Volume**		**Cost/Cy**	**Annual Cost**
HMO Media - 10-year Replacement	178	CY	$ 200.00	$ 3,555.56
Total Media Waste Stream Cost:				$ 3,555.56
Waste Stream	**Daily Production**		**Cost/1,000 Gal**	**Annual Cost**
4% of Forward Flow	14,800	Gallons	$ 6.07	$ 32,790.14
Total Annual Waste Stream Cost:				$ 32,790.14
Total Annual O&M Cost:				**$ 66,747.92**
Cost per Thousand Gallons:				**$ 0.12**

6.4.8 Summary of Selected Alternatives

As identified, there are several different options for the City of Sycamore in terms of radium removal technologies that could be implemented at the existing water treatment facilities. Currently the City is utilizing an adsorption technology provided by WRT. The most appropriate alternative technology to WRT was identified as Hydrous Manganese Oxide (HMO) filtration. Each of the City's existing wells were reviewed, and conceptual designs and costs were developed.

The table below provides a side by side comparison of the reviewed technologies for each facility, and their respective capital and O&M costs annually, as well as over a 20-year life. It should be noted that the capital costs developed for the WRT systems was developed by assuming that the City would be required to invest into the existing facilities again in 2027. Based on the previous contracts that were provided to the City, a capital investment in 2027 was determined through interpolation. It was assumed that in 2007 Well #6, #8, and #9 had a capital cost of approximately $750,000 each, or a total capital cost of $2.25M. This capital cost was calculated by converting the purchase price for Well #10 of $860,000 to 2007 dollars. In 2017 the City obtained an updated contract from WRT for outright purchasing of the equipment after 10 years of service. This purchase price in 2017 equated to $1.36M, and therefore the equipment was depreciated $0.90M over the 10 years from 2007. Assuming the same rate of depreciation for the next 10 years, the estimated capital cost for purchasing the equipment in 2027 would be around $450,000. However, this cost may vary if the depreciation is not linear as estimated, therefore the capital cost for 2027 could be range from approximately $450,000 to $900,000. During the analysis of the WRT contracts, the City reached out to WRT to inquire about the future capital costs for the equipment in 2027. WRT was not able to provide an estimate at that time, and therefore the previous estimates were used at $0.9M.

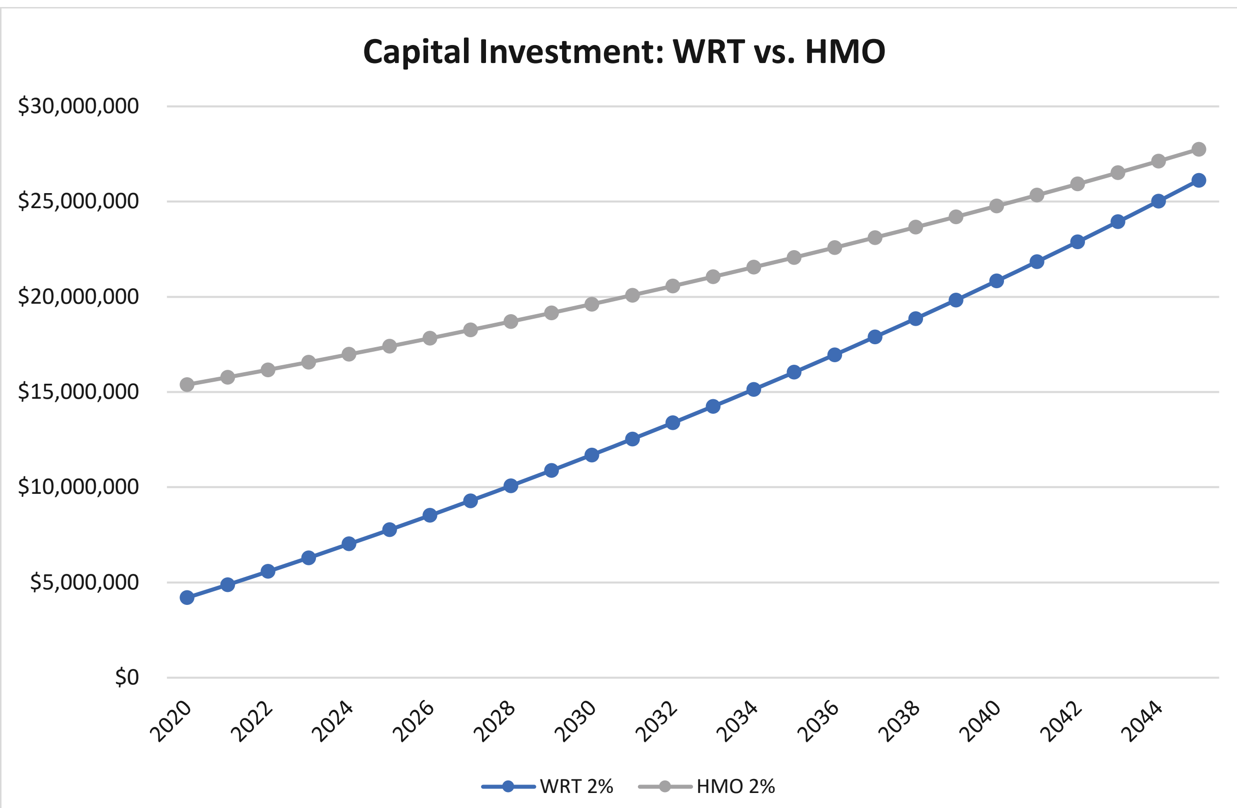
Each of the identified capital costs include the 20% conceptual contingency. Also, it should be noted that these estimated costs include engineering and legal/administrative, which is estimated at 15% of the construction total. The annual operating and maintenance costs for each facility are totalized over the 20 years cycle. The table allows for a direct comparison between the proposed conversion to HMO, as well as the maintaining the WRT systems, and the associated capital investment versus the 20-year O&M costs.

		Capital Cost	O&M Cost	20-Year O&M Costs	20-Year Present Value
Well #6	Alternative #1 - Convert to HMO	$1,935,429	$57,786	$1,155,713	$3,091,142
	Alternative #2 - Maintain WRT	$200,000	$103,874	$2,077,471	$2,277,471
Well #7	Alternative #1 - Convert to HMO	$3,403,595	$90,980	$1,819,601	$5,223,196
	Alternative #2 - WRT	$3,303,369	$140,000	$3,000,000	$6,303,369
	Alternative #3 - Blending	$3,210,473	$43,663	$873,263	$4,083,736
Well #8	Alternative #1 - Convert to HMO	$5,008,845	$80,344	$1,606,877	$6,615,722
	Alternative #2 - Maintain WRT	$350,000	$186,264	$2,676,949	$3,026,949
Well #9	Alternative #1 - Convert to HMO	$2,865,244	$82,501	$1,650,016	$4,515,260
	Alternative #2 - Maintain WRT	$350,000	$173,561	$2,422,884	$2,772,884
Well #10	Alternative #1 - Convert to HMO	$2,176,688	$66,748	$1,334,958	$3,511,646
	Alternative #2 - Maintain WRT	$0	$162,042	$3,240,846	$3,240,846

In addition to comparing the two systems side by side from a capital investment and O&M standpoint, a breakeven analysis was also performed for the two selected alternatives. The breakeven analysis was used to identify the point in time (year) where the two systems would meet in the total overall investment required by the City. This review consisted of totaling both the initial capital costs for each system, as well as the annual operation and maintenance costs year over year.

When reviewing the O&M costs, it was assumed that each year the costs for both systems would increase at 2% annually to address inflation and operation costs (power, chemical, manpower, etc.). Initially maintaining the WRT system has a lower overall capital investment by the City ($4.2M). However, on average, the WRT system has a higher operation and maintenance cost associated with it and is shown by the slope in the green line. In comparison to converting to HMO (identified in blue), the overall capital investment is much higher ($15.3M), and the overall O&M is lower on an annual average basis, a lower slope shown in the blue line.

Therefore, by projecting the costs of the two systems out over several years, it can be anticipated that by 2035-2040 the two systems would meet and "breakeven". Any subsequent years beyond that point, the conversion to HMO would be a financially less expensive to own and operate as an alternative to maintaining the WRT systems at each facility. This equates to approximately a 30-year payback period for the City upon the initial investment.



6.5 Summary

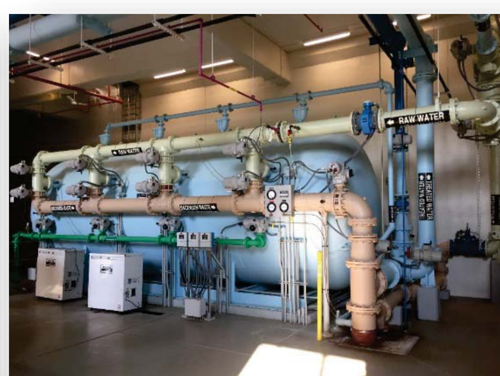
Section six was broken down into three components; water storage, water supply, and water treatment. Each of the respective sections had several projects reviewed and recommended to be implemented over the next 10-20 years by the City of Sycamore.

With regard to water storage, it is recommended the City contract with an inspection company to have Tower #1 evaluated to determine whether any structural concerns exist, evaluate the existing coating, as well as provide an estimated remaining useful service life. It is estimated that this evaluation would cost $20-$30,000. Upon identifying the repair needs and costs, it is recommended that the City move forward with budgeting and getting Tower #1 recoated. It is estimated that recoating the tower could cost $900,000 to $1.1M. The coating of the tower should occur within the next several years. Tower #1 water tower is critical for the City to maintain as it is in an ideal location for fire flows and distribution capacity. Lastly, it is recommended that the City continue to monitor population growth and increases in maximum day water demand to determine whether additional storage will be necessary in the 10-20 year timeframe.

Water supply and water treatment are not separate issues for the City. As recommended in Section 2 and Section 5, Well #7 should be rehabilitated and brought back online within the next several years. It is recommended that this well be brought back into service for emergency use only prior to taking Tower #1 offline for recoating and rehabilitation.

Well #7 is also the critical well in determining the next steps in long-term radium removal. It is recommended that the City start their negotiations with WRT over the next two years. If favorable terms are met with WRT, the City may elect to move forward with the implementation of a new WRT system at Well #7. However, if the negotiations are not favorable, the City will need to start moving forward with design of a new HMO facility at Well #7. Once the new Well #7 HMO facility is online, the City should plan on taking the other facilities offline, one by one, to perform the design, construction, and startup of new HMO facilities. This design and construction of all facilities would need to be completed by the termination of the WRT contract in 2027.

The following section, Section 7, provides an implementation plan and timeline for each of the identified improvements outlined within Section 3, 4, 5, and 6.



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SECTION 7

RECOMMENDATIONS AND SUMMARY

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7. RECOMMENDATIONS AND SUMMARY

The City is responsible for providing a safe and reliable supply of water to more than 17,000 residents, as well as commercial, industrial, and municipal users. The preceding sections have described the planning area, the current and future capacity needs, the existing supply, storage, treatment, and distribution system infrastructure, and recommendations for improvements over the 20-year planning horizon.

As with most communities, Sycamore's water infrastructure has been constructed over decades, with existing equipment dating back to 1970 and water main constructed as far back as the 1920's. While the City has maintained the water system, capital investment will continue to be required to maintain this level of service. Additionally, capital projects focusing on regulatory compliance (radium removal), water quality (chlorine residual and age), and improved service (fire flows) were identified throughout Sections 3-6 of this report. These capital projects vary in scale and priority and must be scheduled carefully to meet the City's long-term water system goals.

The implementation plans on the following pages were developed in conjunction with City staff and aim to allocate capital projects according to the City's priorities and available funding. Discussion of available funding sources, including the State Revolving Fund (SRF) loan program are also included. While this report does not include a rate study, it is recommended that the City complete an analysis either internally or contracted to determine the funding necessary to support the selected implementation plan. This rate study should focus on the existing base rate water charges and radium treatment fees, with a review of the meter maintenance fees. The City has several relatively unique rate structure features which should be considered when analyzing future revenue generation needs. One component which should be specifically reviewed is the tiered rate structure which reduces the unit rate for water up to 60% for high-volume users. It appears that based on future water rate structures the City intends to phase out this mechanism, however the base rate is slated to decrease while higher volume rates increase. The City may consider maintaining base rates or decreasing as a lesser amount in order to generate additional revenues.

City staff and TAI identified several key projects that must be completed on schedule to maintain the overall integrity of the water system. These are included in the implementation plans on the following pages, and are listed chronologically below:

- 2020: Inspect Tower #1 Coating & Structural Integrity ($30,000)
- 2020: Return Well #7 to Service in Emergency Standby (In-House)
- 2021: Recoating Tower #1 ($1.1M)
- 2022: California & Brickville Water Main Replacement ($1.24M)
- 2023: Well #7 Treatment Facility – WRT System ($3.3M) or HMO System ($3.4M)
- 2024: Begin Treatment System Evaluation & Design (WRT Contract Expires 2027)
- 2024 – 2027: Radium Removal Improvements – Maintain WRT ($0.9M) or HMO System ($12.1M)
- 2028 – 2039: Distribution System Projects (Target $1.91M Annually)
- 2040: Construct Tower #3 ($4.0M)

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7.1 Implementation Plans

As identified in Section 6, the City will need to make a significant decision with regards to the future of radium removal within the water system. A number of alternative technologies for treatment were reviewed, and ultimately two main options identified. The City can either elect to maintain the WRT system and enter into a new agreement or construct HMO treatment facilities owned and operated by the City. The implementation plans below reflects the first alternative – maintaining the WRT systems. As discussed in Section 6.4.8, maintaining the WRT system will require a capital investment. The equipment will be 20 years in age at the next contract renewal (2027), and was estimated that the high end of the capital cost investment would be required for purchase of the existing equipment. For the four existing wells, this represents a total capital cost of approximately $0.9M. A new treatment facility would need to be constructed at Well #7, at an estimate project cost of $3.30M.

Table 7-1: Alternative #1 Maintain WRT Treatment (Treatment & Storage Capital Plan)

	Fiscal Year Cash Flow ($ in Millions, 2020)																					
Project Description	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**Project Total**
Tower #1 Inspection	0.03																					***0.03***
Recoating of Tower #1			1.10																			***1.10***
Well #7 - New WRT Facility				3.30																		***3.30***
Well #6/8/9/10 - WRT Rehabilitation								0.90														***0.90***
Additional Elevated Tower (Tower #3)																					4.00	***4.00***
Fiscal Year Total:	**0.03**	**0.00**	**1.10**	**3.30**	**0.00**	**0.00**	**0.00**	**0.90**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.00**	***9.33***

Table 7-2: Alternative #1 Maintain WRT Treatment (Distribution Capital Plan)

	Fiscal Year Cash Flow ($ in Millions, 2020)																					
Project Description	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**Project Total**
California, Brickville, and North Ave		1.43																				***1.43***
Mercantile & Prairie Connection*			0.25																			***0.25***
Elm Street					0.98																	***0.98***
Sycamore High School*						0.68																***0.68***
North Grove School Connection*						0.28																***0.28***
Sabin & Exchange							2.10															***2.10***
Lincoln & Locust								1.40														***1.40***
Somonauk Road (Phase 1)									1.90													***1.90***
Somonauk Road (Phase 2)										1.90												***1.90***
Electric Park											0.86											***0.86***
Bethany Rd. (Rt. 23 to Health Club)												0.57										***0.57***
Annual 4" & 6" Replacement Projects													1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91		***15.28***
Fiscal Year Total:	**0.00**	**1.43**	**0.25**	**0.00**	**0.98**	**0.96**	**2.10**	**1.40**	**1.90**	**1.90**	**0.86**	**0.57**	**1.91**	**1.91**	**1.91**	**1.91**	**1.91**	**1.91**	**1.91**	**1.91**	**0.00**	**27.63**

* Reduced Cost Due to In-House Design and Construction

The second alternative available to the City for radium removal is conversion to hydrous manganese oxide (HMO) treatment. This would include a new HMO treatment facility constructed at Well #7, and replacement of the WRT equipment at Wells #6, 8, 9 & 10. It is anticipated that a new structure would need to be constructed at Well #8 to house the HMO equipment, and similarly an addition to the structure at Well #9. Since the City cannot have more than one treatment facility offline at a given time, conversion to HMO treatment would need to be phased. A service termination agreement would be negotiated with WRT, and the sites would be retrofitted one each year. This could be accomplished through individually bid contracts or a single larger contract spanning several years. While there would be scales of economy realized with a single contract, it may require more coordination between the City and selected Contractor.

Table 7-3: Alternative #2 Convert to HMO Treatment (Treatment & Storage Capital Plan)

		Fiscal Year Cash Flow ($ in Millions, 2020)																				
Project Description	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**Project Total**
Tower #1 Inspection	0.03																					***0.03***
Recoating of Tower #1			1.10																			***1.10***
Well #7 - New HMO Facility				3.50																		***3.50***
Well #6 - HMO Conversion					2.00																	***2.00***
Well #9 - HMO Conversion						2.90																***2.90***
Well #8 - HMO Conversion							5.00															***5.00***
Well #10 - HMO Conversion								2.20														***2.20***
Additional Elevated Tower (Tower #3)																					4.00	***4.00***
Fiscal Year Total:	**0.03**	**0.00**	**1.10**	**3.50**	**2.00**	**2.90**	**5.00**	**2.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.00**	***20.73***

Table 7-4: Alternative #2 Convert to HMO Treatment (Distribution Capital Plan)

		Fiscal Year Cash Flow ($ in Millions, 2020)																				
Project Description	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**Project Total**
California, Brickville, and North Ave		1.43																				***1.43***
Mercantile & Prairie Connection*			0.25																			***0.25***
Elm Street									0.98													***0.98***
Sycamore High School*										0.68												***0.68***
North Grove School Connection*										0.28												***0.28***
Sabin & Exchange											2.10											***2.10***
Lincoln & Locust												1.40										***1.40***
Somonauk Road (Phase 1)													1.90									***1.90***
Somonauk Road (Phase 2)														1.90								***1.90***
Electric Park															0.86							***0.86***
Bethany Rd. (Rt. 23 to Health Club)																0.57						***0.57***
Annual 4" & 6" Replacement Projects																	1.91	1.91	1.91	1.91		***7.64***
Fiscal Year Total:	**0.00**	**1.43**	**0.25**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.98**	**0.96**	**2.10**	**1.40**	**1.90**	**1.90**	**0.86**	**0.57**	**1.91**	**1.91**	**1.91**	**1.91**	**0.00**	**19.99**

* Reduced Cost Due to In-House Design and Construction

7.2 Capital Funding and Alternative Funding Sources

The City of Sycamore has several different funding options available in order to successfully fund the outlined projects. Some of the different funding options include the Illinois EPA Low-Interest Loan State Revolving Fund (SRF), Bonds, Grants, and local transportation funding (DSATS).

7.2.1 Illinois EPA Low-Interest Loan State Revolving Fund (SRF)

The IEPA State Revolving Fund is a program that has been developed as a part of the Illinois Clean Water Initiative (CWI). It is this initiative that maintains the Public Water Supply Loan Program (PWSLP) which funds water distribution, supply, and storage projects, and has been doing so since the late 1980's. Each year, this program receives Federal Capital Funding which is matched with State Funds, interest earning, repayment money, and the sale of bonds. It is these funding mechanisms that are utilized by the State to form a continuous source of financing for the water infrastructure projects.

The Illinois EPA Low-Interest Loan program was developed to provide financial assistance to both the public and private applications for design and construction of projects that protect or improve the quality of Illinois' water resources. In the past few years, the State has funded around $100-300 Million dollars of clean water projects at interest rates ranging from 1.75-2.21%.

A specific application process has been developed to obtain SRF funding, and requires a project nomination form, as well as planning approval of a project plan or facility plan for the community pursuing funding. The project planning report can be submitted anytime throughout the year, however an annual renewal of funding nomination forms should be sent into the State by January 31st of each year. If the City elects to purusue loan funding for the re-coating of Tower #1 in FY2022, a nomination form should be submitted by January 31st, 2021. This nomintion form, along with an approved project plan, would secure funding for bidding the Tower #1 Coating project between July 1st, 2021 and June 30th, 2022. Once a community has an approved proejct plan, additional documentation including a loan application will be completed with a financial checklist. At the point where the project has been bid, and is moved into contruction, a final loan agreement will be executed.

Each year the loan rate is established on July 1st, and a typical loan is written around a 20-year term. However, the state has recently developed additional programs to provide reduced interest rates for "small communities", and "hardship rates". Reduction of rates can also come from specific design considerations that reduce impacts on the environment and reduce the overall energy footprint. This reduction can equate to a reduction of 0.2% off the base interest rate.

Existing SRF Debt Service & Retirement

The City has historically funded capital projects both locally, and through loan programs. Sycamore currently has three Illinois EPA SRF loans on the books in various amounts. The City has annual debt repayments of $50,000 and $60,000 for improvements to Well #9 in 2005 via two separate loans, as well as $70,000 annual for a loan supporting the upfront cost of the WRT system installation in 2007 ($1.3M).

	Fiscal Year Debt Service ($ in Millions, 2020)											
Project Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Well 9- Part 1 (2003 - IEPA Water)	0.05	0.05	0.05	0.05	0.05	0.05						*0.30*
Well 9- Part 2 (2005 - IEPA Water)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06				*0.44*
WRT System Installation (2006- IEPA Water)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07				*0.53*
Fiscal Year Total:	**0.17**	**0.17**	**0.17**	**0.17**	**0.17**	**0.17**	**0.12**	**0.12**	**0.00**	**0.00**	**0.00**	***1.27***

Each of the loans have a 20-year life and are anticipated to be retired in 2025 and 2027. This retirement will result in the City being able to reallocate funds and revenues to future projects, and potentially future debt service if additional loans are procured. By 2027, the City will have retired the existing loans, and will have an additional $180,000 available for future projects. Based on a 20-year loan and 2% interest, this equates to a future loan amount of approximately $3.0M if the City so chose.

Future Debt Service

If the City elected to fund the treatment rehabilitation through SRF loans, the annual debt repayments could be calculated as shown in the below two tables. Depending on the implementation of these projects the City could utilize one larger loan to fund multiple rehabilitations, or separate loans for each well facility. The table below left represents a loan amount of $3.9M, which reflects constructing a WRT treatment facility at Well #7. This also includes the IEPA's 3% contingency and 1.5% construction period interest. The corresponding annual debt repayment is $240,000. Similarly, the below right table illustrates the loan amount associated with constructing an HMO facility at Well #7 as well as converting the remaining wells at a loan amount of $18.2M. The corresponding annual debt repayment for this scenario is approximately $1.1M per year.

City of Sycamore - Maintain WRT System
Debt Service Schedule

Loan Principal at 1st Payment:	**$3,900,000**
Interest Rate:	2.000%
Loan Term (years):	20
Annual Payment:	$238,511

Repayment Schedule:

Year	Beginning Principal Balance	Principal Payment	Interest Payment	Total Payment	Ending Principal Balance	Payment No.
2021	$3,900,000	$160,511	$78,000	$238,511	$3,739,489	1
2022	$3,739,489	$163,721	$74,790	$238,511	$3,575,767	2
2023	$3,575,767	$166,996	$71,515	$238,511	$3,408,772	3
2024	$3,408,772	$170,336	$68,175	$238,511	$3,238,436	4
2025	$3,238,436	$173,742	$64,769	$238,511	$3,064,693	5
2026	$3,064,693	$177,217	$61,294	$238,511	$2,887,476	6
2027	$2,887,476	$180,762	$57,750	$238,511	$2,706,714	7
2028	$2,706,714	$184,377	$54,134	$238,511	$2,522,337	8
2029	$2,522,337	$188,064	$50,447	$238,511	$2,334,273	9
2030	$2,334,273	$191,826	$46,685	$238,511	$2,142,447	10
2031	$2,142,447	$195,662	$42,849	$238,511	$1,946,785	11
2032	$1,946,785	$199,576	$38,936	$238,511	$1,747,209	12
2033	$1,747,209	$203,567	$34,944	$238,511	$1,543,642	13
2034	$1,543,642	$207,638	$30,873	$238,511	$1,336,004	14
2035	$1,336,004	$211,791	$26,720	$238,511	$1,124,213	15
2036	$1,124,213	$216,027	$22,484	$238,511	$908,186	16
2037	$908,186	$220,347	$18,164	$238,511	$687,838	17
2038	$687,838	$224,754	$13,757	$238,511	$463,084	18
2039	$463,084	$229,250	$9,262	$238,511	$233,835	19
2040	$233,835	$233,835	$4,677	$238,511	$0	20

City of Sycamore - HMO Conversion
Debt Service Schedule

Loan Principal at 1st Payment:	**$18,160,000**
Interest Rate:	2.000%
Loan Term (years):	20
Annual Payment:	$1,110,606

Repayment Schedule:

Year	Beginning Principal Balance	Principal Payment	Interest Payment	Total Payment	Ending Principal Balance	Payment No.
2021	$18,160,000	$747,406	$363,200	$1,110,606	$17,412,594	1
2022	$17,412,594	$762,354	$348,252	$1,110,606	$16,650,240	2
2023	$16,650,240	$777,601	$333,005	$1,110,606	$15,872,639	3
2024	$15,872,639	$793,153	$317,453	$1,110,606	$15,079,485	4
2025	$15,079,485	$809,016	$301,590	$1,110,606	$14,270,469	5
2026	$14,270,469	$825,197	$285,409	$1,110,606	$13,445,273	6
2027	$13,445,273	$841,701	$268,905	$1,110,606	$12,603,572	7
2028	$12,603,572	$858,535	$252,071	$1,110,606	$11,745,037	8
2029	$11,745,037	$875,705	$234,901	$1,110,606	$10,869,332	9
2030	$10,869,332	$893,219	$217,387	$1,110,606	$9,976,113	10
2031	$9,976,113	$911,084	$199,522	$1,110,606	$9,065,029	11
2032	$9,065,029	$929,305	$181,301	$1,110,606	$8,135,724	12
2033	$8,135,724	$947,892	$162,714	$1,110,606	$7,187,832	13
2034	$7,187,832	$966,849	$143,757	$1,110,606	$6,220,983	14
2035	$6,220,983	$986,186	$124,420	$1,110,606	$5,234,796	15
2036	$5,234,796	$1,005,910	$104,696	$1,110,606	$4,228,886	16
2037	$4,228,886	$1,026,028	$84,578	$1,110,606	$3,202,858	17
2038	$3,202,858	$1,046,549	$64,057	$1,110,606	$2,156,309	18
2039	$2,156,309	$1,067,480	$43,126	$1,110,606	$1,088,829	19
2040	$1,088,829	$1,088,829	$21,777	$1,110,606	$0	20

7.2.2 Grants

The City may be eligible to receive grant funding from several different sources, including the Department of Commerce and Economic Opportunity (DCEO), as well as the USEPA. Each program is appropriated funds from U.S. Congress in January, and funds begin to be administered by each state in early spring. Each state receives a different allocation of funds depending on several factors that evaluate the total need. Therefore, a state in greater need of funds will be appropriated a larger quantity of funding.

Each of the different grant funding sources have numerous grants available. Typically, in both cases the grants that are obtained are tied to economic need, as well as an attempt to bring jobs and/or resources to the community. A grant that is provided to a community is typically less than $500,000, and is also matched by the community. Therefore, for a project that receives a $200,000 grant, the City would fund $200,000 as well, equating to a total project cost of $400,000.

Due to the income of neighborhoods within the service area, it is unlikely that the City would qualify for the need-based grant programs. The most applicable grant for communities such as Sycamore are energy grants, currently administered by Commonwealth Edison. These grants primarily cover lighting, HVAC, and building envelope improvements, and likely wouldn't be applicable to large scale treatment projects.

7.2.3 Bonds

Bonds can be broken into several different categories including General Obligation Bonds, Revenue bonds, and Tax Increment Financing District Funding.

General Obligation Bonds (GO)

A general obligation bond (GO) is secured through taxable property within a community and is a municipal bond that is backed by the credit and taxing power of the issuing jurisdiction. A GO bond is not issued against the revenue from a project or development. Therefore, the value of the bond is held completely against the asset value and not the amount of the utility consumed. Typically, a general obligation bond has lower interest rates as there is less risk of default and are generally used to fund projects that will serve the community, such as roads, parks, equipment, and bridges.

Revenue Bonds

A revenue bond is supported and funded by the revenue of a specific project, and/or user charge revenues. Typically, holders of revenue bonds can only rely on the specific project's income, has higher risk and pays a higher interest rate. Revenue bonds are issued in blocks of time that typically fully mature within 20 to 30 years. One disadvantage of the revenue bond is that there is inherent concern that the bond ordinance requires the establishment of reserve funds to cover the risk of revenues falling short of the retirement requirement, and this burden falls onto the users of the utility or product being purchased.

Tax Increment Financing District Funding (TIF)

A TIF district is formed within a specific boundary within the facility planning area or municipal boundary within the community. This TIF district is used to create and dedicate a source of revenue that can be used to fund and retire debt within a specific area. Typically, this type of bonding is done within an area that doesn't have infrastructure or services. A TIF district is created prior to the development of a property and the value of the bond is set prior to the start of work. However, there is the option to add additional projects to a TIF district if it is proven that the district can withstand the added debt, the required revenues to payback the deficit, as well as sufficient time to pay it back.

The Tax Increment Allocation Redevelopment Act (TIF Act) in 1977 changed the TIF requirements and provided the ability of municipalities the power and authority to address the adverse conditions and conservation of areas within their planning areas. Municipalities are able to take redevelopment projects that were essential to the economic well-being of the community. Because the majority of capital projects identified benefit the community as a whole, TIF financing for the City's projects is unlikely.

7.3 Recommended Funding for Capital Projects

A number of capital improvement projects have been identified as necessary for the continued operation and maintenance of the City's water system, which range significantly in scale. The City has historically funded smaller capital improvement projects locally utilizing available funding. Based on the evaluations in Sections 3 & 4, the City should be funding roughly $1.91M in annual distribution system replacement. This program would result in replacement of the entire system over a 75-year service life. If the City targeted a 100-year replacement period, it reduces the annual funding level to $1.43M, however this would exceed AWWA published standards for water main service life. Because this is an on-going program it is recommended that these projects be funded locally through water revenues.

In addition to the distribution system rehabilitation, several storage and treatment capital projects have been slated for implementation. These include recoating of Tower #1 ($1.1M), the long-term construction of Tower #3 ($4.0M), Well #7 treatment utilizing either WRT ($3.3M) or HMO ($3.4M), as well as either rehabilitating the existing WRT systems ($0.9M) or conversion to city-wide HMO ($12.1M) at the remaining wells. It is recommended that the City consider funding these projects through the Illinois EPA's SRF low-interest loan program. The current interest rate is 2.0%, lower than typical bonding interest rates. Additionally, the debt service for the SRF loans could be accommodated through user rate increases, rather than property tax increases often used for funding General Obligation Bonds.

As previously discussed, it is recommended that a rate study or analysis be performed to ensure that the City's future rate structures are adequate to support the community's long-term needs. Much of the capital requirements over the next 10 years depends on the whether the City elects to maintain the WRT radium removal processes or convert to facilities owned and operated by the City. To determine terms of a subsequent WRT contract, the City should begin discussions with WRT in regard to Well #7. This well will likely require either WRT or HMO radium removal and can provide a template for future contracts with WRT. If terms are unfavorable for Well #7 in the 2022-23 period, sufficient time remains for the City to begin design and implement an alternate technology prior to the WRT contract ending date in 2027.

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