Comprehensive Water System Plan

2018 Comprehensive Water Plan Update

Lakeville, Minnesota

LAKEV 141978 | June 15, 2018

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RE: 2018 Comprehensive Water Plan Update
Comprehensive Water System Plan
Lakeville, Minnesota
SEH No. LAKEV 141978 4.00

Mr. Zachary Johnson
City Engineer
City of Lakeville
20195 Holyoke Avenue
Lakeville, MN 55044

Dear Mr. Johnson:

Enclosed please find the 2018 Comprehensive Water Plan Update for the City of Lakeville, Minnesota. The primary emphasis of this study was to update previous planning efforts and plan for future water system facilities required to serve areas of anticipated growth in the City. These facilities included wells, water storage, and trunk water main. The existing computer model of the water distribution system was updated and used for the analysis. The system was evaluated with respect to pressure, flow, pipe friction, and fire flow availability. Extended period simulations were also used to analyze system operations.

We will be available to review this report with you at your request. If you have any questions, please don't hesitate to call or email me.

Sincerely,

Chad T. Katzenberger, PE
Project Manager

mrb
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Comprehensive Water System Plan

2018 Comprehensive Water Plan Update
Lakeville, Minnesota

SEH No. LAKEV 141978

June 15, 2018

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Chad T. Katzenberger

Chad T. Katzenberger, PE

Date: 06/15/18   License No.: 46613

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Executive Summary

This report serves as support for the current capital improvement planning process being completed by the City of Lakeville. The focus of the report is to analyze existing water utility facilities, and to anticipate future system needs based on anticipated growth within the City. This report is an update on the last Comprehensive Water Plan completed in 2013. The analysis at that time incorporated growth projections that have since seen significant revision. In addition, the plan for water system facilities to serve future growth has been refined from a perspective of maximizing the use of existing infrastructure, optimizing service to future water system customers, and minimizing future capital costs where possible.

The Lakeville water system consists of infrastructure components that perform supply, treatment, storage and distribution functions. This study evaluates system needs in each category (with the exception of water treatment) to meet existing and projected water use.

Existing facilities include:

- 19 water supply wells pumping from bedrock aquifers with a total supply capacity of 26.3 million gallons per day (MGD)
- One central water treatment facility including gravity filtration for iron and manganese removal
- One below grade concrete water storage reservoir (clearwell) with a capacity of 4.1 million gallons (MG) located at the water treatment facility, including a high service pumping facility that pumps from the clearwell to the distribution system
- Six elevated water storage tanks located on the distribution system with a total useable capacity of 6.75 MG
- Approximately 300 miles of cast iron, ductile iron and PVC water distribution mains ranging in size from 6 inches to 36 inches in diameter
- Three distinct pressure zones including a Normal Zone that is supplied from the water treatment plant, and two reduced pressure zones that serve lower elevations through pressure reducing valves (PRVs) located on the distribution system

Many water system facilities are designed by industry standard to meet maximum daily demands reliably. Maximum daily water use on the Lakeville water system has ranged from 15.0 MGD to 20.4 MGD over the past ten years. The amount of water use varies with population and land use patterns, as well as with environmental factors such as precipitation and temperature. Often peak water use is driven by summer irrigation demand.

The population for Lakeville in 2017 is estimated at 61,938. The population is projected to increase to a 2040 Met Council projection of 83,500. This results in a projected maximum daily water use of potentially 27.3 MGD. New development is expected to drive much of the increase in population and water use in Lakeville. This report includes recommendations for infrastructure improvements to reliably serve projected new development and corresponding increases in water demand.

Recommended improvements in this report include:

- Three new water supply wells
- Trunk distribution mains to serve new development
- Pressure Zone Modifications

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Comprehensive Water System Plan

2018 Comprehensive Water Plan Update

Prepared for City of Lakeville, Minnesota

1 Introduction

The Lakeville water distribution system serves the majority of the businesses and residents within the city limits of Lakeville. There are some properties served by individual or private community wells. This is especially true for areas identified for future expansion. Other areas of the City are supplied with water by the City of Burnsville. The current available service area of the water distribution system is represented in Figure 1-1.

The Lakeville water distribution system currently consists of 19 wells, one water treatment plant, one below-ground storage reservoir, one at-grade storage standpipe, five elevated storage tanks, and approximately 300 miles of water distribution piping. The system is based on three pressure zones as listed in Table 2-4.

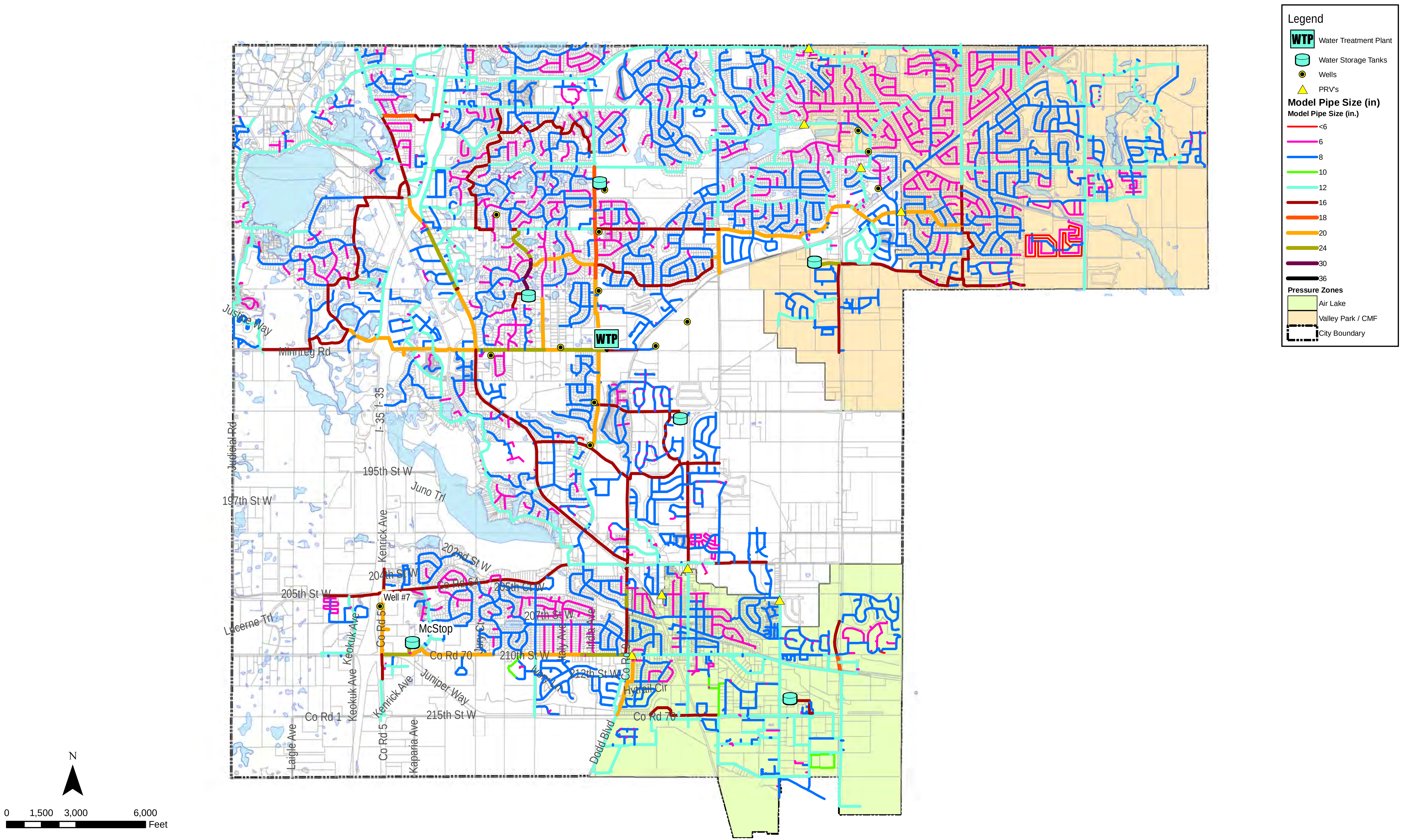
The City of Lakeville's location with respect to nearby major urban centers, principal transportation corridors, and available lands offers potential for future growth and development. Therefore, proper planning is essential to coordinate the expansion of municipal water system facilities with short term as well as long term needs of the community.

1.1 Scope

This report summarizes the results of a water system evaluation completed for the City of Lakeville and provides an update to previous planning efforts. The primary purposes of the study were to evaluate the water needs and system expansion required to serve current and future utility customers.

Present and future water needs of the Lakeville water system have been evaluated, and recommendations made concerning improvements necessary to maintain an adequate level of water service. Current and future water needs were evaluated over a planning period extending to the year 2040. This report will serve as a plan to guide future expansion and redevelopment of the water system.

The study began with an analysis of community development and growth including population, and existing and expected future land uses in Section 3. Section 4 covers water consumption projections, which serve as the foundation for evaluating and identifying recommended improvements to the system. The assumptions and conclusions presented in Section 3 were used to develop projections of water requirements that are presented in Section 4. Section 5 summarizes the evaluation of the water system. Part 6 provides recommended improvements and a capital improvements plan.



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 2-1 Existing Water System.mxd

Project Number: LAKEV 141987
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Map by:
Projection:
Source:

SEH

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 2-1
Existing Water System Model Map

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.

2 Existing Water System

2.1 Supply

Water is supplied to the City of Lakeville's water system from 19 wells that draw from the Prairie du Chien-St.Lawrence and Tunnel City-Wonewoc (Formerly FIG) aquifers. The total operating capacity of the City's wells is 19,150 gpm (27.6 MGD), with a firm supply operating capacity of 16,550 gpm (23.8 MGD). Firm capacity is defined as the system capacity minus the capacity of the largest pump. This is the capacity that can be provided consistently, even during maintenance when one well pump might be out of service.

Supply and storage system components are listed in Tables 2 and 3. The well capacities listed in Table 2 indicate an operating supply capacity that is less than the design capacity of each well. This is due to the interaction of the wells when pumped simultaneously. During peak summer operating conditions, the well production rates are reduced by interference-related drawdown demand of Lakeville. However, care must be taken to ensure the sustainability of the aquifer.

Table 2-1 – Existing Well Supply

Facility Name	Aquifer	Treated	Design Supply Capacity (gpm)	Operating Supply Capacity (gpm)	Operating Supply Capacity (MGD)
Well 2	Jordan	Yes	900	850	1.2
Well 3***	Jordan	No	1,300	1,000	1.4
Well 4	Jordan	Yes	1,250	1,000	1.4
Well 6	Jordan-St. Lawrence	Yes	1,200	1,000	1.4
Well 8	Jordan	Yes	1,580	1,200	1.7
Well 9	Prairie du Chien-Jordan	Yes	1,450	1,200	1.7
Well 10	Prairie du Chien-Jordan	Yes	1,400	1,200	1.7
Well 11	Prairie du Chien-Jordan	Yes	1,300	1,000	1.4
Well 12	Prairie du Chien-Jordan	Yes	1,400	900	1.3
Well 13	Prairie du Chien-Jordan	Yes	1,400	1,000	1.4
Well 14	Prairie du Chien-Jordan	Yes	1,550	1,200	1.7
Well 15	Jordan	Yes	1,500	1,200	1.7
Well 16	Jordan	Yes	1,500	1,200	1.7
Well 17	Prairie du Chien-St Lawrence	Yes	1,400	1,200	1.7
Well 18**	Tunnel City-Wonewoc	Yes	600	500	0.7
Well 19	Prairie du Chien-Jordan	Yes	1,300	1,100	1.6
Well 20	Jordan	Yes	1,200	1,200	1.7
Well 21	Jordan	Yes	1,400	1,400	2.0
Well 22	Tunnel City-Wonewoc	Yes	800	800	1.2
Total			**23,130**	**19,150**	**27.6**
Firm Capacity (Two Largest Out of Service)				**16,550**	**23.8**

** Well 18, completed in the Tunnel City-Wonewoc, will be utilized to the largest extent possible to reduce pumping from Prairie du Chien - Jordan Aquifer.

*** Wells 3 designated for emergency use only (Excluded from normal supply)

2.2 Treatment

The water treatment plant for the City of Lakeville provides iron and manganese removal through a gravity filtration system. The design capacity of the filters is 20 MGD, with room for expansion to 30 MGD with four additional filter cells. A filter loading study was previously conducted, indicating that the loading rate on the existing filters could safely be increased to 26.5 MGD.

Filtered water is stored in a below-grade clearwell prior to pumping into the distribution system at the high service pumping station. The high service pumping station contains four pumps currently, including two pumps with 4 MGD (2825 gpm) design capacity, one pump with 8 MGD (5700 gpm) design capacity, and one pump with 14 MGD (8300 gpm) design capacity. The existing firm pumping capacity of the facility is 16 MGD (11,350 gpm), with the largest pump out of service.

2.3 Storage

Water storage tanks play an important role in the operation of a water system by sustaining system pressure and supplying water when needed. Six elevated tanks and one ground level resevoir provide distribution storage for the Lakeville water system. These facilities are noted in Table 2-2. All facilities, with the exception of the water treatment plant clearwell provide “floating” storage for the system meaning, they supply flow from the tank via gravity.

Table 2-2 – Existing Water Storage Facilities

Facility Name	Overflow Elevation	Type	Storage Capacity (MG)	Usable * Storage (MG)
Clearwell	1069	Ground	4.10	4.10
Airlake	1109	Hydropillar	0.50	0.50
Fairfield	1230	Hydropillar	0.75	0.75
Michaud Park	1230	Spheroid	1.00	1.00
Dakota Heights	1230	Standpipe	2.00	1.00
Valley Park/CMF	1121	Composite	1.50	1.50
Hoylyoke	1230	Composite	2.00	2.00
Total			**11.85**	**10.85**
Total Elevated				**6.75**

* Usable storage at Dakota Heights is shown as 1.0 since pressures in the area are below 35 psi static when it is full. Homes in this area typically are on booster pumps/tank systems which the City participates 50/50 on cost.

2.4 Pressure Zones

Due to the nature of the land elevations served within the service area of the Lakeville water system, multiple pressure zones have been developed to assure adequate pressure is provided to each customer. Water system pressure will vary around the service area based on land elevations, as well as, to a lesser extent, supply rates and customer demands. In general, as customer demands increase, pressures will decrease, however, the effect of demands on overall system pressures is usually minor. Areas higher in topographic elevation will also tend to exhibit lower water system pressures.

A water distribution system must be 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. Pressures that are too high can cause problems with system operation and maintenance, 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. Typical 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 State Plumbing code calls for PRV's (Pressure Reducing Valves) be installed at service lines where pressures monitored in the street (Main) exceed 80 psi. 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.

With this in mind, the Lakeville water system has been designed with three Hydraulic Grade Levels (HGL) and three pressure zones in order to sustain adequate system pressure. A summary of each pressure zone is identified in Table 2-3.

Table 2-3 – Existing Pressure Zones

Pressure Zone	HGL (ft)	Elevations Served	Static Pressure Range (psi)	Pressure Zone
Normal Zone	1,230	949 to 1170	26 to 122	Normal Zone
Valley Park	1,121	919 to 1020	44 to 88	Valley Park
Air Lake	1,109	939 to 987	52 to 74	Air Lake

2.5 Distribution System

The water distribution system provides a means of transporting and distributing water from the supply sources to Utility 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. Furthermore, the distribution system must be able to provide not only uniform distribution of water during normal and peak demand conditions, but must also be capable of delivering adequate water supplies for fire protection purposes.

The Lakeville water system is comprised of approximately 328 miles of water mains ranging in size up to 36 inches in diameter as illustrated in Figure 2-1. The current water main size inventory is summarized in Table 2-4 below. Of the 328 miles of water main, thirty-two percent 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 Lakeville water system supports the ability of the water system to transmit large system flows.

Table 2-4 – Water Main

Pipe Size (inches)	Percent of total (%)	Length (feet)	Length (Miles)
4	0.8%	13,318	2.5
6	20.9%	361,836	68.5
8	45.8%	794,053	150.4
10	0.4%	7,521	1.4
12	20.6%	356,521	67.5
16	7.0%	121,753	23.1
18	0.4%	7,112	1.3
20	3.0%	52,361	9.9
24	0.9%	15,747	3.0
30	0.1%	1,633	0.3
36	0.0%	404	0.1
Total	100%	1,732,259	328

3 Population & Community Growth

This chapter summarizes the planning assumptions made regarding future service area characteristics for the Lakeville water service area. To maintain consistency between individual planning efforts, the results of previous planning efforts were reviewed. The input received from local officials and City staff members was also considered and incorporated.

3.1 Population Forecast

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.

Table 3-1 – Historical Population

Year	Population	Households	Annual Growth Rate (%)
1970	7,196	1,883	
1980	14,790	4,337	7.5%
1990	24,854	7,851	5.3%
2000	43,128	13,609	5.7%
2010	55,954	18,683	2.6%
2015	59,991	20,308	1.4%
2016	60,965	20,581	1.0%

Source: State Demographer

The City of Lakeville has experienced an exponential increase in population in the last 45 years, with the population nearly doubling since the mid 90's. The City's estimated population in 2016 was 60,965 according to the state demographer. Table 3-1 above summarizes past trends and Table 3-2 summarizes population projections from the Metropolitan Council for the City of Lakeville. These forecasts were adopted by the Metropolitan Council as part of the Thrive 2040 Regional Development Framework.

Table 3-2 – Projected Population

Year	Thrive 2040 Population	Households	Employment	Annual Growth Rate (%)	2% Annual Growth Population
2010	55,954	18,863	13,862		
2020	64,300	22,300	18,200	2.8%	65,990
2025	69,450	24,300	19,250	1.6%	72,859
2030	74,600	26,300	20,300	1.4%	80,442
2035	79,050	28,150	21,400	1.2%	88,814
2040	83,500	30,000	22,500	1.1%	98,058

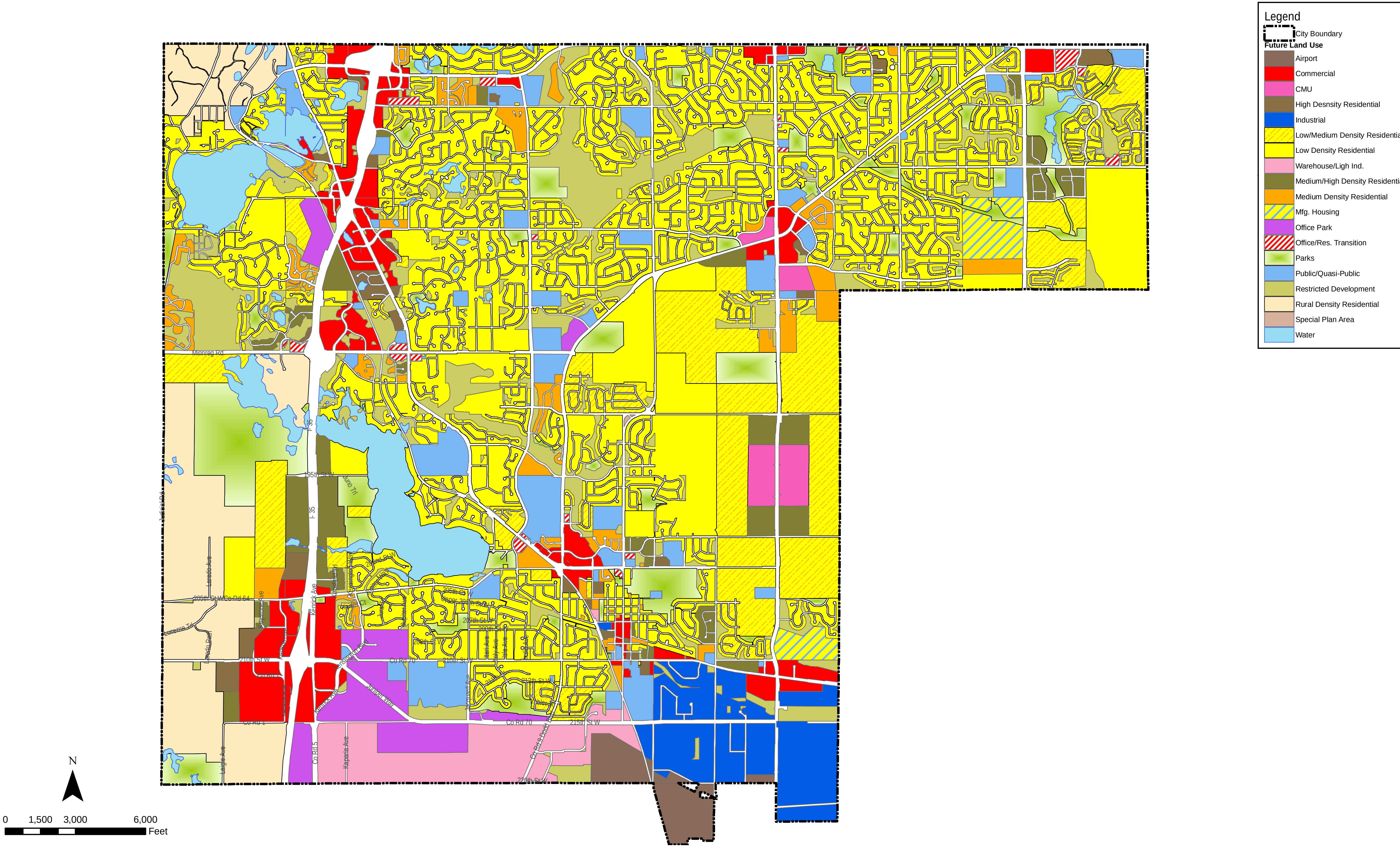
Based on the developable land in Lakeville currently, it is thought that the 2040 projected population of 83,500 is just short of ultimate build-out and saturated development. The City's Economic Development department estimates that 2% growth rate may be reflective of near-term growth. For the purposes of this study, we have examined a range of potential growth bounded by the Metropolitan Council projections on the low end, and a 2% growth rate on the high end.

3.2 Existing Land Use

For this study, existing City land use data was reviewed. Figure 3-1 illustrates current land uses and represents the nature and extent of existing development within the City, future growth and land use.

Due to the uncertainty with growth projections and water use projections, it is useful to estimate future water system demands from multiple perspectives to find a range of potential outcomes. In addition to the population-based method used in the later sections, projected land uses were also examined for this plan, and water demands projected based on an assumed unit demand per area for varying land uses.

Since the City is currently in the process of developing a land use plan, the values in Table 4-6 for acreage for each category of development are estimated. The unit demands for each type of development are typical values, and were chosen here to match the City's current water and sewer planning documents.



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 3-1 Land Use.mxd

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Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 3-1
Land Use Map

3.3 Future Service Areas

The Comprehensive Water Plan of 2008 considered MUSA planned expansion areas and timelines that represented the development projections at that time. The recent economic recession and housing market retreat have forced a reconsideration of growth projections for Lakeville. The City is currently in the beginning stages of developing a comprehensive land use plan. Preliminary information from that plan, along with population projections previously developed by the Metropolitan Council for Lakeville, were considered for the projection of future water demands that will drive water utility infrastructure investment.

It is understood that land development is currently increasing in the east-central portion of the city (bounded by Dodd Boulevard on the west and north, Lakeville Boulevard on the south, and the municipal boundary on the east). Preliminary land use planning includes commercial and medium to high density residential development along the Cedar Avenue corridor between Lakeville Boulevard and Dodd Boulevard. Outside of that corridor, it is expected that development will be mostly low to medium density residential.

Though there are other areas for future development to the west, south, and northeast of the current water utility service area, the vast majority of growth and water system expansion is expected to occur in the east-central area as defined above.

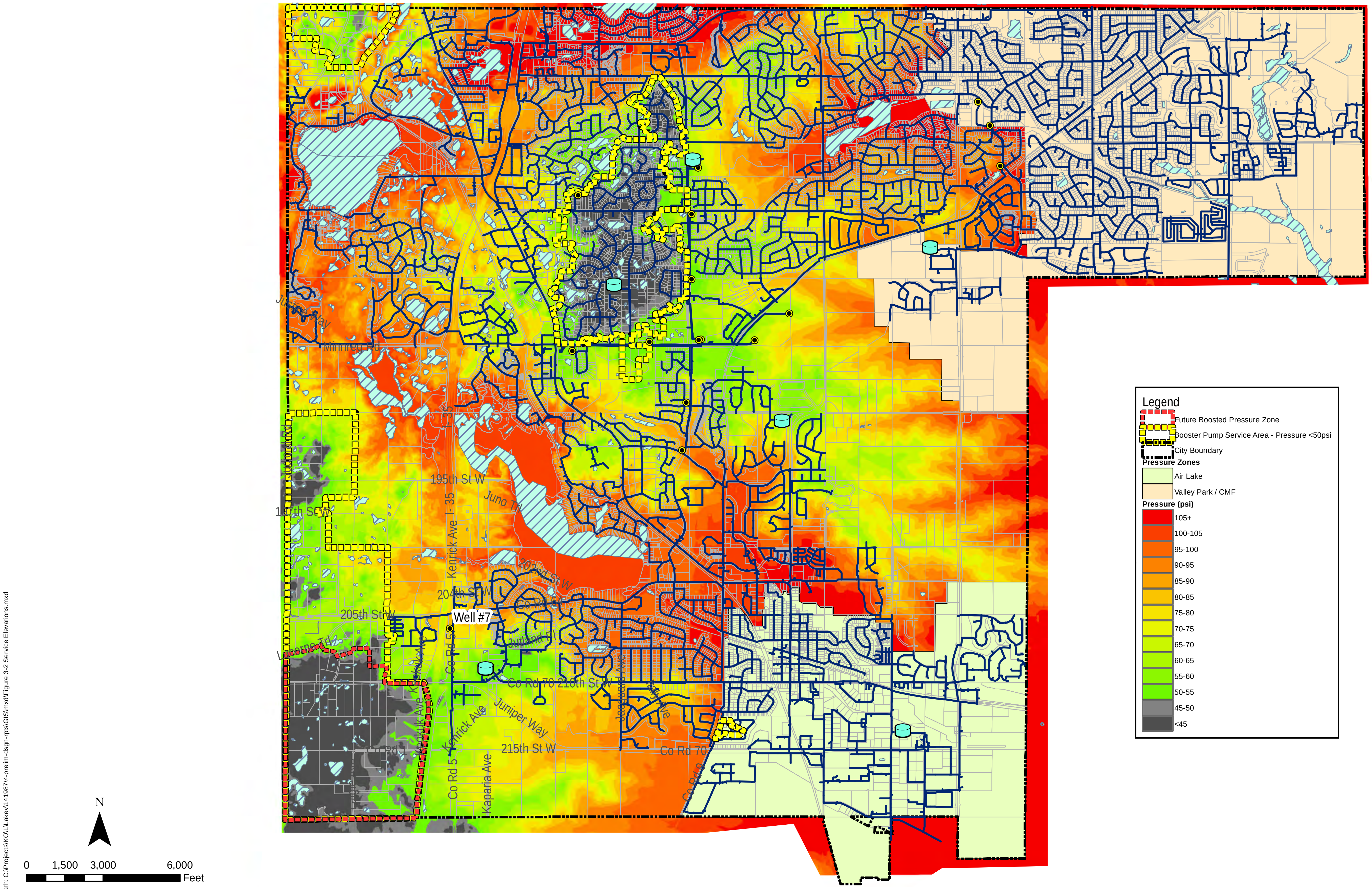
3.4 Elevations Served

The expansion service areas shown in Figure 3-2 include land with elevations ranging from 930 to 1180. These expansion areas include parts of the City, within city limits which have yet to be served by municipal water service. This elevation range will likely require service from both the normal and reduced pressure zones. A portion of the expansion area west of I-35 is unable to be served by the existing normal pressure zone. Higher elevations in this location will result in pressures below recommended levels. If this area is served in the future, a small boosted pressure zone including pumping station would be recommended. A minimum area to be served by this zone is indicated in Figure 3-2 as “Future Boosted Pressure Zone”. However, Service to this area is not planned for the foreseeable future.

There are also existing locations within the service area that may have less than ideal service pressure during high demand scenarios. It is not feasible to isolate these areas into a separate boosted pressure zone. Therefore, it has been the practice of the City to have users install booster pumps where service pressures are below ideal (typically 50 psi). Areas where this condition is likely to occur are indicated figure 3-2 and noted as “Booster Pump Service Area”. These areas were identified based on land elevations which would result in the pressures indicated.

4 Water Requirements

Projections of customer demands serve as the basis for capital improvements planning. Several standard methods were used in this study to project water supply and storage needs based on estimates of population and community growth. This chapter summarizes the methodology used and the results of these projections.



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 3-2 Service Elevations.mxd

Project Number: LAKEV 141987
Print Date: Print Date: 6/14/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 3-2
Future Service Elevations

4.1 Water Consumption History

An analysis was made of past water consumption characteristics by reviewing annual pumpage and water sales records for the period from 2007 to 2017. Average and maximum day water consumption during this period, together with the per capita pumpage, has been analyzed. Projections of future water requirements are based on the results of this analysis, coupled with estimates of population and community growth discussed in Section 2.

Table 4-1 – Historical Water Use

Year	Population Estimate	Average Day Demand (MGD)	Average Per Capita Demand (gpcd)	Maximum Day Demand (MGD)	Peaking Factor (MD/AD)	Maximum Day Per Capita Demand (gpcd)
2007	53,829	7.2	134	20.4	2.8	379
2008	54,328	6.7	123	20.2	3.0	372
2009	55,772	6.6	118	17.1	2.6	307
2010	55,954	5.8	104	13.2	2.3	236
2011	56,534	6.3	111	15.0	2.4	265
2012	57,048	6.9	121	18.9	2.7	331
2013	57,805	6.3	109	16.0	2.5	277
2014	58,562	6.0	102	16.0	2.7	273
2015	59,991	5.9	99	15.1	2.5	252
2016	60,965	5.9	96	15.6	2.7	256
2017	61,938	6.3	101	16.5	2.6	267
Average		6.4	109	16.7	2.6	292.2
Maximum		7.2	133.8	20.4	3.0	379.0
Design			**109**	**-**	**3.0**	**331**

A summary of recent historical water pumpage is provided in Table 4-1. Over the 11 year period of data summarized in the table, daily water pumpage varied from a low of 5.8 million gallons per day (MGD) in 2010 to a high of 7.2 MGD in 2007 which was a dry and hot year, which may have led to excessive outdoor water use. The highest maximum day demand rate was experienced in 2007 at 20.4 MGD. It is thought that conservation activities, as well as a downturn in the housing market, are contributing factors to the reduction in demand since 2007.

4.2 Per Capita Usage

Water use is often proportional, and is therefore correlated with a community's population. An analysis of per capita water consumption for the Lakeville water system for three customer classifications was made from the available sales records and is summarized in Table 4-2.

Lakeville's residential per capita sales have varied over 4 years documented below, averaging approximately 76 gallons per capita per day (gpcd) over the recent 4-year period. Lakeville's commercial and industrial per capita sales have remained somewhat consistent with a recent decline in 2016. Water conservation will be considered as part of future planning in the following section.

Table 4-2 – Historical Per Capita Water Use

Year	Population Estimate	Res. Sales (MG)	Res. Per Capita (gpcd)	Com. Sales (MG)	Com. Per Capita (gpcd)	Ind. Sales (MG)	Ind. Per Capita (gpcd)
2013	57,805	1877.2	89	211.0	10	73.6	3
2014	58,562	1739.0	81	205.0	10	67.8	3
2015	59,991	1636.0	75	193.1	9	67.9	3
2016	60,965	1329.4	60	150.3	7	51.2	2
Average		1645.4	76.2	189.8	8.8	65.1	3.0
Maximum		1877.2	89.0	211.0	10.0	73.6	3.5

4.3 Variations in Water Use

Water demands are variable throughout the day and the season. The heaviest demand conditions typically occur during a Maximum Day (MD) demand scenario in the summer, when outdoor water use is at its highest level.

4.3.1 Seasonal Variations

Seasonal fluctuations in water usage are important factors in the design and sizing of water supply and storage facilities. The seasonal nature of water consumption in Lakeville can be demonstrated by an analysis of monthly pumpage variations. Lakeville's monthly pumpage variations in 2017 are presented in Figure 4-2. In 2017, the maximum monthly pumpage occurred in July, while the minimum monthly pumpage occurred November through April.

Table 4-2 revealed an interesting trend of the 2017 water use. During the cold-season months the average day pumpage was almost constant, at an average of 3.9 mgd compared to a yearly average daily pumpage of 6.3 mgd. Thus, the warm months raised the annual average day pumpage from 3.9 mgd to 6.3 mgd. Lakeville experiences a substantial warm-season water demand compared to the cold-season.

Table 4-3 – Seasonal Water Pumpage (MG)

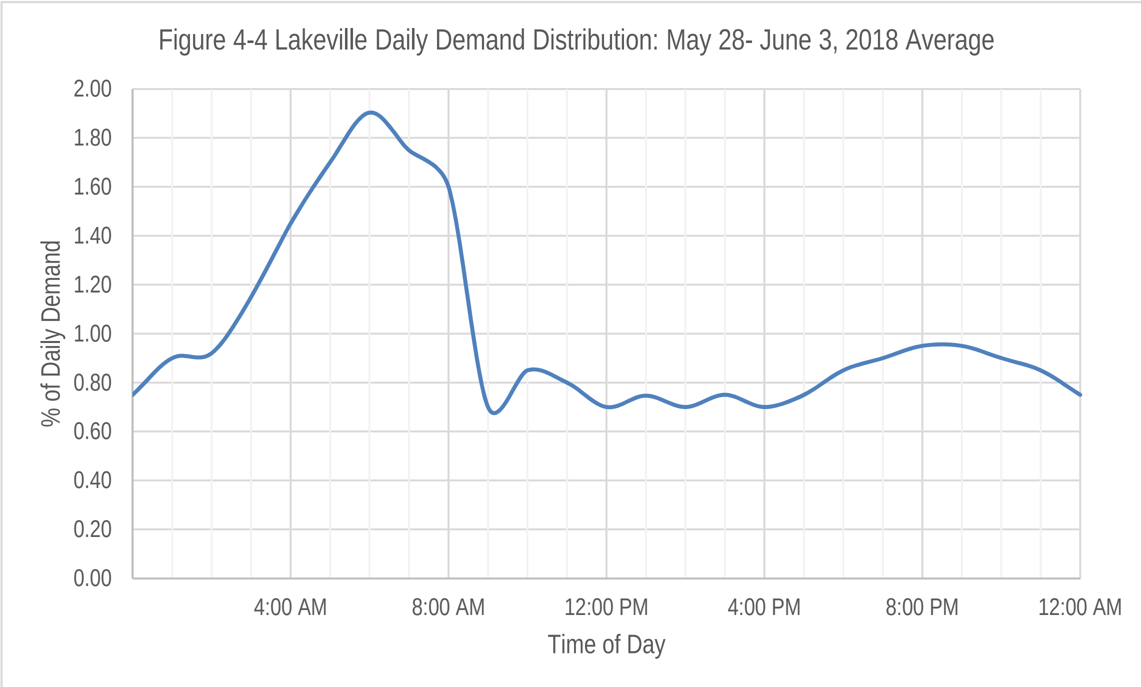
Installation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Well 10	51.7	46.7	51.6	50.0	49.5	46.9	47.5	50.7	48.9	54.0	52.9	54.2
Well 11	0.0	0.0	0.0	0.0	3.3	4.9	10.8	2.3	3.9	0.0	0.0	0.0
Well 12	0.0	0.0	0.0	0.0	0.0	5.3	2.6	0.0	0.0	0.0	0.0	0.0
Well 13	0.0	0.0	0.0	0.0	0.0	1.8	5.7	0.8	1.5	0.0	0.0	0.0
Well 14	14.3	14.3	13.6	10.9	42.3	34.7	34.8	18.1	34.3	11.7	1.8	3.2
Well 15	0.0	0.0	0.0	0.0	0.0	0.0	5.4	2.5	0.0	0.0	0.0	0.0
Well 16	0.0	0.0	0.0	0.0	0.0	10.5	14.8	5.0	7.5	0.0	0.0	0.0
Well 17	0.0	0.0	0.0	0.0	0.0	16.1	20.0	10.2	27.2	2.5	0.0	0.0
Well 18	0.0	0.0	0.0	10.9	19.8	18.9	19.1	18.0	17.6	18.3	17.8	18.5
Well 19	51.6	46.3	51.3	49.4	50.1	33.3	38.2	31.2	42.1	47.8	44.7	47.2
Well 2	0.0	0.0	0.0	0.0	4.3	21.5	24.2	7.8	27.7	19.8	0.0	0.0
Well 20	0.0	0.0	0.0	0.0	0.0	19.3	20.1	5.0	15.6	0.6	0.0	0.0
Well 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Well 4	0.0	0.0	0.0	0.0	0.0	17.1	9.4	0.0	0.0	0.0	0.0	0.0
Well 6	0.0	0.0	0.0	0.0	0.0	33.8	44.0	32.8	0.0	0.0	0.0	0.0
Well 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Well 8	0.0	0.0	0.0	0.0	17.0	28.6	28.8	14.3	10.5	0.0	0.0	0.0
Well 9	0.0	0.0	0.0	0.0	0.0	37.8	53.5	55.1	47.3	0.0	0.0	0.0
AD Pumpage (MGD)	**3.8**	**3.8**	**3.8**	**4.0**	**6.0**	**11.0**	**12.2**	**8.2**	**9.5**	**5.0**	**3.9**	**4.0**

4.4 Hourly Demand Fluctuations

Over the course of a given day, water uses often follow a diurnal demand distribution. Figure 4-1 represents a typical demand distribution graph for residential water use. Commercial and industrial uses are usually more constrained and predictable. The residential demand graph depicts low water demand during the late evening and early morning periods. As the morning progresses, there is an increase in demand as automatic sprinkler systems are operated in conjunction with increased home water use. During late morning to early afternoon there is a slight recovery prior to a second peak use in the early evening.

Most water systems are designed to meet the maximum daily demand rate with supply facilities such as wells, treatment processes, and high service pumping facilities. Storage reservoirs are used to supplement the supply of treated water during the peak usage hours within each day. During lower usage periods, the system is able to produce water in excess of the demand. This excess is used to fill the storage reservoirs. When the demand rate exceeds the production rate, the stored water in the reservoirs is used to make up for the deficit.

Based on accounts of utility operations staff in Lakeville, the demand distribution in Lakeville may have a higher peak in the morning than in the evening, due to the predominance of automatic sprinkler systems in the city. The storage tanks in Lakeville are also observed to lose a greater quantity of water during the morning peak use period.



4.5 Water Conservation

Water conservation occurs in two different forms, active conservation and passive conservation. Active conservation efforts include mechanisms such as educational programs, customer incentives and conservation ordinances while passive conservation results are a product of the installation of water efficient fixtures (toilets, showerheads and washers) implemented by manufacturing standards and plumbing codes which may or may not be a result of intended conservation efforts.

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. 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. In summary, when estimating projected water use, both active and passive water conservation should be accounted for.

As previously noted, nationwide per capita indoor water use has been trending downward. The Water Research Foundation previously published an executive report profiling the Residential End Use of Water in 1999 and followed up with a second version of the report in 2016. In Table 3-6, the report profiled water use trends across the country and found that per capita average water use has decreased from 69.3 gpcd in 1999 (REU 1999) to 58.6 gpcd in 2016 (REU 2016). The improved efficiency of clothes washers and toilets account for most of the water savings.

Table 4-4 – Indoor Conservation Potential - Per Capita Water Use

Water Use	REU 1999[1]	REU 2016[2]	2007 MWCP[3]	High Efficiency[4]
Showers	11.6	11.1	8.8	8.4
Clothes Washers	15	9.6	10	8.7
Dishwashers	1	0.7	0.7	0.6
Toilets	18.5	14.2	8.2	6.1
Baths	1.2	1.5	1.2	1.2
Leaks	9.5	7.9	4	3.2
Faucets	10.9	11.1	10.8	6.9
Other Domestic Uses	1.6	2.5	1.6	1.6
TOTAL	**69.3**	**58.6**	**45.3**	**36.7**

1. 1999 report, Residential end use of water (REU 1999)
2. 2016 report, Residential end use of water, Version 2 (REU 2016)
3. 2007 Madison Water Conservation Plan (Vickers, Amy. 2002. Handbook of Water Use and Conservation: Homes, Landscapes, Industries, Businesses, Farms)

Even without an intentional conservation program and or effort to switch to more efficient fixtures, reductions in total water use will be expected as old toilets and washers wear out. Per capita water use has the potential to be reduced to 36.7 gpcd in the future (REU 2016). For purposes of this report, Table 4-6 will be considered the maximum water use reduction potential used in the most optimal conservation effort. However, future water use projections will be based on previous historical percapita water use experienced in Lakeville.

4.5.2 Maximum Day Water Conservation

Conservation with regards to the Maximum day demand may provide more immediate benefit to Lakeville, and Lakeville is required to provide sufficient supply and storage for the maximum day demand. 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.

4.6 Water Needs Projections

4.6.1 Projected Water Use By Population

Based on the population projection range presented in Table 3-2 above, water demands are projected in Table 4-5. These demand projections are based on an assumed average day per capita demand rate of **109** gallons per capita per day (gpcd), which is an average of the prior 10 years. The maximum day demand is projected using a peaking factor (maximum day demand to average day demand ratio) of **3.0**, which is the highest of the previous tenyears. The projected demand rates represent a high water use year for the projected population, and likely a summer with low rainfall.

Using a relatively high demand projection rate, though within reason, aides in assuring sufficiently sized infrastructure planning. A capital improvement plan based on such projections will allow for the City to reliably meet the future demands of the water system.

Table -5 – Projected Water Use – By Population

Year	Population		Average Day Demand (MGD)		Maximum Day Demand (MGD)	
	Thrive 2040 (Low)	2% Annual Growth (High)	Low	High	Low	High
2020	64,300	65,990	7.0	7.2	21.0	21.6
2025	69,450	72,859	7.6	7.9	22.7	23.8
2030	74,600	80,442	8.1	8.8	24.4	26.3
2035	79,050	88,814	8.6	9.7	25.8	29.0
2040	83,500	98,058	9.1	10.7	27.3	32.1
Based on 109 gpcd total system 10 year historical water use						

4.6.2 Projected Water Use By Future Land Use

Due to the uncertainty with growth projections and water use projections, it is useful to estimate future water system demands from multiple perspectives to find a range of potential outcomes. In addition to the population-based method used in the previous section, projected land uses were also examined for this plan, and water demands projected based on an assumed unit demand per area for varying land uses. The method used is summarized in Table 4-6

Since the City is currently in the process of developing a land use plan, the values in Table 9 for acreage for each category of development are estimated. The unit demands for each type of development are typical values, and were chosen here to match the City’s current water and sewer planning documents. The Ultimate demand documented in this estimate is greater than that shown in the 2040 population projection method since it assumed complete development of the City.

Table 4-6 – Projected Ultimate Water Use - By Land Use

	Area (ac)	Units per Acre	Pers. per Unit	Unit Demand (gpcd)	Unit Demand (gpd/ac)	Average Day Demand (MGD)
Cedar Ave Commercial	80				1,200	0.096
Cedar Ave MD / HD Res.	490	7	2.56	77	1,380	0.676
South Office Park	490				1,200	0.588
South Light Industrial	105				1,200	0.126
West Commercial	70				1,200	0.084
West LD Residential	140	3	3.16	77	730	0.102
West MD / HD Residential	140	7	2.56	77	1,380	0.193
Rural / Open Space	2,000				-	-
Remainder - Low Dens. Res.	3,380	3	3.16	77	730	2.5
Estimated Total - Added Average Day Demand through Ultimate Development						**4.3**
2017 Average Day Demand						**6.3**
Projected Average Day Demand through Ultimate Development						**10.6**
Ultimate Projected Maximum Day Demand through Ultimate Development (Assumes a Maximum Day Peaking Factor of 3.0)						**31.8**

4.7 Water Needs for Fire Protection

In addition to the water supply requirements for residential, public, commercial, and industrial consumption, water system planning for fire protection needs is an important consideration. In most instances, water main sizes are designed specifically to supply needed fire flow requirements.

Benefits of providing adequate fire protection for Lakeville include the reduction of insurance rates for residential homes and commercial business in the community. In the United States, 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. The ISO has developed a method for design and evaluation of a municipal system which will indicate the Needed Fire Flow (NFF). For residential buildings the NFF is determined by the distance between structures as shown below:

Distance between Structures (ft)	***Fire Flow*** *(gpm)*
More than 100	500
31-100	750
11-30	1,000
Less than 11	1,500

Fire protection needs vary with the physical characteristics of each building that is 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, and the 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.

However, in high value districts containing commercial and industrial buildings, fire flow requirements of up to 3,500 gpm or more can be expected. These values can be reduced if existing buildings have sprinklers. Below is a formula that has been established for determining the NFF for commercial and industrial structures and is documented in the *Fire Protection Rating System* and AWWA M31:

$NFF = 18 \times F \times A^{0.5} [O \times (X+P)]$

Where: NFF = *needed fire flow (gpm)*

F = *class of construction coefficient*

A = *effective area (ft^2)*

O = *occupancy factor*

X = *exposure factor*

P = *communication factor*

Based on current insurance classification guidelines, base fire flow requirements are not expected to change over the planning period. The base fire flow used in this plan of 3,500 gpm for 3 hours is based on typical ISO recommendations.

Table 3-11 shows typical fire flow requirements for various land uses. These requirements were used as a basis for evaluating the Lakeville water system. The requirements shown in the table are only intended as a general guideline. The actual needed fire flow for a specific building can vary considerably, as discussed above.

Table 4-7 – Typical Fire Flow Requirements

Land Use	Approximate Needed Fire Protection (gpm)
Single & Two-Family (Below)	
-Over 100 feet Building Separation	500
-31 to 100 feet Building Separation	750
-11 to 30 feet Building Separation	1,000
-10 feet or Less Building Separation	1,500
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 (Industrial Park)	2,000 to 3,500
Heavy Industrial (Mfg, Consumables)	2,500 to 3,500+
Other Commercial, Industrial & Public Buildings	Up to 12,000

Water System Evaluation

Water systems are analyzed, planned, and designed primarily through the application of basic hydraulic principles. A map of the existing water system is shown in Figure 1-1. The existing water system contains multiple tanks, wells, pressure reducing valves (PRV's) and pressure zones. When analyzing the various components of a water system, important factors that must be considered when performing this analysis 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 needs
- Other operational criteria which define the manner in which the system can most efficiently be operated

For this study, an evaluation of the Lakeville water system was performed to determine the adequacy of the system to supply existing and future water needs, and to supply water for fire protection purposes.

The system was evaluated based on the following criteria:

- Reliable Supply Capacity of Entire System
- Reliable Pumping Capacity into each Zone
- Storage Volume in each Zone
- Pressures
- Fire Projection
- Reliability

The water system evaluation was based on compliance with Minnesota state code requirements and standard water industry engineering practice.

5.1 Reliable (Firm) Supply Capacity

The reliable supply capacity of a water system is the total available delivery rate with the largest pumping unit(s) out of service. The reliable supply capacity is less than the total supply capacity because well and other high service pumps must be periodically taken out of service for maintenance. These water supply pumps can be off-line for periods of several days to several weeks, depending on the nature of the maintenance being performed. For a system as large as Lakeville with 18 high capacity wells typically in use, it is somewhat likely for two wells to be offline at the same time, comprising approximately 10 percent of the total supply capacity.

The current reliable water supply capacity is given in Table 2-1. Under present operating conditions, the existing wells have a combined total capacity of about 27.6 mgd when operating 24 hours per day. However, the reliable capacity of the supply wells is approximately 23.8 mgd with the two highest yielding wells out of service. The availability of this reliable supply capacity assumes that there will be no significant declines or changes in the water supply capacity over the next 20 years. The above calculations also exclude the use of Well No.3 in the capacity calculations.

To determine if Lakeville should plan for additional supply, the demands of the system must be compared to supply capacity. The projected average day and maximum day demands are compared to total and reliable supply capacities in Table 5-1, assuming the growth projections discussed in previous sections. The results in Table 5-1 indicated a potential need for more reliable supply in the future; however, future demands are estimated projections (not records) and thus should be re-evaluated frequently (every five years ±).

Table 5-1 – Projected Water Supply Needs

Year	Maximum Day Demand (MGD)		Additional Well Supply Capacity Recommended (gpm)	
	Low	High	Low	High
2020	21.0	21.6	0	0
2025	22.7	23.8	0	600
2030	24.4	26.3	1,000	2,400
2035	25.8	29.0	2,000	4,300
2040	27.3	32.1	3,100	6,400

A previous study was conducted review potential locations for future wells along the Dodd Blvd. corridor. That study is attached in Appendix A. It included a review of hydrogeologic conditions and raw water transmission capacity.

The findings indicated that the aquifer and transmission main should support 2-3 additional wells along that corridor. There are potential well interference issues, and transmission main friction losses that limit development beyond that. With this construction of Well 21 and 22, the Dodd raw waterline is approaching its capacity. For this planning effort the raw water model was revisited, with the new wells placed into operation. With all wells in operation, the average velocity in the main is between 4-5 feet per second. Assuming the reasonable normal limit of 5-6 fps, it is feasible that an additional two wells could be placed into operation along this line from a hydraulics perspective. Additional wells could potentially be added beyond that for redundant supply, assuming all would not be in operation at the same time.

Previous planning included the intent to construct additional future wells in the east central portion of the city, extending a second raw water transmission main to transport water back to the existing water treatment facility. The long range water system capital improvement plan set forth in this plan includes this assumption. As the need for the transmission main, and those additional wells, becomes more imminent, it is recommended that an aquifer pumping test be conducted in the vicinity of proposed new wells to assess the local aquifer properties in more detail. Regular collection of static water level and drawdown information for every well would also be helpful.

5.1.2 Total System Storage

To determine the water storage needs of a community, average daily demands, peak demands, and emergency needs must be considered. Table 5-2 shows the calculations used to determine future water storage volume requirements for Lakeville. 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 in Table 5-2 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 WTP high service pumping (largest pump out of service) is acpaable of supplying maximum day demands. Also, there is an assumption that the firm well capacity is equal to or greater than the firm pumping capacity at the water treatment facility. It should be noted that the calculation is examining elevated storage capacity only, since the storage capacity at the water treatment plant is accounted for by the firm high service pumping rate that draws from the below-grade clearwell.

Because there are multiple pressure zones in Lakeville served by elevated storage, it is important to evaluate the needs of each zone separately. In the case of Lakeville, two of the elevated storage tanks are in reduced pressure zones (Air Lake and Valley Park/CMF). Water from these tanks is not available to serve the needs of the normal pressure zone.

Table 5-2 indicates that with the addition of the new 2.0 MG Holyoke elevated storage tank, the entire water system should not have a shortage of water storage in the near future through the 2040 design year.

Storage need in the reduced pressure zones (Air Lake and Valley Park/CMF) is more a function of flow distribution than capacity, therefore individual calculations similar to those in Table 5-2 are not included for these zones. The reduced zones are served by multiple PRVs with ample capacity to maintain water levels in the Air Lake and Valley Park/CMF tanks provided there is enough storage on the system as a whole. The storage tanks on the high zone are capable of serving the reduced zones as well. The presence of elevated storage in these zones helps to control PRV operation and to provide a local reservoir of water for fire demands. The current storage capacity in the reduced zones is sufficient to serve these functions through ultimate build-out of the water distribution system.

5.2 Water Distribution System Analysis

Now that a macroscopic analysis of supply, pumping and storage capacity was performed for each pressure zone, the water distribution system must be analyzed. Two important factors in proper distribution system performance are the normal pressures and the available flow for fire protection. The following sections discuss how the system was analyzed using a computer water model.

5.2.1 Water System Computer Model

The 2018 hydraulic computer model was generated to closely match the City's current water distribution system using CAD and GIS information. The Lakeville system was modeled using WaterGEMS®, a pipe network program developed by Bentley®. Pipe roughness coefficients were based on industry standards.

5.2.2 Normal Pressures

Water system pressure is primarily a function of elevation with some degree of pressure loss as water flows across the system. Static pressures throughout the distribution system as determined by the water model are shown in Figure 5-1 for average day demand, Figure 5-2 for maximum day demand, and Figure 5-3 for peak hour demand. Low pressures generally occur in areas where the elevations are relatively high compared to the overflow elevation or hydraulic grade line of the pressure zone.

5.2.3 Available Flow for Fire Protection

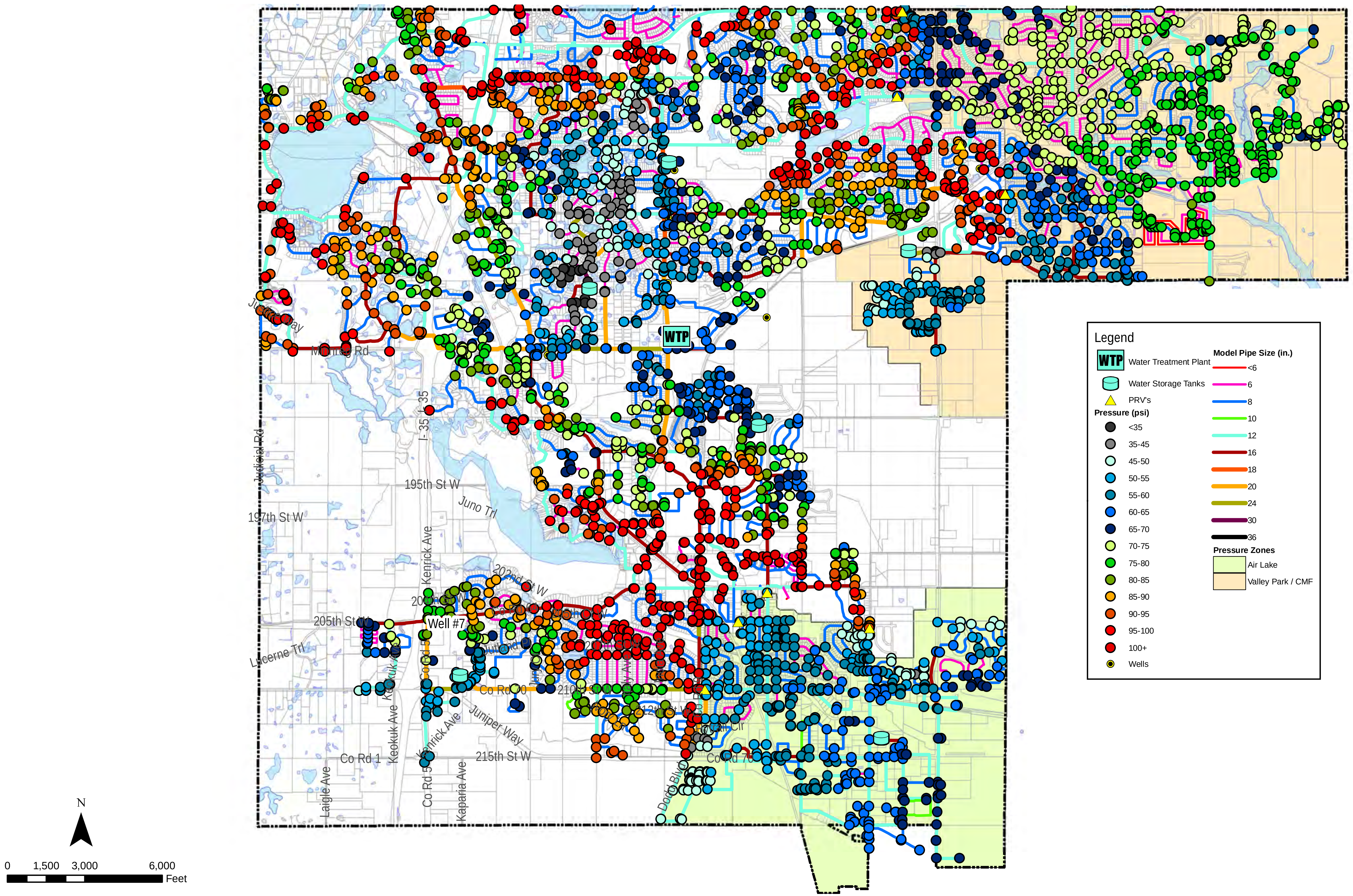
The modeled fire flows were run up to a maximum of 3,500 gpm. The computer model indicates that higher flows are available in some areas, but at some point they become unrealistic because there are not enough hydrants or fire equipment to deliver such high rates.

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 a fire in a typical residential area for single-family residential dwellings with spacing between 31 to 100 feet. The distance between buildings and the corresponding fire flow was previously summarized in table 4-7.

While the minimum available fire flow for residential buildings with greater than 100 feet between them should be at or above 500 gpm, typically more available flow is needed. Needed fire flow can approach 10,000 gpm for some properties. It is not realistic for a water distribution system to provide that amount of water for fire protection in most cases. Therefore, those properties would need other fire protection systems to augment the water from the distribution system.

ISO does expect communities to provide up to 3500 gpm for 3 hours where needed fire flow is in excess of 3500 gpm. The community's fire insurance rating can be impacted for providing less than this where needed. These flow rates are usually necessary for high density or industrial properties.

The computed fire flows for the current distribution system are represented in Figure 5-5. They are represented by fire flow districts in gallons per minute.



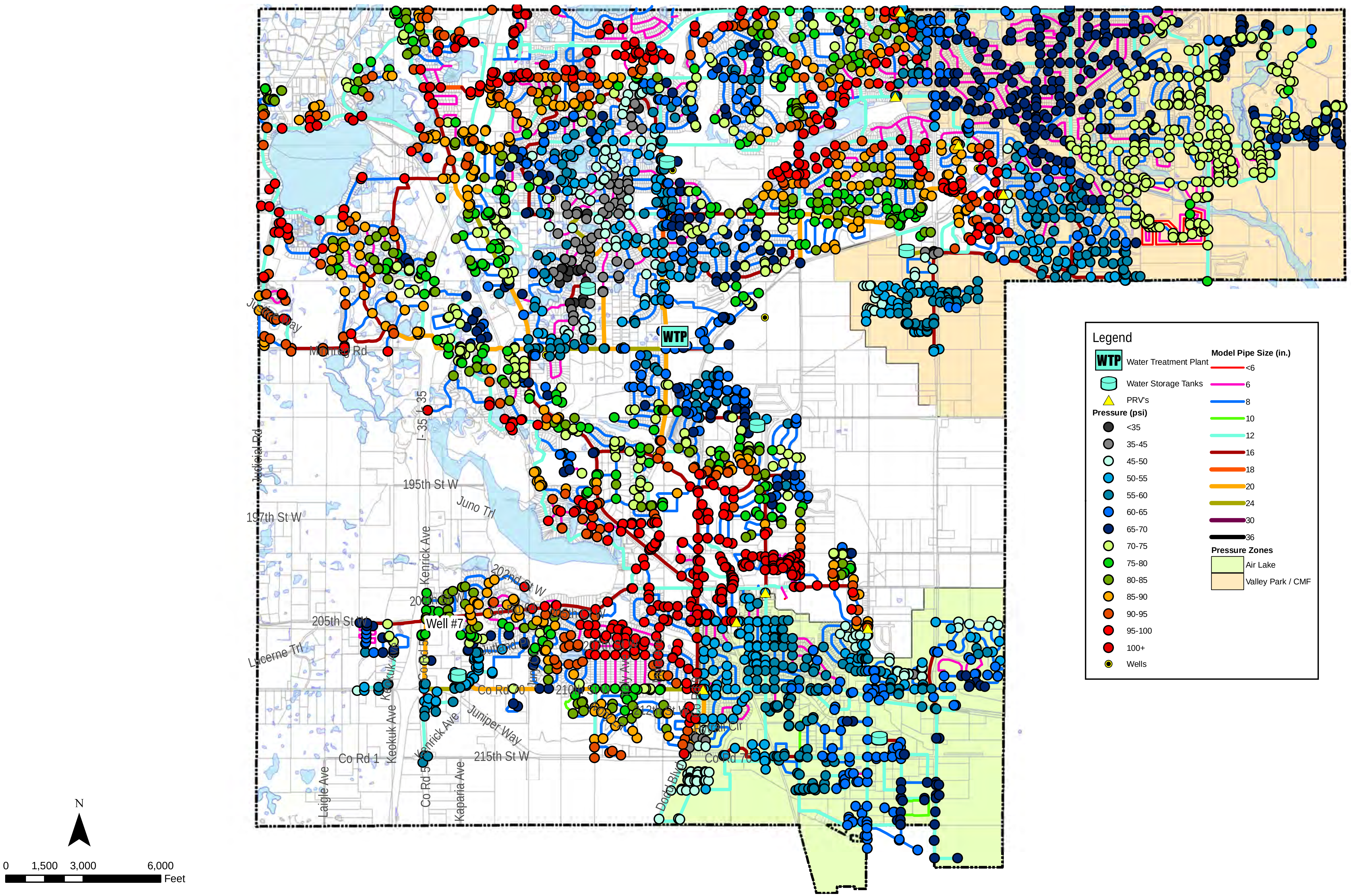
Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 5-1 Existing AD Pressure.mxd

Project Number: LAKEV 141987
Print Date: Print Date: 6/15/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 5-1
Existing Average Day Demand
Water System Pressure



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 5-2 Existing MD Pressure.mxd

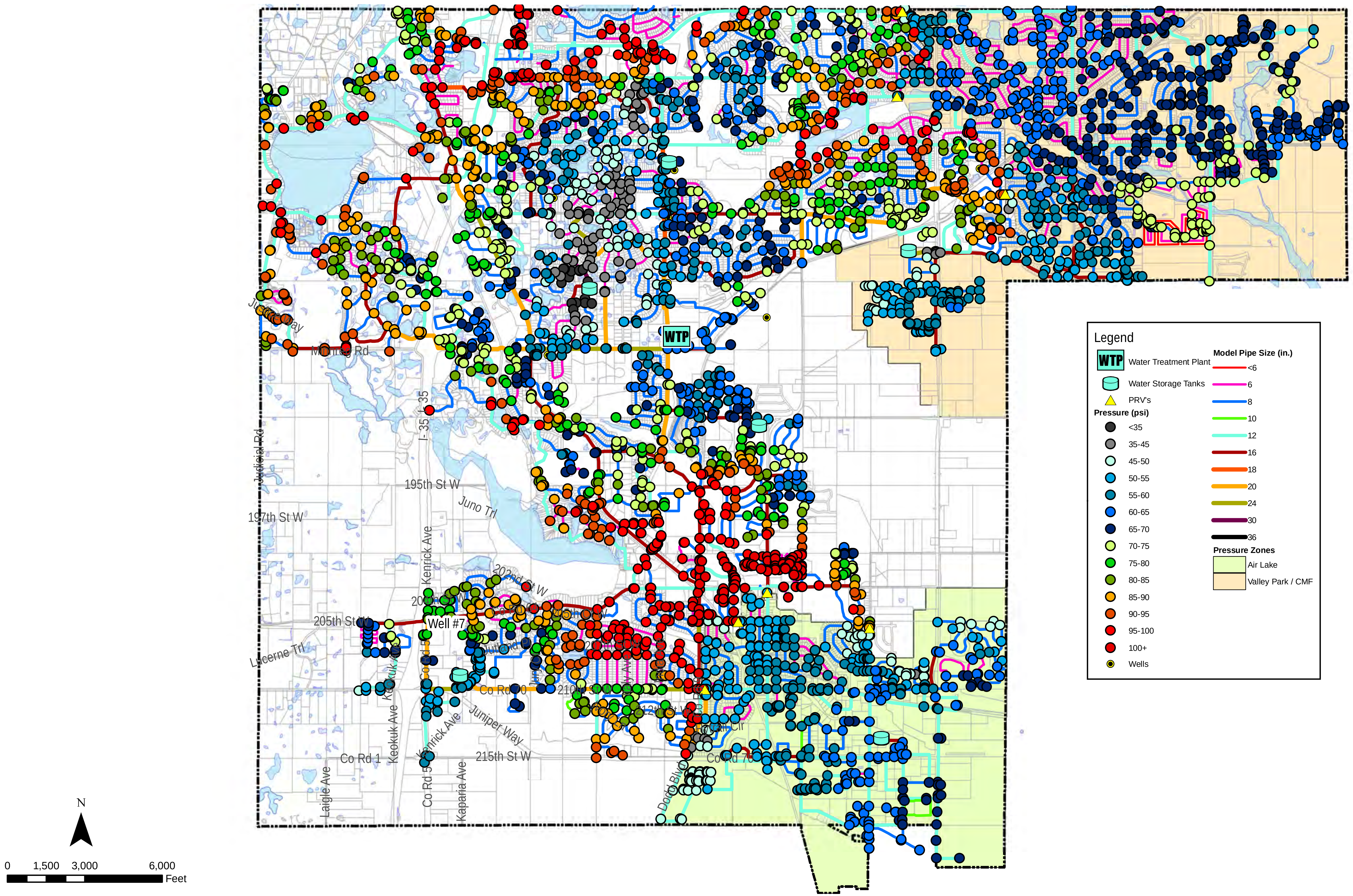
SEH

Project Number: LAKEV 141987
Print Date: Print Date: 6/15/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 5-2
Existing Maximum Day Demand
Water System Pressure



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 5-3 Existing PKHR Pressure.mxd

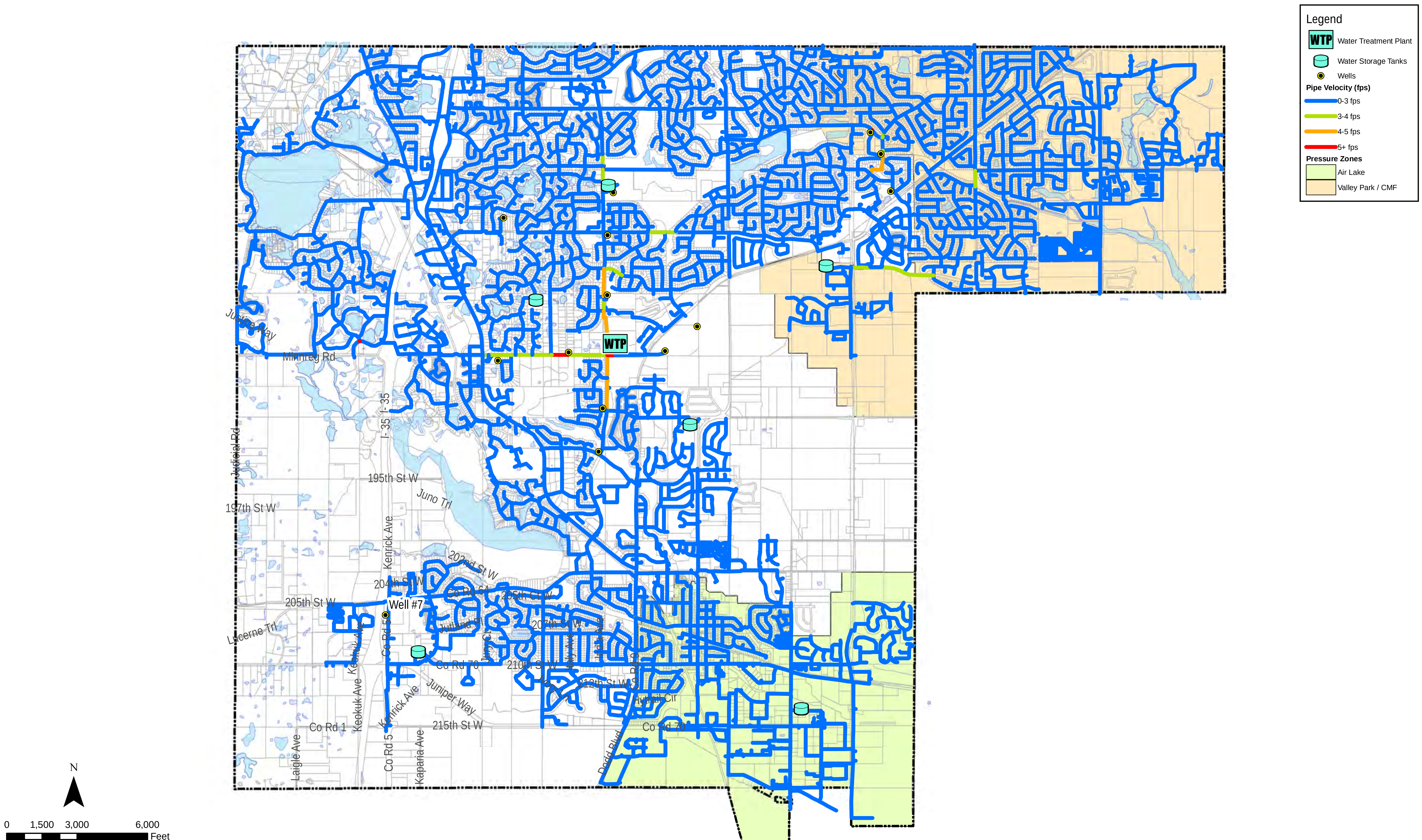
Project Number: LAKEV 141987
Print Date: Print Date: 6/14/2018

Map by:
Projection:
Source:

SEH

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 5-3
Existing Peak Hour
Water System Pressure



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 5-4 Existing PK HR Velocity.mxd

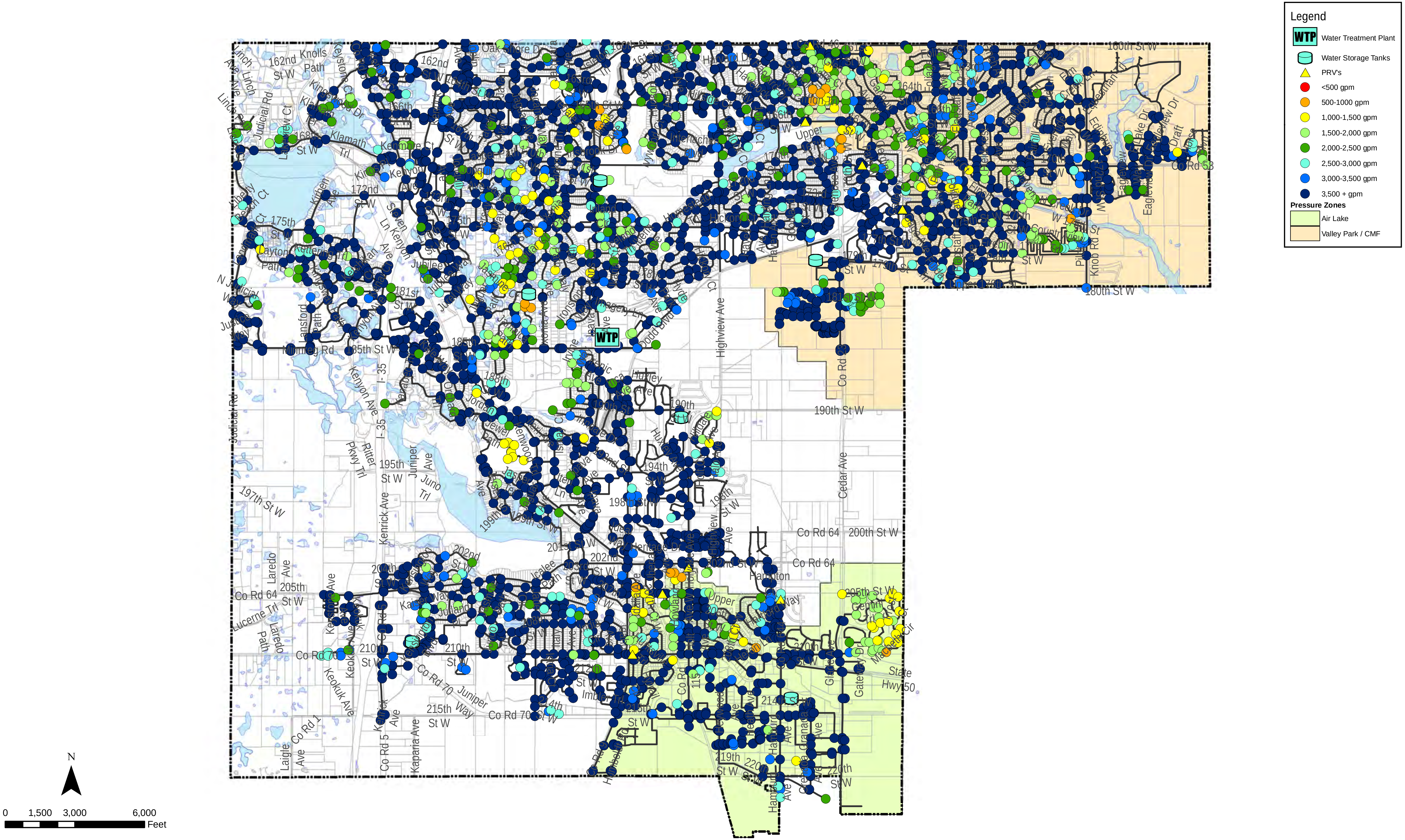
Project Number: LAKEV 141987
Print Date: Print Date: 6/15/2018

Map by:
Projection:
Source:

SEH

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 5-4
Existing Peak Hour
Pipe Flow Velocity



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 5-5 Existing MD FF.mxd

Project Number: LAKEV 141987
Print Date: Print Date: 5/23/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 5-5
Existing Max Day
Calc. Avail. Fire Flow @ 20 psi

5.2.4 Pipe Velocities and Friction Loss

Pipe segments are considered potentially deficient, or most-limiting, if they have the following conditions:

- Velocities greater than 5 ft/s; and
- Head losses greater than 10 ft/1000 ft.

Velocities in pipe segments are acceptable up to about 10 ft/s during emergency or extreme demand conditions of short duration. As velocities increase, pipe friction increases and problems with water hammer occur. This is especially true in systems with higher pressures.

We have checked the system for locations where velocities and head losses meet the above stated conditions. There are several locations where pipe velocities exceed 5 ft/s. The majority of these locations are near the water treatment plant as the high service pumps are operating at peak capacity. In addition, several locations throughout the distribution system where inconsistent sizing creates bottlenecks were also apparent. These bottlenecks also results in head losses greater than 10 ft/1000 ft. Results of this analysis are shown in figure 5-4.

6 Recommended Improvements

With future development, Lakeville will require additional supply, storage and trunk water main to meet the water supply needs of its residents and businesses. Water treatment capacity may need to be expanded in the future as well. A previous study evaluated the capacity of the existing water treatment facility. This section evaluates the capacity of water supply and distribution facilities based on current and projected water demands. The proposed distribution system layout for the ultimate service area was presented in Figure 6-1.

6.1 Water Supply Wells

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 two pumps out of service (i.e. firm capacity). Current well supply capacity in Lakeville is 27.6 MGD, and the firm pumping capacity is 23.8 MGD. Maximum day demands reached a peak of 20.4 MGD in 2007. That rate has fluctuated since then, but could reach that level during an extreme drought year.

Based upon the peak demand projections in Table 4-5 and the well analysis shown in table 5-1, 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 City recently completed a well improvement project where wells number 21 and 22 were added to the water system. If growth continues at the projected rate, additional wells will be needed as indicated in Table 6-1

Figure 6-1 shows the proposed locations of future wells. A study was conducted as part of this plan update to review potential locations for future wells along the Dodd Blvd. corridor. That study is attached in Appendix A. It included a review of hydrogeologic conditions and raw water transmission capacity.

The findings indicate that the aquifer and transmission main should support 2-3 additional wells along that corridor. There are potential well interference issues, and transmission main friction losses that limit development beyond that.

The current plan is to construct additional future wells in the east central portion of the city, extending a second raw water transmission main to transport water back to the existing water treatment facility. The long range water system capital improvement plan set forth in this plan includes this assumption. As the need for the transmission main, and those additional wells, becomes more imminent, it is recommended that an aquifer pumping test be conducted in the vicinity of proposed new wells to assess the local aquifer properties in more detail.

6.2 Trunk Water Main

As development progresses into the expansion areas, a trunk water main system must be constructed to deliver adequate flows for various conditions including emergency fire flow. A trunk water main is defined as a pipe sized such that it can supply water for nearby users as well as serve a greater function by transporting water across the system to meet the demands of the extended water system. The majority of trunk water main improvements identified are outside of the existing service area and should be constructed as development occurs and road improvements are constructed. Figure 6-1 presented the proposed preliminary routing of trunk water mains to serve future development areas. Actual main routing will depend on a variety of local factors as individual projects progress. This map should be seen as a recommendation for the general hydraulic capacity of the distribution system as it is extended to serve new development. Generally speaking, the trunk main layout is comprised of a gridded network of 20-inch, 16-inch, and 12-inch diameter water mains.

6.3 Water Storage

With the completion of the Holyoke 2.0 MG storage tank, water storage needs for the entire system can be satisfied for the foreseeable future. However, as the system evolves and expands, it may be necessary to construct a boosted pressure zone in the Southwest part of the City (see Figure 3-2). If this occurs, it may be prudent to also construct an appropriately sized water tower to serve the newly created pressure zone. Such a configuration may allow for the construction of a relatively small water tower to primarily meet the equalization storage needs of the pressure zone. Potential alternatives for this pressure zone are presented later in this report.

6.4 Water Booster Station

The Southwest portion of the City has high land elevations which equate to potentially low water system pressures. As a result a proposed boosted pressure zone was developed in the ultimate water system plan. There are two booster station options explored as part of this planning effort.

The first was a high capacity booster station. This option would involve the construction of full booster pumping station either above or below grade to provide water boosted pressure and high capacity flow to the proposed high pressure zone. A typical station of this nature would include multiple large capacity pumps to support fire flow and a series of smaller pumps to provide flow to meet domestic water demands and maintain system pressure. While a system such as this would provide desired flow and pressure in the project area, investment in this type of facility would be very costly. ($800,000 - $1,000,000 depending on features).

Modeling has revealed that even with lower pressures in this area, properly sized trunk water main would be able to carry sufficient fire flows without high capacity pumping. As a result, an alternative booster station option was explored which This option would serve to increase system pressure on a normal operational basis, while large capacity flows for fire protection and flushing would bypass the station and flow at lower pressures. Systems such as these typically include a small insulated and heated enclosure with two small pumps, intended to supply domestic flow rates and desirable system pressure. While a system such as this would not provide a boost in fire flow, normal system operating pressures would be maintained above 40 psi. When larger flows are demanded, such as during a fire event, flows would be conducted through a pressure sustaining valve (similar to a PRV) located at in vaults surrounding the pressure zone. For purposes of this plan, it is assumed that the City would pursue the smaller scale booster station option with an estimated cost of $300,000 - $400,000 (excluding Valve Vaults).

6.5 Ultimate Water System Modeling Results

As development progresses into the expansion areas, a trunk water main system must be constructed to deliver adequate flows for various conditions including emergency fire flow. The majority of trunk water main improvements identified are outside of the existing service area and should be constructed as development occurs. Figure 6-1 presented the proposed preliminary routing of trunk water mains to serve future development areas. Actual main routing will depend on a variety of local factors as individual projects progress. This map should be seen as a recommendation for the general hydraulic capacity of the distribution system as it is extended to serve new development. Generally speaking, the trunk main layout is comprised of a gridded network of 20-inch, 16-inch, and 12-inch diameter water mains.

6.5.1 System Pressures After Improvements

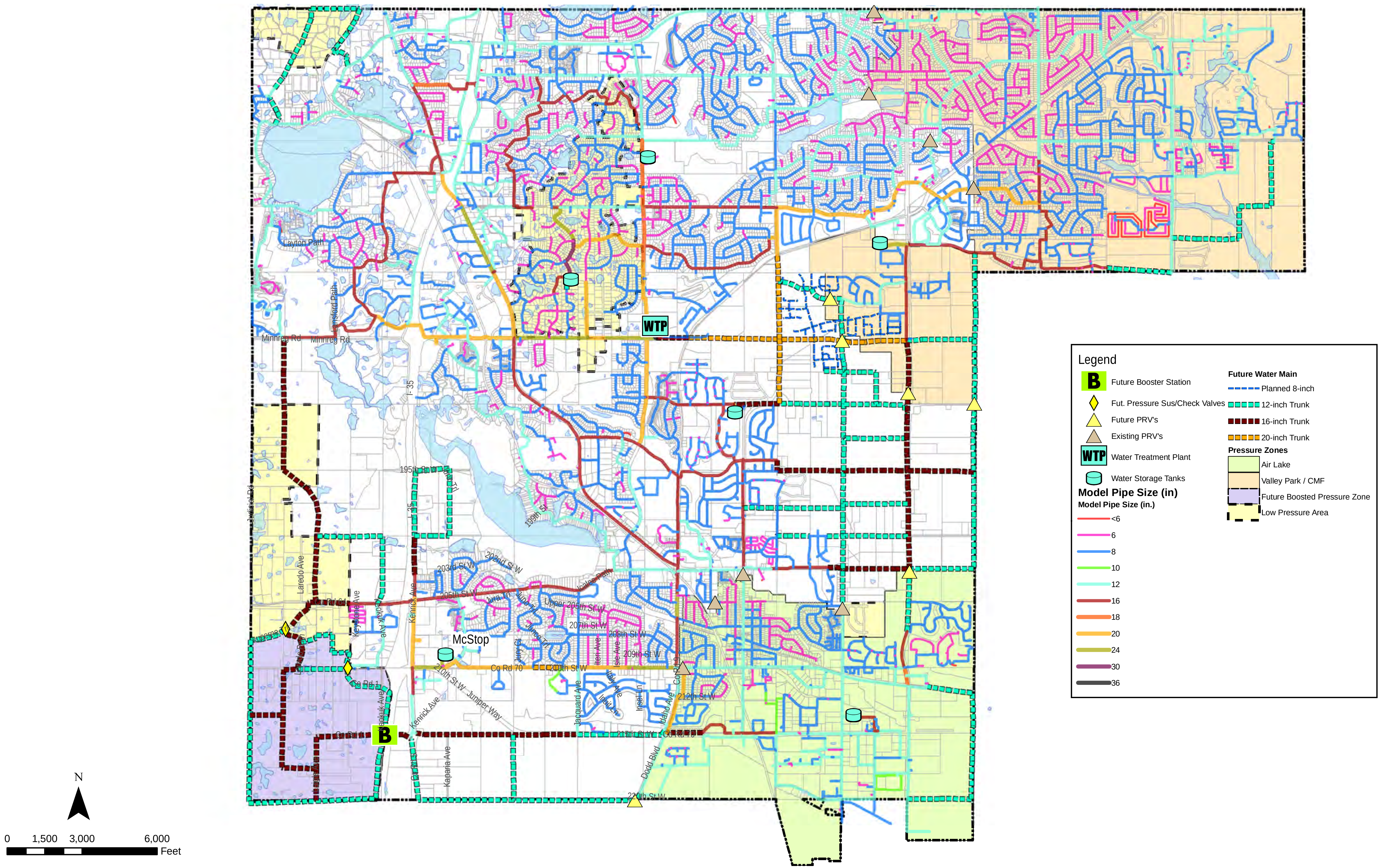
The future maximum day system pressures after all recommended improvements are represented in Figure 6-2. Peak hour pressures are shown in Figure 6-3.The modeling results indicate that the trunk main capacities as modeled will allow the distribution of flow under projected peak hour demands without significant losses due to friction. In addition, the division into pressure zones of the future expansion area in the east-central portion of the city was designed to maintain static system pressures within acceptable operating ranges where possible. The average day and peak hour conditions represent a range of expected typical operating pressures.

6.5.2 Available Fire Flows After Improvements

The future available fire flows under maximum day demands are represented in Figure 6-4 These flows represent the future expected available fire flows with all recommended system improvements.

7 Capital Improvements Plan

One of the main objectives of this study was to develop a long-range Capital Improvement Plan (CIP) for water system facilities. The CIP provides information on the anticipated cost and timing of future water supply, storage and distribution improvements.



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 6-1 Ultimate Water System.mxd

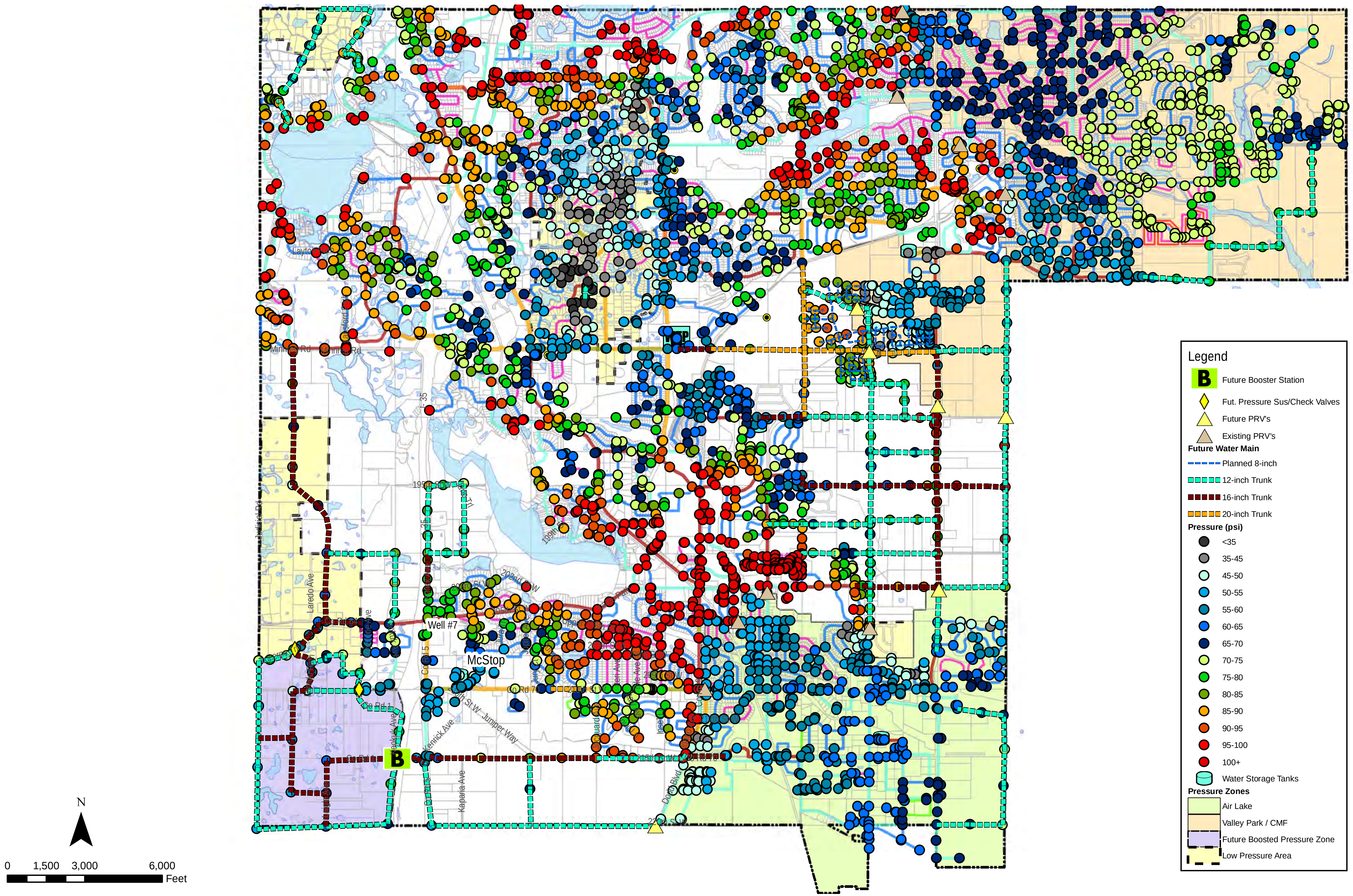
SEH

Project Number: LAKEV 141987
Print Date: Print Date: 6/19/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 6-1
Ultimate Water System Map



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 6-2 Ultimate Max Day Pressure.mxd

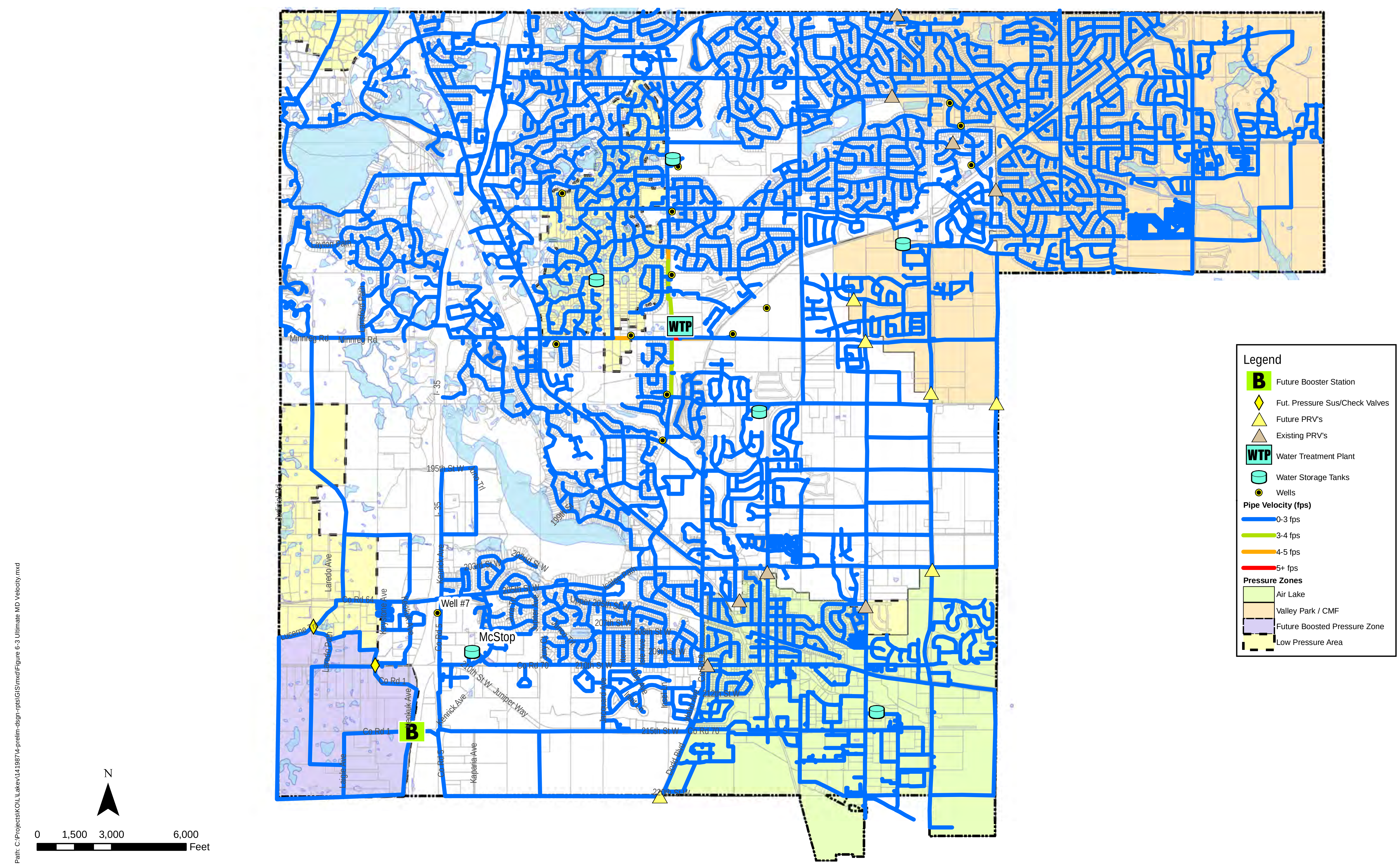
SEH

Project Number: LAKEV 141987
Print Date: Print Date: 6/19/2018

Map by:
Projection:
Source:

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 6-2
Ultimate Water System
Ultimate Max Day Demand Pressure



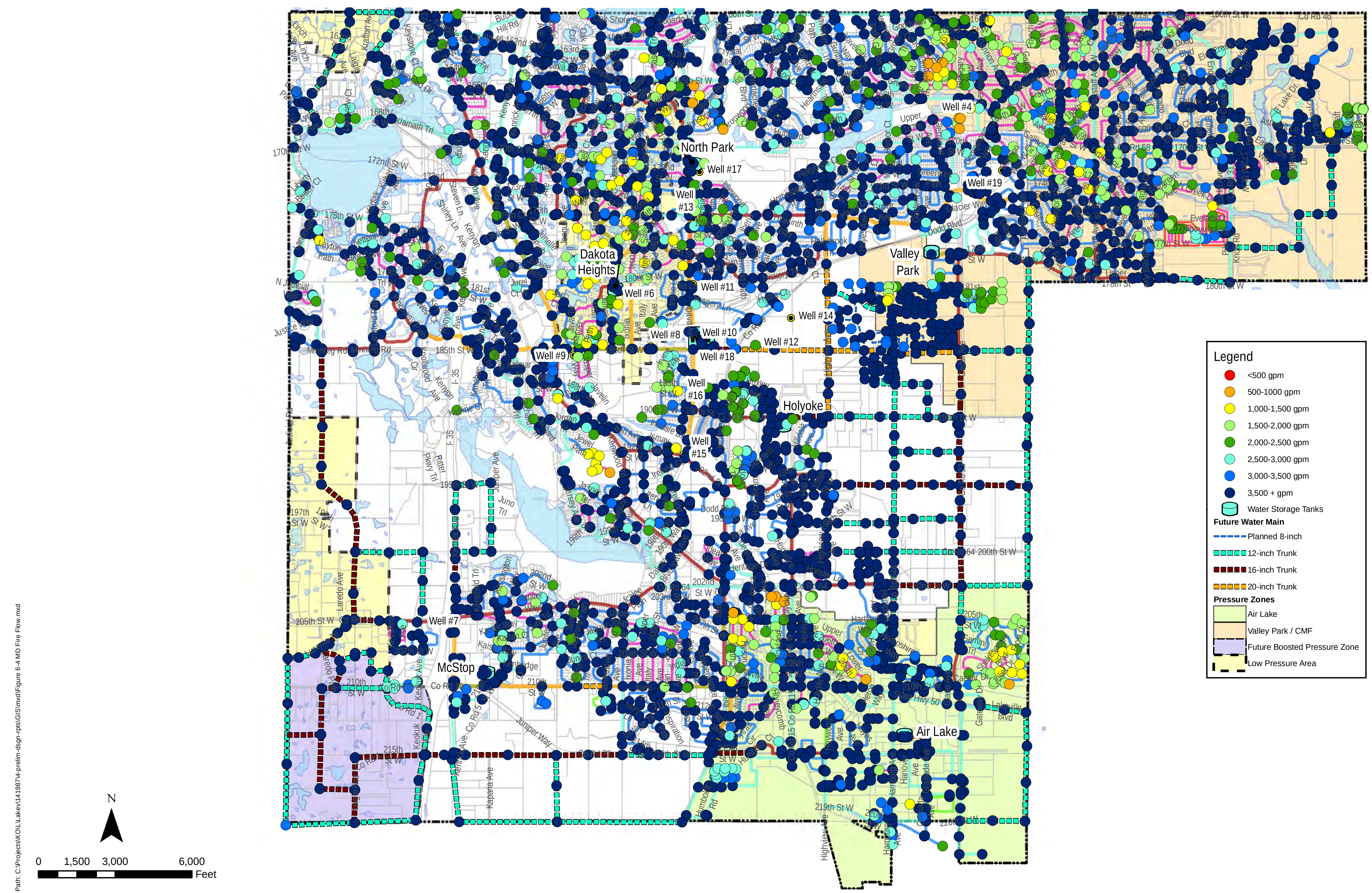
Project Number: LAKEV 141987
Print Date: Print Date: 6/19/2018

Map by:
Projection:
Source:

SEH

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 6-3
Ultimate Max Day Demand
Pipe Velocity



Path: C:\Projects\KO\L\Lakev\141987\4-prelim-dsgn-rpts\GIS\mxd\Figure 6-4 MD Fire Flow.mxd

Project Number: LAKEV 141987
Print Date: Print Date: 6/15/2018

Map by:
Projection:
Source:

SEH

2018 Comprehensive Water Plan
Lakeville, Minnesota

FIGURE 6-4
Ultimate Water System
MD Calc. Aval. Fire Flow @ 20 psi

7.1 Estimated Cost of Water System Improvements

The estimated costs of future trunk water main extensions, storage and well facilities, and raw water main are shown in Tables 15, 16, and 17 respectively. Costs for future water treatment facility improvements are no included in this plan.

7.2 Trunk Water Main Oversize Costs

Right-of-way costs that may be related to the final construction are not included. Trunk facilities are defined as all pipes greater than 8 inches in diameter. The City's cost, oversize cost, is only a part of the total cost and is defined by the difference in cost between the actual improvement and a residential equivalent improvement (defined as an 8-inch water main of equal length).

7.3 Wells

Estimates for well construction include a test well, production well construction, pump and motor installation, pitless unit installation, on site water main, hydrant, paving, meter vault, electrical and controls. The value also includes an estimate for engineering and administrative costs.

7.4 Raw Water Collection/Supply Lines

Right-of-way costs that may be related to the final construction are not included. The transmission line costs also do not include well site main installation as those costs are addressed in the individual well cost estimates. The value includes an estimate for engineering and administrative costs.

7.5 Water Booster Station

The trunk distribution features column in table 7-1 below outlines the construction of various pressure reducing valves (PRV's) and pressure sustaining valves (PSV's) which are placed on the border of system pressure zones. This also includes the construction of a small scale water booster station and PSV in 2030.

7.6 Water Treatment Facility Improvements

Planning and cost estimates for future water treatment facility improvements are not included in this plan as they have been addressed in a previous facility plan completed by Black and Veatch.

7.7 Capital Improvement Plan Timeline

Table 7-1 summarizes estimated annual costs (in 2018 dollars) for the recommended future improvements.

Table 7-1 – Capital Improvements Timeline

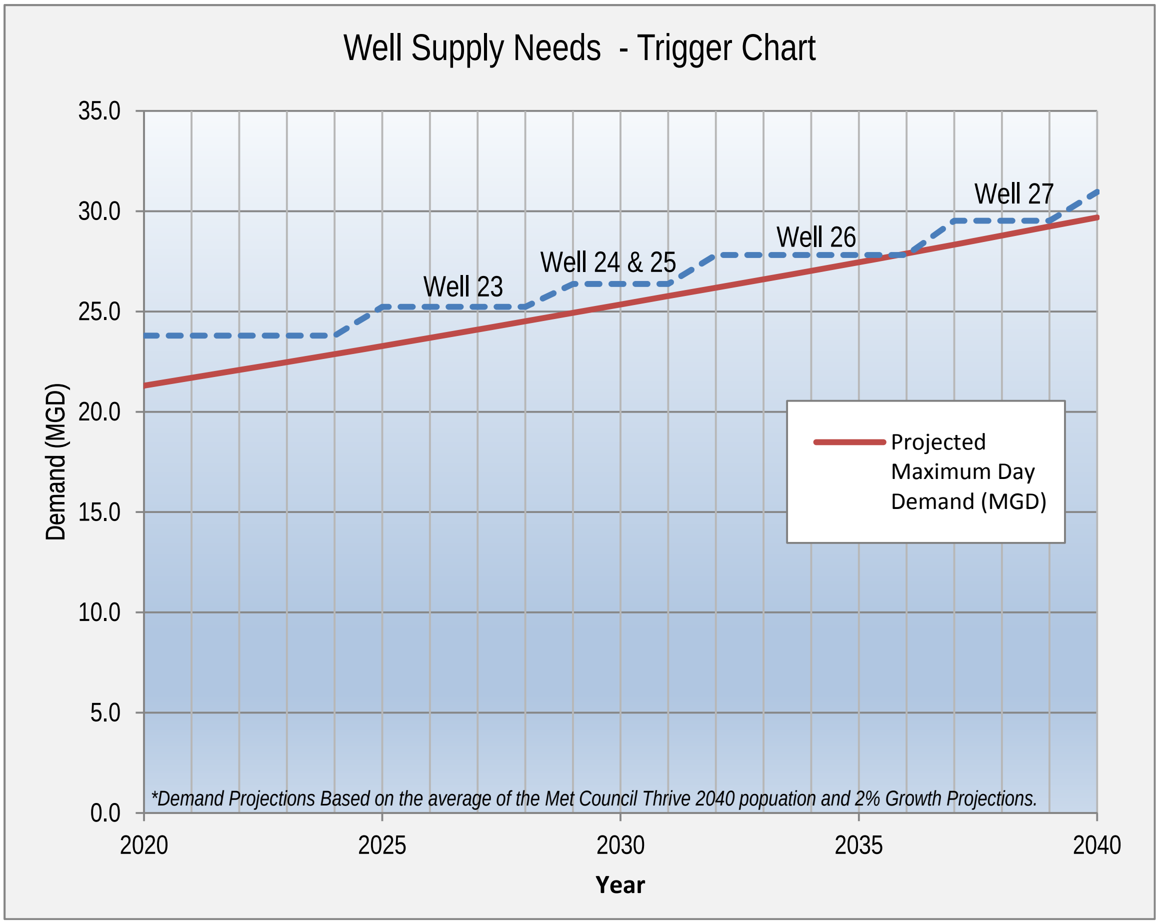
Year	Trunk Main Extension	Trunk Distribution Features	Raw Water Transmission Main	Well	Well Cost	Total
2019	$265,000					$265,000
2020	$265,000	$150,000				$415,000
2021	$265,000					$265,000
2022	$265,000	$150,000				$415,000
2023	$265,000					$265,000
2024	$265,000	$150,000		23	$1,000,000	$1,415,023
2025	$265,000					$265,000
2026	$265,000	$150,000				$415,000
2027	$265,000					$265,000
2028	$265,000	$150,000		24,25	$1,800,000	$2,215,000
2029	$265,000					$265,000
2030	$265,000	$550,000				$815,000
2031	$265,000		$1,300,000	26	$1,000,000	$2,565,026
2032	$265,000	$150,000				$415,000
2033	$265,000					$265,000
2034	$265,000	$150,000				$415,000
2035	$265,000					$265,000
2036	$265,000	$150,000	$280,000	27	$1,000,000	$1,695,027
2037	$265,000					$265,000
2038	$265,000	$150,000				$415,000
2039	$265,000					$265,000
2040	$265,000	$150,000	$250,000	28	$1,000,000	$1,665,028

7.8 Trigger Chart

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.

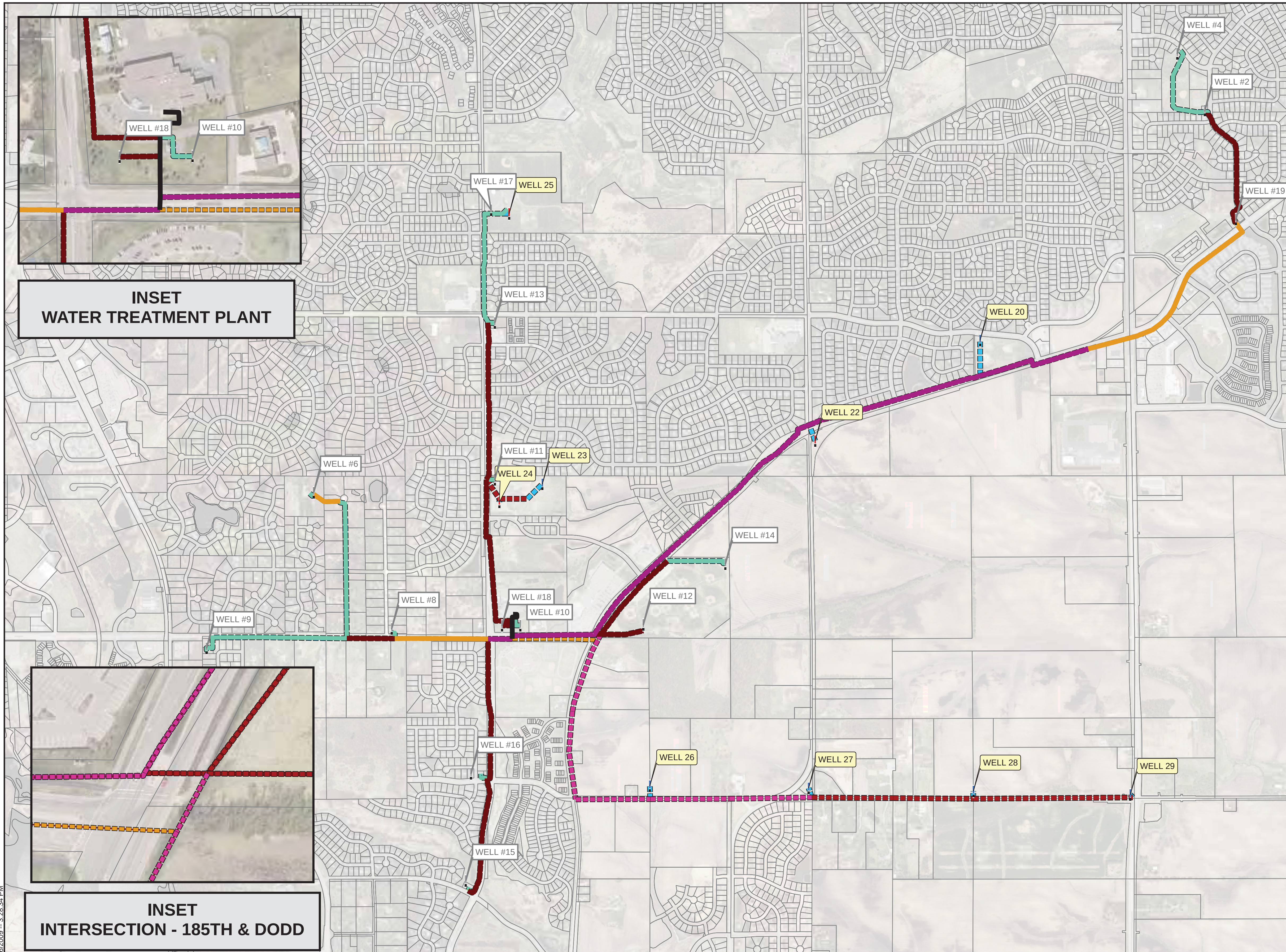
A trigger chart is presented in below, which correlates well and storage improvements to system demands. Future capital improvement planning can thus be tied to actual system demands and the timeline adjusted as necessary.



Well Supply Needs - Trigger Chart
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Demand (MGD)
Well 23
Well 24 & 25
Well 26
Well 27
Projected Maximum Day Demand (MGD)
*Demand Projections Based on the average of the Met Council Thrive 2040 popuation and 2% Growth Projections.
2020
2025
2030
2035
2040
Year

Appendix A

Raw Water System Analysis



Legend

Wells

- Future FIG Well
- Future PDCJ Well
- Existing Wells

Existing Raw Water Main (Dia.)

- 10-Inches
- 12-Inches
- 16-Inches
- 20-Inches
- 24-Inches
- 30-Inches

Proposed Raw Water Main (Dia)

- 12-Inches
- 16-Inches
- 20
- 24-Inches

0 1,000 2,000 4,000 Feet

Map Document: (L:\Resources\Cartographic\Templates\EmptyLayouts\B_ANSI_11x17L\11x17L_Std3_VertBlk.mxd)
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www.sehinc.com

Project: LAKEV 123875
Print Date: 06/25/2015

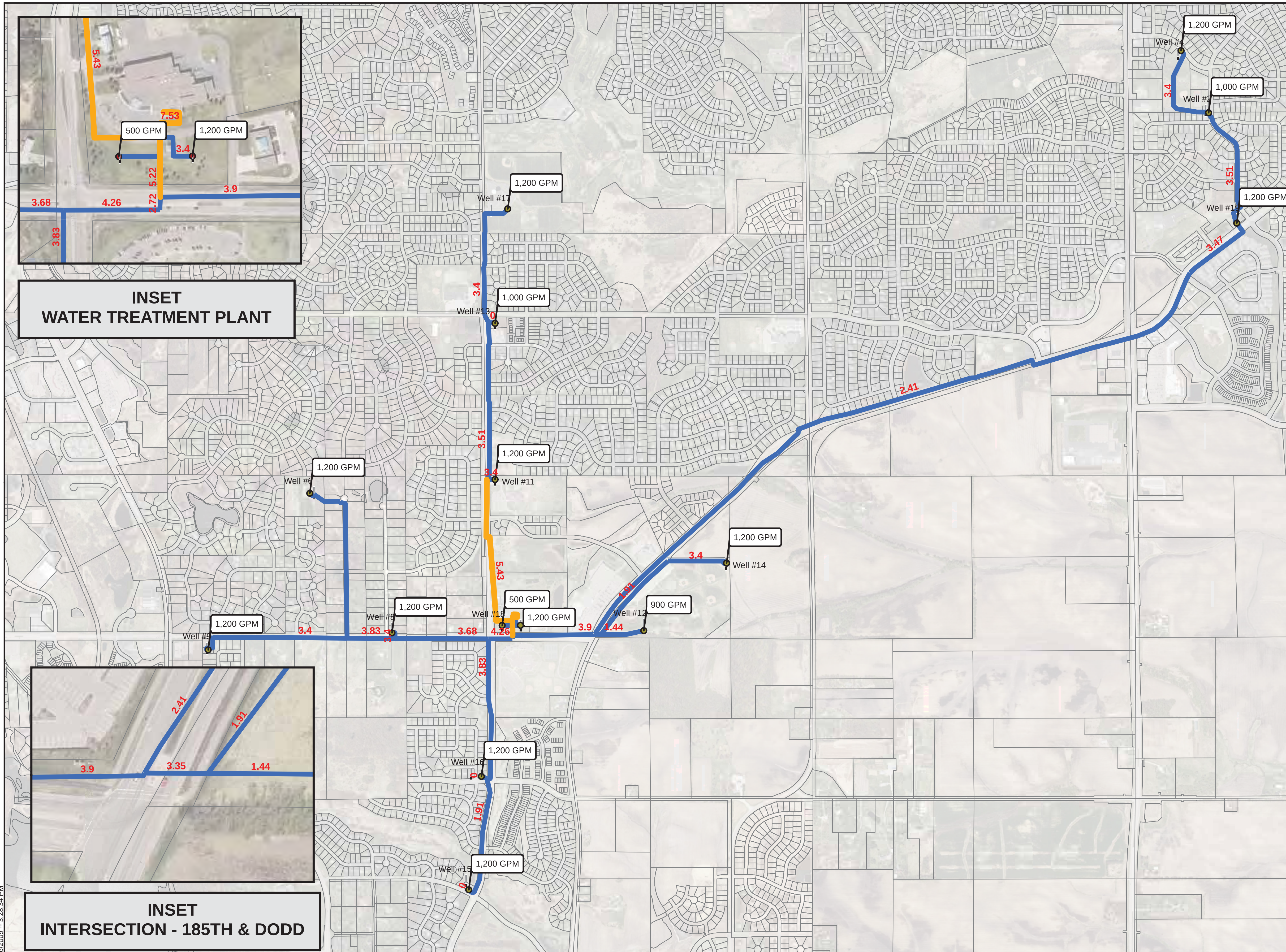
Map by: JDC
Projection: Dakota County
Source: City of Lakeville

Raw Water System Modeling

Lakeville, Minnesota

Existing & Proposed Raw Water System Pipe Sizes

Figure 1



Legend

Existing Raw Water Main

Pipe Velocity (fps)

- 0-5
- 5-8
- 8-10
- 10+
- Existing Wells

Table 1
Existing Production Well Capacities
Lakeville, Minnesota

Well Name	Model Flow Rate (gpm)	Model Flow Rate (MGD)
WELL 02	1,000	1.4
WELL 04	1,200	1.7
WELL 06	1,200	1.7
WELL 08	1,200	1.7
WELL 09	1,200	1.7
WELL 10	1,200	1.7
WELL 11	1,200	1.7
WELL 12	900	1.3
WELL 13	1,000	1.4
WELL 14	1,200	1.7
WELL 15	1,200	1.7
WELL 16	1,200	1.7
WELL 17	1,200	1.7
WELL 18	500	0.7
WELL 19	1,200	1.7
Total	**16,600**	**23.9**

Table Notes: Flow rates verified with Utility Staff

Source: Water Model

0 500 1,000 2,000
Feet

Map Document: (L:\Resources\Cartographic\Templates\EmptyLayouts\B_ANSI_11x17L\11x17L_Std3_VertBlk.mxd)
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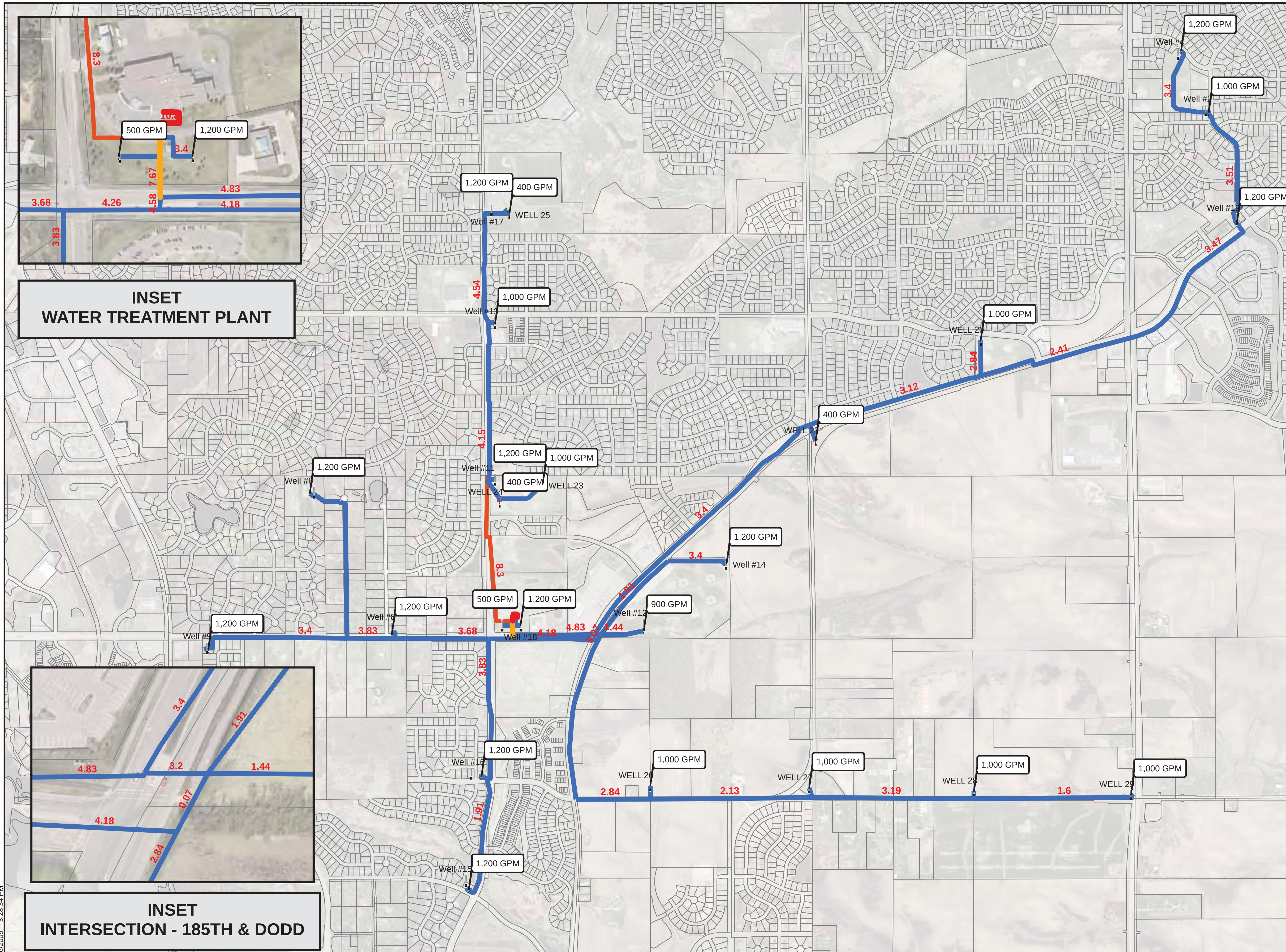
Map by: JDC
Projection: Dakota County
Source: City of Lakeville

Raw Water System Modeling

Lakeville, Minnesota

Existing Raw Water System Pipe Velocity

Figure 2



Legend

- Existing Wells
- Proposed Wells
  - Future FIG Well
  - Future PDCJ Well
- Raw Water Main
- Pipe Velocity (fps)
  - 0-5
  - 5-8
  - 8-10
  - 10+

Table 2
Anticipated Well Production Well Capacities
Lakeville, Minnesota

Well Name	Model Flow Rate (gpm)	Model Flow Rate (MGD)
WELL 02	1,000	1.4
WELL 04	1,200	1.7
WELL 06	1,200	1.7
WELL 08	1,200	1.7
WELL 09	1,200	1.7
WELL 10	1,200	1.7
WELL 11	1,200	1.7
WELL 12	900	1.3
WELL 13	1,000	1.4
WELL 14	1,200	1.7
WELL 15	1,200	1.7
WELL 16	1,200	1.7
WELL 17	1,200	1.7
WELL 18	500	0.7
WELL 19	1,200	1.7
WELL 20*	1,000	1.4
WELL 21*	-	0.0
WELL 22*	400	0.6
WELL 23*	1,000	1.4
WELL 24*	400	0.6
WELL 25*	400	0.6
WELL 26*	1,000	1.4
WELL 27*	1,000	1.4
WELL 28*	1,000	1.4
WELL 29*	1,000	1.4
Total	**23,800**	**34.3**

Table Notes: *Indicated Proposed Future Well

Source: Water Model

0 500 1,000 2,000 Feet

Map Document: (L:\Resources\Cartographic\Templates\EmptyLayouts\B_ANSI_11x17L\11x17L_Std3_VertBlk.mxd)
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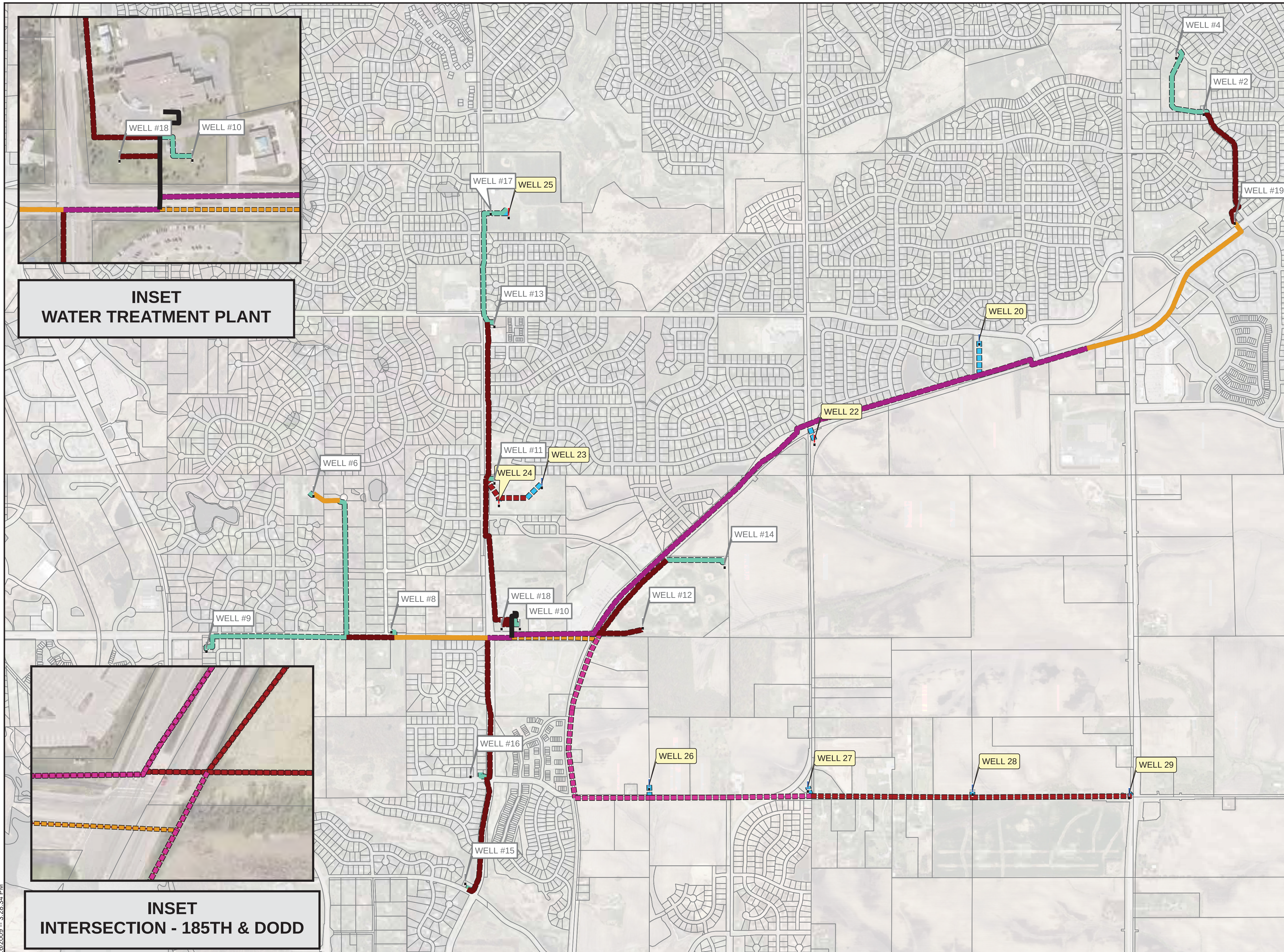
Map by: JDC
Projection: Dakota County
Source: City of Lakeville

Raw Water System Modeling

Lakeville, Minnesota

Proposed Raw Water System Pipe Velocity

Figure 3



Legend

Wells

- Future FIG Well
- Future PDCJ Well
- Existing Wells

Existing Raw Water Main (Dia.)

- 10-Inches
- 12-Inches
- 16-Inches
- 20-Inches
- 24-Inches
- 30-Inches

Proposed Raw Water Main (Dia)

- 12-Inches
- 16-Inches
- 20
- 24-Inches

0 1,000 2,000 4,000 Feet

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Map by: JDC
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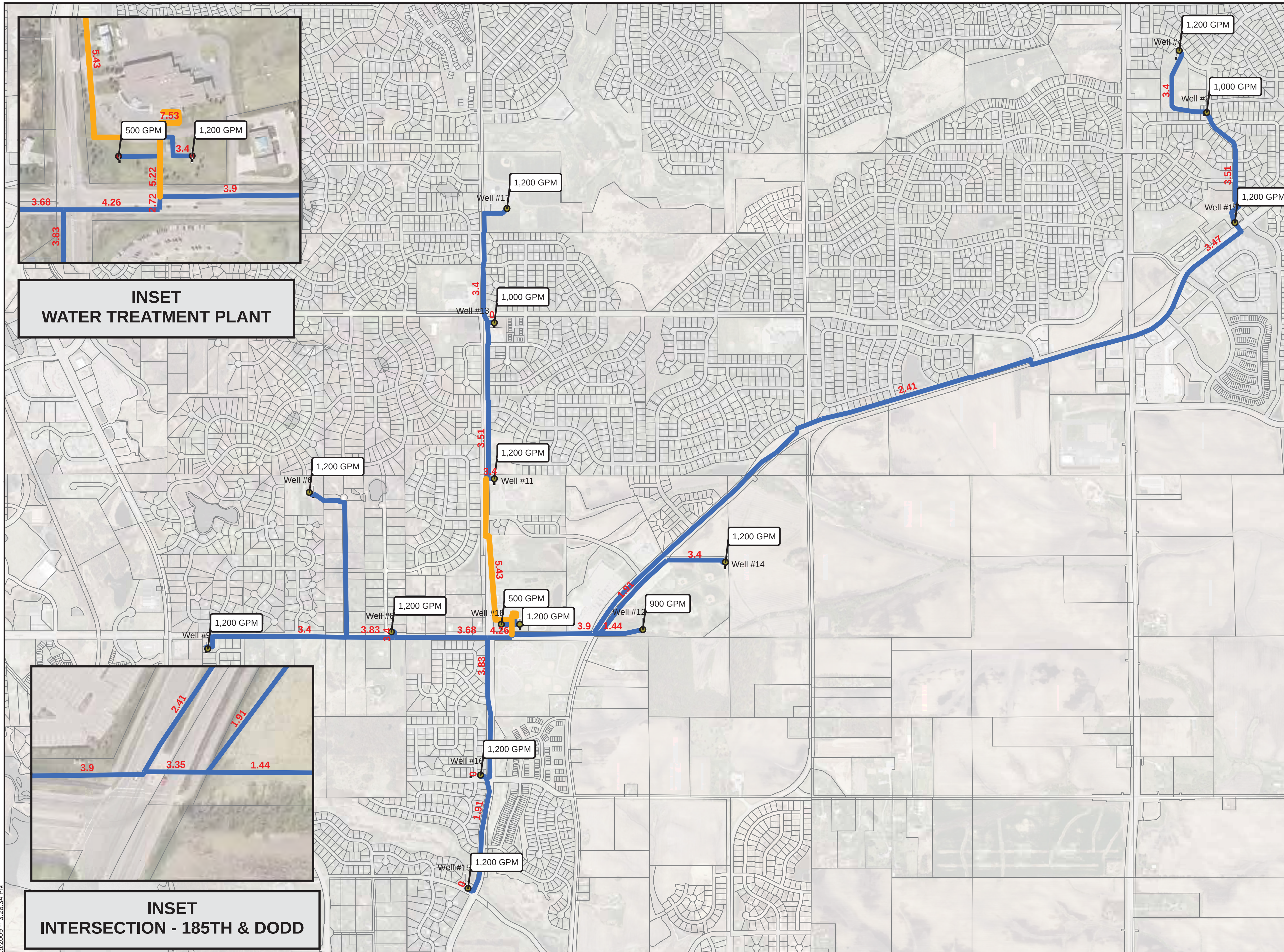
Raw Water System Modeling
Lakeville, Minnesota

Existing & Proposed Raw Water System Pipe Sizes

Figure 1



Legend

Existing Raw Water Main

Pipe Velocity (fps)

- 0-5
- 5-8
- 8-10
- 10+

Existing Wells

Table 1
Existing Production Well Capacities
Lakeville, Minnesota

Well Name	Model Flow Rate (gpm)	Model Flow Rate (MGD)
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WELL 10	1,200	1.7
WELL 11	1,200	1.7
WELL 12	900	1.3
WELL 13	1,000	1.4
WELL 14	1,200	1.7
WELL 15	1,200	1.7
WELL 16	1,200	1.7
WELL 17	1,200	1.7
WELL 18	500	0.7
WELL 19	1,200	1.7
Total	**16,600**	**23.9**

Table Notes: Flow rates verified with Utility Staff

Source: Water Model

0 500 1,000 2,000
Feet

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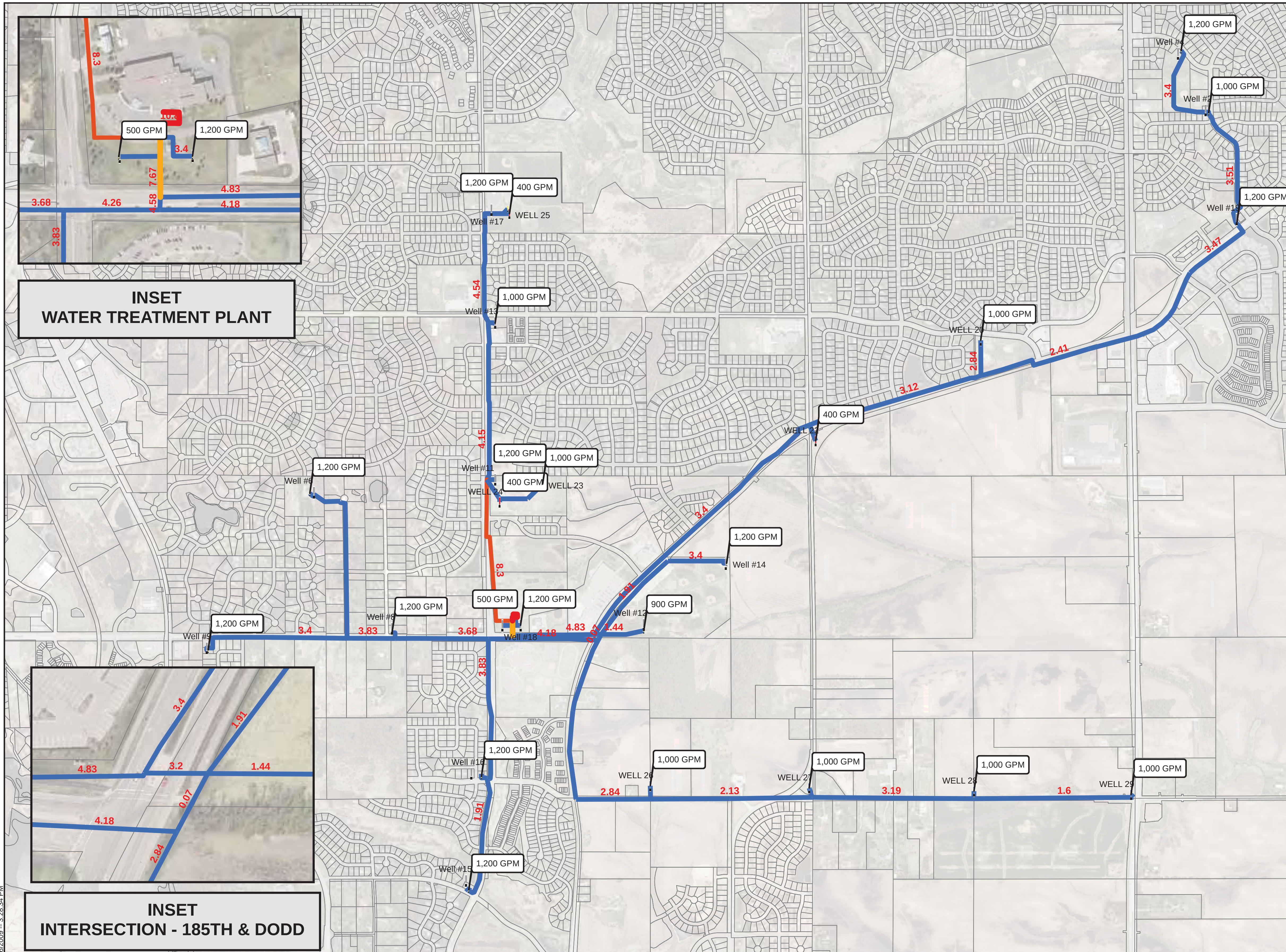
Raw Water System Modeling

Lakeville, Minnesota

Existing Raw Water System Pipe Velocity

Figure 2



Legend

! Existing Wells

Proposed Wells

! Future FIG Well

! Future PDCJ Well

Raw Water Main

Pipe Velocity (fps)

- 0-5
- 5-8
- 8-10
- 10+

Table 2
Anticipated Well Production Well Capacities
Lakeville, Minnesota

Well Name	Model Flow Rate (gpm)	Model Flow Rate (MGD)
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WELL 09	1,200	1.7
WELL 10	1,200	1.7
WELL 11	1,200	1.7
WELL 12	900	1.3
WELL 13	1,000	1.4
WELL 14	1,200	1.7
WELL 15	1,200	1.7
WELL 16	1,200	1.7
WELL 17	1,200	1.7
WELL 18	500	0.7
WELL 19	1,200	1.7
WELL 20*	1,000	1.4
WELL 21*	-	0.0
WELL 22*	400	0.6
WELL 23*	1,000	1.4
WELL 24*	400	0.6
WELL 25*	400	0.6
WELL 26*	1,000	1.4
WELL 27*	1,000	1.4
WELL 28*	1,000	1.4
WELL 29*	1,000	1.4
Total	**23,800**	**34.3**

Table Notes: *Indicated Proposed Future Well

Source: Water Model

0 500 1,000 2,000 Feet

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Project: LAKEV 123875
Print Date: 06/25/2015

Map by: JDC
Projection: Dakota County
Source: City of Lakeville

Raw Water System Modeling

Lakeville, Minnesota

Proposed Raw Water System Pipe Velocity

Figure 3

Appendix B

Development Analysis

SEH

Building a Better World for All of Us®

MEMORANDUM

TO: City of Lakeville

FROM: Chad T. Katzenberger, PE

DATE: October 29, 2014

RE: Water Distribution System Modeling – 2015 Utility Reconstruction Project
SEH No. LAKEV 125769

BACKGROUND

This memo is intended to summarize the utilization of the City's existing water model to analyze the effects of potential water distribution piping changes as part of a 2015 street/utility reconstruction project. The City's water model was recently updated as part of a 2013 water system comprehensive planning effort. This model was utilized to compare various water system configuration options discussed later in this memo.

PROJECT LOCATION

The roads identified for reconstruction as part of the 2015 reconstruction project were provided by City staff as a figure drafted by WSB titled 2015 Street Reconstruction Project. This figure identifies all roads on a map slated for reconstruction. There is approximately 54,000 feet of 6, 8 & 12-inch water main currently serving this area. (See Figure 1)

Table 1
Existing Project Area Piping Summary

Pipe Size	Length (ft)	Length (Miles)	% of total
6-inch	25,852	4.9	48%
8-inch	14,924	2.8	28%
12-inch	13,251	2.5	25%
Total	**54,027**	**10.2**	**100%**

Table Notes: Hydrant leads not included

Source: Water Model

Some of the unique features of the project area include:

- The boundary of the primary pressure zone and the Valley Park Pressure zone.

- The Primary Pressure Zone operates at a higher hydraulic grade line than that of the Valley Park Pressure Zone
- There is a pressure reducing valve (PRV) Station located along the pressure zone boundary which may currently have limited functionality.
- There is an existing 12-inch water main with very few water services running near the North border of Foxbourough Park which may be a candidate for elimination.
- There is a heavy saturation of 12-inch trunk water main in the project area.
- The majority of the 2015 Utility reconstruction project area consists of residential lots.

MODEL CAPABILITIES & ANALYSIS

The complete and calibrated water model has many uses that are very helpful in analyzing both the current water system and potential future improvements. For purposes of this memo, standard functions of the water model software were used to analyze the City's existing water system as it relates to available pressure and fire flow.

Water systems are analyzed, planned, and designed primarily through the application of basic hydraulic principles. Some important factors that must be considered when performing this analysis include: Component size, physical features, pressure requirements and land use characteristics.

For this water model analysis effort, the water system was analyzed according to:

- Reliable Service Pressure
- Fire Flow Capacity
- System functionality

The water system evaluation was based on standard water industry engineering practice.

WATER SYSTEM PRESSURES

Water system pressure in the project area range from 50-65 psi in the valley park pressure zone and 75-110 psi in the primary pressure zone. Proposed system piping will maintain similar pressure levels.

AVAILABLE FIRE FLOW

Water system planning for fire protection is an important consideration. In most instances, water main sizes are designed specifically to supply desired fire flows. Guidelines for determining fire flow requirements are provided by the ISO. ISO is the insurance service 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, and the 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. For purposes of water system modeling analysis, only results up to 3,500 gpm are provided.

Nearly all of the project are consists of Low Density residential properties. Typical fire flow requirements for this type of property range from 500-1,500 gpm while maintaining a water system residual pressure of 20 psi. (These requirements are intended as a general guideline. The actual needed fire flow for a specific building can vary.)

Figure 3 illustrates the estimated available fire flow throughout the entire project area for a typical maximum day water demand while maintaining a residual pressure of 20 psi throughout the system.

As can be seen in the figure, the majority of the project area indicates fire flow availability that range from 700 gpm to 3,500 gpm. Lower available fire flow typically occur at relatively higher elevation areas with small diameter water main. Average available fire flow across in the project area is 2,700 gpm.

As new water infrastructure is proposed, future water main can be sized to increase available flow in areas that currently have less than robust fire flow availability. Conversely, those areas that have more than robust flow availability could have the possibility for a reduced water main size while maintaining existing fire flow availability levels.

WATER MAIN SIZING OBJECTIVES

- Increase available Fire Flow to a minimum of 1,500 gpm in all project areas
- Maintain or increase current available fire flow levels
- Upsize existing water main were necessary to achieve desired fire flow levels.
- Reduce pipe size in areas with more than adequate fire flow availability while maintaining existing fire flow availability.

WATER SYSTEM IMPROVEMENTS OPTIONS

Option A – Remove existing 12-inch main & replace existing water main in kind (size for size)

- Remove existing 12-inch water main running near the North border of Foxbourough.
- Replace all other water main in kind
- See Figure X for proposed pipe location and sizing

This option is documented in Figure 3 and represents the resulting fire flow available with the water system improvements noted above. In general, even with the removal of the 12-inch main along Foxbourough, the available fire flow would remain nearly identical to existing fire flow conditions. This indicates that the removal of this water main would have a negligible effect on realized available fire flow.

Table 2

Option A - Project Area Piping Summary

Pipe Size	Length (ft)	Length (Miles)	% of total
6-inch	25,852	4.9	50%
8-inch	14,924	2.8	29%
12-inch	10,814	2.0	21%
Total	**51,590**	**9.8**	**100%**
Table Notes: Hydrant leads not included			

Source: Water Model

Option B – Re-size new water main

- Remove existing 12-inch water main running near the North border of Foxbourough.

- Replace existing water main with sizes proposed in figure 4
- Option results in a net reduction of 12-inch main and an overall pipe volume reduction of 25%

This option is documented in Figure 4 acknowledges the understanding that existing water main may be sized larger than what is needed to serve the project area. As a result a water main sizing scenario was developed to analyze potential modifications to existing water main sizes. For this option water main diameters were selected to meet the sizing objectives noted above with the overall goal of reducing net water main size across the project area. An iterative pipe sizing process was utilized to determine the posed pipe sizes. The resulting fire flow for the proposed option is documented in Figure 4. As can be seen in this figure, though pipe sizes are reduced in size in many areas, fire flow capacities are maintained at levels that exceed the minimum 1,500 gpm requirement, with the majority of the levels being maintained well above this threshold. Some sections of pipe in the valley park pressure zone were upsized from 6-inch to 8-inch resulting an increase in fire flow availability in areas that currently exhibit limited flow availability.

However, it should be noted that one section of water main along Goodview Trail and Godson Drive would experience a slight reduction in available fire flow compared to current conditions. However, the available flows would still exceed the 1,500 gpm minimum requirement. The primary reason for the limited flow in this area is due to the piping configuration along this stretch. The water main travels along Goodview and bends around to Godson where it continues to the boundary of the valley park pressure zone. At this point the water main is valved shut to isolate the two pressure zones. As a result, was can only be delivered from one direction, slightly limiting flow. If the City determined additional fire flow should be provided to this area, a check valve in a manhole could be installed at the pressure zone boundary in place of the current isolation valve. On a normal basis, this type of valve would remain shut, however, if a large enough flow were demanded (above 2,000 gpm), this valve would open and supplement the area in question with additional flow.

Table 3
Option B - Project Area Piping

Pipe Size	**Length (ft)**	**Length (Miles)**	**% of total**
6-inch	19,781	3.7	38%
8-inch	30,765	5.8	60%
12-inch	1,042	0.2	2%
Total	**51,588**	**9.8**	**100%**
Table Notes: Hydrant leads not included			

Source: Water Model

CONCLUSIONS

In an effort to best allocate limited water system improvement funds, it would be feasible to resize water main as described in Option B. Though the water main would be reduced in size in many areas, appropriate fire flow levels would be maintained. Additionally, water main would be slightly upsized in other areas to increase flow availability to acceptable levels.

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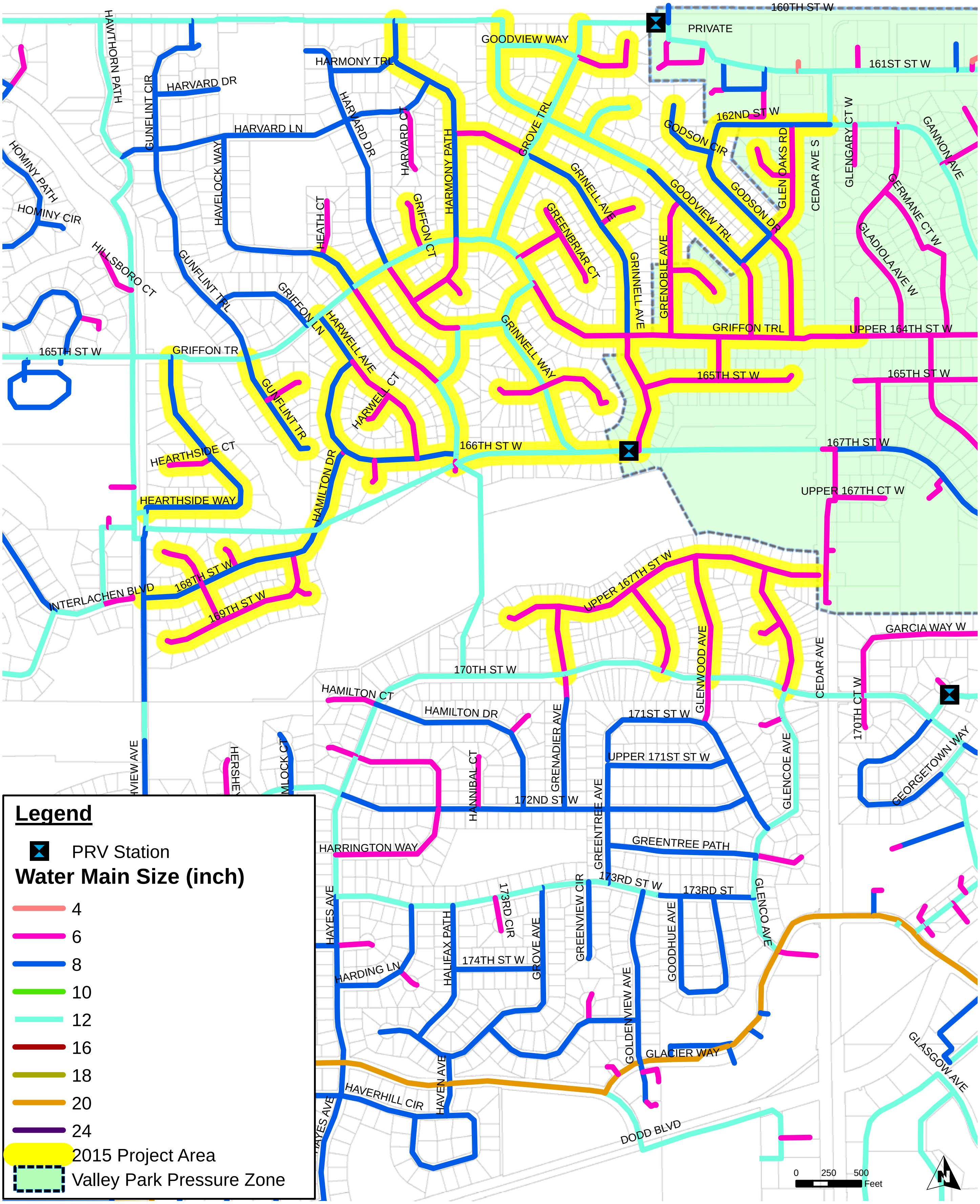
Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water\2015 Utility Reconstruction\gis\Figure 1 - Existing Water System & Project Location.mxd

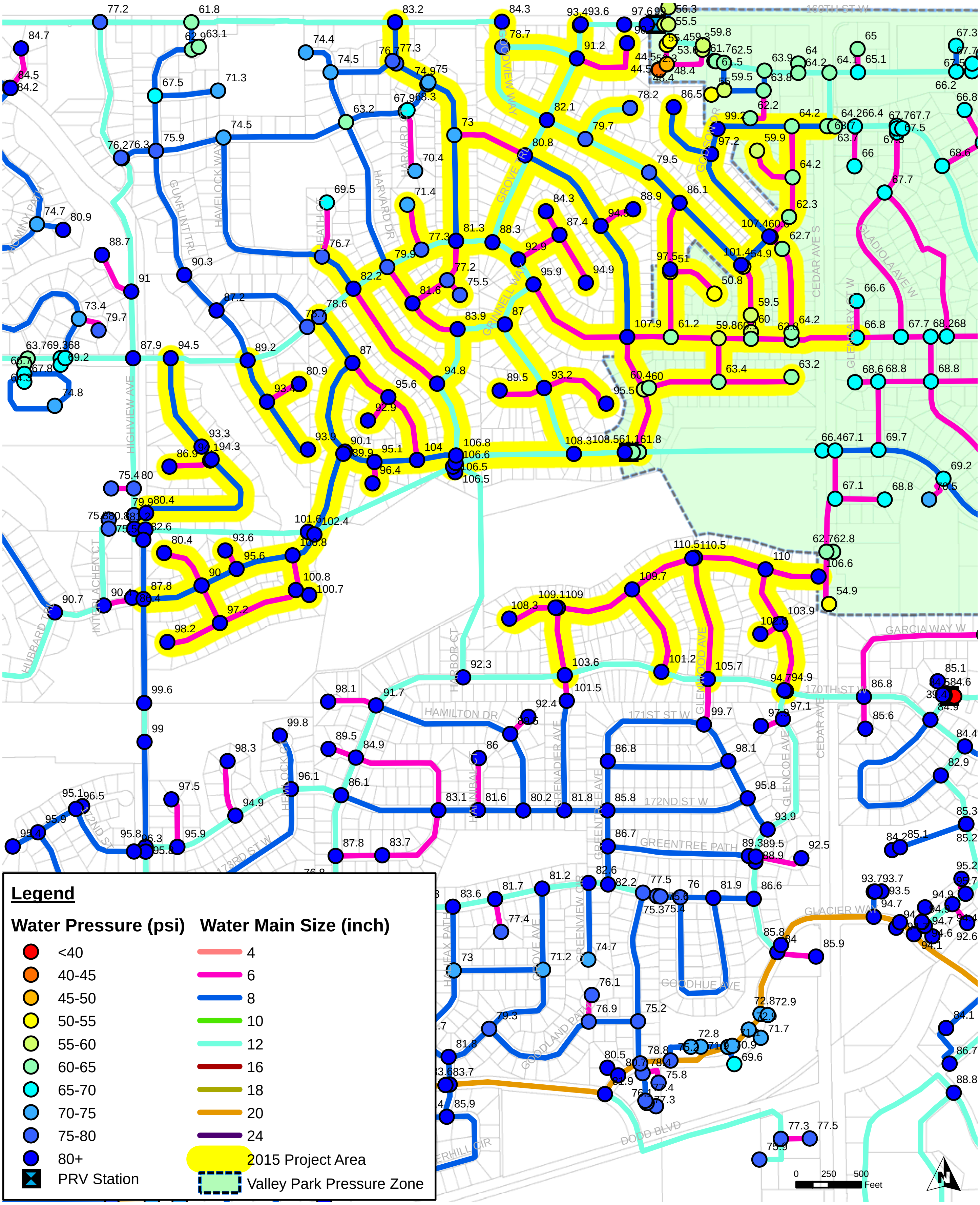


Project Number: LAKEV 125769
Print Date: 10/28/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 1
Existing Water System Map &
2015 Utility Improvement Area



Path: C:\Users\ckatzenberger\Desktop_ Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water\2015 Utility Reconstruction\gis\Figure 2A - Existing Water System Pressures.mxd

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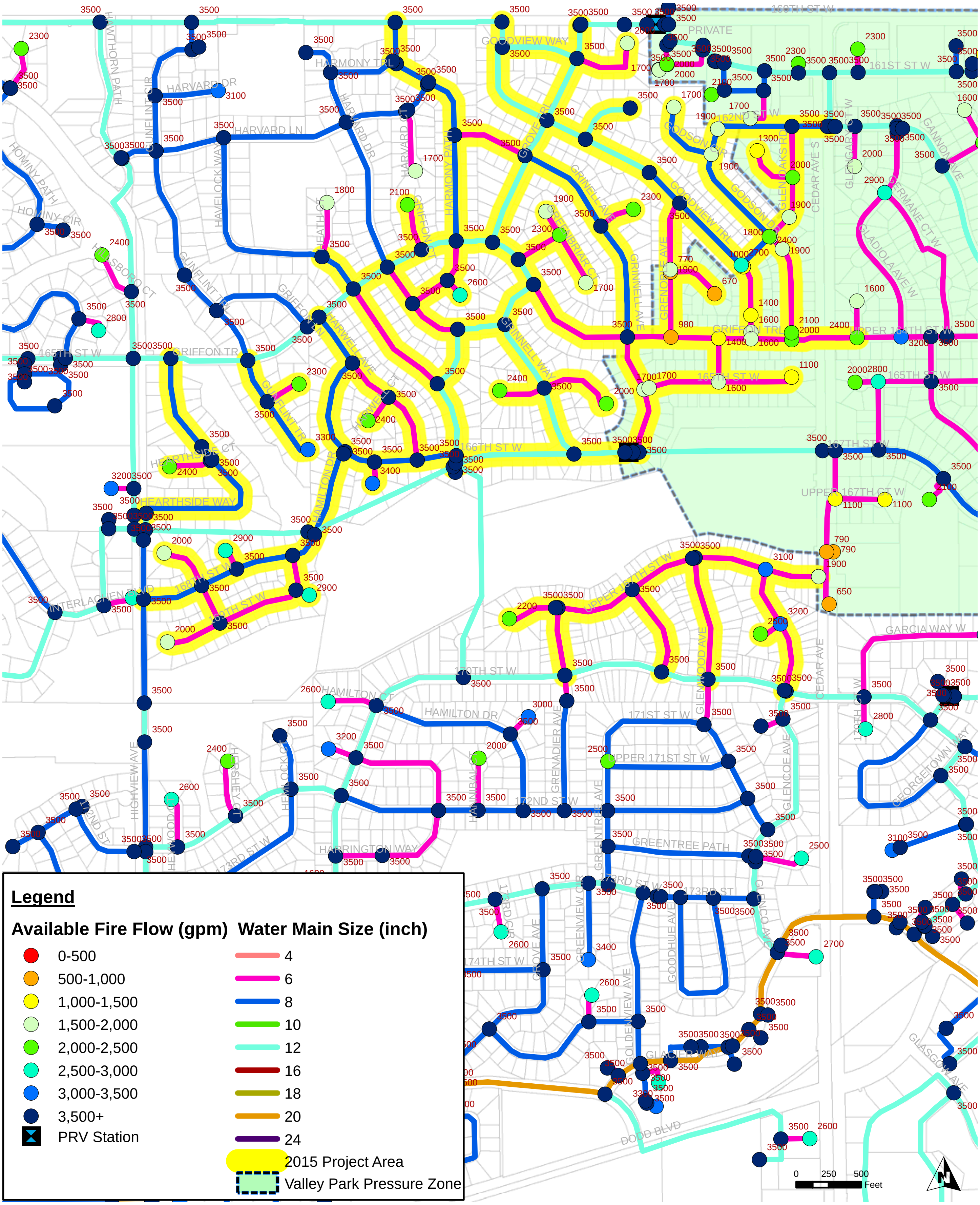
Project Number: LAKEV 125769
Print Date: 10/29/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 2A
Existing Water System Pressures



Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakeville\Common\Water\2015 Utility Reconstruction\gis\Figure 2B - Existing Water System Avail FF.mxd

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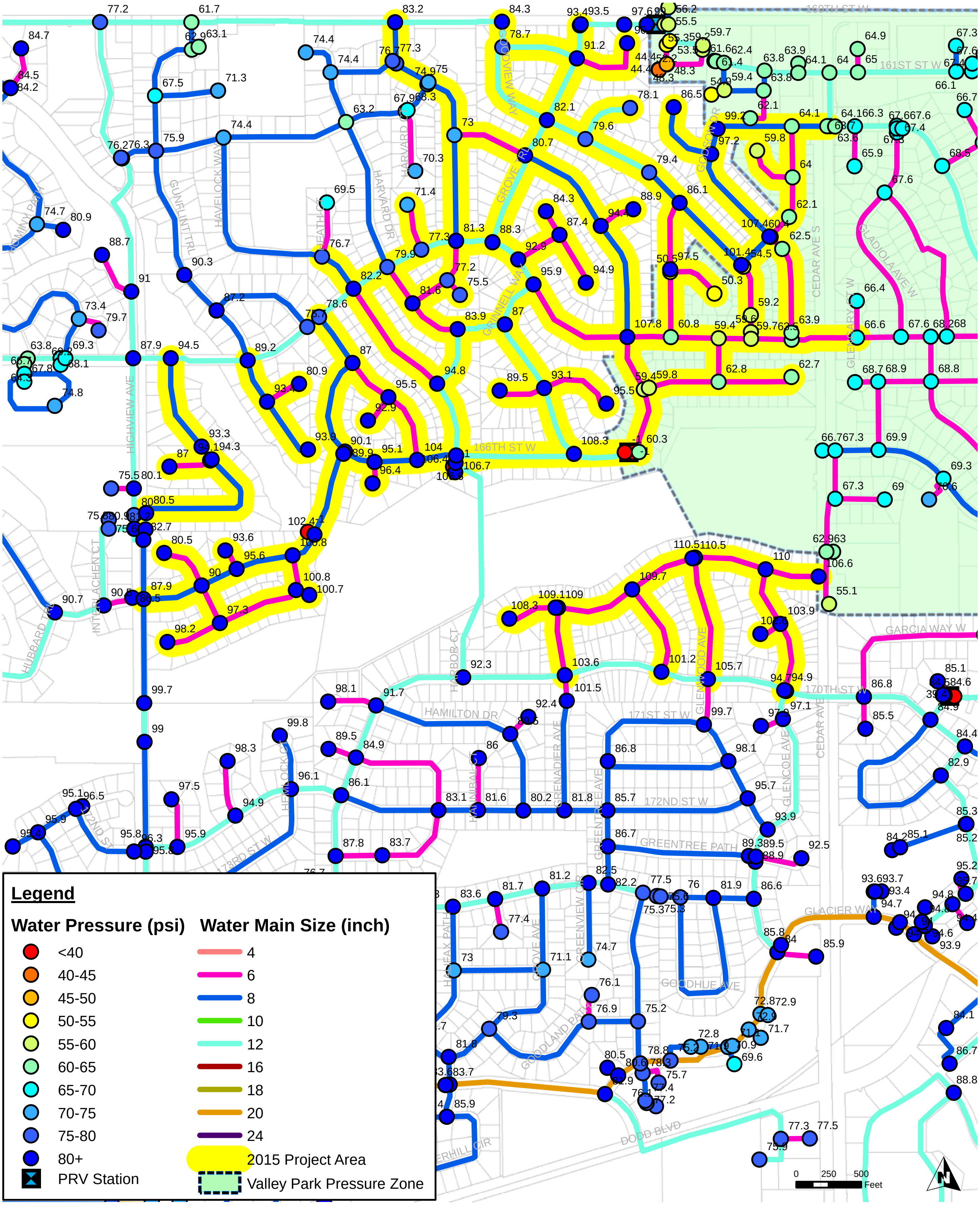
Project Number: LAKEV 125769
Print Date: 10/29/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 2B
Existing Water System
Calculated Available Fire Flow



Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water\2015 Utility Reconstruction\gis\Figure 3A - Option 1 Pressure.mxd

Project Number: LAKEV 125769
Print Date: 10/29/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

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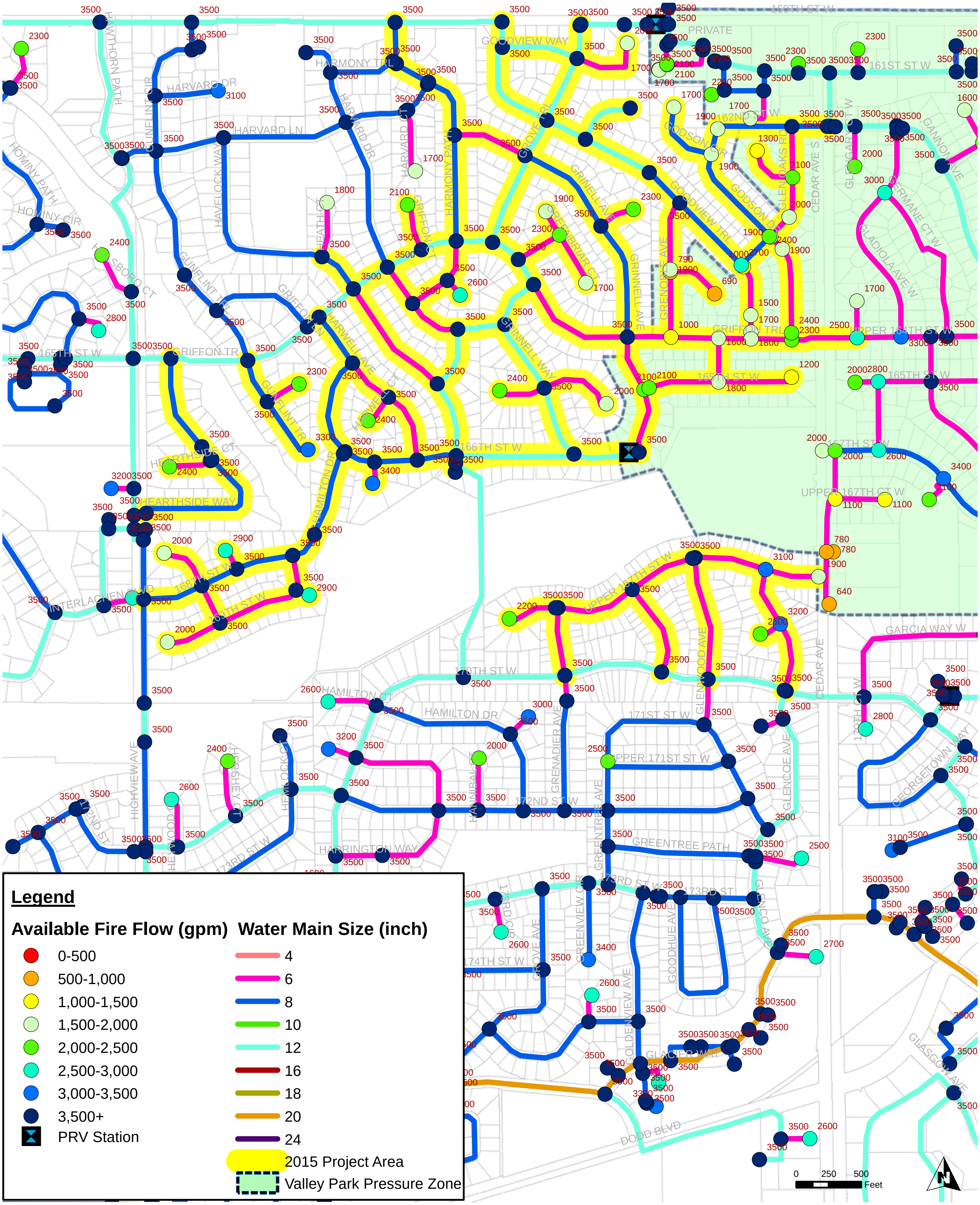
Water System Model Analysis
Lakeville, Minnesota

FIGURE 3A
Option 1
Water System Pressures



Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water\2015 Utility Reconstruction\gis\Figure 3B - Option 1 Avail FF.mxd

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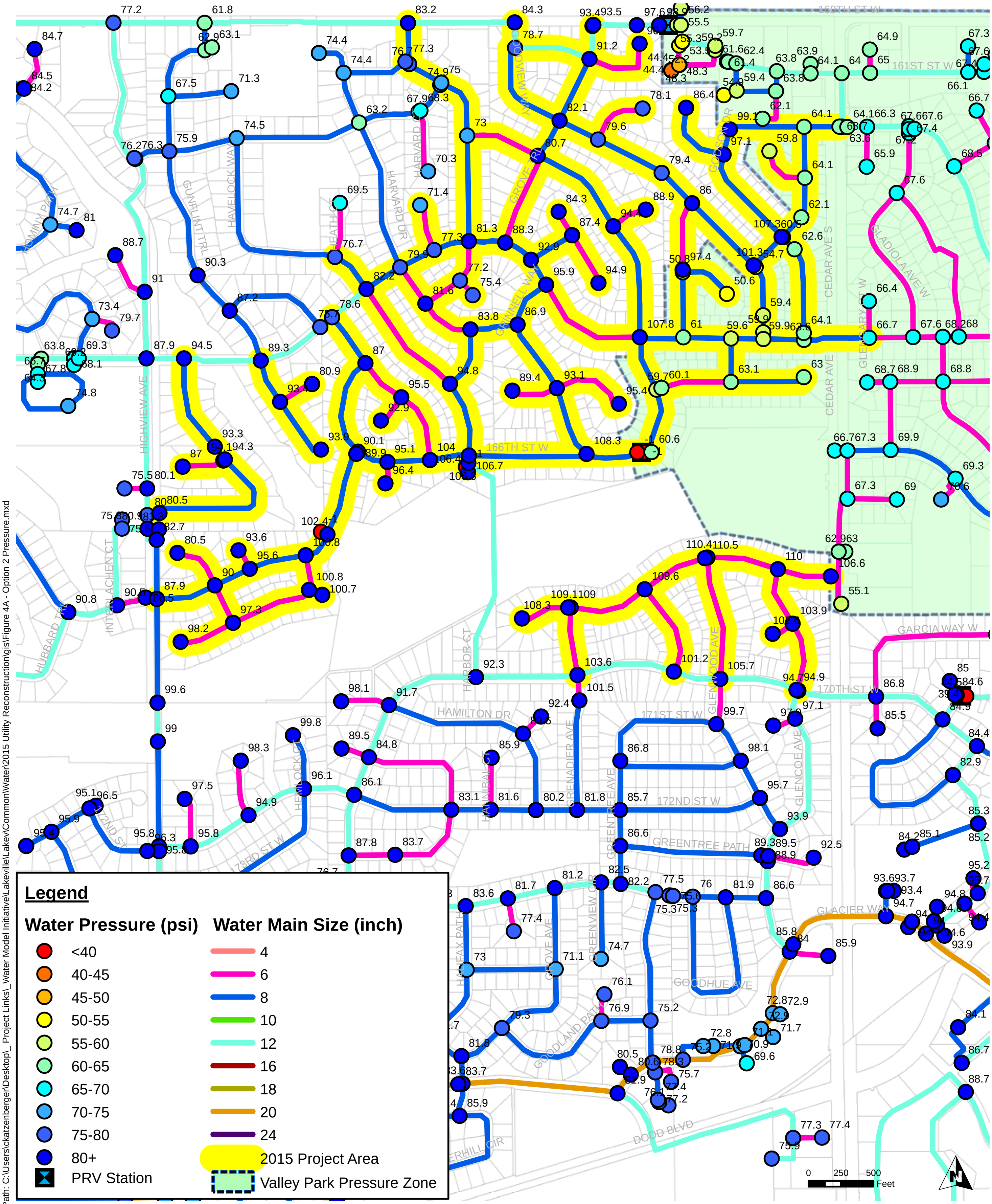
Project Number: LAKEV 125769
Print Date: 10/29/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 3B
Option 1
Calculated Available Fire Flow

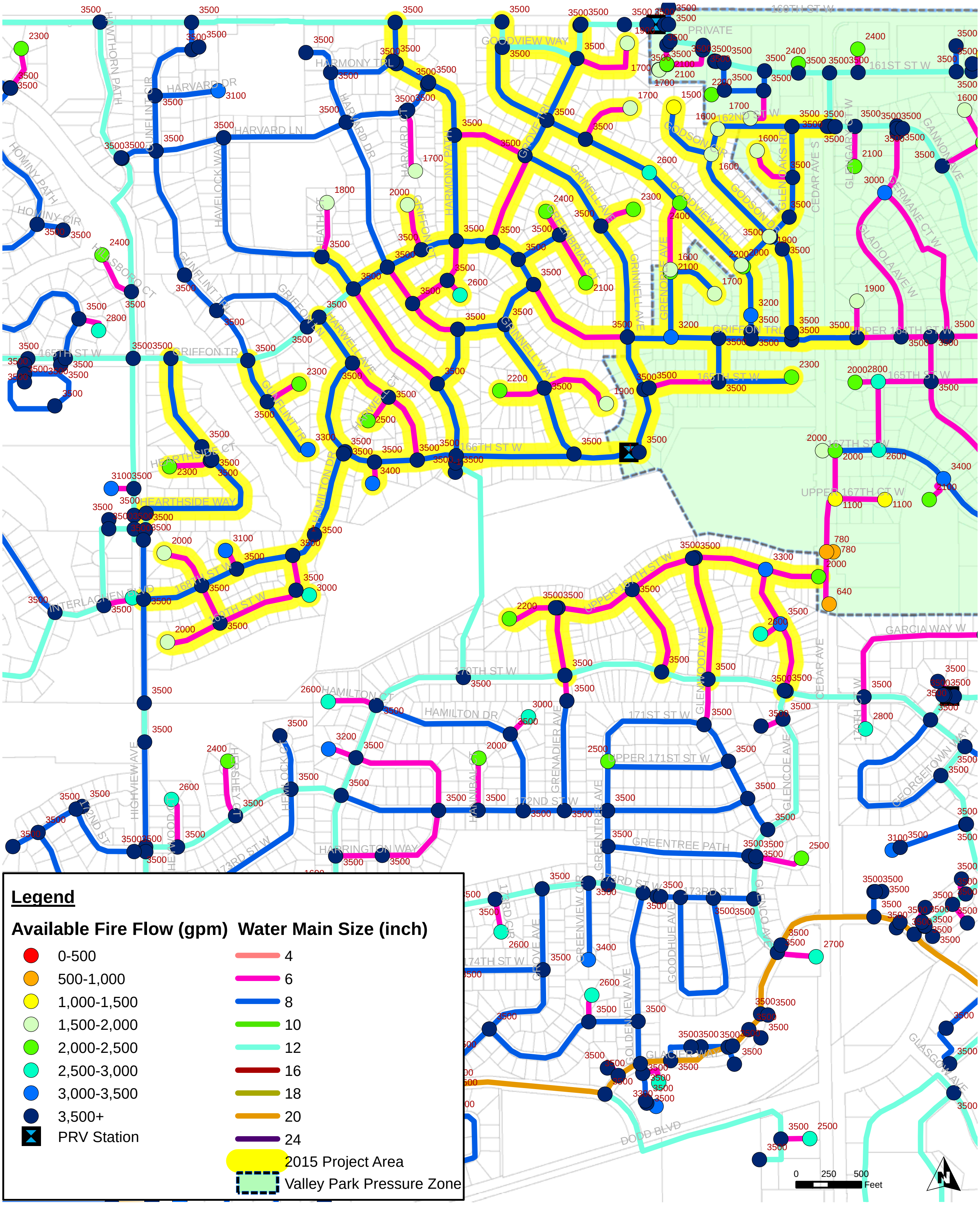


Project Number: LAKEV 125769
Print Date: 10/29/2014

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 4A
Option 2
Water System Pressures



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Project Number: LAKEV 125769
Print Date: 10/29/2014

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Water System Model Analysis
Lakeville, Minnesota

FIGURE 4B
Option 2
Calculated Available Fire Flow

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MEMORANDUM

TO: City of Lakeville

FROM: Chad T. Katzenberger, PE

DATE: December 15, 2017

RE: Water Distribution System Modeling – Avonlea Addition
SEH No. LAKEV 125769 14.00

BACKGROUND

This memo is intended to summarize the utilization of the City's existing water model to analyze the potential interim operation of proposed water main within the Avonlea 4th Addition. Portions of the proposed plat fall within both the CMF reduced pressure zone (HGL=1121'), while the south west portion falls within the main pressure zone (HGL=1230'), as defined by the comprehensive water system plan. Initially, it is anticipated that the system will first be fed by the CMF reduced pressure zone, with looped connections to the main pressure zone to be constructed at a later date. The memo will aim to analyze the implications of operating the water system in this manor from a system pressure and fire flow perspective.

PROJECT LOCATION

The plat identified for development was provided by City staff as represented in drawings labeled Avonlea 4th Addition – Preliminary Plat. Anticipated water main sizes were provided by the City of Lakeville and are documented in Figure 1.

MODEL CAPABILITIES & ANALYSIS

The complete and calibrated water model has many uses that are very helpful in analyzing both the current water system and potential future improvements. For purposes of this memo, standard functions of the water model software were used to analyze the City's existing water system as it relates to available pressure and fire flow.

Water systems are analyzed, planned, and designed primarily through the application of basic hydraulic principles. Some important factors that must be considered when performing this analysis include: Component size, physical features, pressure requirements, and land use characteristics.

For this water model analysis effort, the water system was analyzed according to:

- Reliable Service Pressure
- Fire Flow Capacity
- System functionality

The water system evaluation was based on standard water industry engineering practice.

Engineers | Architects | Planners | Scientists

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WATER SYSTEM PRESSURES

The water system model was operated with the proposed water system piing layout, with the assumption that all sections of main would be served by the CMF zone in the short term. Water system pressure in the project area are as expected, with the sections of main falling within the CMF pressure zone having pressures in the 45-55psi while the areas that ultimately should be served by the main zone have pressures in the 25-40 psi range (see Figure 1). 10 state standards recommend that system pressures be maintained above 35 psi with ideal pressure being 40psi or greater.

In the long term, the pressure issue will be eliminated once the southwest and northeast section of the development is connected to the main pressure zone and isolated from the CMF zone. In the interim, additional remedial efforts could be pursued. These alternatives are discussed below.

AVAILABLE FIRE FLOW

Water system planning for fire protection is an important consideration. In most instances, water main sizes are designed specifically to supply desired fire flows. Guidelines for determining fire flow requirements are provided by the ISO. ISO is the insurance service 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, and the 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. For purposes of water system modeling analysis, only results up to 3,500 gpm are provided.

Much of the project area consists of Medium Density residential properties. Typical fire flow requirements for this type of property range from 1,000-1,500 gpm while maintaining a water system residual pressure of 20 psi. (These requirements are intended as a general guideline. The actual needed fire flow for a specific building can vary.)

Figure 2 illustrates the estimated available fire flow throughout the entire interim project area for a typical maximum day water demand while maintaining a residual pressure of 20 psi throughout the system.

As can be seen in Figure 2, the areas of lower land elevation, served by the CMF zone have available fire flow in the range of 3,500 gpm, but as elevations rise, system pressure is reduced as is calculated available fire flow. Areas that are to eventually be served by the main pressure zone will have slightly limited pressure and fire flow until connecting main can be extended from the main zone.

TEMPORARY WATER SEVICE TO AREAS OF HIGHER ELEVATION (FUTURE MAIN PRESSURE ZONE)

As noted above, those areas with higher land elevations, which are slated to be served by the main pressure zone, will have limited system pressure and fire flow until these area can receive water from the CMF pressure zone. While it appears the available fire flow levels may be tolerable, system pressure in the some areas fall below 40 psi. Limited pressure will be available until this area can be connected to the main pressure zone. Two potential options are presented below to address the limited pressures in the short term.

High Capacity Booster Station

This option would involve the construction of full booster pumping station either above or below grade to provide water boosted pressure and high capacity flow to the areas that will eventually be served by the main pressure zone. A typical station would include multiple large capacity pumps to support fire flow and a series of smaller pumps to provide flow to meet domestic water demands and maintain system pressure. While a system such as this would provide desired flow and pressure in the project area, investment in this type of facility would be very costly. ($400,000 - $1,000,000 depending on features) System such as this are typically intended to provide water service on a long term basis. Financial investment in a facility of this magnitude may not be warranted on a temporary basis. Upon connection of the areas in question to the main pressure zone, this type of facility would no longer serve a useful purpose.

Small Capacity Pressure Booster Station

This option would serve to increase system pressure on a temporary basis, while large capacity flows for fire protection and flushing would need to bypass the station and flow at lower pressures. Systems such as these typically include a small insulated and heated enclosure with two small pumps, intended to supply domestic flow rates and desirable system pressure. While a system such as this would not provide a boost in fire flow, normal system operating pressures would be maintained above 40 psi. A system such as this could be removed upon connection to the main pressure zone as it would no longer be needed to boost system pressure,

CONCLUSIONS

The City must decide what level of system pressure and fire flow is tolerable in the interim, until these areas can be served by their ultimate intended pressure zone. There are other small neighborhood areas of the exiting Lakeville water system that operate with less than ideal system pressures (30-40 psi). Some residents in these areas have small booster pumps installed on their service connections, to boost water pressure inside the home. However, the 10-States Recommended Standards for Water Works states that *Individual booster pumps shall not be allowed for any individual residential service from the public water supply mains.* As a result, if the City desires to provide increased system pressure in the areas in questions, a small booster station can be considered.

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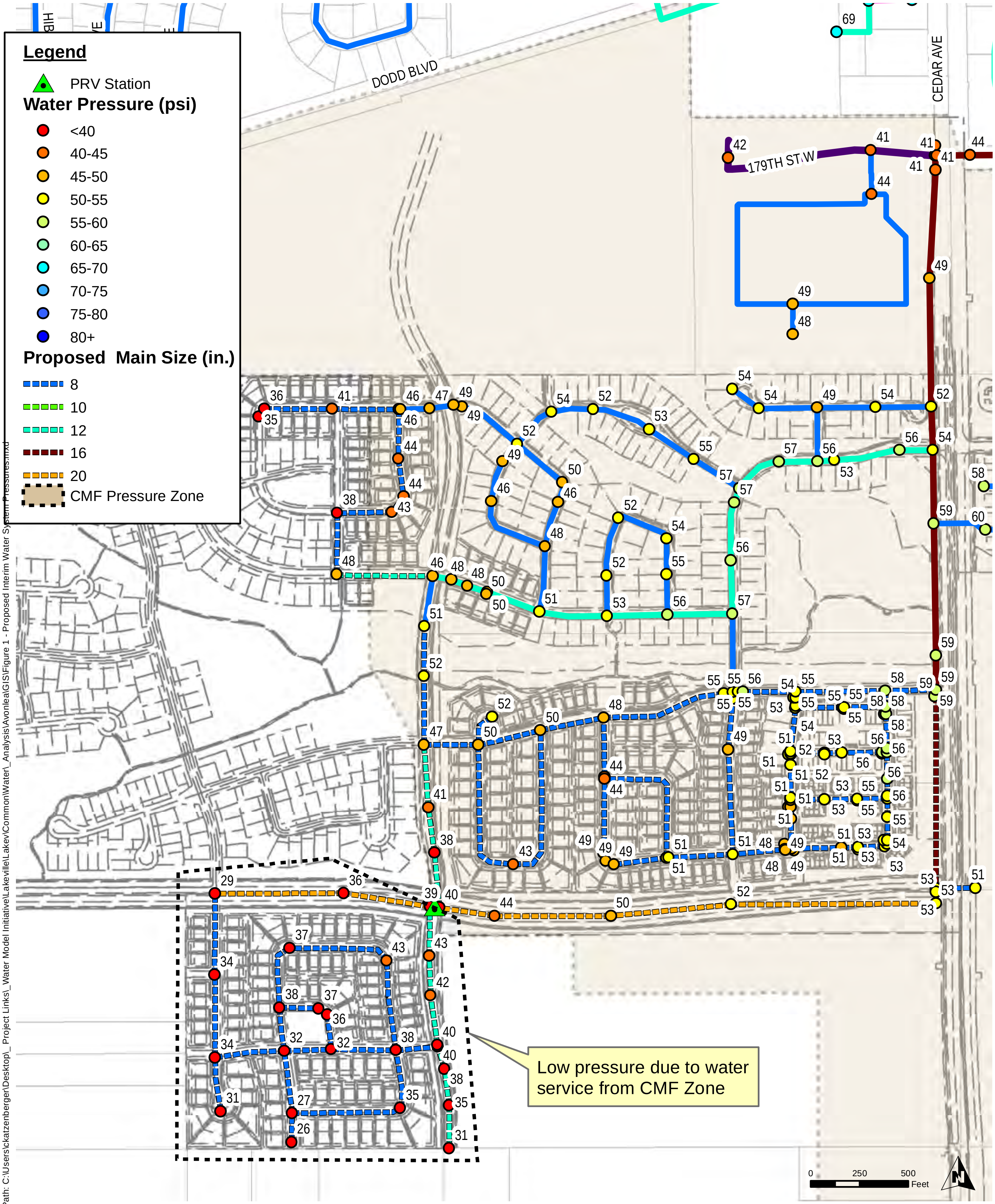


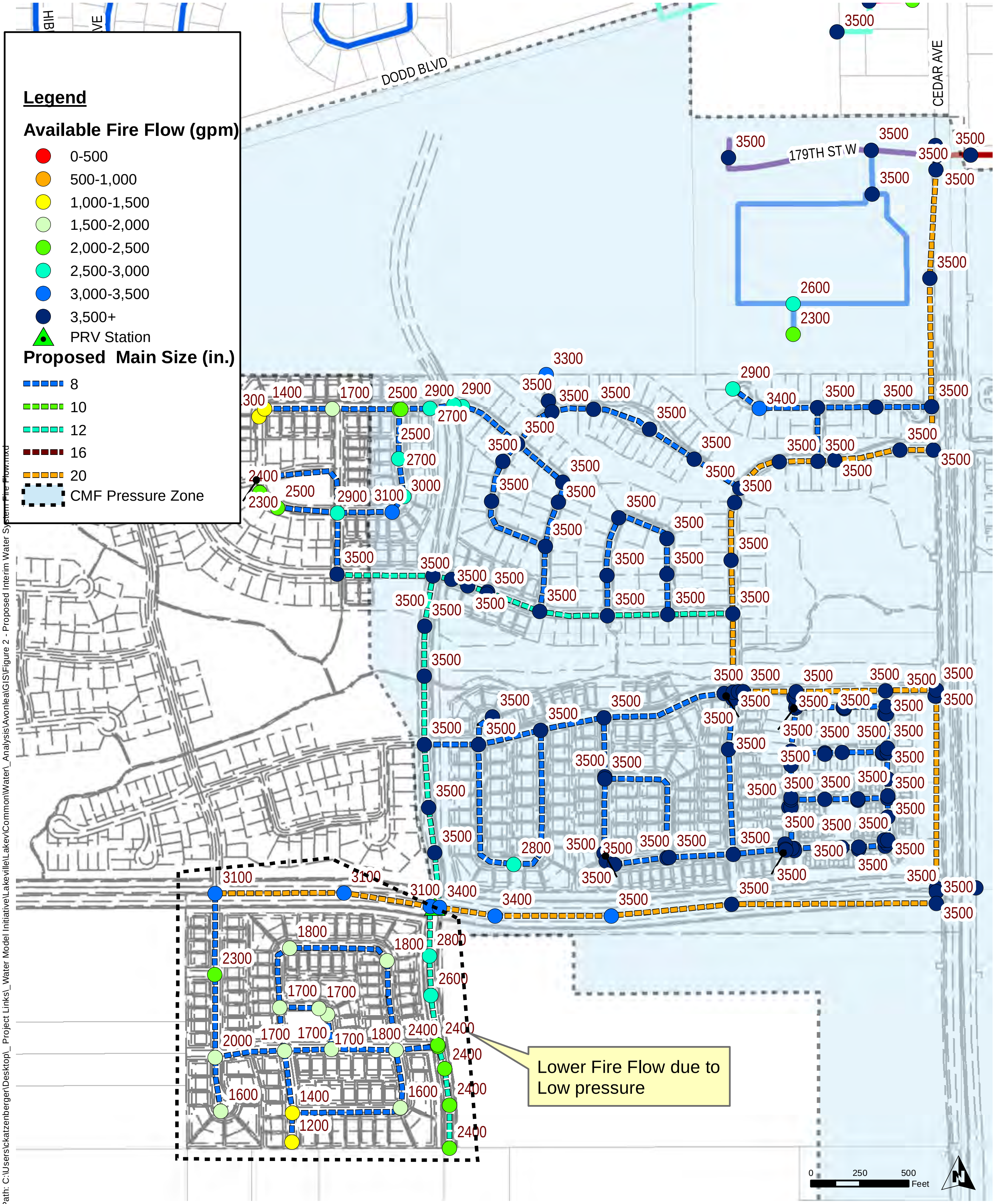
Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water_Analysis\Avonlea\GIS\Figure 1 - Proposed Interim Water System Pressures.mxd

Project Number: LAKEV 125769
Print Date: 12/14/2017

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

Water System Model Analysis
Lakeville, Minnesota

FIGURE 1
Near Term
System Pressures



Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Lakeville\Lakev\Common\Water_Analysis\Avonlea\GIS\Figure 2 - Proposed Interim Water System Fire Flow.mxd

Project Number: LAKEV 125769
Print Date: 12/7/2017

Map by: CTK
Projection: CC
Source: WaterCAD, Tiger, City Files

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Water System Model Analysis
Lakeville, Minnesota

FIGURE 2
Near Term
Calculated Available Fire Flow

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