Comprehensive Water System Plan

2020 Comprehensive Water Plan

Le Sueur, Minnesota

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Comprehensive Water System Plan

2020 Comprehensive Water Plan

Prepared for City of Le Sueur, Minnesota

1 Introduction

The Le Sueur water system serves the City of Le Sueur, which is a community of approximately 4,000 people located in Le Sueur County within the Minnesota River Valley. The City of Le Sueur is surrounded by agriculture and supports robust industry within the City limits. Its location with respect to easy access along Highway 169 along with its rich history presents an opportunity to support growth and development and enhance existing services. Therefore, proper planning is essential to coordinate the renewal and expansion of the municipal water system facilities with short term and long term needs of the community.

This report summarizes the results of a water system evaluation completed for the Le Sueur water system. The primary purpose of the study was to evaluate the water needs and system expansion required to serve current and future utility customers to the year 2040. This report will serve as a plan to guide future expansion and redevelopment of the water system.

1.1 Scope

The Comprehensive Water Plan is intended to document the analysis and processes that lead to the development of the capital improvement recommendations. The following list summarizes each Section included in this report.

- Section 1:
  - Covers the project overview and identifies existing background information and reports referenced in the 2040 Comprehensive Water Plan.
- Section 2:
  - Reviews each component of the existing water system including infrastructure, water quality and operational processes.
- Section 3:
  - Analyzes the community’s historical and projected development and growth including population, land uses and water service area.
- Section 4:
  - Establishes historical water use trends and develops water use projections based on Section 3 assumptions and conclusions.
- Section 5:
  - Evaluates and compares the existing water system to the projected water use and quality needs.

- Section 6:
  - Recommends improvement projects to address system deficiencies identified in Section 5.
- Section 7:
  - Outlines when recommended improvement projects should be implemented into the capital improvement plan.

Because needs change with time, municipal water system planning is a continuous function. Therefore, the longer term projections and improvements discussed in this report should be reviewed, re-evaluated and modified as necessary, to assure the adequacy of future planning efforts. Proper future planning will help assure that system expansion is coordinated and constructed in the most effective manner.

1.2 Background Information and Previous Study Reports

This plan reviews the following background information and previous water planning study reports provided by the City This plan builds upon previous efforts and integrates new available information and system performance data:

- Well and Boring Logs
- Well Maintenance and Rehab Reports
- Well Level Monitoring Logs
- Water Use Reports Submitted via MPARS
- Water Use Data from Billing Records (2018)
- Well Water Quality Testing Data (2019)
- Consumer Confidence Reports
- Water Treatment Plant Plans
- ISO Survey Reports
- Tank Inspection Reports
- Water System Report (2010)
- Le Sueur 2040 Comprehensive Plan (2016)
- Water Supply Plan (2010)
- Well Head Protection Plan (2016)
- Maps and GIS Data

2 Existing Water System

This section summarizes the components of the existing Le Sueur water system. The following components will be reviewed in detail:

- Supply - Four (4) municipal wells
- Treatment - One (1) water treatment plant
- Storage - Three (3) elevated storage tanks
- Pressure Service Areas - Three (3) pressure zones
- Booster Pumping – One (1) booster station
- Distribution System

2.1 Supply

Depending on available resources, municipalities have the option of using different water sources as their municipal supply. The water source chosen as the supply influences the design of other water infrastructure and quality of finished water. The following sections provide an in-depth analysis of the Le Sueur water system's supply in terms of:

- Water Source
- Water Quality
- Vulnerability to Contamination
- Production Reliability

2.1.1 Water Source

The Le Sueur water system utilizes four municipal groundwater wells as the City's water source. Each well is drilled into one of three aquifers:

- Quaternary Water Table Aquifer
- Wonewoc Aquifer
- Mount Simon Aquifer

Details of each well design are shown in Table 2-1.

Table 2-1 – Existing Supply Facilities

Well Name	Unique Well Number	Location	Installation Year	Depth (ft)	Casing Diameter (in)	Casing Depth (ft)	Aquifer Source	Treatment
Well No. 3	218364	Near Low Zone Tower	1953	278	16	278	Quaternary Water Table Aquifer	WTP
Well No. 5	240067	WTP Site	1968	245	16	245	Quaternary Water Table Aquifer	WTP
Well No. 6	127283	Near Middle Zone Tower	1978	660	16	660	Wonewoc-Mt. Simon	WTP
Well No. 7	524753	WTP Site	1993	690	18	690	Mt. Simon	WTP

Source: Minnesota Well Index & City Maintenance Records

2.1.2 Source Water Quality

Water samples from each municipal well were collected and analyzed to establish the existing water quality. The analytes selected for analysis were chosen based on their known presence in Minnesota groundwater. Typical analyte concentrations for each well are shown in Table 2-2.

Table 2-2 – Existing Source Water Quality

Analyte	Reporting Limit	Well No. 3 (QWTA)	Well No. 5 (QWTA)	Well No. 6 (Wonewoc)	Well No. 7 (Mt. Simon)
Phosphorus (mg P/L)	0.05	0.06	<0.05	0.05	<0.05
Ammonia (mg/L)	0.1	0.17	0.16	0.92	0.37
Iron (mg/L)	0.01	1.75	0.7	1.53	0.69
Manganese (mg/L)	0.01	0.49	0.51	0.1	0.11
Magnesium (mg/L)	0.01	30.2	30.1	34.3	23.1
Calcium (mg/L)	0.01	94.5	91.9	88.8	64.7

Source: City provided results from UC Laboratory

2.1.3 Source Water Vulnerability

In 2016 the City completed a Well Head Protection Plan (WHPP) which established the vulnerability of each well. The results of this plan indicated that two of the four wells were marked as highly vulnerable as shown in Table 2-3.

Table 2-3 – WHPP Vulnerability Classification

Well	Vulnerability Classification	Reason	Comments
Well No. 3	High	• Due to proximity to Well 5 classified as highly vulnerable	No vulnerability analysis performed
Well No. 5	High	• High geologic sensitivity rating • Detectable concentration of nitrate	
Well No. 6	Low		
Well No. 7	Low		

Source: WHPP Part II provided by the City

2.1.4 Source Water Reliability

Reliability of the water source was established based on determining the supply pumping capacity and the volume of source utilization.

The total pumping capacity was determined to be 1,870 gpm as shown in Table 2-4. In the event the largest capacity well is offline, the pumping capacity, otherwise known as firm pumping capacity, will be 1,120 gpm.

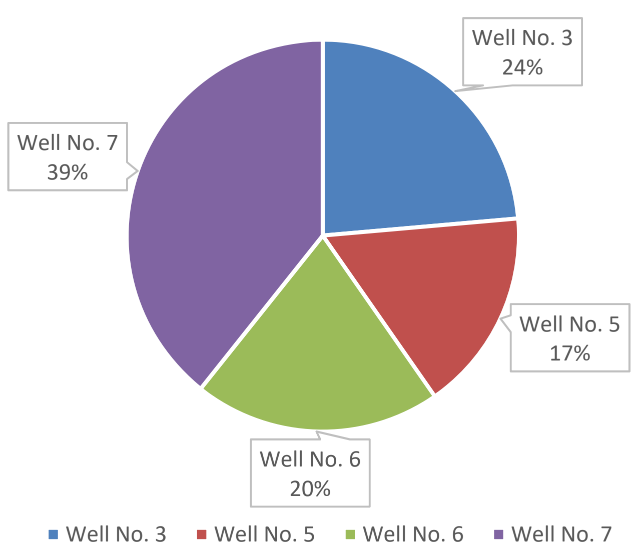
Table 2-4 – Well Pumping Capacity

Well	Capacity (gpm)
Well No. 3	400
Well No. 5	320
Well No. 6	400
Well No. 7	750
Total Pumping Capacity	1,870
Firm Pumping Capacity	**1,120**
[1] Largest capacity well	

Source: Data provided by the City

Pumping records from 2018 were analyzed to establish the percentage of water pumped from each well. Results shown in Figure 2-1 indicate the majority of the City's water is pumped from Well No. 7, which makes up approximately 39% of the annual water source.

Figure 2-1 – 2018 Well Pumping Percentage



2.2 Treatment

Water Treatment Plants (WTPs) are designed to treat source water exceeding water quality regulatory standards to within regulatory limits. Treatment processes required for each WTP vary based on the source water quality and the finished water quality requirements. The following sections provide an in-depth analysis of the Le Sueur water system's treatment in terms of:

- Water Treatment Process Design
- Treatment Capacity
- HSP Pumping Capacity

2.2.1 Water Treatment Process Design

In 1995, the City built a concrete gravity filter WTP for iron and manganese removal. The treatment process includes:

- Aeration
- Detention
- Gravity filtration
- Chemical feed
- Chlorine prior to aeration
- Chlorine and potassium permanganate prior to detention
- Chlorine and potassium permanganate after detention
- Chlorine, poly-phosphate, fluoride in finished water
- Backwash system with a reclaim tank
- Finished water clearwell

2.2.1.1 Water Treatment Plant Modifications

The existing treatment process has been modified slightly from the original design. The following treatment processes have changed.

2.2.1.1.1 Removal of Potassium Permanganate Chemical Feed

In 2012, the potassium permanganate chemical feed system broke and the City stopped injecting the chemical. While the feed system was offline, it was observed that the iron and manganese filter effluent concentrations were below typical levels. It was assumed that the filters were operating biologically. The City has not injected potassium permanganate since.

2.2.1.1.2 Backwash Reclaim Process & SCADA Integration

The Backwash recycle system was upgraded in 2012 to provide a level of valve upgrades and SCADA integration. Ultimately the SCADA integration improvements were completed in 2019.

2.2.1.2 Existing Water Treatment Plant Process

Water from the municipal wells is pumped to the WTP for treatment. Figure 2-1 provides a schematic of the treatment process and Figure 2-2 represents the hydraulic profile of the treatment plant. Individual stages of the treatment process are described in further detail in the following sections.

2.2.1.2.1 Aeration

Aeration is used to increase the oxygen concentration in the raw water to oxidize dissolved iron and manganese to form a solid precipitate. Details of the aeration process are provided in Table 2-5 below.

Table 2-5 – Aerator Process Details

Parameter	
Equipment	Aerator
Manufacturer	General Filter Company
Installation Year	1996
Material	Aluminum
Quantity	1
Dimensions (LxWxH)	8'x8'x10'
Design Loading Rate	25 gpm/ft2
Design Capacity	1600 gpm
Last Maintenance	Never Cleaned
Overall Condition	Appears Exterior in Good Condition Unknown Condition of Interior

Source: SEH Condition Assessment Evaluation & Data provided by City

2.2.1.2.2 Detention

Detention is used to provide additional time for the dissolved iron and manganese to oxidize and form the solid precipitate and allow chemical reactions to take place. Details of the detention process are provided in Table 2-6 below.

Table 2-6 – Detention Process Details

Parameter	
Equipment	Detention Tank
Installation Year	1996
Material	Concrete
Quantity	1
Dimensions (LxWxH)	33'x14'x22'
Flow Pattern	Over Under
Number of Baffles	2
Current Operational Flow Rate	1,200 gpm
Detention Time	46 minutes
Last Maintenance	2016
Overall Condition	Appears Above Water Level in Good Condition Unknown Condition of Below Water Level

Source: SEH Condition Assessment Evaluation & Data provided by City

2.2.1.2.3 Gravity Filtration

Filtration is used to remove the solid iron and manganese precipitate from the water. The filters are believed to be operating biologically, which can aid in the removal process, because chlorine is not fed into the water prior to the filters. When filters are operated biologically, iron and manganese is consumed by the biological organisms as the water passes though the filter. Filter run times are determined through head loss conditions. When the level of water above the filter media rises to between 7.5 and 8.5 feet, WTP operators backwash initiate a backwash. Details of the filtration process are provided in Table 2-7 below.

Table 2-7 – Filtration Process Details

Parameter	
Equipment	Gravity Filters
Installation Year	1996
Material	Concrete
Quantity	4
Dimensions (LxW)	12'x12'
Area (1 Filter)	144 ft2
Total Area (4 Filters)	576 ft2
Media	18" Anthracite 12" Sand
2Max Sustainable Flow Rate (2.6 gpm/sf)	1,500 gpm
Existing Flow Rate1	1050 – 1150 gpm
Existing Loading Rate1	1.82 – 2.00 gpm/ft2
Underdrain	False floor Media retaining nozzles No air scour
Backwash Type	Water only
Backwash Rate	1,300 – 1,350 gpm
Backwash Duration	20 minutes
Filter Backwash Frequency	1 backwash/month
Last Maintenance	2012
Overall Condition	-Appears Above Water Level in Good Condition -Unknown Condition of Below Water Level

[1] Dependent on combination of wells pumping

[2] Based on original plant design assumptions, potential for current system to operate at this rate needs to be tested.

Source: SEH Condition Assessment Evaluation & Data provided by City

In about 2008, the filter backwash waste valves were replaced but the original actuators were placed on the new valves. Then, between 2012 and 2014, the WTP underwent a project to improve the filter backwash supply piping. The project included installing new backwash supply piping and valves that had not been in place prior to the project.

2.2.1.2.4 Finished Water Storage

Water from the filters is stored in the clearwell until it is pumped into the distribution system. Chlorine is not added to the water until it is pumped out of the clearwell. Details of the clearwell are provided in Table 2-8 below.

Table 2-8 – Finished Water Storage Details

Parameter	
Equipment	Clearwell Tank
Installation Year	1996
Material	Concrete
Quantity	1
Dimensions (LxWxH)	35'x25'x17'
Storage Capacity	100,000 gallons
Last Inspection	2010
Overall Condition	Appears in Good Condition

Source: SEH Condition Assessment Evaluation, KLM Inspection Report & Data provided by City

2.2.1.2.5 High Service Pumps

The high service pumps are used to pump water from the clearwell to the distribution system to meet system demands and fill the distribution storage tanks. From the WTP there are two dedicated pumping system. One system pumps into the Low Zone and the other pumps into the Middle Zone. Details of the high services pumps are provided in Table 2-9 below.

Table 2-9 – WTP High Service Pumping Details

Parameter	
Process	Pumping to Distribution System
Equipment	High Service Pumps
Middle Zone	
Manufacturer	Fairbanks Morse
Model	14M-7000W
Quantity	2
Stage	3
Driver	40 HP
Impeller Diameter	7.780 inches
RPM(s)	1770
Installation Year	1996
Quantity	2
Design Flow Rate	750 gpm
TDH	170 feet
Overall Condition	-Appears in Good Condition
Low Zone	
Manufacturer	Fairbanks Morse
Model	14M-7000W
Quantity	2
Stage	2
Driver	75 HP
Impeller Diameter	8.950 inches
RPM(s)	1780
Installation Year	1996
Quantity	2
Design Flow Rate	1500 gpm
TDH	150
Overall Condition	Appears in Good Condition

Source: SEH Condition Assessment Evaluation & Data provided by City

2.2.1.2.6 Chemical Feed

Prior to leaving the WTP chlorine and fluoride are injected into the pipes on the discharge side of the Low and Middle Zone pumps. Chlorine is added to disinfect the water and restrict biological growth in the distribution system. Fluoride is added as a dental health benefit. Details of the chemical feed systems are provided in Table 2-10 and 2-11 below.

Table 2-10 – Chlorine Feed System Details

Parameter	
Chemical	Gas Chlorine
Equipment	Chlorine Gas Cylinders
Storage Capacity	150 lbs per cylinder
Number of Cylinders	4
Chemical Feed	
Location	1 Feed to Low Zone Finished Water 1 Feed to Middle Zone Finished Water
Miscellaneous Items	
Other Equipment	Scale Cylinder Mounted Chlorinators Automatic Switchover Ejectors Gas Chlorine Detector Chlorine Booster Pump

Source: SEH Condition Assessment Evaluation & Data provided by City

Table 2-11 – Fluoride Feed System Details

Parameter	
Chemical	Hydrofluosilicic Acid
Equipment	Storage Tank Scale Pumps Break Boxes Diffuser
Storage Capacity	160 Gallon (Low) 50 Gallon (Middle)
Number of Feed Systems	2
Chemical Feed	
Location	1 Feed to Low Zone Finished Water 1 Feed to Middle Zone Finished Water

Source: SEH Condition Assessment Evaluation & Data provided by City

2.2.1.2.7 Backwash/Reclaim System

Backwashing is used to clean the filters to remove solids trapped in the filter bed. It is required when effluent water quality decreases or head loss increases. To backwash, finished water flows from the distribution system to the bottom of the filter at a high flow rate to displace the solids. During a backwash water at the top of the filter contains the displaced solids. This water is collected and conveyed to the reclaim tank. The reclaim tank acts as a sedimentation tank, allowing the solids to settle. Water from the reclaim tank is pumped back to the detention tank and is treated by the treatment process. Reclaiming water from the backwash cuts down on the amount of water that is wasted. Details of the backwash system are provided in Table 2-12 below.

Table 2-12 – Backwash and Reclaim Process Details

Parameter	
Process	Backwash
Backwash	
Equipment	Backwash Tank
Installation Year	1996
Backwash Type	Water only
Backwash Rate	1300 - 1350 gpm
Backwash Duration	20 minutes
Reclaim	
Equipment	
Pumping Rate	230 – 250 gpm
Reclaim Pump Location	Approximately 2’ from Tank Bottom
Settled Solids Disposal	Sanitary Sewer

Source: SEH Condition Assessment Evaluation & Data provided by City

2.2.1.3 Finished Water Quality

In addition to collecting water samples from each municipal well, a sample was collected from the clearwell to establish the existing finished water quality for this plan. Typical analyte concentrations for each well and the clearwell are shown in Table 2-13. Water quality results for finished water in the clearwell represent the effectivenss of the water plant at removing the listed elements from the source water. The primary function of the water treatment filtation plant is to remove iron and manganese. The finished water quality results show that the existing treatment process is quite effective.

Table 2-13 – Raw and Finished Water Quality Comparison

Analyte	Reporting Limit	Regulatory Limit	Well No. 3 (QWTA)	Well No. 5 (QWTA)	Well No. 6 (Wonewoc)	Well No. 7 (Mt. Simon)	Clearwell
Phosphorus (mg P/L)	0.05	-	0.06	<0.05	0.05	<0.05	<0.05
Ammonia (mg/L)	0.1		0.17	0.16	0.92	0.37	0.12
Iron (mg/L)	0.01	0.3	1.75	0.7	1.53	0.69	0.03
Manganese (mg/L)	0.01	0.05	0.49	0.51	0.1	0.11	<0.01
Magnesium (mg/L)	0.01	-	30.2	30.1	34.3	23.1	32.1
Calcium (mg/L)	0.01	-	94.5	91.9	88.8	64.7	89.7
Alkalinity (mg/L as CaCO3)	20	-	388	388	388	388	388
Hardness (mg/L as CaCO3)		-	364	353	363	257	356
Samples collected on 10/2/2019							

Source: City provided results from UC Laboratory, US EPA (NPDWR, NSDWR, CCL)

2.2.2 Treatment Capacity

The WTP was designed to have a treatment capacity of **2.0 MGD**. However, the existing treatment operational capacity is estimated to be approximately **1.6 MGD** due to limited well supply as well as limitations in the treatment process when operating as a biological treatment plant. Since the water treatment plant operation was changed to function without permanganate, formal capacity testing has not been completed. Future recommendations will include pilot testing to evaluate the potential to increase the functional treatment flow rate and evaluate the cause of the current treatment capacity bottleneck (potential filter or aerator limitations.)

2.2.3 WTP Pumping Capacity

The four high services pumps (HSPs) are utilized to pump water from the clear well into the distribution system. The Low Zone and Middle Zone each have two pumps dedicated to pump water into their respective zones. The total pumping capacity was determined to be 3,000 gpm for the Low Zone and 1,500 gpm for the Middle Zone as shown in Table 2-14. In the event the largest capacity pump is offline, the pumping capacity, otherwise known as firm pumping capacity, will be 1500 gpm in the Low Zone and 750 gpm in the Middle Zone. The firm capacity is what is used for pump sizing to support peak system demands.

Table 2-14 – WTP Pumping Capacity

	HSP 1	HSP 2	HSP 3	HSP 4
Zone	Low		Middle	
Pumping Capacity (gpm)	1,500	1,500	750	750
1Total Pumping Capacity (gpm)	3,000		1,500	
Firm Pumping Capacity (gpm)	**1,500**		**750**	

Source: Data provided by the City

[1] *Assumes both pumps on operating to satisfy as large system demand and lower head.*

2.3 Storage

Municipalities maintain storage tanks throughout the distribution system to:

- Store water in the distribution system
- Dampen dynamic pressure swings in the distribution system
- Maintain system pressure
- Provide operational flexibility at supply facilities
- Increase water supply reliability
- Meet peak hour demands
- Provide additional flow for fire protection

The following sections will provide details of the Le Sueur water system's storage in terms of:

- Storage Design and Capacity

2.3.1 Storage Design and Capacity

The Le Sueur water system has three elevated storage tanks to provide distribution storage. The three tanks provide a total distribution storage capacity of 1.05 MG. With the addition of the clearwell at the WTP, the total system storage capacity is 1.15 MG. Additional details for each storage tank is noted in Table 2-15.

Table 2-15 – Existing Storage Facilities

Structure Name	Storage Type	Constructed Year	Rehabbed Year	Inspected Year	Style & Primary Material	Pressure Zone	Overflow Elevation (ft)	Storage Capacity (gal)
Low Zone Tower	Elevated Storage	1957	2002	2010	Multi-leg Steel	Low	145	500,000
Middle Zone Tower	Elevated Storage	1996	-	2010	Single Pedestal Steel	Middle	153	250,000
High Zone Tower	Elevated Storage	2006	-	2010	Single Pedestal Steel	High	141.5	300,000
Clearwell	Ground Storage	1996	N/A	2010	Rectangular Tank Concrete	Low/Middle	-	100,000
Total Distribution System Storage (MG)								**1.05**
Total System Storage (MG)								**1.15**

Source: 2010 KLM Inspection Reports provided by the City

2.4 Pressure Zones

Pressure zones allow regions of the system to operate at different hydraulic grade levels (HGLs) while still maintaining a connection to the water source via booster pumps, pressure reducing valves (PRVs), or pressure sustaining valves (PSV). The following sections will provide details of the Le Sueur water system's pressure zones in terms of:

- Zone Boundary Design

2.4.1 Zone Boundary Design

The Le Sueur water system has been designed with three HGLs and three pressure zones in order to sustain adequate system pressure. Additional details for each storage tank is noted in Table 2-16.

Table 2-16 – Existing Pressure Zones

Pressure Zone	HGL (ft)	Lowest Elevation Served (ft)	Highest Elevation Served (ft)
Low Zone	1.120.3	736	844
Middle Zone	963.0	820	878
High Zone	992.0	775	987

Source: 2010 KLM Inspection Reports provided by the City & Water Model

2.5 Booster Stations (Water Transfer)

Booster stations are designed to act as a water transfer point from areas of low HGL to an area of high HGL. The following sections will provide details of the Le Sueur water system's booster station. The following sections provide an in-depth analysis of the Le Sueur water system's booster station in terms of:

- Booster Station Design
- Pumping Capacity

2.5.1 Booster Station Capacity

The Le Sueur water system currently has one booster station to pump water from the Low Zone to the High Zone. The booster station increases the HGL by approximately 150 ft.

The total pumping capacity was determined to be 1,600 gpm as shown in Table 2-17. In the event the largest capacity pump is offline, the pumping capacity, otherwise known as firm pumping capacity, will be 850 gpm.

Table 2-17 – Booster Station Pumping Capacity

Booster Station HSP	Capacity (gpm)
B-HSP 1[1]	750
B-HSP 2	750
B-HSP 3	100
Total Pumping Capacity[1]	1,600
Firm Pumping Capacity	850
[1] Largest capacity pump	

Source: Data provided by the City

[1] Assumes both pumps on operating to satisfy as large system demand and lower head.

2.6 Distribution System

The water distribution system provides a means of transporting and distributing water from the supply sources to customers and other points of usage. The distribution system must be capable of:

- Supplying adequate quantities of water at reasonable pressures throughout the service area under a range of operating conditions
- Providing a uniform distribution of water during normal and peak demand conditions
- Delivering adequate water supplies for fire protection purposes

The following sections will provide additional details of the Le Sueur water system's distribution system in terms of:

- Distribution System Design

2.6.1 Distribution System Design

The Le Sueur water system is comprised of approximately 36 miles of water mains ranging in size from 4-inches to 12-inches in diameter. The current water main size inventory is summarized in Table 2-18 below. Of the 36 miles of water main, 31.4% is 10 inches in diameter or larger which represent the transmission mains in the system. The presence of large water main as exists in the Le Sueur water system supports the ability of the water system to transmit large system flows while the smaller diameter mains support distribution to end users.

Table 2-18 – Existing Pipe Network

Pipe Size	Length (ft)	Length (mi)	Percentage
4	15,861	3.0	8.3%
6	60,459	11.5	31.8%
8	53,432	10.1	28.1%
10	27,477	5.2	14.4%
12	33,105	6.3	17.4%
Total	190,334	36.0	100.0%

Source: GIS provided by the City, and the Water Model.

3 Population & Community Growth

This section summarizes the planning assumptions made regarding future service area characteristics for the Le Sueur water service area. Input received from local officials and utility staff members was considered and incorporated. The following components will be reviewed in detail:

- Population
- Land Use
- Water Service Area

3.1 Population

There is generally a close relationship between a community's population and total water consumption volumes. Future water sales can be expected to generally reflect future changes in service area population. Similarly, commercial, public, and industrial water consumption will also tend to vary proportionately with the growth of the community.

3.1.1 Historical Population

Over the last 50 years the City of Le Sueur's population has steadily increased to 4,091 as reported in 2019. Historical records indicate a steady growth in population as indicated in Table 3-1.

Table 3-1 – Historical Population Data

Year	Population	Annual Growth Rate
1960	3,310	-
1970	3,745	1.31%
1980	3,763	0.05%
1990	3,714	-0.13%
2000	3,922	0.56%
2010	4,058	0.35%
2015	4,055	-0.01%
2019	4,091	0.22%

Source:2040 Comprehensive Plan provided by City & MN State Demographer

3.1.2 Projected Population

During the City's 2040 Comprehensive Plan the City updated their population projections. These population projections were used to keep consistency between planning documents. The projections indicate that the population has the potential to increase to 5,260 by the year 2040 as shown in Table 3-2.

Table 3-2 – Population Projections

Year	Population	Annual Growth Rate
2020	4,061	-
2025	4,268	1.02%
2030	4,486	1.02%
2035	4,873	1.73%
2040	5,260	1.59%

Source:2040 Comprehensive Plan provided by City

For this study it is assumed that the total percentage of population served by the year 2040 will be similar to the current service percentage. As a result, future water users will grow at a rate similar to the population growth.

3.2 Land Use

Water consumption is also closely related to land use categorization. Generally, land use provides a rough estimate of how much water is used by an area.

3.2.1 Existing Land Use

Existing land use categories were determined from the City's GIS as illustrated in Figure 3-1. The City of Le Sueur breaks their land use types into the following categories:

- Agricultural
- Commercial
- Industrial
- Institutional
- Public
- Residential
- Right of Way
- Vacant

Based on GIS data area land use estimates were made for each category as shown in Table 3-3. The data showed the largest user type was agricultural with a land use estimate of 30%. It is estimated that approximately 9% of the land is currently vacant. How the vacant land is used will impact the projected water use.

Table 3-3 – Land Use

Land Use	Area (acre)	Percentage
Agricultural	926.5	30%
Residential (Single Family)	928.8	20%
Residential (Multi-Family)	90.8	3%
Commercial	138.0	4%
Industrial	205.6	7%
Public	328.3	10%
Institutional	102.49	3%
Right of Way	433.3	14%
Vacant	273.9	9%

Source: GIS provided by the City

3.2.2 Projected Land Use

Planned land use plays an important role in projecting future water consumption. Projected land use was determined from the City's GIS zoning as illustrated in Figure 3-2.

Comparing the land use to the zoning map identifies the central portion of the City is fairly developed indicating the majority of the future development will occur in the north and south. These areas are currently zoned for residential and industrial users.

3.3 Water Service Area

The Le Sueur water system provides water to water users within the city limits. It is anticipated that the water system will grow with the City as undeveloped areas are developed in the future.

3.3.1 Historical Service Area

Historically, the Le Sueur water system has supplied water to users within City limits. Figure 3-3 illustrates the locations and demand distribution of users across the City according to 2018 billing records.

3.3.2 Projected Water Service Area

The future water service area was projected to expand to the undeveloped areas within the City limits and within the proposed system land use map. At this time it is not expected that the water system would be extended to serve communities outside City limits.

4 Water Requirements

The following topics will be reviewed in detail to establish the foundation for future infrastructure planning:

- Historical Water Use
- Projected Water Use
- Other Water Use Requirements

4.1 Historical Water Use

Water use projections are derived from historical water use trends. Water consumption is commonly evaluated by:

- Year
- Customer Categories
- Per Capita Demand
- Pressure Zone
- Unaccounted Water
- Large Customers
- Seasonal Variations

Historical water use records were collected and analyzed to establish water use trends specific to the Le Sueur water system. The last 10 years of water records are shown in tables in the following sections, and were used for the analysis in this report.

Of all the records analyzed, the year 2014 was an outlier of the water use data. At this time it is not known what made data from this year so different from the other years. For the analysis, any extreme maximum or minimum occurring in the year 2014 was ignored to not skew the results.

4.1.1 Historical System Wide Water Use

Historical water records provide an overview of the water system consumption as a whole. Understanding the system demands on a large scale will establish system consumption trends and help project a future system baseline demand. Table 4-1 depicts the system wide water use over the last 10 years.

The Average Day (AD) water use has remained relatively stable over the last 10 years typically ranging from 1.05 to 1.24 MGD. Records indicate that the MD water use had more variation ranging from 1.42 to 1.95 MGD which is likely from seasonal impacts.

4.1.1.1 Historical System Wide Water Use Summary

For water use projection calculations the following values will be used:

- AD = 1.19 MGD
- MD = 1.95 MGD
- MD:AD Ratio = 1.57

Table 4-1 – Historical System Wide Consumption

Year	Population	Average Day (AD) Water Pumped (MGD)	Maximum Day (MD) Water Pumped (MGD)	MD:AD Ratio
2009	4,332	1.12	-	-
2010	4,058	1.05	1.51	1.43
2011	4,045	1.11	1.47	1.32
2012	4,049	1.12	1.53	1.36
2013[2]	4,074	1.15	1.74	1.51
2014[1]	4,073	1.22	1.74	1.42
2015[2]	4,064	1.18	1.42	1.21
2016[2]	**4,053**	**1.24**	**1.95**	**1.57**
2017[2]	4,066	1.19	1.61	1.36
2018[2]	4,091	1.18	1.61	1.36
5-Year Average	**4,058**	**1.19**	**1.67**	**1.40**

[1] Not included in 5 Year Average
[2] Included in 5 year Average

Source: 2009 – 2018 Water Use Data provided by the City

4.1.2 Historical Water Use by Customer Category

Evaluating water consumption based on customer category identifies trends specific to the customer category. Analyzing the records in this manner will identify how water consumption will change in the future based on population increasing, industries leaving or industries starting in the City. Table 4-2 depicts water use by customer category over the last 10 years.

The Le Sueur water system serves residential, industrial, commercial, institutional, and other water users within the City limits. For the purpose of reporting, the City records water use in terms of residential, commercial and industrial, and other water users.

4.1.2.1 Residential Users

Residential users consume up approximately 25% of the daily water pumped into the distribution system. The AD demand ranged from 0.17 to 0.26 MGD over the 10 year period. Historical records indicate that in recent years the AD demand has been decreasing. A decreasing trend in residential water consumed in many water utilities has been commonly seen in recent years due to highly efficient water fixtures and other conservation efforts made. Though residential use has decreased it has not had a large impact on water use in Le Sueur since the majority of water use in the City is from commercial and industrial uses.

4.1.2.2 Commercial and Industrial Users

Commercial and industrial users consume up approximately 75% of the daily water pumped into the distribution system. The AD demand ranged from 0.68 to 0.77 MGD over the 10 year period. Due to the majority of water being consumed by commercial and industrial users, the system does not see significant spikes due to higher seasonal use as seen in communities with the majority residential users.

4.1.2.3 Total Average Day Water Sold

Adding together the average day residential, commercial and industrial water use calculates the total average day water sold. The historical AD demand ranged from 0.88 to 0.96 MGD over the 10 year period.

4.1.2.4 Historical Customer Category Water Use Summary

For water use projection calculations the following values will be used:

- Residential AD Water Sold = 0.19 MGD
- Commercial-Industrial AD Water Sold = 0.73 MGD
- Total AD Water Sold = 0.92 MGD

Table 4-2 – Historical Customer Category Consumption

Year	Water Sold		
	Average Day Residential Water Sold (MGD)	Average Day Commercial Industrial Water Sold (MGD)	Total Average Day Water Sold (MGD)
2009	0.26	0.68	0.94
2010	0.18	0.71	0.89
2011	0.18	0.72	0.90
2012	0.26	0.71	0.96
2013[1]	0.21	0.71	0.92
2014[2]	0.18	0.43	0.61
2015[1]	0.18	0.77	0.96
2016[1]	0.17	0.74	0.91
2017[1]	0.19	0.70	0.88
2018[1]	0.19	0.75	0.94
5-Year Average	**0.19**	**0.73**	**0.92**
Maximum	0.26	0.77	0.96

[1] Not included in 5 Year Average

[2] Included in 5 year Average

Source:2009 – 2018 Water Use Data provided by the City

4.1.3 Historical Per Capita Demand

Calculating the per capita demand based on customer category identifies trends specific to the customer category in relation to population of the service area. Analyzing the records in this manner will identify how water consumption will change in the future based on population changing. Table 4-3 depicts water use by per capita demand over the last 10 years.

4.1.3.1 Residential Users

The residential per capita demand has ranged from 42 to 63 gpcd over the 10 year period. In recent years the demand has been consistently around 46 gcpd.

4.1.3.2 Commercial and Industrial Users

The commercial and industrial per capita demand has ranged from 191 to 171 gpcd over the 10 year period. Unlike the residential per capita demand, the commercial and industrial per capita demand tends to vary significantly from year to year depending on specific commercial and industrial uses.

4.1.3.3 Total Average Day Water Sold

Adding together the average day per capita residential, commercial and industrial water use calculates the total average day per capita water sold. The historical AD per capita demand ranged from 209 to 238 gpcd over the 10 year period.

4.1.3.4 Total Average Day Water Pumped

The total average day water pumped accounts for the entire volume of water pumped from the source. This includes the volume of water unmetered at the WTP and distribution system, and losses in the system. The historical AD water pumped per capita demand ranged from 258 to 307 gpcd over the 10 year period.

4.1.3.5 Historical Per Capita Demand Summary

For water use projection calculations the following values will be used:

- Residential AD Per Capita Water Use = 46 gpcd
- Commercial-Industrial AD Per Capita Water Use = 180 gpcd
- Total AD Water Sold Per Capita Water Use = 227 gpcd
- AD Water Pumped Per Capita Water Use = 292 gpcd

Table 4-3 – Historical Per Capita

Year	Residential Daily Per Capita Water Use (gpcd)	Commercial-Industrial Daily Per Capita Water Use (gpcd)	Total Average Day Water Sold (gpcd)	Total Average Day Water Pumped (gpcd)
2009	59	158	217	258
2010	44	174	218	260
2011	45	179	233	274
2012	63	175	238	277
2013	52	175	228	283
2014	45	105	151	301
2015	45	190	237	290
2016	43	183	226	307
2017	46	171	217	292
2018	46	183	229	289
5-Year Average	46	180	227	292
Minimum	43	171	217	283

[1] Not included in 5 Year Average

[2] Included in 5 year Average

Source:2009 – 2018 Water Use Data provided by the City

4.1.4 Historical Water Use by Pressure Zone

Evaluating water consumption trends based on pressure zones identify demands specific to the each zone. Understanding the demand distribution between zones will allow for better infrastructure and operational analysis within the zone. Table 4-4 depicts water use by pressure zone derived from 2018 billing data.

Table 4-4 – Historical Pressure Zone Demand

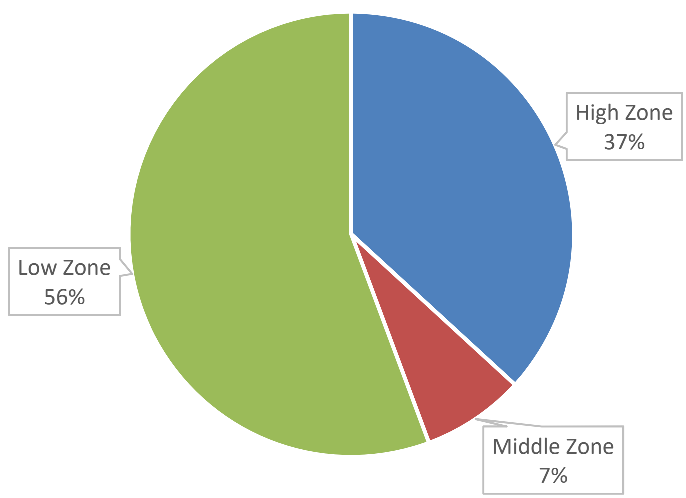
Demand	High Zone	Middle Zone	Low Zone	Low Zone + High Zone	Total (Low + Middle + High)
Average Day (AD) (gpm)	304	62	460	764	826
Average Day (AD) (MGD)	0.44	0.09	0.66	1.10	1.19
Maximum Day (MD) (gpm)	499	102	754	1,253	1,354
Maximum Day (MD) (MGD)	0.72	0.15	1.09	1.80	1.95

Source:2018 Billing Data & Water Use Records Provided by the City

4.1.4.2 Zone Demand Distribution

Billing records from 2018 were placed geographically by address to establish the demand distribution across the system. The demand within each zone was summed to establish the zone demand. This analysis indicated that the Low Zone has the largest demand, closely followed by the High Zone and then Middle Zone.

Figure 4-1 – Pressure Zone Demand Percentage



4.1.4.2.2 Low Zone

Users in the Low Zone consume approximately 56% of the daily water sold. This zone has predominately residential users and a few large users. The Low Zone's average day and maximum day demand were calculated to be 0.66 MGD and 1.09 MGD, respectively. Due to the zone configuration, the High zone pulls water from the Low zone. Therefore the Low and High zone demands can be added together to establish a combined demand of 1.10 MGD for an average day demand, and 1.80 MGD for a maximum day demand.

4.1.4.2.3 High Zone

The High Zone consumes approximately 37% of the daily water sold. Like the Low Zone, this zone has predominately residential and a few large users. The High Zone's average day and maximum day demand were calculated to be 0.44 MGD and 0.72 MGD, respectively.

4.1.4.2.4 Middle Zone

The Middle Zone consumes approximately 7% of the daily water sold. This zone has predominately residential users and a few medium users. The Middle Zone's average day and maximum day demand were calculated to be 0.09 MGD and 0.15 MGD, respectively.

4.1.4.3 Historical Pressure Zone Water Use Summary

For water use projection calculations the following values will be used:

- Low Zone AD Demand = 0.51 MGD
- Middle Zone AD Demand = 0.07 MGD
- High Zone AD Demand = 0.34 MGD
- Low Zone MD Demand = 1.09 MGD
- Middle Zone AD Demand = 0.15 MGD
- High Zone MD Demand = 0.72 MGD

4.1.5 Unaccounted Water

There is generally a close relationship between the total gallons of water pumped, and the gallons of water metered and sold to water utility customers. Total metered water sales are always less than the amount of pumpage due to several factors, including:

- Unmetered water usage for maintenance purposes such as hydrant flushing and water main repairs
- Unmetered water usage for fire fighting
- Inaccuracies in water metering devices
- Unaccounted-for public water consumption
- Leakage within the distribution system

The difference between total pumpage and total water sales is termed "unaccounted" water. The amount of unaccounted water is an indication of the condition of the water system and is most commonly expressed as a percentage. When a distribution system is very old or poorly maintained, the percentage of water loss often increases dramatically. Unaccounted water was shown in Table 4-5.

Over the years, the City has noticed drastic differences in their pumpage and total water sales. The difference has been determined to be inaccurate metering in the distribution system. In effort to address this issue, the City implemented a meter replacement project in 2019 to upgrade the majority of the distribution meters. The City is taking another action to address the high unaccounted water percentage by doing leak detection surveys at least once a year and more frequently as needed.

For water use projection calculations the following values will be used:

- AD Water Sold = 0.92 MGD
- AD Water Pumped = 1.19 MGD
- Unmetered-Unaccounted Water Use = 22.5%

Table 4-5 – Historical Unaccounted Water

Year	Average Day Water Sold (MGD)	Average Water Pumped (MGD)	Unmetered-Unaccounted Water Use
2009	0.94	1.12	15.9%
2010	0.89	1.05	16.1%
2011	0.94	1.11	15.2%
2012	0.97	1.12	14.0%
2013	0.93	1.15	19.4%
2014	0.61	1.22	49.9%
2015	0.96	1.18	18.4%
2016	0.91	1.24	26.5%
2017	0.88	1.19	25.9%
2018	0.94	1.18	20.8%
5-Year Average	0.92	1.19	22.2%
Maximum	0.96	1.24	26.5%

[1] Not included in 5 Year Average

[2] Included in 5 year Average

Source:2009 – 2018 Water Use Data provided by the City

4.1.6 Historical Large Customers

The City of Le Sueur's largest water customers include industrial, residential, commercial and institutional users. The highest ten users consume approximately 74% of the water on an average day and are listed in Table 4-6. The City's largest user is Agropur Inc., which consumes a little over half of the water pumped every day.

Future water use projections should consider the expansion or abandonment of these top ten users as they will greatly impact the amount of water required to be pumped, treated, distributed and stored.

Table 4-6 – 2018 Top 10 Users

User	Category	Amount Consumed (MGY)	Average Day (AD) Water Consumed (MGD)	Percent of Total Annual Water Delivered
Agropur Inc.	Industrial	198.59	0.54	58.1%
Cambria	Industrial	24.37	0.07	7.1%
MRVPUC	Industrial	12.20	0.03	3.6%
Hometown Bio Energy	Industrial	3.62	0.01	1.1%
Conifer Terrace Mobile Home	Residential	3.13	0.01	0.9%
Le Sueur Apartments	Residential	2.24	0.01	0.7%
Le Sueur, Inc	Industrial	2.23	0.01	0.7%
MN Valley Health Center	Institutional	2.10	0.01	0.6%
General Mills Inc	Industrial	1.92	0.01	0.6%
Aqua Shine, Inc	Commercial	1.71	0.004	0.5%
Total				**73.8%**

Source: City of Le Sueur

4.1.7 Historical Seasonal Variation

Analyzing seasonal water use identifies water consumption fluctuations due to environmental factors such as temperature and precipitation. Common reasons for seasonal consumption fluctuations include:

- Lawn Watering
- Outdoor Recreation
- Agricultural Irrigation

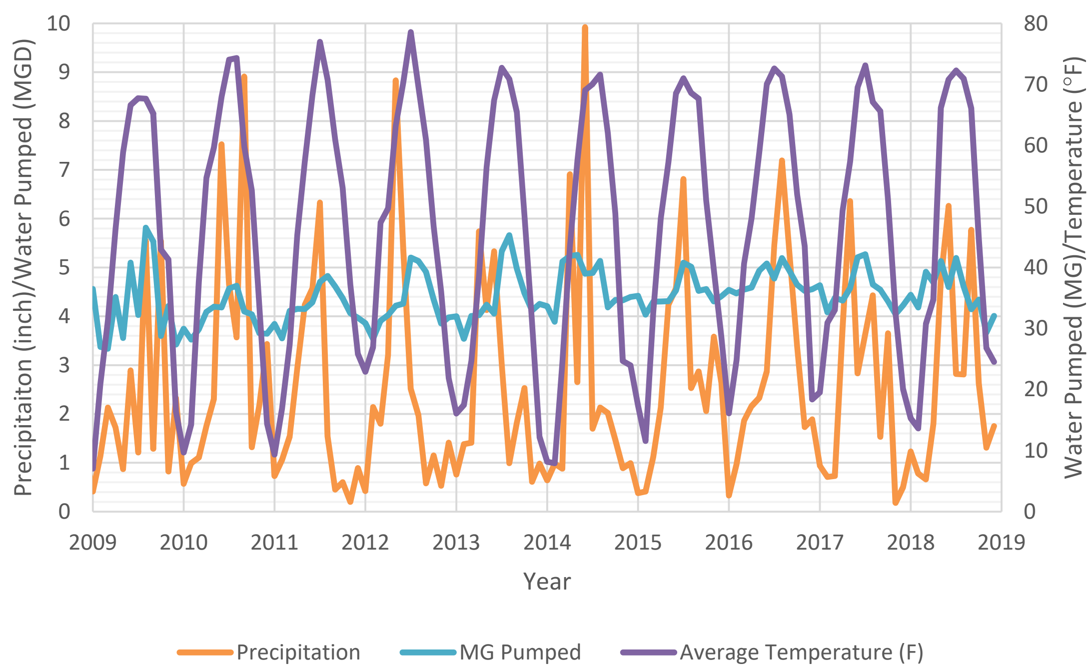
It is important to understand these differences in water consumption when designing and evaluating treatment and storage needs. Table 4-7 and Figures 4-1, 4-2 and 4-3 depict environmental and water consumption trends over the last 10 years.

Records of well pumping, temperature and precipitation were compared from 2009 to 2019 to identify the typical relationship between water consumption and environmental factors. All three records correlated closely over the last 10 years with annual highs and lows occurring during similar times of the year. Overall, the data indicates that water consumption increased during summer months.

Table 4-7 – Summer Water Usage

Year	Summer Precipitation	Average Summer High Temperature (°F)	Average Day (AD) Water Pumped (MGD)	Maximum Day (MD) Water Pumped	MD:AD Ratio
2009	9.65	77.83	1.12	0.00	0.00
2010	15.75	82.47	1.05	1.51	1.70
2011	12.44	82.03	1.11	1.47	1.56
2012	9.88	84.30	1.12	1.53	1.59
2013	9.33	80.30	1.15	1.74	1.87
2014	13.75	79.47	1.22	1.74	2.83
2015	13.91	78.97	1.18	1.42	1.48
2016	15.52	80.37	1.24	1.95	2.13
2017	10.90	79.20	1.19	1.61	1.83
2018	11.89	79.90	1.18	1.61	1.72
5-Year Average	13.19	79.58	1.19	1.67	1.81
Maximum	15.52	80.37	1.24	1.95	2.13

Figure 4-2 – Annual Precipitation, Pumpage and Temperature



Well pumping records from the last 10 years also indicated the magnitude of the difference between the seasonal pumping. Table 4-8 indicates that during summer months more water is consumed. The data also indicates that the difference between winter and summer pumping has been declining. This is likely due to increase conservation efforts from water users such as installing dampness sensing water sprinklers and watering during the early morning or later evening.

Table 4-8 – Seasonal Water Trends

Year	(MG)								Difference
	January	February	December	June	July	August	AD Winter	AD Summer	
2009	36.5	27	27.4	40.8	32.2	46.5	1.01	1.30	24%
2010	30	28.2	29.2	33.4	36.6	37	0.97	1.16	18%
2011	30.7	28.4	31.8	34.3	37.6	38.6	1.01	1.20	18%
2012	30.9	28.3	31.8	34.1	41.6	41	1.01	1.27	22%
2013	32	28.3	34	32.4	42.7	45.3	1.05	1.31	22%
2014	33.7	31.1	35.2	39	39.1	41.1	1.11	1.30	16%
2015	35.4	32.3	35.3	36.2	40.8	40.1	1.14	1.27	12%
2016	36.3	35.8	36.4	40.7	38.2	41.6	1.21	1.31	10%
2017	37.1	32.6	33.8	41.7	42.2	37.2	1.15	1.32	14%
2018	35.5	33.5	32.1	36.8	41.5	36.9	1.12	1.25	12%
5-Year Average	35.26	32.50	34.32	37.56	41.08	40.22	1.13	1.29	14%

Well pumping records from 2018 also confirm the observation that water use increases in the summer months. The data indicate that approximately 27% or the annual water was pumped between the beginning of June and end of August. Of these three months, July had the highest pumping percentage of 9.6%.

Figure 4-3 – Monthly AD Demand

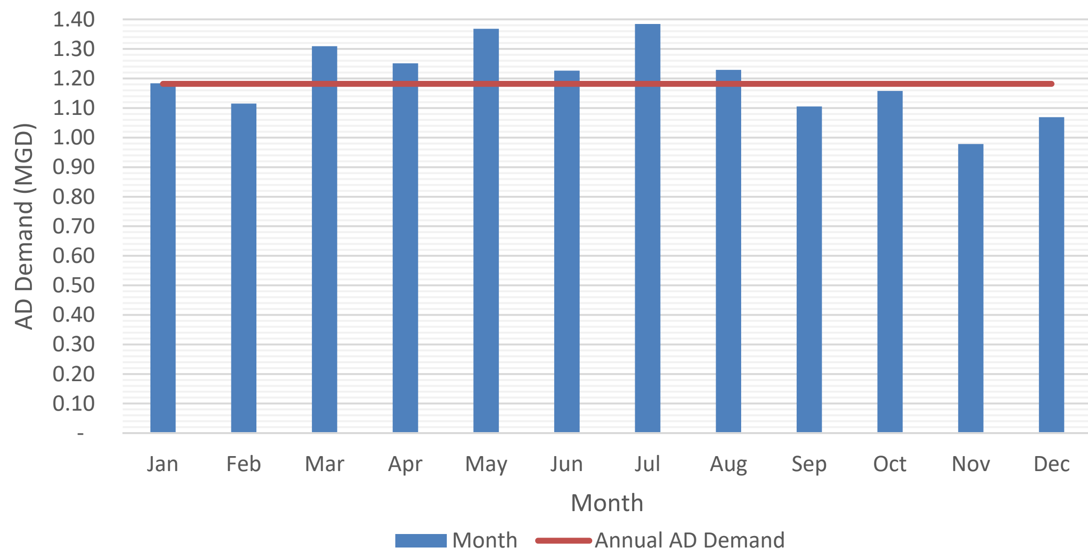
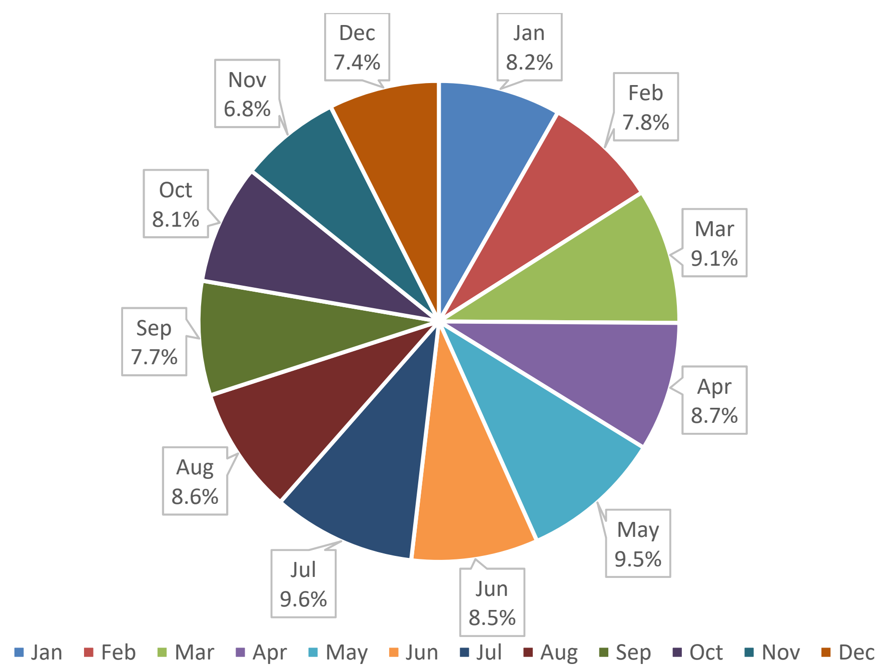


Figure 4-4 – 2018 Monthly Water Consumption



4.1.7.2 Historical Seasonal Water Use

For future planning purposes the following values will be used:

- AD Winter Demand = 1.13 MGD
- AD Summer Demand = 1.29 MGD
- Difference in Seasonal Demand = 14%

4.1.8 Historical Hourly Variations

Hourly water use trends represent typical water consumption at different points of the day. Analyzing variations in water use will identify how the water system is impacted by these changing demands. To analyze hourly demands in the Le Sueur system field data was collected by the Telogs over one week. This data was used along with typical industry diurnal trends to create AD diurnal curves for the Le Sueur system as seen in Figure X.

4.1.8.1 Diurnal Curve

A diurnal curve graphically shows how the hourly demand varies throughout the day. It is represented as a percentage of the total day demand. For example, during an hour of high water use above the AD demand the percentage is above 100%. Similarly, during an hour of low water use below the AD demand the percentage is below 100%. When averaging all the hourly percentage the total demand is equal to 100%.

Diurnal curves were created for the Low and Middle Zone, and the High Zone.

Figure 4-5 – Low and Middle Diurnal Curve

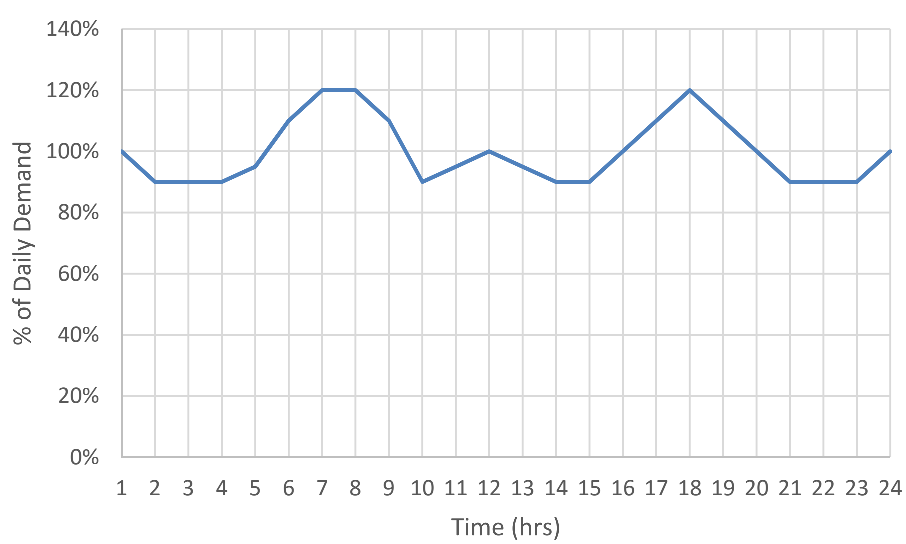
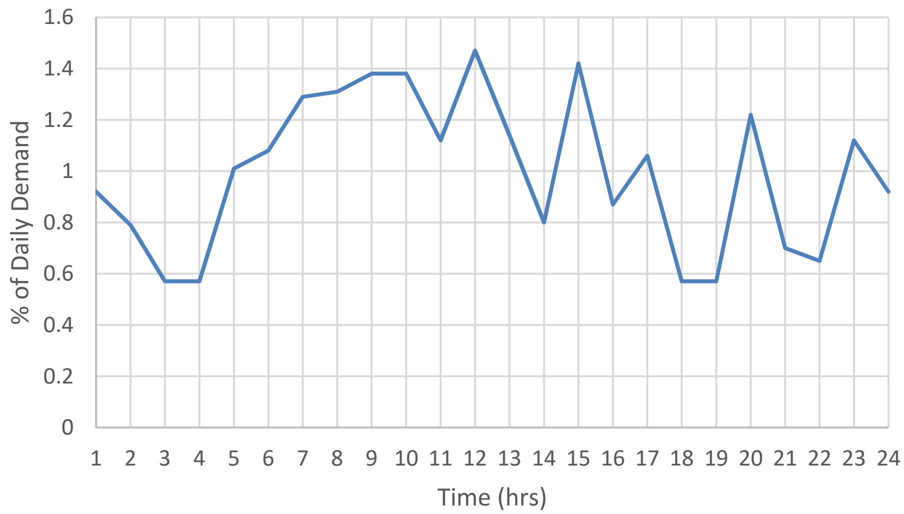


Figure 4-6 – High Diurnal Curve



4.1.9 Historical Water Use Summary

Historical water use established in this section will be used as the foundation for water use projections to 2040. The following values will be used:

- AD Demand = 1.19 MGD
- MD Demand = 1.95 MGD
- MD:AD Ratio = 1.57
- Average Day Residential Water Sold = 0.19 MGD
- Average Day Commercial Industrial Water Sold = 0.73 MGD
- Residential AD Per Capita Water Use = 46 gpcd
- Commercial-Industrial AD Per Capita Water Use = 180 gpcd
- Total AD Water Sold Per Capita Water Use = 227 gpcd
- Total AD Water Pumped Per Capita Water Use = 292 gpcd
- Low Zone AD Demand = 0.66 MGD
- Middle Zone AD Demand = 0.09 MGD
- High Zone AD Demand = 0.44 MGD
- Low Zone MD Demand = 1.09 MGD
- Middle Zone AD Demand = 0.15 MGD
- High Zone MD Demand = 0.72 MGD
- Total AD Water Pumped = 1.19 MGD
- Unmetered-Unaccounted Water Use = 22.5%
- Large Customers Use = 75% of Demand
- AD Winter Demand = 1.13 MGD
- AD Summer Demand = 1.32 MGD
- Hourly Variations

4.2 Projected Water Use

Projections of customer demands serve as the basis for establishing water requirements for capital improvements planning. Several standard methods were used in this study to project water demands based on estimates of population and community growth. This section summarizes the methodology used and the results of these projections. Water use projections will be reviewed in the following sections in terms of:

- Population
- Customer Category
- Pressure Zone

4.2.1 Projected Water Use by Population

Commonly, water consumption trends tend to follow population trends. As the City's population is expected to increase, it can also be assumed that the water consumption will increase. The overall system's projected water use in relation to population was used to calculate the:

- Projected Average Day Water Demand (Pumped)
- Projected Maximum Day Water Demand (Pumped)

To project future average day demands the established historical average day per capita water pumped value was multiplied by the expected population through the year 2040. This calculation indicated that by the year 2040 the average day demand had the potential to increase to 1.49 MGD.

Similarly, the maximum day water sold demand was established by multiplying the projected average day water sold demand and the historical MD:AD ratio though the year 2040. This calculations indicated that by the year 2040 the maximum day demand will increase to 2.33 MGD.

4.2.1.1 Projected System Wide Water Use

For the 2040 water system evaluation the following values will be used:

- AD Water Pumped= 1.49 MGD
- MD Water Pumped = 2.33 MGD

Table 4-9 – Projected Water Use

Year	Population	Average Day (AD) Water Pumped (MGD)	Maximum Day (MD) Water Pumped (MGD)
2020	4,173	1.22	1.91
2025	4,386	1.28	2.01
2030	4,610	1.35	2.11
2035	4,845	1.41	2.22
2040	5,092	1.49	2.33

Source: MN State Demographer, City Projection Estimates & Historical Water Use

4.2.2 Projected Water Use by Customer Category

Water consumption also follows trends specific to the customer type. As the quantity of customers varies, it can be expected that the water use will vary proportionally. For the purpose of this projection it is assumed that the quantity of customers vary proportionally to the population trends. The system's customer category water use in relation to population was used to calculate the:

- Projected Residential Average Day Water Sold Demand
- Projected Commercial-Industrial Average Day Water Sold Demand

4.2.2.1 Average Day Residential Water Sold

To project future residential average day demands the established historical residential average day per capita water sold value was multiplied by the expected population through the year 2040. This calculation indicated that by the year 2040 the residential average day demand will increase to 0.23 MGD.

4.2.2.2 Average Day Commercial-Industrial Water Sold

Similarly, the projected commercial-industrial average day water sold demand was established by multiplying the historical residential average day per capita water sold value and the expected population through the year 2040. This calculations indicated that by the year 2040 the commercial-industrial average day demand will increase to 0.92 MGD.

4.2.2.3 Projected Customer Category Water Use

For the 2040 water system evaluation the following values will be used:

- AD Residential Water Sold = 0.23 MGD
- AD Commercial-Industrial Water Sold = 0.92 MGD

Table 4-10 – Projected Water Use by Customer Category

Year	Population	Average Day Residential Water Sold (MGD)	Average Day Commercial-Industrial Water Sold (MGD)	Total Average Day Water Sold (MGD)
2020	4,173	0.19	0.75	0.95
2025	4,386	0.20	0.79	1.00
2030	4,610	0.21	0.83	1.05
2035	4,845	0.22	0.87	1.10
2040	5,092	0.23	0.92	1.16

4.2.3 Water Use by Pressure Zone

As the population within each pressure zone increases the zone demand will also increase. Assuming that the ultimate zone consumption is similar to the historical consumption zone demand will increase as shown in Table 4-11.

Table 4-11 – Projected Pressure Zone Demand

Demand	High Zone	Middle Zone	Low Zone	Low Zone + High Zone	Total (Low + Middle + High)
Average Day (AD) (gpm)	381	77	597	957	1035
Average Day (AD) (MGD)	0.55	0.11	0.83	1.38	1.49
Maximum Day (MD) (gpm)	597	121	903	1,500	1,618
Maximum Day (MD) (MGD)	0.86	0.17	1.3	2.16	2.33

Source:2018 Billing Data & Water Use Records Provided by the City

4.2.3.1.2 Low Zone

The water use projections assumed the Low Zone would continue to consume approximately 56% of the daily water sold. The Low Zone's projected average day and maximum day demand were calculated to be 0.83 MGD and 1.3 MGD, respectively. Due to the zone configuration, the High zone pulls water from the Low zone. Therefore the Low and High zone demands can be added together to establish a combined demand of 1.38 MGD for an average day demand, and 2.33 MGD for a maximum day demand.

4.2.3.1.3 High Zone

The High Zone consumes approximately 37% of the daily water sold. Like the Low Zone, this zone has predominately residential and a few large users. The High Zone's average day and maximum day demand were calculated to be 0.55 MGD and 0.86 MGD, respectively.

4.2.3.1.4 Middle Zone

The Middle Zone consumes approximately 7% of the daily water sold. This zone has predominately residential users and a few medium users. The Middle Zone's average day and maximum day demand were calculated to be 0.11 MGD and 0.17 MGD, respectively.

4.2.3.2 Projected Pressure Zone Water Use

For water use projection calculations the following values will be used:

- Low Zone AD Demand = 0.83 MGD
- Middle Zone AD Demand = 0.11 MGD
- High Zone AD Demand = 0.55 MGD
- Low Zone MD Demand = 1.3 MGD
- Middle Zone AD Demand = 0.17 MGD
- High Zone MD Demand = 0.86 MGD

4.2.4 Projected Water Use Summary

Projected water use established in this section will be used as the foundation to evaluate the water system for capital improvement planning. The following values will be used:

- AD Water Sold (2040) = 1.49 MGD
- MD Water Sold (2040) = 2.47 MGD
- AD Residential Water Sold (2040) = 0.23 MGD
- AD Commercial-Industrial Water Sold (2040) = 0.92 MGD
- Low Zone AD Demand = 0.83 MGD
- Middle Zone AD Demand = 0.11 MGD
- High Zone AD Demand = 0.55 MGD
- Low Zone MD Demand = 1.3 MGD
- Middle Zone MD Demand = 0.17 MGD
- High Zone MD Demand = 0.86 MGD

4.3 Other Water Use Requirements

In addition to establishing water use requirements based on projected water use demands, requirements can be derived from water industry standards. The following sections will review the water system requirement industry standards for:

- Conservation
- Fire Flow

4.3.1 Conservation Impacts

As historical water consumption records indicated an increasing trend in water use, water conservation efforts became more prevalent to protect supply resources from being depleted. Water conservation occurs in two different forms:

- Active
- Passive

Water use trends over the last decade indicate that water consumption has been decreasing due to both active and passive conservation efforts. However, active and passive water conservation should still be accounted for when estimating projected water use requirements. Active conservation is the process of consciously making an effort to reduce the volume of water consumed. Active conservation efforts include mechanisms such as educational programs, conservation ordinances and customer incentives.

Research has indicated that individual conservation efforts including educational programs, public information, school programs, retrofit programs, conservation ordinances, and/or regulations can reduce water use about 1%-4% per program.

Passive conservation is not intentionally making an effort to reduce the volume of water consumed, but actions taken result in less water consumption. Passive conservation results are the product of the Installation of water efficient fixtures (toilets, showerheads and washers) etc.

It should be also noted that indoor residential water use has decreased about 15.4 percent from 69.3 GPCD in 1999 to 58.6 GPCD in recent years nationwide. Furthermore, homes built according to EPA's water sense specification use 37 percent less water than the average home and 47 percent less water than an average home in 1999.

4.3.1.1.1 Residential Water Conservation

Table 4-3 showed residential water use to be approximate 46 gpcd. Table 4-12 reported that, nation-wide, communities could potentially reduce residential demands to as low as 36.7 gpcd. However, with each step to decrease average day residential demand, the next step becomes increasingly more difficult.

4.3.1.1.2 Non-Residential Water Conservation

Table 4-3 showed non-residential water use to be approximate 180 gpcd. Conservation for non-residential customers can become challenging, as each non-residential customer has to be individually examined for their ability to conserve water. The top 10 large users identified in Table 4-7 consume approximately 74% of the daily water. Working with these customers to implement conservation practices into their daily operations could reduce the volume of water consumed in the future.

4.3.1.1.3 Maximum Day Water Use Conservation

Conserving on the maximum day is usually connected to outdoor water use, such as lawn watering. Indoor water use is usually constant throughout the year, as people generally do not change their domestic hygiene habits from summer to winter. Conservation of outdoor water use, however, is challenging to achieve because it usually requires some degree of authority action, either by increasing rates (charging higher fees for excess water use) or by enforcement (writing citations). Alternate day lawn watering is used by many utilities; however, the water reduction of alternate day lawn watering is often offset (or even reversed) by excessive watering when watering occurs. Given the City of Le Sueur's relatively low Max Day to Average Day water use ratio, critical implementation of such controlling measures may not be necessary.

4.3.2 Fire Flow

Fire protection is an important factor to consider for capital improvement planning. In most instances, water main sizes are designed specifically to meet water requirements for fire flow. Guidelines for determining fire flow requirements are provided by the Insurance Service Office (ISO).

4.3.2.1 ISO Requirements

ISO is the organization responsible for evaluating and classifying municipalities for fire insurance rating purposes. Fire protection needs vary with the physical characteristics of each building to be protected. For example, needed fire flows for a specific building can vary from 500 gpm to as high as 12,000 gpm, depending on:

- Habitual classifications
- Separation distances between buildings
- Height
- Materials of construction
- Size of the building
- Presence or absence of building sprinklers.

Municipal fire insurance ratings are partially based on the City's ability to provide needed fire flows up to 3,500 gpm. If a specific building has a needed fire flow greater than this amount, the community's fire insurance rating will only be based on the water system's ability to provide 3,500 gpm.

The minimum fire flow available at any given point in a system should not be less than 500 gpm at a residual pressure of 20 psi. This represents the amount of water required to provide for two standard hose streams on at fire in a typical residential area for single-family residential dwellings with spacing between 31 to 100 feet.

Table 4-13 below shows typical fire flow requirements for various land use types. These requirements were used as a basis for evaluating the Le Sueur water system. The requirements shown in Table 4-13 are only intended as a general guideline. The actual needed fire flow for a specific building can vary.

Table 4-12 – Typical Fire Flow Requirements

Land Use	Building Separation (feet)	Available fire flow @ 20 psi (gpm)
Single & Two Family Residential	>100	500
Single & Two Family Residential	30-100	750
Single & Two Family Residential	11-30	1000
Single & Two Family Residential	<10	1500
Multiple Family Residential Complexes	-	2,000 to 3,000+
Average Density Commercial	-	1,500 to 2,500+
High Value Commercial	-	2,500 to 3,500+
Light Industrial	-	2,000 to 3,500
Heavy Industrial	-	2,500 to 3,500+

Source: Insurance Services Office

5 Water System Evaluation

Water systems are analyzed, planned, and designed to comply with rules and regulations enforced by regulatory agencies, and through hydraulic analysis. Some important factors that must be considered when designing water system include:

- The location and capacity of supply facilities.
- The location, sizing, and design of storage facilities.
- The location, magnitude, and variability of customer demands.
- Water system geometry and geographic topography.
- Minimum and maximum pressure requirements.
- Land use characteristics with respect to fire protection need.

A system-wide evaluation was performed to identify strengths and weaknesses of the Le Sueur water system. This section will detail the analysis including the:

- Methods of Analysis
- Water System Analysis

5.1 Methods of Analysis

To evaluate the strengths and weaknesses of the Le Sueur water system, the following analyses were preformed:

- Water Quality Compliance
- Mass Balance
- Water Model

5.1.1 Water Quality Compliance

Water utilities serving the public population are required to comply with all federal and local government enforced water quality regulations. It is important to analyze water quality to establish if the water system is in compliance with all regulations. The following sections will provide a review of the water quality regulations and standards enforced.

5.1.1.1 Water Quality Regulations & Standards

Federal and local government agencies enforce water quality regulations created to protect public health. The existing regulations on contaminants have been developed over time, and are continuously evolving as research is completed and additional harmful contaminants are discovered.

5.1.1.1.1 Safe Drinking Water Act (SDWA) Regulations

In 1974 Congress passed the Safe Drinking Water Act (SDWA) empowering the US EPA to create enforceable regulations on water quality to protect public health. The act was amended in 1986 and 1996 to include additional regulations and resources ensuring the protection of public health and water sources. Major regulations and standards included in the SDWA are described in detail in the following sections.

National Primary Drinking Water Regulations (NDPWR)

The National Primary Drinking Water Regulations (NPDWR) are enforceable regulations and treatment techniques designed to restrict contaminant levels in drinking water. Contaminates regulated by the NPDWR include microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemical and radionuclides. The allowable level of each contaminant present in drinking water is determined based on scientific research and known adverse health effects.

The US EPA utilize the maximum contaminant level goal (MCLG) and maximum contaminant level (MCL) to evaluate water quality. The MCLG is the desirable contaminant level in the water and is not a legally enforceable standard. The MCL is the maximum allowable contaminant level and is legally enforceable. For some contaminants the treatment technique (TT) is substituted for the MCL. TT is the treatment process required to reduce certain contaminants present in the water. Like the MCL the TT is a legally enforceable treatment technique.

National Secondary Drinking Water Regulations (NSDWR)

The National Secondary Drinking Water Regulations (NSDWR) are non-enforceable standards designed to address cosmetic and aesthetic issues related to water quality. Although not legally enforceable, the US EPA recommends public utilities adopt these standard. The US EPA NSDWR are provided in Appendix X.

Contaminant Candidate List (CCL)

The Contaminant Candidate List (CCL) is a list maintained by the US EPA of contaminants that are not regulated under existing law, but are known to be present in water sources. These contaminants may be regulated in future versions of the NPDWR or NSDWR. Contaminants on the list include microorganism, inorganic chemicals and organic chemicals. The US EPA CCL is provided in Appendix X.

5.1.1.1.2 Minnesota Department of Health Requirements

All regulations established by the U.S. EPA are adopted by the MDH. MDH also develops their own health standards to indicate at what concentrations a contaminant may be impacting human health. A comparison between the U.S. EPA standards and MDH guidelines is provided in Appendix X.

Along with adopting rules and regulations, the MDH implements a Drinking Water Protection Program to help public utilities stay in compliance and protect water sources. Through the program water sampling is performed, public water contamination problems are address, training is given to water operators, and grants are administered for infrastructure improvements and water protection.

5.1.2 Mass Balance

A mass balance evaluation compares the supply and demands of the system to evaluate if the system will have a water deficiency or water surplus. A water deficiency indicates that the water supply volume is less than the volume of water required to meet the system demand. A water surplus indicates that the water supply volume is greater than the volume of water required to meet the system demand.

Depending on the portion of the water system being evaluated, different mass balance analyses are performed. The following sections will provide details of the mass balance analyses used to evaluate the water system in terms of:

- Pumping Capacity
- Treatment Capacity
- Storage Capacity

5.1.2.1 Pumping Capacity Evaluation

Pumping capacity evaluations compare the pumping capacity to the system demand. This calculation determines whether the pumping capacity is capable of meeting system demands. The firm pumping capacity is utilized in this type of evaluation. As stated previously, the firm pumping capacity is the pumping capacity with the largest pump offline. In pumping capacity evaluations the MD demand is considered to account for the worst case scenario.

5.1.2.2 Treatment Capacity Evaluation

Treatment capacity evaluations compare the treatment capacity to the system demand. This calculation determines whether the treatment capacity is capable of producing enough treated water to meet system demands. The treatment capacity of each treatment stage is utilized in this type of evaluation. Also, the MD demand is considered to account for the worst case scenario.

5.1.2.3 Storage Capacity Evaluation

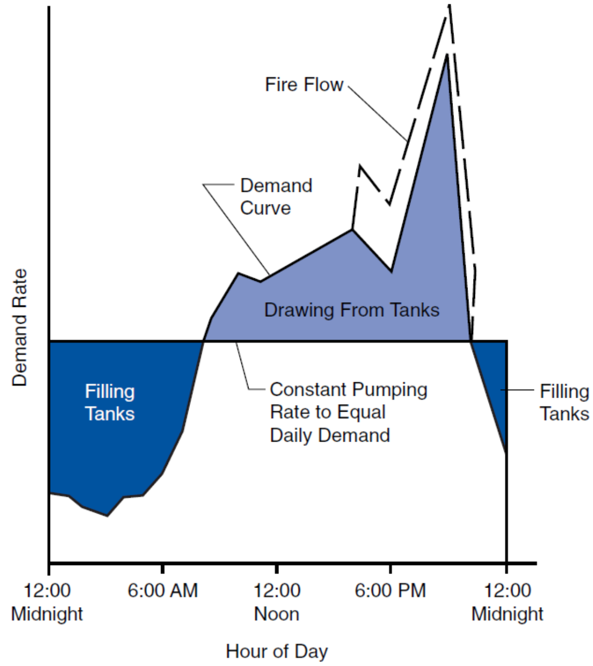
Mass balance evaluations for system storage review the following storage types:

- Equalizing storage (sometimes termed operational storage).
- Fire storage.
- Emergency storage.

5.1.2.3.1 Equalizing Storage

Equalizing storage works to allow the supply and treatment pumping systems to be sized and operate to produce at the rate of average demand over the course of a day. For example, during peak hours of water use, when customers are using large amounts of water, system demand may exceed the production rate of the water supply/treatment. It is during this time when water storage facilities will drain to satisfy the increased system demand. This concept is further illustrated in the figure below.

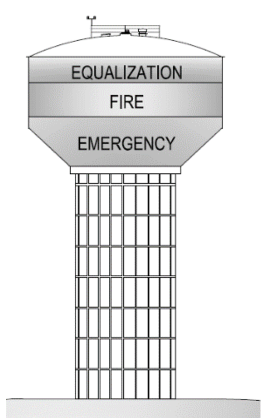
Figure 5-1 – Equalization Storage



5.1.2.3.2 Fire Storage

Fire storage includes water held in the tank in the case of an emergency. To assure a reliable supply for fire protection, this reserve storage should not be utilized to meet peak hour requirements and should be available when needed. Guidelines for determining fire flow requirements are developed based on recommendations offered by the Insurance Services Office (ISO), which is responsible for evaluating and classifying municipalities for fire insurance rating purposes. When a community evaluation is conducted by ISO, the water system is evaluated for its capacity to provide needed fire flow at a specific location and will depend on land use characteristics and the types of properties to be protected. A balance between having enough storage or two much storage must be found. For purposes of this evaluation it will be assumed that the goal for fire protection storage will be a volume equal to fighting a 2,500 gpm fire for two hours. This figure will be used as a basis for estimating the amount of water to be held in the proposed storage tank for fire protection.

WATER STORAGE ALLOCATION



5.1.2.3.3 Emergency Storage

Emergency storage is required to meet system water demands during an emergency event that limits or disrupts supply. Some examples of emergency events include water main breaks, equipment failure, and power failure or source contamination.

A mass balance analysis was performed to identify if the storage capacity is capable of meeting projected water use demands over the planning period.

5.1.2.3.4 Average Day Water Use Storage

An alternative more simple criteria for sizing water storage is to simply have a minim of an average day of water use in storage. This common criteria is used by the Minnesota department of health and is common for sizing water tanks in smaller water system. Since the Le Sueur water system has both traditional water users along with multiple large users, a balance between the water storage sizing criteria should be balanced.

The For purposes of this evaluation, the sizing criteria developed for the Le Sueur water system are as follows:

1. ***Requirement 1** - Available storage should be large enough to provide equalization storage (15% of MD) plus (+) Fire storage (+) 1/2 Average Day Demand for reserve storage. (Fire storage based on largest land use fire flow requirement in the zone being analyzed)*
2. ***Requirement 2** - Average daily consumption should not exceed the available storage.* This sizing metric is commonly used by the Minnesota Department of Natural Resources (DNR) when determining if additional water storage is warranted.

This sizing practice is a commonly used industry requirement for storage that also accounts for hourly system operation in order to satisfy peak water demands.

5.1.3 Water Model

A water model is a useful tool in evaluating current water system conditions as well for simulating the operation of proposed improvements. The construction of a water model of Le Sueur’s water system was included as part of the 2040 Comprehensive Water Plan to aid in the current and future planning process. The following sections briefly summarize the means and methods used to develop the water model, and the capabilities of the model.

5.1.3.1 Model Construction

The computer model was developed using WaterCAD v8i software. The hydraulic computer model was initially set up using GIS information depicting the City's existing distribution system. All pipes 4 inches and larger were included in the model, and ground elevations were gathered from existing Lidar topographic data. The model was also analyzed visually to verify locations of the existing distribution piping.

Historical water pumping records were used to represent current demands on the system and were distributed through the model according to historical customer use. Water use data collected from 2018 billing records were assigned geographically in the model according to customer parcel, providing for a realistic distribution of water system demands. Storage and supply facilities were modeled based on available water system data. As the City's water system expands, calibration can be done to include future facilities as they are constructed.

5.1.3.2 Model Calibration

A well calibrated water distribution model is paramount for the use of the model as a trusted water system evaluation tool. As a result, extensive field testing and calibration exercises were conducted to assure that the newly created water model produces reliable results that closely match field conditions.

The Le Sueur water system model was calibrated using results of flow testing performed for this study in the summer of 2019. Appendix B summarizes flow testing results. During the model calibration process, pumping rates, customer demands, and tower water levels were set to the field conditions, and pipe roughness coefficients were adjusted until the calibrated system model adequately simulated field test data.

Precise duplication of the field test results at all locations during the calibration process is not realistic due to the many factors that influence the field test results. The goal of model calibration is to minimize the error between the field test data and the model simulations and create a "best fit" at all locations; therefore, some error between the field tests and model simulations is expected. However, limits to the amount of allowable error must also be made to ensure the calibrated model is a reasonably accurate representation of the actual water distribution system. The desired accuracy for Le Sueur's computer model is the greater of plus or minus 25 percent or 2 psi of the recorded pressure difference to a maximum of 5 psi, and plus or minus 10 percent of the recorded flow. For adequate model calibration, the desired accuracy must be met at a minimum percentage of the field test locations. The goal of this project is to have a minimum of 80 percent of the field test results within the desired calibration accuracy before the model is considered calibrated. Overall, the model calibration results met the calibration standards, with 14 out of 15 (93 percent) residual hydrants within the desired calibration criteria. Appendix B summarizes the accuracy of the Le Sueur model calibration.

Additionally, an extended period model simulation (EPS) calibration or "macro–calibration" operation was conducted. Rather than simulating discrete points in time, the system was modeled with historical demands and operational information from data provided by the City and collected during field testing. The model results were then compared with historical tank levels to confirm the accuracy of the model. Overall, the EPS calibration was within an allowable range of the field results.

The calibration of the system resulted in reasonable pipe friction values which are comparable to what would be expected for the age and materials of the pipe present. In an effort to achieve uniform and consistent calibration results, when pipe age information was available, the friction values for various age groups were adjusted uniformly to a best fit result. From this point an iterative process was utilized to achieve the set calibration goals.

5.1.3.3 Model Capabilities

A complete and calibrated water model has many uses that aid in analyzing both the existing water system and potential proposed improvements. For purposes of this report standard functions of the water model software were used to analyze the City's existing water system as well as project specific issues.

Some of the standard water model analysis features include:

- Steady-state simulation:
- Extended-period simulation (EPS):
- Fire-flow analysis:
- Water-age analysis:

5.1.3.3.1 Steady State Simulations

Pressure

This analysis takes a look at water system operation at a single point in time and allows system pressures and flows to be monitored. The following topics are considered in steady state pressure analysis:

- Desired pressure range
- Factors impacting pressure
- Standards for pressure

Desired Pressure Range

A water distribution system is designed to provide pressures within a range of minimum and maximum allowable conditions. When system pressure is too low, customers may complain of inadequate water supply, customer meters may tend to record inaccurately, and fire protection will be limited. When system pressure is too high system operation and maintenance issues may occur, and will tend to cause higher consumption rates by customers. High water system pressures can also increase the amount of water loss, as leakage rates will increase with increases in system pressure.

Factors Impacting Pressure

Water system pressure will vary around the service area based on land elevations, and to a lesser extent supply rates and customer demands. Areas higher in topographic elevation will tend to exhibit lower water system pressures. In general, as customer demands increase pressures will decrease, however, the effect of demands on overall system pressures is usually minor.

Pressure Range Standards

Ten States Standards for water system design suggest that a minimum pressure of 35 psi and a maximum pressure of 80 psi be provided at all locations in the service area under normal operating conditions. If service pressures exceed 80 psi at the water main in the street, plumbing code calls for PRV's (Pressure Reducing Valves) be installed at service lines. Furthermore, water systems are required to be operated so that under fire flow conditions, the residual pressure in the system will not fall below 20 psi at any location.

Due to the nature of the ground elevations within the service area of the Le Sueur water system, three (3) pressure zones have been developed to assure adequate pressure is provided to each customer.

Pipe Carrying Capacities

The pipe network and physical condition of the pipes impact the flow carrying capacity of a water system. Flow carrying capacity refers to the ability of the pipe network to transfer water across the system without inducing high velocity and head loss. Pipes with high velocities and head losses often indicate water mains that are exceeding their flow capacity. Mathematically, head loss is a function of velocity, and high head losses often occur within water mains that exhibit high velocities (greater than 5 feet per second). However, older water mains may also exhibit high head losses as a result of loss in hydraulic capacity due to the deterioration of the interior of the pipe, even when velocities are within acceptable values. In gravity systems (or when the well pumps are off), head losses within the distribution system result in lower system pressures. When the well pumps are on (filling the tower), head losses can contribute to higher operating costs, as more power is required to overcome the energy losses occurring within the water mains.

5.1.3.3.2 Extended Period Simulations

This operation is similar to the steady state operation except that multiple points in time are monitored allowing features such as tank levels to be analyzed through hourly, daily and weekly operation.

A reliable water system is capable of meeting system demands under extreme conditions without impacting pressure across the system or reducing operational capabilities. To evaluate the reliability of a system extended period modeling for multiple days of MD demands can be performed to simulate extreme conditions. The primary purpose of this simulation is to check for cumulative system imbalances that are not evident in standard simulations. Tower and system supply placement, and distribution pipe sizes can lead to system imbalances that are not exposed under AD demands. These imbalances can in turn contribute to a reduced storage-replenishment rate which could then limit the system's ability to refill the towers during nighttime low demand periods.

5.1.3.3.3 Fire Flow Simulations

This analysis determines the amount of water that can be pulled from various locations in the water system while maintaining a residual pressure of 20 psi. The strength of the distribution system can often be directly correlated to the results of fire flow analysis.

The model was set to simulate fire flows up to 3,500 gpm without dropping the system below 20 psi. Results indicate that flows higher than this upper threshold are available in some areas of the system, but at some point they become unrealistic because there are not enough hydrants or fire equipment to deliver such high flow rates. For the purposes of this analysis, only flows up to 3,500 gpm are documented.

5.1.3.3.4 Water Age Analysis

This operation makes an estimate of the age of water at various points in the water distribution system. As water is pumped into the water system from the WTP it is either consumed or continues to travel to the farthest most portions of the distribution system. Water starts to become noticeably older as it gets farther away from the WTP, on dead end pipes, and on sections of pipes with low consumption. When water ages the likelihood of poorer water quality and disinfection by-products increases. Regulatory agencies have regulations on water quality that utilities must comply with. Water age modeling can be beneficial to evaluate the average age of water in the distribution system and identify areas of particularly old water that may not meet regulations.

5.2 Water System Analysis

Using the methods outlines in the previous section, the following topics will be reviewed in detail to identify system strengths and deficiencies in terms of water quality, projected water use and system growth:

- Supply
- Treatment
- Storage
- Booster Station
- Distribution System

5.2.1 Supply

The existing four municipal wells were evaluated to determine if the existing water quality and production capacity would adequately meet future system needs.

5.2.1.1 Water Quality Supply

Comparing the water quality testing for each municipal well to the regulations set by the governing agencies identified that all of the City's wells exceed the regulatory limit for iron and manganese.

Table 5-1 – Source Water Quality Compliance

Analyte	Reporting Limit	Regulatory Limit	Well No. 3 (QWTA)	Well No. 5 (QWTA)	Well No. 6 (Wonewoc)	Well No. 7 (Mt. Simon)
Phosphorus (mg P/L)	0.05	-	0.06	<0.05	0.05	<0.05
Ammonia (mg/L)	0.1		0.17	0.16	0.92	0.37
Iron (mg/L)	**0.01**	**0.3**	**1.75**	**0.7**	**1.53**	**0.69**
Manganese (mg/L)	**0.01**	**0.05**	**0.49**	**0.51**	**0.1**	**0.11**
Magnesium (mg/L)	0.01	-	30.2	30.1	34.3	23.1
Calcium (mg/L)	0.01	-	94.5	91.9	88.8	64.7
Alkalinity (mg/L as CaCO3)	20	-	388	388	388	388
Hardness (mg/L)		-	364	353	363	257
Samples collected on 10/2/2019						

Source: City provided results from UC Laboratory, US EPA (NPDWR, NSDWR, CCL)

5.2.1.1.2 Iron

Iron is a naturally occurring element on the earth's crust and is commonly present in water sources. The NSDWR set a standard of less than 0.3 mg/L iron be present in drinking water. Concentrations above this standard can result in:

- Rust colored water
- Staining to fixtures and clothing
- Metallic tasting water
- Undesirable bacterial growth at treatment facilities

Water quality testing established the iron concentration present in the City's drinking water source ranges between approximately 0.69 mg/L to 1.75 mg/L which is above the NSDWR standard.

5.2.1.1.3 Manganese

Similar to iron, manganese is also a naturally occurring element on the earth's crust and is commonly present in water sources. The NSDWR set a standard of less than 0.05 mg/L manganese be present in drinking water. Concentrations above this standard can result in:

- Black or brown colored water
- Staining to fixtures and clothing
- Bitter or metallic tasting water
- Headache, apathy, irritability, insomnia, leg weakness and nervous system disorders can occur from the long term consumption of high concentrations

Water quality testing established the manganese concentration present in the City's drinking water source ranges between approximately 0.10 mg/L to 0.51 mg/L which is above the NSDWR standard.

5.2.1.1.4 Supply Water Quality Summary

Water quality testing identified that the concentration of iron and manganese exceeded NSDWR. However, it does not exceed the standard to the point where treatment is not an option, and is therefore still an acceptable water source.

5.2.1.2 Mass Balance

A mass balance analysis was performed to identify if the firm well pumping capacity is capable of meeting projected water use demands over the planning period. With the largest well offline, the existing firm capacity is 1,120 gpm or 1.61 MGD. Water use projections estimate that by the year 2040 the MD system demand will increase to 1,600 gpm or 2.3 MGD. The increase in demand results in a supply deficit of 500 gpm.

Table 5-2 – Supply Mass Balance

Year	Existing Pumping Capacity	Existing Firm Pumping Capacity	Projected MD Demand (gpm)	Supply Surplus (+) / Deficit (-) (gpm)
2019	1,870 gpm 2.69 MGD	1,120 gpm 1.61 MGD	1,324	-204
2020			1,329	-209
2025			1,396	-276
2030			1,468	-348
2035			1,542	-422
2040			1,618	-501

5.2.1.2.2 Supply Mass Balance Summary

Based on the analysis, the City will need to install another well to meet projected system demands. The City should plan to add an additional well with a pumping capacity of greater than 500 gpm to ensure they have sufficient pumping capacity. The addition of the well will increase the well:

- Projected Total Pumping Capacity = 2,470 gpm or 3.55 MGD
- Projected Firm Pumping Capacity = 1,720 gpm or 2.48 MGD.

5.2.2 Treatment

The existing WTP was evaluated to determine if the existing water quality and production capacity would adequately meet future system needs.

5.2.2.1 Treatment Water Quality

The supply water quality analysis identified that the raw water in all four municipal wells exceed the NSDWR for iron and manganese. To address this issue the City pumps all raw water to the WTP to remove the iron and manganese prior to pumping it to the distribution system. Comparing the water quality results for the municipal wells and clearwell to the regulations set by the governing agencies identified that the treatment processes implemented at the WTP successfully reduce the concentration of iron and manganese to and below the NSDWR standards.

Table 5-3 – Raw and Finished Water Quality

Analyte	Reporting Limit	Regulatory Limit	Well No. 3 (QWTA)	Well No. 5 (QWTA)	Well No. 6 (Wonewoc)	Well No. 7 (Mt. Simon)	Clearwell
Phosphorus (mg P/L)	0.05	-	0.06	<0.05	0.05	<0.05	<0.05
Ammonia (mg/L)	0.1		0.17	0.16	0.92	0.37	0.12
Iron (mg/L)	**0.01**	**0.3**	**1.75**	**0.7**	**1.53**	**0.69**	**0.03**
Manganese (mg/L)	**0.01**	**0.05**	**0.49**	**0.51**	**0.1**	**0.11**	**<0.01**
Magnesium (mg/L)	0.01	-	30.2	30.1	34.3	23.1	32.1
Calcium (mg/L)	0.01	-	94.5	91.9	88.8	64.7	89.7
Alkalinity (mg/L as CaCO3)	20	-	388	388	388	388	388
Hardness (mg/L as $CaCO_3$)		-	364	353	363	257	356
Samples collected on 10/2/2019							

Source: City provided results from UC Laboratory, US EPA (NPDWR, NSDWR, CCL)

5.2.2.1.2 Treatment Water Quality Summary

Water quality testing identified that the concentration of iron and manganese exceeded NSDWR in the raw water. However, the treatment processes implemented at the WTP successfully reduce the iron and manganese concentration to below NSDWR standards.

5.2.2.2 Treatment Mass Balance Analysis

Mass balance evaluations were performed to identify if the existing treatment and high service pumping capacity would be adequate for projected demands.

5.2.2.2.1 Treatment Capacity

The supply analysis identified that the well firm pumping capacity will need to be increased by a minimum of 500 gpm to meet the projected 2040 MD demand. If the well firm pumping capacity is not increased to meet system demands, the wells will be the limiting factor in the treatment process. To analyze the capacity limitations in terms of only the treatment processes it was assumed that the well firm pumping capacity was not the limiting factor. For the treatment capacity analysis it was assumed that a new well would have a production capacity of at least 600 gpm:

- Projected Total Pumping Capacity = 2,470 gpm or 3.55 MGD
- Projected Firm Pumping Capacity = 1,720 gpm or 2.48 MGD.

Each stage of the treatment process was evaluated to determine if the treatment capacity was sufficient to meet system demands.

Table 5-4 – Treatment Mass Balance

<table>
<tr><th>Year</th><th>Projected Well Pumping Capacity</th><th>Projected Well Firm Pumping Capacity</th><th>Aerator Design Capacity (gpm)</th><th>Detention Tank Design Capacity</th><th>Gravity Filter Design Flow Rate (gpm)</th><th>Projected MD Demand (gpm)</th><th>Limiting Stage by Design Capacity</th></tr>
<tr><td>2019</td><td rowspan="6">2,470 gpm
3.55 MGD</td><td rowspan="6">1,720 gpm
2.48 MGD</td><td rowspan="6">1,600</td><td rowspan="6">Existing:
1,200 gpm
0.52 ft/min
64.1 min

Design:
1,400
0.65 ft/min
51.3 min</td><td rowspan="6">Existing:
1,200 gpm
2.08 gpm/ft^2

[1]Max Sustainable:
1,500 gpm
2.60 gpm/ft^2)</td><td>1,324</td><td>-</td></tr>
<tr><td>2020</td><td>1,329</td><td>-</td></tr>
<tr><td>2025</td><td>1,396</td><td>-</td></tr>
<tr><td>2030</td><td>1,468</td><td></td></tr>
<tr><td>2035</td><td>1,542</td><td>Filtration</td></tr>
<tr><td>2040</td><td>1,617</td><td>Aeration
Filtration</td></tr>
<tr><td colspan="8">Notes: Assume capacity limitations are not due to well capacity.
[1]Based on original plant design assumptions, potential for current system to operate at this rate needs to be tested.</td></tr>
</table>

Aeration Capacity

The existing aerator has a design capacity of 1,600 gpm. Maximum day demand projections indicate that by the year 2040 the demand will exceed than the aeration capacity by approximately 17 gpm. The design aeration capacity will need to be increased to meet the 2040 maximum day demand of 1,617gpm.

Detention Capacity

The existing detention tank has a design flow of 1,500 gpm and a design horizontal flow through velocity of 0.65 ft/min. Maximum day demand projections indicate that by the year 2035 the demand will be greater than the design flow by approximately 42 gpm. Typically the flow through velocity of the tank should be between 0.5 – 1.5 ft/min. increasing the design flow rate to meet the 2040 maximum day demand would result in a flow through velocity of 0.70 ft/min, which is within the acceptable range. The existing detention tank design capacity is capable of meeting 2040 maximum day demands.

Increasing the flow rate will result in a lower detention time. The design detention time is 51.3 minutes, but increasing the flow rate will decrease the design detention time to 47.4 minutes. If the lower detention time results in inadequate filtration the addition of chemical oxidants can be used to adjust the detention time required to achieve acceptable filtration results.

Filtration Capacity

The existing filter has a design capacity of 1,500 gpm, and design loading rate of 2.60 gpm/ft^2 Maximum day demand projections indicate that by the year 2035 the demand will be greater than the design flow by approximately 42 gpm. Typically the filter loading rate should be between 2 – 4 gpm/ft^2. Increasing the design flow rate to meet the 2040 maximum day demand would result in in a filter loading rate of 2.81 gpm/ft^2. The design filtration capacity should be increased to meet the 2040 maximum day demand of 1,617 gpm.

5.2.2.2.2 WTP Pumping Capacity

A mass balance analysis was performed to identify if the firm high service pumping capacity for the Low and Middle Zone is capable of meeting projected water use demands over the planning period.

Low Zone

With the largest high service pump offline the existing Low Zone firm capacity is 1,500 gpm or 2.16 MGD. Water use projections estimate that by the year 2040 the Low Zone MD system demand will increase to gpm or 1.16 MGD. The increase in demand results in a supply surplus of 693 gpm.

Middle Zone

With the largest high service pump offline the existing Middle Zone firm capacity is 750 gpm or 1.08 MGD. Water use projections estimate that by the year 2040 the Middle Zone MD system demand will increase to 108 gpm or 0.16 MGD. The increase in demand results in a supply surplus of 642 gpm.

Table 5-5 – WTP Pumping Capacity

Year	[1]Existing Total Pumping Capacity		Existing Firm Pumping Capacity		Projected MD Demand (gpm)		Supply Surplus (+) / Deficit (-) (gpm)	
	Low Zone	Middle Zone	Low Zone	Middle Zone	Low + High Zone	Middle Zone	Low + High Zone	Middle Zone
2019	3,000 gpm 4.32 MGD	1,500 gpm 2.16 MGD	**1,500 gpm 2.16 MGD**	**750 gpm 1.08 MGD**	1225	99	275	651
2020					1229	99	271	651
2025					1292	105	208	645
2030					1358	110	142	640
2035					1427	116	73	634
2040					1500	121	0	629

[1]Based on high demand, low head condition, [2]Based on assumption of largest pump offline

5.2.2.2.3 Treatment Mass Balance Summary

The results from the treatment capacity analysis identified improvements at the WTP that the City will need to implement prior to reaching the projected 2040 demand. These improvements include:

- Increasing the aeration capacity to be capable of operating at a higher rate
- Improving filter performance to be capable of operating at a loading rate of 2.81 gpm/ft^2

5.2.3 Booster Station

Mass balance evaluations were performed to identify if the existing booster station pumping capacity would be adequate for projected demands.

5.2.3.1 Booster Station Mass Balance

A mass balance analysis was performed to identify if the firm booster station pumping capacity is capable of meeting projected water use demands in the high zone over the planning period. With the largest pump offline, the existing booster station firm capacity is 850 gpm or 1.22 MGD. Water use projections estimate that by the year 2040 the high zone MD demand will increase to 597 gpm or 0.85 MGD. The increase in demand results in a surplus supply of 253 gpm.

Table 5-6 – Supply Mass Balance

Year	Population	MD Demand (gpm)	[1]Existing Booster Station Pumping Capacity	[2]Existing Booster Station Firm Pumping Capacity	Projected High Zone MD Demand (gpm)	Supply Surplus (+) / Deficit (-) (gpm)
2019	4,091	1111	1,600 gpm	**850 gpm**	488	362
2020	4,132	1392			489	361
2025	4,173	1406			514	336
2030	4,386	1420			541	309
2035	4,610	1434			568	282
2040	4,845	1448			597	253

[1]Based on high demand, low head condition, [2]Based on assumption of largest pump offline

5.2.3.1.2 Booster Station Mass Balance Summary

The mass balance analysis identified that the existing booster station pumping capacity is adequate to meet the projected system demands in 2040.

5.2.4 Storage Analysis

To determine the water supply and storage needs of a community, average daily demands, peak demands, and emergency needs must be considered. In the sections below, calculations are used to determine future water supply and storage volume requirements for the Le Sueur water system. Water storage facilities should be capable of supplying the desired rate of fire flow for the required length of time during peak demands when the water system is already impacted by other uses and with the largest supply pump out of service.

The calculations below assume that maximum day demands are occurring on the system, storage volume is reduced by peak demands greater than firm supply pumping rate (i.e. equalization storage is expended). For purposes of this analysis, it is assumed that the "firm capacity" of the water supply wells and booster pumps (largest pump out of service) is capable of supplying maximum day demands.

Because there are multiple pressure zones in the Le Sueur water system, served by elevated storage, it is important to evaluate the needs of each zone separately as well as for the complete system. The overall system wide storage capacity was evaluated for the years 2020, 2030 and 2040 for each individual pressure zone as well as for the complete system. Results from the evaluation using the identified sizing criteria is documented in table 5-7 below. Complete storage calculations are included in appendix C.

Table 5-7 – System Storage Needs Summary

	Entire Water System	Low Zone	Middle Zone	High Zone
Existing Firm Pump Cap. (MGD)	2.0	2.0	1.1	2.3
Existing Storage Volume (MG)	1.05	0.50	0.25	0.30
2020 Planning Period				
Assumed Firm Pump Cap. (MGD)	2.0	2.0	1.1	2.3
Average Day Demand (MGD)	1.2	0.7	0.09	0.45
Max Day Demand (MGD)	1.9	1.1	0.15	0.91
Req. 1 Recommended Storage Volume (MG)	1.2	0.8	0.37	0.53
Req. 2 Recommended Storage Volume (MG)	1.2	0.7	0.10	0.55
Additional Storage Recommended (MG)	**0.20**	**0.20**	**None**	**None**
2040 Planning Period				
Assumed Firm Pump Cap. (MGD)	2.5	2.3	1.1	2.3
Average Day Demand (MGD)	1.5	0.8	0.11	0.5
Max Day Demand (MGD)	2.3	1.4	0.18	0.9
Req. 1 Recommended Storage Volume (MG)	1.4	0.9	0.46	0.53
Req. 2 Recommended Storage Volume (MG)	1.2	0.8	0.14	0.55
Additional Storage Recommended	**0.40**	**0.30**	**None**	**0.06**
Interzone Supply/Pumping Recommended represents water that would need to flow from a higher elevation zone				

The results shown above indicate that the entire water system is currently short roughly 200,000 gallons of storage when compared to the sizing criteria, by 2040 this deficit could grow to 400,000 gallons. When evaluating each pressure zone individually, the low zone indicates a current shortage of 200,000 gallons and a potential shortage of 300,000 gallons by 2040. The other zones have a minimal shortage indicated and would benefit from additional .storage added to the overall system. Storage calculations for the high zone assume reliable supply though the booster station. For this to be the considered reliable, a backup power generator should be added or be made available to this facility.

5.2.5 Distribution System

The existing distribution system was evaluated to determine if the existing infrastructure adequately meet future system needs.

5.2.5.1 Distribution System Water Model Analysis

The existing system was evaluated based on the following criteria:

- Pressure.
- Available Fire Flow.
- Flow Capacity.
- Water Age

One difference between the existing distribution system and the 2040 distribution system is the improvements made during a 2020 road construction project as well as various pipe upgrades as shown in figure 7-1.. These improvements include upgrading pipe sizes and installing a PRV between the Low Zone and the Middle Zone.

5.2.5.1.1 Pressure

Existing AD Pressure

Two steady state scenarios were modeled to establish the static pressures of the existing system when the pumps are on and off during an AD demand. Figures 5-1 and 5-2 illustrates the pressure across the system.

Model results indicated that system pressures are typically within the desired pressure range with most of the system falling between 50 to 75 psi. There were no areas identified to have low pressure in the system. Few areas were identified to have high pressures outside of the desired range. However, the City did not report any concerns regarding the system static pressure at this time. Table 5-2 provides details of the pressure in each Pressure Zone.

Table 5-8 – Existing System AD Pressure

Zone	Typical Zone Pressure (psi)	Lowest Pressure (psi)	Highest Pressure (psi)
High	55 – 80	55	152 (At Booster Station)
Middle	49 – 75	49	75
Low	55 – 85	51	93

Source: Water Model

Existing Peak Hour Pressure

Two steady state scenarios were modeled to establish the static pressures of the existing system when the pumps are on and off during a peak hour demand. Figures 5-3 and 5-4 illustrates the pressure across the system.

Model results indicated that system pressures are typically within the desired pressure range with most of the system falling between 50 to 75 psi. There were no areas identified to have low pressure in the system. Few areas were identified to have high pressures outside of the desired range. However, the City did not report any concerns regarding the system static pressure at this time. Table 5- 3 provides details of the pressure in each Pressure Zone.

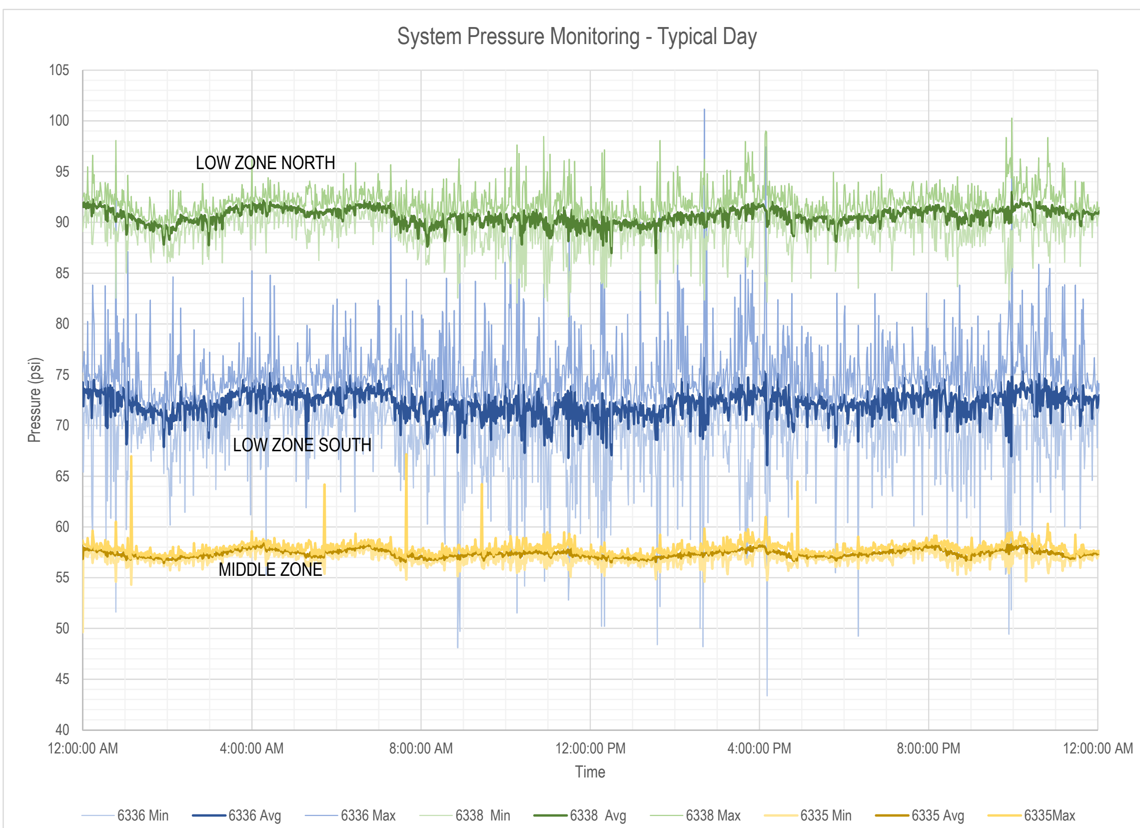
Table 5-9 – Existing System Peak Hour Pressure

Zone	Typical Zone Pressure (psi)	Lowest Pressure (psi)	Highest Pressure (psi)
High	55-64	55	147
Middle	50-72	49	74
Low	50-80	42	95

Source: Water Model

Existing Pressure Sustainability

During the process of field testing, pressure monitors were deployed through the water distribution system. These monitors are able to capture fluctuating pressure readings at a high rate of frequency which can detect pressure transients if present. If note is the results from the low zone pressure monitoring. The two deployed monitors in the Low Zone indicated system pressures that fluctuated over the course of time. While the average system pressures at each location generally trended with the water tower level, for brief moments the pressure tends to fluctuate up and down. When compared to the data collected in the middle zone, which had some minor peaks and valves which correlate with the start and stop of high service pumps, the low zone pressure tends to fluctuate to a greater extend. This may be due to the general layout of larger water system users in relation to system storage as well as limited water main looping.



2040 Pressure

Two steady state scenarios were modeled to establish the static pressures of the 2040 system when the pumps are on and off during an AD demand. Figures 5-5 and 5-6 illustrates the pressure across the system.

Similar to the existing system pressure results, 2040 system pressures are typically within the desired pressure range with most of the system falling between 50 to 75 psi. The typical pressure in the High Zone dropped with more of the system having between 55 – 65 psi. The other zones experienced very minor pressure changes. Table 5-44 provides details of the pressure in each Pressure Zone.

Table 5-10 – 2040 System AD Pressure

Zone	Typical Zone Pressure (psi)	Lowest Pressure (psi)	Highest Pressure (psi)
High	55 – 65	57	152
Middle	49 – 73	49	75
Low	52 – 85	50	92

Source: Water Model

2040 Peak Hour Pressure

Two steady state scenarios were modeled to establish the static pressures of the 2040 system when the pumps are on and off during a 2040 peak hour demand. Figures 5-7 and 5-8 illustrates the pressure across the system.

Model results indicated that available fire flow ranges from less than 500 - 3,500 gpm. There were no areas identified to have low pressure in the system. Few areas were identified to have high pressures outside of the desired range. However, the City did not report any concerns regarding the system static pressure at this time. Table 5- 5 provides details of the pressure in each Pressure Zone.

Table 5-11 – Existing System Peak Hour Pressure

Zone	Typical Zone Pressure (psi)	Lowest Pressure (psi)	Highest Pressure (psi)
High	55-79	55	146
Middle	50-70	49	74
Low	50-90	40	95

Source: Water Model

5.2.5.1.2 Fire Flow

Existing MD Available Fire Flow

Two fire flow scenarios were modeled to establish the available fire flow of the existing system when the pumps are on and off during an MD demand. Figures 5-9 and 5-10 illustrates the estimated available fire flow while maintaining a residual system pressure of 20 psi.

Available fire flow varies across the system ranging from less than 500 - 3,500 gpm. However, most of the system has adequate available fire flow between 1,000 - 3,500 gpm. The lowest available fire flows occur on old 4-inch pipe and dead end pipes. Table 5-6 provides details of the available fire flow in each Pressure Zone.

Table 5-12 – Existing System MD Fire Flow

Zone	Typical Zone Fire Flow (gpm)	Lowest Fire Flow (gpm)	Highest Fire Flow (gpm)
High	1,700 – 3,500	1,397	3,500
Middle	1,000 – 3,500	458	3,500
Low	1,000 – 3,500	507	3,500

Source: Water Model

2040 MD Available Fire Flow

Two fire flow scenarios were modeled to establish the available fire flow of the 2040 system when the pumps are on and off during an MD demand. Figures 5-11 and 5-12 illustrates the estimated available fire flow while maintaining a residual system pressure of 20 psi.

Similar to the existing system available fire flow, the 2040 system available fire flow varies across the system ranging from less than 500 - 3,500 gpm. There were not significant differences in available fire flow between the existing and 2040 system with the exception of the increased fire flow in the Low Zone due to the PRV installation between the Low and Middle Zones. Table 5-7 provides details of the available fire flow in each Pressure Zone.

Table 5-13 – 2040 System MD Fire Flow

Zone	Typical Zone Fire Flow (gpm)	Lowest Fire Flow (gpm)	Highest Fire Flow (gpm)
High	2,000 – 3,500	1,375	3,500
Middle	1,000 – 3,500	457	3,500
Low	1,100 – 3,500	494	3,500

Source: Water Model

5.2.5.1.3 Flow Carrying Capacity

Existing Peak Hour Carrying Capacity

A steady state scenario was modeled to establish pipe velocities, head losses and flow for the existing system when the system pumps are on during an MD demand. Figure 5-13 illustrates the estimated velocities across the system.

Modeling results conclude that pipe velocities vary across the system. The majority of pipes have velocities below 3 feet per second (fps), however there are some pipe segments that exceed 3 fps. Older and smaller pipes in the Low Zone had the highest velocities ranging from 3 – 5+ fps. The high zone also had velocities around 3 fps along the major transmission pipe.

2040 Peak Hour Carrying Capacity

A steady state scenario was modeled to establish pipe velocities, head losses and flow for the proposed system when the system pumps are on during a proposed MD demand. Figure 5-14 illustrates the estimated velocities across the system.

The 2040 carrying capacity results were very similar to the existing results. The majority of pipes have velocities below 3 feet per second (fps), however there are some pipe segments that exceed 3 fps. Older and smaller pipes in the Low Zone had the highest velocities ranging from 3 – 5+ fps. The high zone also had velocities around 3 fps along the major transmission pipe.

5.2.5.1.4 Water Age

Existing Water Age

A water age scenario was modeled to evaluate the age of water in the distribution system over 30 days (720 hr) with an average day (AD) demand. Figure 5-15 shows the average water age in the pipes over the 30 day simulation.

Modeling results indicate the Low Zone has the youngest water with the majority of the zone having water less than 3 days old. The High Zone has similar water age in most of its system, with only the longer dead ends having water older than 7 days. The water age in the Middle Zone is the oldest in the system.

Dead End Analysis

Oldest water in the system is found at the end of dead end pipes. These pipes tend to have the oldest water because once water enters the pipe it remains stagnant until it is consumed. Many of these pipes are located along the pressure zone boundary.

Proposed Water Age

A water age scenario was modeled to evaluate the age of water in the distribution system over 30 days (720 hr) with a 2040 average day (AD) demand. Figure 5-5-16 shows the average water age in the pipes over the 30 day simulation.

Water age for the 2040 system had similar water as the existing system. Modeling results indicate the Low Zone has the youngest water with the majority of the zone having water less than 3 days old. The High Zone has similar water age in most of its system, with only the longer dead ends having water older than 7 days. The water age in the Middle Zone is the oldest in the system.

5.2.5.1.5 Distribution System Water Model Summary

Based on the modeling results the following observations were made for each analysis

Pressure

Both the existing system pressure and 2040 system pressure are with the desirable pressure range with few exception. No additional improvement to improve pressure are recommended at this time.

Fire Flow

The available fire flow across the system is within an acceptable range for both the existing and 2040 system. No additional improvement to increase available fire flow are recommended at this time.

Flow Carrying Capacity

Velocities exceeded 3 fps in both the existing and 2040 system. Replacing the old and smaller diameter pipes would decrease pipe velocities and improve flow transfer capabilities across the system. These pipe improvements should be made as opportunities allow with road construction projects.

Water Age

The water age in the Middle Zone is significantly older than the rest of the system. Improvements to reduce the water age in the system include pipe looping and active system flushing.

Other Observations

The existing distribution system has a single pipe to serve the entire High Zone. In the event that the pipe would be out of service, the City has no other way to pump water to the zone. To add redundancy to the system an additional pipe should be installed to connect the Low and High Zones. Additionally, the discharge from the water plant to the middle zone is a single pipe. If this connection were to fail, delivery of water to the middle zone would be cut off, the addition of a second water feed point may be beneficial.

6 Improvement Alternatives Review

With the updated water use projections, the recommended short and long term water system improvement recommendations have been revisited and summarized below. Many of the improvements previously identified have been confirmed and a more exhaustive list of improvements has been developed.

The purpose of this section of the report is to review and facility improvement priorities for the water system moving forward. With growth of the City, and therefore the water system expected during the next planning period, additional water system to facilities should be planned for so that all customers receive exceptional water service.

This section will provide recommendations to remediate deficiencies and to prepare the system for future growth. A map of planned improvements is shown in Figure 6-1 and will be reference throughout this section. The contents of this section will present multiple alternatives for each system need type. Upon concussion of this section, a combination of the proposed improvement alternatives will be selected which will support the long rang facility planning priorities. Each facility selected for a given water system function may influence the need and priority of other functions. The advantages and disadvantages of each alternative will be summarized below along with the overall impact on other water system needs. The net result of this exercise will be to assemble a suite of proposed water system improvements to economically and effectively serve the needs of the water system customers.

This section aims to summarized and define suggested water system improvements to assure that the Le Sueur water system is capable of suppling excellent water service through the defined planning period. In the previous sections various water system deficiencies were identified. These deficiencies include anticipated water supply and transfer limitations as the water system expands and water demand grows. Though the alternative analysis process, a series of water system improvement alternatives were identified. These alternatives include new water supply, treatment, water transfer facilities (booster stations), storage faculties, water main and other key water main improvements that would aid in the delivery of water to an area of need.

6.1 Water Supply Alternatives

A community's water supply capacity is sized to meet maximum day demands reliably. The industry standard is to provide enough pumping capacity to meet the maximum day demand rate with the largest well pump of service (i.e. firm capacity). Current well supply capacity in Le Sueur is 2.7 MGD (1,870 gpm), and the firm pumping capacity is 1.6 MGD (1,120 gpm).

Water use projections and water supply analysis completed in section 5 indicate a near term firm water supply shortage of 200 gpm and a potential long term shortage of 500 gpm compared to existing well capacity. The potential for this shortage is based on maximum day demand projections and the assumption of the largest active well taken offline. This shortage could be even larger of a new large user were to locate to the City. As such it is recommended that at least one new well be constructed to support water system supply both in the near and long term. The location of the new well be either near the existing water treatment plant, and connected to the existing plant or located in the high zone and connected to a potential water treatment facility discussed later in this report.

Based upon the peak demand projections and the well analysis discussed in section 5.2, it is estimated that projected maximum daily demand may exceed firm/reliable well supply capacity. For that reason, additional capacity is recommended in the future. The previous section of this report identified the need for approximately 1.0 MGD or more in reliable (well) supply capacity to meet projected water system demand growth through the 2040 planning period. This would be roughly equivalent to one new well similar to other new system wells. Alternative for adding new well supply are discussed briefly below.

6.1.1 Supply Alternative 1 - New Well No.8 at Existing Water Plant

The simplest way to address the water supply shortage would be to construct an additional water supply well within the vicinity of the existing water treatment plant to support system redundancy. The primary function of this well would be mechanical redundancy and would access the Mt. Simon aquifer similar to Well No.7. The addition of the new well would increase firm treatment capacity to meet the future water system demand projections. Currently a potential well site has yet to be identified. For purposes of budgetary comparison, a location within a 1/2 mile radius of the existing water treatment plant is assumed. This facility would require a dedicated well house to contain process and electrical equipment as well as a dedicated raw water main connecting the well to the existing water treatment plant.

Budgetary Cost: $1,210,000

6.1.2 Supply Alternative 2 – New Well No.8 & 9 High Zone Wells

An alternative to simply adding more supply to the existing plant would be to locate redundant water supply in the high pressure zone. Currently this zone is remote from the rest of the water system if the supply main to the booster were to break, this zone would be out of water without any form of supply. As a result, this option to locate new supply in this pressure zone is presented as an alternative. Two wells are recommended for this alternative to support a mechanically redundant system which would likely need to feed a water treatment facility.

***Budgetary Cost: $1,825,000**

*Estimated cost for supply wells and pumping equipment, it is assumed that a treatment facility will also be needed which is discussed later in the alternatives section.

6.2 Water Treatment Alternatives

In addition to a potential water supply shortage, the existing treatment plant may be approaching its reliable capacity during a maximum day water use event. Given the normal operational rate of 1,200 gpm (1.7 MGD) and design capacity of 1,500 gpm (2.1 MGD) reliable treatment capacity of the existing water treatment plant may be exceeded if a major maximum day water use event is experienced in the next few years. Options to increase existing plant capacity or add additional treatment are discussed later in this section. A minimum additional operational treatment capacity of 0.7 MGD (500 gpm) is recommended to be added to the water treatment capabilities in the future so that the plant is capable of operating at a rate of 1,700 gpm (2.5 MGD) or greater.

6.2.1 Water Treatment Alternative 1 – Existing Water Plant Optimization

Review of the exiting water treatment plant revealed a system that is operating well as a biological plant. As such, the through plant flow and filter loading rate is likely on the low end of what may be possible. There may be the potential to increase the treatment capacity of the existing facilities with some minor improvements and adjustments within the existing facility footprint. (New filter media, increased filtration rate, proactive treatment enhancements). Before a substantial investment is made in upgrades to the existing water plant or other treatment facilities, it is recommended that the City complete a pilot water treatment study to evaluate the effectiveness of the existing biological treatment process. Such a study would rely on field testing of various treatment processed to identify the most effective set of treatment processes for the Le Sueur water supply source. Recommendations would then be made for potential value added Improvements to increase plant capacity with minimal facility expansion.

Water Treatment Optimization Pilot Study: $40,000

Potential Water Treatment optimization Upgrades $750,000 - $1,500,000

6.2.2 Water Treatment Alternative 2 – Existing Water Plant Expansion

If the pilot study mentioned in the previous section indicates that increasing the through production rate of the existing treatment equipment is not possible, then a potential water plant expansion upgrade would be a possible alternative. Such an improvement would add parallel treatment equipment that would provide a similar function to the existing plant treatment facilities. Such an improvement would likely require a building expansion to house the extra detention tanks, filters and other associated facilities. An alternative to a parallel expansion would be the addition of other treatment mechanisms which would then in turn allow the existing plant to operate at a much higher water production rate. The extent and validity of the proposed improvements should be vetted through the proposed water treatment plant optimization pilot study.

Budgetary Cost: $2,000,000 - $3,000,000

6.2.3 Water Treatment Alternative 3 – New 1.0 MGD High Zone Water Treatment Plant

This alternative would be part of the new water supply alternative to locate two new wells in the high pressure zone. Such an improvement would require the construction of a completely new water treatment facility to accept and treat water from the proposed high zone wells. Given the many unknowns for such a project, a base budgetary cost of $4,000,000 was included for comparisons with the other alternatives. First a sustainable water source would need to be identified then the plant could be designed and developed to meet the needs of the specific water supply.

***Budgetary Cost: $4,000,000**

*Cost for connecting water supply wells included in supply alternative 2.

6.3 Water Transfer Alternatives

The presents of three pressure zones and a single treatment plant required water to be split between the zones. Below is a summary of potential water transfer improvements that become more or less necessary depending on the water supply and treatment alternatives selected. The goal of a water transfer facility is to move water between pressure zones so that system demands can be satisfied and storage tanks refilled by the water supply facilities. Water transfer facilities can take the form of a booster pumping station to move water from a lower pressure zone to a higher zone or the form of a pressure reducing valve facility moving water by gravity from a higher pressure zone to a lower zone. Some of the alternatives presented below become a lower priority depending on the ultimate location of the prosed supply facilities (wells and treatment) For example, if new well facilities were to be constructed in the high pressure zone, supply redundancy would be provided by the combination of the new supply wells and existing booster station and the high zone booster station supply main redundancy would a low priority.

6.3.1 High Zone Booster Station Supply Main Redundancy

Currently, the high zone booster station is connected to a single water main which feeds water from the middle pressure zone. If this line were to break, the entire high zone would be without a reliable water supply. Alternatives to increase supply redundancy to this zone will be explored in the supply section. An alternative to locating new wells in the high zone would be to add redundant water lines connecting to the booster station. Additionally, a backup power generator is recommended. Two sub alternatives for this option were explored.

Budgetary Cost: $1,500,000

6.3.1.1 High Zone Redundant Water Line to Existing Booster Sta.

The first sub alternative would take the approach of installing a parallel water line near the existing booster station feed line from the main looped system in the low zone to the booster station. A parallel discharge line would also be installed and would return south across Highway 169 where it would connect to a proposed main along Forest Prairie Road. This installation would require two additional crossings of Highway 169, which would not be desirable.

Budgetary Cost: $2,130,000

6.3.1.2 High Zone Redundant Water Line & Service Flow Booster

This alternative would reduce the amount of pipe required and eliminate the highway crossings. Since the redundant lines would not be connected to the existing booster station, a new second water boosting facility would be constructed Such a facility would not require the same level of facility as exists at the existing booster station since it will be considered a backup redundant facility, only typical water service flows would need to be conveyed and chemical feed would not be required. As a result a minimal pitless booster station or small below grade facility could be installed in the existing road right of way along the anticipated pressure zone boundary.

Budgetary Cost: $1,720,000

6.3.2 Low to Middle Zone Water Transfer – Booster Pumping

Currently there is not a reliable way to transfer water from the low zone to the middle zone, if additional storage is constructed in the low zone, a transfer location in the form of a booster station to provide redundancy is recommended. This will allow for water to be moved from the low zone storage to middle and ultimately the high zone if needed. This facility becomes an even greater priority of additional storage is ultimately developed in the low pressure zone. Additionally, there is currently only a single water main feeding from the water plant to the middle zone. If this main were to break there would not be a means to pump water to the Middle Pressure zone. It is recommended that a redundant station be installed outside the vicinity of the existing water plant so that alternative piping is access to provide redundancy. This facility would pull from the low pressure zone and pump to the middle zone to fill the exiting water tower. This sort of facility could be constructed much like the statin mentioned in the previous alternative to limit the amount of property needed.

Budgetary Cost: $600,000

6.3.3 Middle to Low Zone Water Transfer – Gravity/PRV

A low cost high value alternative to support water transfer from the middle pressure zone to the low pressure zone would be the construction of a PRV (Pressure Reducing Valve) structure. This would allow water to flow by gravity from the middle pressure zone to the low zone and would be controlled hydraulically to sustain a set downstream pressure, only opening when needed. In addition to allowing low zone access to middle zone water storage volumes, such a facility would support low zone fire flow capacities. Appendix E documents previous evaluation efforts to support the construction of a new PRV station when the TH 112 Turnback Water Infrastructure Improvements are completed.

Budgetary Cost: $125,000 (Already scheduled)

6.4 Water Storage Alternatives

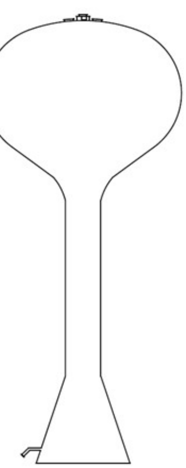
Previous analysis indicated that there is currently a water storage shortage. There are many possible permutations and alternatives to add additional storage capacity to system. The need and location of water storage is heavily influenced by the amount and location of supply water available in each pressure zone available from either water supply wells or transfer facilities. Additionally, the combined overall water system has a specific recommended water storage volume recommended to sustain reliable water service. The two most feasible and effective alternatives are summarized below and present economical solutions to the existing water storage shortage. Section 5.2 of this report explored overall water system storage needs. The alternatives listed below aim to address the overall water system storage shortages to and provide storage support to all of the pressure zones. Overall water use projections indicate a potential system wide water storage shortage of 300,000 gallons by 2040 (Assuming water can easily be transferred between zones). When examining individual isolated pressure zone storage needs, the low zone currently has a shortage of 450,000 gallons and a long term shortage estimate of 550,000 gallons. The other isolated zone combinations also indicate some level of storage need that can addressed through pressure zone transfer pumping to access storage from other zones.

6.4.1 Water Tower Style Considerations

Before specific alternatives for water storage can be developed, the types of possible water storage facilities can be considered. There are multiple water tower styles that may be of beneficial use for the City of Le Sueur. Each have advantages and disadvantages, varying initial construction costs and ultimate maintenance needs. Three possible water tower style options are discussed further below.

6.4.1.1 Single Pedestal Sphere

A single pedestal sphere water tower is the most commonly built tank style in the past few decades. These tanks are especially popular for tanks 500,000 gallons and smaller. This type of a water tower is comprised of welded steel construction with a spherical water storage tank supported by a single cylindrical welded steel support pedestal and a flared conical base.



Advantages:

- Low maintenance, durable and efficient structure.
- Simple and attractive appearance
- Enclosed shaft allows for interior ladders and piping to be protected against weather and vandalism and easily allows for pipe insulation
- Easy access for maintenance and operation

Disadvantages:

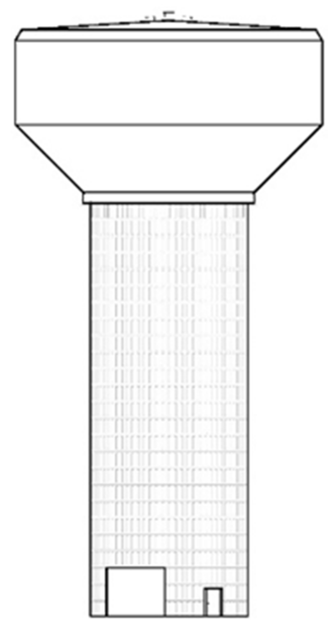
- Requires future maintenance painting of entire structure (steel)
- Construction cost can be more variable due to fluctuations in steel prices.

6.4.1.2 Composite Elevated Storage Tanks

A composite elevated storage tank consists of a welded carbon-steel water storage tank resting on a steel-reinforced concrete support column. The concrete column is typically constructed with special horizontal and vertical rustication patterns formed into the exterior of the tower which provides for a pleasing aesthetic. This tank style has become the most commonly constructed water tower for capacities of 1,000,000 gallons and greater. However, this size may be considered economical in the 750,000 gallon size as well.

Advantages:

- Low maintenance, durable and efficient structure utilizing the most advantageous characteristics of each material; the tensile strength of steel for the water containment vessel and the compressive strength of concrete as the support column for the tank.
- No coatings system needed for concrete shaft, which results in maintenance savings since this area will not require painting.
  - Architectural Rustications allow for the concrete to be cast in such a manor to provide for an aesthetically pleasing water tower column.
- Now the most commonly constructed water tower style & typically most economical style in capacities greater than 1,000,000 gallons.



Disadvantages:

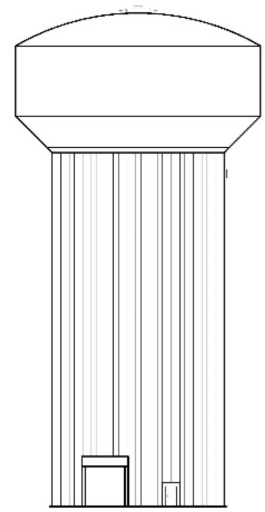
- Initial construction requires specialized field erection of concrete column, increasing the probability for construction issues.
- Construction staging can be more heavily influenced by weather conditions.

6.4.1.3 Fluted Column Elevated Storage Tank

A fluted steel column elevated storage tank consists of a welded carbon-steel water storage tank resting on a steel support column. Up until recent times, this style of tank has traditionally been the most commonly constructed tank in the twin cities metro Area and to a more limited extend, outstate.

Advantages:

- Simple & clean design comprised of an all steel construction.
- The larger diameter, all steel support column is fluted to provide structural rigidity with an aesthetically pleasing appearance with the column being well-proportioned to the tank diameter.
- All-steel construction permits cost-effective, year-round construction
- Much of the structure can be “shop fabricated” reducing the chance for error.



Disadvantages:

- More materials and labor required for initial and future painting due to larger surface area.
- May require more long term maintenance.
- Construction cost can be more variable due to fluctuations in steel prices.

6.4.2 Storage Alternative 1 - New 1,000,0000 Gallon Low Zone Water tower – Demo existing low zone tower

This alternative aims to address the current water storage shortage in the low zone by simply constructing a new water tower to serve this pressure zone. Since this zone serves the majority of the system demand, it is sensible to locate additional storage in this zone. The drawback to this location is that in order for the other zones to access, it will need to be pumped. This alternative was suggested as an option since the existing storage tank located in the low zone is aging and would be a good candidate for replacement. Rather than invest substantial money in the rehabilitation of this tank, these funds could be used to construct a new larger, more modern water storage facility to serve the same purpose with a larger volume. Construction a water storage facility of this size would also present an alternative where the new tank could be constructed as a composite tank or single pedestal sphere which would reduce future maintenance costs.

6.4.3 Storage Alternative 2 – New 500,000 Gallon Middle Zone Water Tower

This alternative would add additional shortage on the system to be accessed by gravity by the middle and low pressure zone (pending Interzone connection additions) and pumping via the booster station to the high zone. Since the existing middle zone tower I relatively new (constructed in 1996) this tank would not be a good candidate for replacement as the low zone tank presented in alternative 1. The drawbacks to this alternative would be the presence of an additional storage facility requiring maintenance long term (4 total). Alternatively, this facility could be constructed as a 750,000 gallon facility which would reduce the value of the existing 250,000 middle zone tank.

6.5 Distribution System Improvements

This section summarizes distribution system improvements that are recommended to strengthen the existing system, enhance supply reliability, loop major transmission mains, and improve flow capacity and fire protection to various parts of the City. The goal of these suggested improvements include:

1. Upgrade undersized water main
2. Develop pressure zone interconnection redundancy
3. Increase water transmission capacity
4. Increase fire flow
5. Support Redundant operation
6. Loop Long lengths of dead end pipe
7. Enhance trunk water main grid
8. Maintain right sized piping
9. Maintain consistent and optimized water system pressure

As discussed in the previous chapters, there are various parts of the water distribution system where recommended fire flows cannot be supplied. For isolated deficiencies, it is often not economical to recommend specific improvements as these deficiencies will eventually be corrected by annual water main replacements (replacing existing older small diameter mains) and/or distribution system growth (primarily as a result of looping existing dead end mains). In locations where more widespread deficiencies are found, specific water distribution system improvements are presented in Figure 6-1. A well-developed trunk water main and distribution system helps to deliver adequate flows for various conditions including emergency fire flow.

Actual main routing will depend on a variety of local factors as individual street rehabilitation projects progress. This map should be seen as a recommendation for the general hydraulic capacity of the distribution system to optimize existing water service. These improvements are intended to support robust fire flow and increased system which lead in water service redundancy and reduce water age which benefits water quality.

As stated above, the improvements presented in Figure 6-1 represent a conceptual plan for potential long term water system improvements to improve and expand the hydraulic capacity of the water distribution system. These improvements are presented to improve flow capacity, increase system reliability and support long term community development and growth. Although the local knowledge of development patterns was utilized in the preparation of the trunk water main plan, as a conceptual plan, the actual size and location of the improvements will depend upon future planning efforts and the circumstances at the time of the improvement are implemented and may not follow exactly as shown in the figure.

6.5.1 Water Distribution Water Age Enhancements - Flushing

Previous water age modeling indicated old water being present in the low use areas of the water system. Potential water system looping and increase in use can help reduce water age in various parts of the water system. Generally speaking, the looking of water main provides a general benefit that promotes water circulation. In parts of the water system where this is not possible, other endeavors such as regular hydrant flushing, or the installation of an automatic flushing station may be beneficial. Though not a priority, the installation of an automatic flushing station near the airport would increase water flow to the south portion of the water system. Budgetary costs for such a facility would be +/- $25,000. In lieu of such a facility, an increase in regular hydrant flushing in this portion of the City may prove to be more advantageous.

6.5.2 Water Distribution Pressure Sustainability

During the course of water system field testing, system pressure monitors were paced throughout the water distribution system. The result of this monitoring indicates that regular service pressure in the low zone tends to fluctuates in the far extents of the water system. This water system pressure “noise” is a function of the higher zone demand and the proximity of large water users in relation to the water storage tank. One of the functions of a water tower is to sustain water system pressure. The portions of the water system that are more remote experience a greater fluctuation in pressure.

6.5.2.1 Water Bulk Fill Station with Hydropneumatic Tank

One potential solution to adding some element of pressure sustainability “cushioning” would be the connection of a “hydropneumatic” tank to the distribution system. Such a facility acts as a small water storage vessel to move water in and out of the system as needed to sustain a steady pressure. Water towers provide a similar function by cushioning with atmospheric pressure and an elevated water column. These sorts of tanks are common on water systems that don’t have a connected water tower and sustain pressure though constant pumping. Such tanks can also be utilized to cushion transient pressure surges. These sorts of facilities limit the likelihood of a system damaging pressure hammer/surge (Transient) which may occur through the sudden stop of flow in a water system. Such transient surges can lead to water main breaks. As a result of these considerations, the City could install a hydropneumatic tank in the low zone to address these concerns. Since such a facility would require a small building to house the tank, there would be a potential to make this a multi-use facility to function as a self-serve bulk water truck fill station. This proposed drive up facility could be equipped with a digital self-pay metering system to allow users to purchase water 24 hours a day while automatically accounting for the water sold. Such a facility would be a natural choice for the location of a hydropneumatic tank to buffer the on/off flow and pressure changes that are prevalent when a station such as this is in use.

Budgetary Cost = $350,000

6.5.3 Distribution System Planning

Figure 6-1 illustrates a vision of potential water main improvements to meet current and projected water system needs through the 2040 planning period. As mentioned previously, these improvements are intended to correct existing deficiencies as well as meet the needs for future growth and development. To demonstrate the effectiveness of the recommended improvements, Figures 6-2 and 6-3 illustrate the anticipated maximum day demand pressures and maximum day fire flows, respectively, with the recommended improvements under projected 2040 demands conditions.

The recommended improvement plan to serve the future service area has been developed as a tool to guide City of Le Sueur in the siting and sizing of future system improvements. While the plan may represent the current planned expansion of the City of Le Sueur system, future changes in land use, water demands, or customer characteristics could substantially alter the implementation of the plan. For this reason, it is recommended that the plan be periodically reviewed and updated using area planning information to reflect the most current projections of City of Le Sueur service area growth and development.

The improvement plan is a guidance document that details existing conditions and recommendations for the future. The plan is based on future conditions as perceived in 2017. As time progresses, additional information will become available and events will shape the development of the City of Le Sueur service area. The plan must be dynamic in response; it should be studied and used but also adjusted to conform to the changes and knowledge that will come with time. Updates should be made on a regular basis, probably every five to ten years.

6.6 Summary of Improvement Alternatives

Below summary of the potential improvement alternatives previously discussed along with the associated costs. All projects listed are not required. As decisions are made with regard to various project to pursue, others will not be necessary. For comparison purposes two different project scenarios were developed, packaging various improvements together to meet the long term, project package A and package B. Each suite represents a collection of projects that would address the identified water system deficiencies.

Table 6-1 – Improvement Project Alternatives

Type	Improvement	Alternative	Estimated Cost
Supply	New Well No.8 + Building + Raw Water Main	A	$1,210,000
Supply	New Well No.8 + No.9 in High Zone	B	$1,825,000
Treatment	Treatment Plant Optimization Pilot Study	A	$40,000
Treatment	*Treatment Plant Optimization Upgrades (Increase Capacity)	A	$1,500,000
Treatment	Treatment Plant Expansion (Increase Capacity)	-	$3,000,000
Treatment	High Zone Well/Treatment Search	B	$150,000
Treatment	High Zone Water Treatment Plant (1.0 MGD)	B	$5,400,000
Transfer	High Zone Redundant Water Line & Service Flow Booster	A	$1,717,000
Transfer	High Zone Redundant Water Line to Existing Booster Sta.	-	$2,122,000
Transfer	Low to Middle Booster Station	A & B	$600,000
Transfer	High Zone Booster Station Generator	A	$200,000
Transfer	**Middle/Low Zone PRV	A & B	$125,000
Storage	Low Zone 1.0 MG Water Tower	A & B	$3,652,000
Storage	Middle Zone 0.5 MG Water Tower	-	$2,900,000
Quality	Flushing Station / UDF	A & B	$30,000
Operations	SCADA, Controls Fiber Conversion	A & B	$2,000,000
Distribution	Truck Fill w/Hydropneumatic Tank	A & B	$350,000
Distribution	Water Main Condition Assessment	A & B	$150,000
Sum of Alternative Package A Improvements		**A**	**$11,574,000**
Sum of Alternative Package B Improvements		**B**	**$14,282,000**

*Median Estimate final costs will vary depending on improvement on outcomes from the pilot study, **Budget number shown not included in total since the design and construction is already in progress.

7 Recommended Improvements

This section will provide recommendations to remediate deficiencies and to prepare the system for future growth. The previous section identified and considered multiple water system improvement options and alternatives. This section will make a recommendation for the selected improvement alternatives. A map of planned improvements is shown in Figure 7-1 and will be reference throughout this section. Recommended improvements were categorized in terms of Supply, Treatment, Storage, Transfer and Distribution Improvements. In general these improvements are identified to support water system operations through the 20 year planning period.

Through the alternatives evaluation process, the following projects were selected to the future operation of the water system. Through a process of summarizing evaluating each project alternative, an effort was completed to select a suite of proposed projected that provide the most value to the City.

The list below represents the collection of the highest ranking projects that could be combined to satisfy the water system deficiencies for each of the short and long term planning periods. This concentrated list of projects represent a collection of improvements intended to address the anticipated water system deficiencies in an efficient and economical manner. The selected alternatives (Suite A) revolve around the overall decision of whether to expand supply and treatment capacity at the existing plant or develop a new water treatment facility and supply wells in the high zone. Ultimately the alternative to expand and enhance existing supply facilities was selected due to the economic impacts and the known water source characteristics. The decision to expand and optimize the existing water treatment facility represents an overall savings of $2, 000,000 - $4,000,000 depending on the ultimate water treatment required and the ancillary system improvements selected. Projected pressure and fire flow for the selected improvements are shown in Figures 7-2 and 7-3.

7.1 Proposed Water System Improvement Projects

7.1.1 New Well # 8

The installation of an additional well with a pumping capacity of at least 600 gpm will be required to increase the well firm pumping capacity to 1,720 gpm. With the proposed water treatment plant capacity optimization enhancements, additional water supply will be needed at the water treatment plant. This additional supply can also function to satisfy overall water supply needs.

7.1.2 Water Treatment Plant Optimization (Increase Capacity)

Given the modest magnitude of anticipated water treatment plant capacity needs, the first course of action that can be pursued is the increase in capacity of the existing water plant. This serves to benefit the City as a known functional facility may possibly be optimized to meet oval water system needs rather than constructing additional facilities. It is recommended that the option to first expand existing plant capacity be explored. If this is not feasible, the next course of action would be to expand the facility footprint. Both of these treatment alternatives would access the redundancy and know characteristics of existing well facilities.

Phase 1: Water Treatment Plant Enhancement Pilot Study
Phase 2: Water Treatment Plant Optimization Enhancements

7.1.3 New 1,000,000 Low Zone Water Tower

This facility would be connected to the low zone and replace the existing 500,000 gallon water tower and would support future water storage needs across the water system. It is recommended that this facility be constructed as a single pedestal or composite style water tower due to the reduced future maintenance costs.

7.1.4 High Zone Redundant Water Line & Service Flow Booster

This facility is recommended to support redundant supply pumping to the high pressure zone from the Low Zone. The installation of an additional pipe connecting the Low and High Zones will add redundancy to the system. Currently of the existing pipe breaks, the high zone will be without water supply until the water pipe is fixed. In order to provide supply redundancy, a second water main connection to this zone is recommended. This facility would be sized to meet maximum day demands in the high zone and would include a service flow pump station.

7.1.5 Low to Middle Booster Station

This facility is recommended to support redundant supply pumping to the middle pressure zone. Currently there is only a single pipe between the water treatment plant and the distribution grid in the middle zone. IF this pipe ere to fail, this zone would be without water supply. It is recommended that small scale service flow booster station be installed pulling from the low zone and pushing into the high zone providing for system redundancy. This facility becomes even more beneficial if additional storage is added to the low pressure zone.

7.1.6 TH 112 Low/Middle Zone PRV Station

The development of a connection between the low and middle pressure zones will allow for additional water circulation, more robust fire flow and supply redundancy. This improvement along with select water main upgrades has been scheduled to be included when utility work related to the TH 112 turn back project is completed.

7.1.7 Water Main Improvements

One potential set of possible system wide water main improvements are shown in figure 7-1 which is a long range water system planning map. As water mains are replaced and as part of various street rehabilitation projects or an annual renewal program, decisions can be made to size mains to be in line with the recommended sizing shown on this map. The recommended pipe replacements shown on this planning map are primarily associated with hydraulic capacity and general system operation. There will be existing main included on the map that does not indicate the need for upsizing. Those existing mains may still require replacement due to condition or break history, but can be replaced with a similar size main, be rehabilitated through lining or could very well be in sufficient condition to have a life that is extended beyond the current planning period. A condition assessment of the exiting water main is recommended to determine the rate for which water main should be replaced to stay ahead of the expected pipe life expectancy.

The improvements shown in Figure 7-1 will build a strong network of transmission mains throughout the system to help support future growth. Installing a strong transmission main network between the pressure zones and throughout the distribution system will help ensure that water demands for consumption and fire protection can easily reach areas of future development. The transmission main should be constructed of at least 10-inch diameter main, as smaller diameter mains do not have the large flow capacity required to meet large water requirements (i.e. industrial fire flows).

7.1.8 Other Water Infrastructure Improvements

Water system SCADA and communications network fiber optic conversion: Currently there are many unknowns as to the security and future reliability of the communication network needed to operate the overall water system controls and monitoring system. For purposes of long range planning funds have been identified to be put to use for the installation of a City dedicated fiber optic network for water system facilities.

7.2 Capital Improvements Plan

The proposed Capital Improvements Plan is presented in Table 7-1. The plan presents budget cost estimates and a proposed schedule for the recommended system-wide improvements that should be implemented over the planning period. The table below provides a high level summary of short and long range water system facility capital costs. These costs are based on recent projected history an anticipated system growth.

The proposed Capital Improvements Plan has been formulated based on all the information presented in this study. All the improvements have been developed and prioritized based on deficiencies identified in the existing water system. The actual construction cost for the recommended improvements may vary from the costs outlined in this report, depending on the year facilities are constructed, the rate of increase in future construction costs, and unforeseen conditions which could be encountered during design of the improvements. In establishing priorities for these improvements, it will be necessary to take into consideration the availability of financial resources and local Village needs to assure that the recommended improvements are implemented in an orderly, coordinated, and economical fashion.

Table 7-1 – Capital Improvement Plan (Selected Project Alternatives)

Type	Improvement	Estimated Cost
Transfer	Middle/Low Zone PRV (In Progress)	$125,000
Storage	Low Zone 1.0 MG Water Tower	$3,652,000
Treatment	Treatment Plant Optimization Pilot Study	$40,000
Supply	New Well No.8 + Building + Raw Water Main	$1,210,000
Operations	SCADA, Controls Fiber Conversion Phase 1	$500,000
Transfer	High Zone Booster Station Generator	$200,000
Treatment	*Treatment Plant Optimization Upgrades (Increase Capacity)	$1,500,000
Transfer	High Zone Redundant Water Line & Service Flow Booster	$1,717,000
Operations	SCADA, Controls Fiber Conversion Phase 2	$500,000
Transfer	Low to Middle Booster Station	$600,000
Distribution	Truck Fill w/Hydropneumatic Tank	$350,000
Operations	SCADA, Controls Fiber Conversion Phase 3	$500,000
Quality	Flushing Station / UDF	$30,000
Operations	SCADA, Controls Fiber Conversion Phase 4	$500,000
	Total	**$11,424,000**

Table 7-2 – Water Main Improvement Summary

Long Range Distribution Planning					
	Segment	**Quantity**	**Unit**	**Price**	**Budgetary Cost**
Upsize Existing	6-inch	13,700	LF	$60	$822,000
	8-inch	400	LF	$75	$30,000
	10-inch	1,000	LF	$90	$90,000
	12-inch	500	LF	$110	$55,000
Total Upsize Budget					**$997,000**
Future Expansion	8-inch	2,700	LF	$75	$203,000
	10-inch	3,200	LF	$90	$288,000
	12-inch	12,000	LF	$110	$1,320,000
Total Trunk Main Budget					**$1,811,000**
	TH 112 Turnback Project	9,900	LF	In Progress	

7.3 Next Steps

The timing of future water improvements will be influenced by a number of parameters. Items such as development pressure in specific areas, aging facilities and/or facilities which are undersized, availability of funds, etc. all play a role in the timing of future improvements.

Because of the factors involved, it is difficult to accurately predict the timing of future improvements, especially those which may occur far into the future. There are however some incremental next steps the City can take in order to position itself to develop the proposed improvement alternatives. Efforts can be made to identify sites for the improvement alternatives and additional planning efforts can be pursued. Below is a brief list of potential action items that can be taken to put this water master plan into action.

1. **Water Tower Planning:** Evaluate the potential for siting an elevated storage facility near the existing low tower so that land can be set aside. Water Tower Site Identification, Funding Request
2. **Water Treatment Plant Capacity Optimization Pilot Study:** Evaluate existing treatment process for the potential to increase flow capacity through the existing plant
3. **Well No.8 Investigation**: Evaluate the potential for siting a new well to identify land requirements (location and size) so that land acquisitions can be made or existing City property utilized.

Appendix A

Report Figures

Appendix B

Field Testing

Appendix C

Water Storage Calculations

Appendix D

Alternatives Cost Estimates

Appendix E

Supplemental Water Model Analysis – TH 112

Appendix F

DNR Water Supply Plan

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