AGENDA
SHAKOPEE PUBLIC UTILITIES COMMISSION
REGULAR MEETING
September 9, 2024
at 5:00 PM

1. **Call to Order** at 5:00pm in the SPU Service Center, 255 Sarazin Street
   1a) Roll Call

2. **Communications**
   2a) Customer Communications, re: Backflow Testing and Penalties Appeal response (GD)

3. **Consent Agenda**
   C=> 3a) Approval of August 3, 2024 Minutes (GD)
   C=> 3b) Approval of September 9, 2024 Agenda (JK)
   C=> 3c) September 9, 2024 Warrant List (KW)
   C=> 3d) Monthly Water Dashboard for July 2024 (LS)
   C=> 3e) Reservoir Structure Inspections (LS)
   C=> 3f) July 31, 2024 Financials Reports (KW)
   C=> 3g) 2025 Budget Timeline (KW)
   C=> 3h) Statement of Work – Audit Services: Clifton, Larson Allen LLP (CLA) (KW)
   C=> 3i) MMPA August 2024 Meeting Update (GD)
   C=> 3j) Res #2024-27 Resolution of Appreciation to Gregory Triplett (GD)
   C=> 3k) Res #2024-28 Resolution of Appreciation to Cynthia Nickolay (GD)
   C=> 3l) Controlled Substance and Alcohol Testing Policy (GD)

   * Motion to approve the Consent Agenda

4. **Public Comment Period.** Please step up to the table and state your name and address for the record.

5. **Reports: Water Items**
   5a) Customer Appeal of Backflow Penalties (GD)
   5b) 2024 Comprehensive Water Plan Update by SEH, Inc. (JA) *

   * Motion to accept the report and the recommendations contained within, request more information or direct revisions to the report.

   5c) Water System Operations Report – Verbal (LS)
   5d) AMI Water Meter Installations – Actions for Failure to Install (SW)
   5e) Jackson Township Park Water Service Request by the City of Shakopee (JA) *

   * Motion to approve the water service consistent with the provision in Resolution #814

   5f) Request to Authorize Use of Reclaimed Water in Car Wash (JA) *

   * Motion to Authorize the General Manager to proceed as described and direct staff to update the Water Policy Manual to incorporate the requirements to allow reclaimed water to use in certain acceptable situations.

6. **Liaison Report** (JD)

7. **Reports: Electric Items**

7a) Electric System Operations Report – Verbal (BC)

8. **Reports: General**

8a) Marketing/Key Accounts Report – Verbal (SW)

8b) Organization Chart Changes 2024 - 2025 (GD) *

* Motion to accept the changes to the Organizational Chart 2024 - 2025

8c) General Manager Report – Verbal (GD)

8d) NES WTP Site Search Update: Shakopee Gravel/Hawkins potential site plans (GD) **

** A portion of this meeting may be closed under Minnesota Statutes, Section 13D.05, subdivision 3(c) to review confidential or protected nonpublic appraisal data and to develop or consider offers or counteroffers for the purchase of property at 1776 Mystic Lake Drive S

9. **Items for Future Agendas**

10. **Tentative Dates for Upcoming Meetings**

- September 23, 2024 Workshop
- October 7, 2024
- November 4, 2024

11. **Adjournment**

Shakopee Public Utilities
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Shakopee, Minnesota 55379
Main 952.445-1988 • Fax 952.445-7767
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SHAKOPEE PUBLIC UTILITIES
MEMORANDUM

TO: Greg Drent, General Manager

FROM: Joseph D. Adams, Planning & Engineering Director

SUBJECT: 2024 Comprehensive Water Plan Update

DATE: September 5, 2024

ISSUE

Attached is the updated final 2024 Comprehensive Water Plan Update for Commission review.

BACKGROUND

A draft report was previously reviewed with the Commission at their August 5, 2024, meeting.

During the discussion the Commission requested the consultant Chad Katzenberger of SEH, Inc. expand the study to address the facilities and identify associated costs to provide water service to Louisville township under the scenarios of the eventual addition of the township area with municipal water service from SPU either as an annexed area of the City of Shakopee or as a wholesale customer of SPU as a separate entity. These two scenarios would be compared to the base situation of not expanding water facilities to serve beyond the eventual borders of the City of Shakopee with the full annexation of Jackson township.

DISCUSSION

The Commission's planning consultant, SEH's Chad Katzenberger, will present the report and be available for questions.

The 2024 Comprehensive Water Plan will be used in a financial analysis of the Commission's Water Capacity (Connection) Fund and Trunk Water Fund and their associated fees, the Water

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Capacity Charge (WCC) and the Trunk Water Charge (TWC), that are paid by new development and when applicable by projects resulting in increased water usage.

REQUESTED ACTION

Staff requests the Commission either accept the report and the recommendations contained within it, request more information or direct revisions to the report. Once the report is accepted by the Commission, staff will utilize the information within as a guide when preparing the Commission's Capital Improvement Plans and Water System Operating Budgets going forward.

2024 Comprehensive Water Plan

Comprehensive Water System Plan Update

Shakopee, Minnesota

SHPUC 177653 | September 5, 2024

Building a Better World for All of Us®

Engineers | Architects | Planners | Scientists

Building a Better World
for All of Us®

September 5, 2024

RE: Comprehensive Water System Plan Update
2024 Comprehensive Water Plan
Shakopee, Minnesota
SEH No. SHPUC 177653 4.00

Ryan Halverson, PE
SPU
255 Sarazin Street, PO Box 470
Shakopee, MN 55379

Dear Mr. Halverson:

We are pleased to present to you the comprehensive water plan report, an updated and thorough evaluation of our water system's current status and future needs. This report addresses critical areas, such as well replacement, water quality issues, development potential, and the planning of new water treatment plants. Highlights from the report include:

- **Identification of Future Well Sites:** Essential for accommodating growth and replacing aging wells.
- **System Updates:** Incorporating newly constructed facilities, including Well 23 and Tanks 8 & 9.
- **Well Analysis:** Comparing unconfined versus confined wells, with recommendations for the Jordan Wells in alignment with DNR suggestions.
- **Growth Evaluation:** Assessing potential system growth, including redevelopment and expansion in Louisville Township, refining demand projections and analysis of potential "large" water users and system impacts.
- **Water Treatment Planning:** Proposing a site near the Gravel Pit for the Normal HES Water Treatment Plant.
- **Capital Improvement Plan:** Three potential CIPs are presented with alternative options for providing water service to Louisville Township

This comprehensive plan aims to ensure that the SPU water system remains robust, efficient, and capable of meeting future demands while maintaining high standards of water quality and service reliability. Thank you for your help in developing this important updated comprehensive water plan, we look forward to discussing the proposed projects with you further.

Sincerely,

Chad Katzenberger
Senior Engineer
(Lic. CO, MN, SD, WI)

dmk
x:\pt\s\shpuc\177653\4-prelim-dsgn-rpts_final report\2024 comprehensive water system plan update_final draft.docx

2024 Comprehensive Water Plan

Shakopee, Minnesota

SEH No. SHPUC 177653

September 5, 2024

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 Katzenberger, PE

Date: September 5, 2024 License No.: 46613

Reviewed By: Taylor Thom, PE Date: September 5, 2024

Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
St. Paul, MN 55110-3507
651.490.2000

SEH

Distribution

No. of Copies	Sent to
1	Ryan Halverson SPU 255 Sarazin Street, PO Box 470 Shakopee, MN 55379

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Comprehensive Water System Plan Update

Prepared for Shakopee Public Utilities

1 Introduction

Shakopee Public Utilities (SPU) owns and operates the municipal drinking water system which services the City of Shakopee, Minnesota; a community of approximately 48,200 residents located in the northern part of Scott County. The water system has a long history with the first well being constructed in 1910, which fed a small network of water main and a wooded storage tank which sustained system pressure. The small network of water main continued to grow and extend out as the community grew, which now feeds approximately 45,000 people via an estimated 12,135 metered accounts. The SPU provides water service to residences and businesses within the City limits of Shakopee.

SPU provides water to its customers via nineteen (19) groundwater wells, located throughout the water system. The SPU water system includes nineteen (19) wells, five (5) elevated storage tanks (with a sixth tank to be online soon), three (3) ground storage facilities and four (4) booster stations. SPU maintains over 226 miles of transmission and distribution water mains ranging in material (cast iron, ductile iron, and HDPE) and size up to 18 inches in diameter. The system utilizes four (4) pressure zones: the Normal Elevation Service (NES); the First High Elevation Service (1HES), East Zone, and the Second High Elevation Service (2HES) zones. This can be seen in Figure 1 – 2024 Existing Water System Map.

The City of Shakopee's location near major urban centers, key transportation routes, and available land presents significant growth potential. Therefore, strategic planning is crucial to align the expansion of municipal water system facilities with both short-term and long-term community needs. To anticipate the rising population and its demand for high-quality drinking water, SPU regularly updates its long-range planning documents. Following the 2018 Comprehensive Water System plan and the 2019 Supplement, SPU is reassessing future system demands and infrastructure needs with this study. This report summarizes the findings of a water system evaluation for the SPU. The study's primary objectives were to assess the water needs and system expansion required to serve current and future utility customers.

New population projections and anticipated land use maps have been developed. Similar to the 2018 plan and the 2019 supplemental update, this study evaluates the current and future water needs of the SPU system and recommends necessary improvements to maintain adequate water service. The assessment covers a planning period extending to 2045. This report will guide the future expansion and redevelopment of the water system.

1.1 Scope

This 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. Additionally, the projected water system facility needs, and cost estimates are discussed with evaluation based on the City's overall Comprehensive Plan. Below is a summary of the outlined scope items that this plan intends to address.

1. **Provide Updated Water System Demand Projections:** In conjunction with new population forecasts and land use projections, anticipated water system demand projections can be updated with new supporting data.
2. **Update Projected Water System Facility Needs:** As water use forecast changes, the required facilities to support the growth are reviewed and developed to meet the projected need.
3. **Provide Cost Estimates for Projected Water Facilities:** Updated costs for proposed facilities and expansion to support the growth reviewed and developed to meet the projected need.

Because needs change with time, municipal water system planning is a continuous process. 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 assure system expansion is coordinated and constructed in a most effective manner.

1.2 Background and Previous Studies

This plan reviews previous water planning studies completed in prior planning periods, first initiated in 1976. Referenced studies include:

- Comprehensive Trunk Water System Study, January 1976
- Fire Flow Study, 1979. Analyzed fire flows and recommended system improvements to improve deficient fire flows.
- County Road No. 17 – 13th Avenue Area Trunk Water Study, 1980
- Water Connection Charge Study, May 1981 with December 1982 Supplement
- Comprehensive Water Plan, April 1993 (Update to original)
- Conservation and Emergency Management Plan (CEMP), October 1996
- Municipal Water Source Study – Part I, January 1995
- Municipal Water Source Study – Part II, March 1995
- Report on Water System Operations and Modifications to Address High Nitrate Levels in Well Water, December 1996
- 1999 Comprehensive Water Plan Update, July 1999. (Update to 1993 plan and evaluated water system needs for new MUSA Additions)
- Alternative Water Supply Analysis, September 1999
- Water Treatment Plan Feasibility Study, May 2001
- East Water Storage Tank Design Report, January 2003
- Water Trunk Charge and Connection Charge Analysis, March 2003
- Water Rate Study, Preliminary Draft April 2004

- 2004 Comprehensive Water Plan Update, 2004
- Aquifer Sustainability Study, 2005
- Southeast Area Water Service Report, December 2006
- 2006 DNR Water Supply Plan, December 2006
- 2017 DNR Water Supply Plan, February 2017
- Comprehensive Water System Plan, 2018 with 2019 Water Treatment Supplement
- DNR Water Supply Plan Amendment, 2022

The table below provides a history of water system facility construction.

Table 1 – SPU Water System Facility Construction Timeline

Year	Facility	Type	Status	Notes
1910	Well No. 1	Supply	Inactive	First Well
1910	Wood Storage Tank	Storage	Inactive	First Storage Tank
1940	0.25 MG Spheroid	Storage	Active	Currently Tank No. 2
1945	Well No. 2	Supply	Active	
1956	Well No. 3	Supply	Active	
1966	2.0 MG Reservoir	Storage	Active	Current Tank No. 1
1972	Wells No. 4 and No. 5	Supply	Active	Installed by Eagle Creek Township
1973	Eagle Creek Water Main	Distribution	Active	Connected City to Eagle Creek Wells
1980	1.5 MG Hydropillar	Storage	Active	Current Tank No.3
1980	Well No. 6	Supply	Active	Trunk Main Also Constructed (Kmart Project)
1986	Well No. 7	Supply	Active	Driven by Growth
1989	Well No. 8	Supply	Active	Driven by Growth
1995	First High Elev. Service	Distribution	Active	Development into Higher Elevation Areas
1995	Well No. 9	Supply	Active	Supply to First High Elevation Service Area
1998	Well No. 10	Supply	Active	Water to Dilute Nitrates from Wells No. 6 & 7
1999	SCADA System	-	Active	First SCADA Addition to the System
2000	Trunk Main	Distribution	Active	Southbridge/101 Trunk Main
2001	Well No. 11	Supply	Active	
2001	Well No. 12	Supply	Active	
2002	Well No. 13	Supply	Active	
2002	0.5 MG Elevated Storage	Storage	Active	Current Tank No. 4
2004	Well No. 14	Supply	Active	
2005	Well No. 15	Supply	Active	
2005	2.5 MG Ground Storage	Storage	Active	Current Tank No. 5
2005	2.5 MG Ground Storage	Storage	Active	Current Tank No. 6
2006	Well No. 16	Supply	Active	

Year	Facility	Type	Status	Notes
2006	Well No. 20	Supply	Active	
2006	Well No. 21	Supply	Active	
2007	Well No. 17	Supply	Active	
2015	2.0 MG Ground Storage	Storage	Active	Current Tank No. 7
2019	0.75 MG Elevated Storage	Storage	Active	Current Tank No. 8
2022	Well No. 23	Supply	Active	
2025	0.5 MG Elevated Storage	Storage	Active	Tank No. 9 Under Construction – To be Online in 2025

Source: SPU Records

2 Existing Water System

The Shakopee water system has a long history, as the first well was constructed in 1910. This well fed a small a small network of water main and a wooden storage tank which sustained pressure for the system. The small network of water main continued to grow and extend out as the community grew. The table above shows a sequential history of the expansion and growth of the SPU water system.

The water system has grown to include eight storage tanks (with a ninth to be online in 2025), nineteen groundwater supply wells, and four pumping stations. The system utilizes four pressure zones: the Normal Elevation Service (NES); the First High Elevation Service (1HES), East Zone, and the Second High Elevation Service (2HES) zones. The East Zone has the same hydraulic grade line as the Second High Zone. The Second High Zone is also separated out into separate sections. The separation is due to how development has occurred with respect to the elevation of the landscape.

2.1 Supply

Table 2 lists Shakopee's groundwater supply wells. Shakopee receives water from deep wells located throughout the system. Water is accessed from one of three different aquifers including: Prairie du Chein-Jordan Sandstone (CJDN), Tunnel City – Wonewoc Bedrock (CGC, CWC), and Mt. Simon-Hinckley bedrock (CSTLCMTS).

The Prairie du Chien-Jordan Sandstone aquifer has been the primary aquifer option for the City as the Tunnel City-Wonewoc bedrock aquifer is generally unproductive in the Southwest Metro area and Mt. Simon/Hinckley bedrock aquifer is protected by Minnesota Statues due to overuse and is also susceptible to radium and slow recharge.

Previous studies as well the aquifer study update (Appendix A) investigated the sustainability of the use of the Prairie du Chien-Jordan Sandstone to serve the region. The studies concluded that the Prairie du Chein-Jordan aquifer is truncated, encompassed, and isolated in Shakopee; however, regional groundwater models such as the Metropolitans Metro Model 3 indicate that the aquifer will stay sufficiently saturated as it is still hydraulically connected to horizontal flow into the City's source water aquifer. Recharge to the aquifer is estimated to range from 7.6 to 12.2 billion gallons per year. Modeling from the Metro Model 3 during this study indicate recharge over City limits is closer to 12 billion gallons per year. Precipitation trends under current climate scenarios indicate that Minnesota is likely to increase. Additionally, the City's source water aquifer is recharged over a much larger regional area. Locally to Shakopee, the source water aquifer bedrock units are hydraulically connected through unconsolidated sediment that fill in "bedrock valleys" where the bedrock units are not laterally connected. The groundwater flow modeling appears to suggest that the Prairie du Chien-Jordan Aquifer will remain in a fully-saturated condition (groundwater heads at or above the Jordan Sandstone), even under reduced recharge and aquifer capacity conditions. Outflows from water supply wells within the model domain currently make up 6% to 14% of water inflows. Because outflows were increased by wells it is a likely presumption that the increase in pumping is balanced by a decrease in aquifer outflows to surface water features.

As a result, it appears as though the aquifer has the capacity to meet the future demand of Shakopee. However, care must be taken to ensure the sustainability of the aquifer.

Table 2 – Existing Well Facilities

MN Unique Well ID #	Facility	Year Installed	Pressure Zone	Capacity (gpm)	Well Depth (ft)	Status
Well No. 2	206803	1944/2002	Normal	300	525	Active
Well No. 3	205978	1956	Normal	900	755	Emergency
Well No. 4	206854	1971	Normal	716	254	Active
Well No. 5	206855	1971	Normal	850	253	Active
Well No. 6	180922	1981	Normal	1175	222	Active
Well No. 7	415975	1986	Normal	1100	218	Active
Well No. 8	500657	1989	Normal	1100	262	Active
Well No. 9	554214	1994	1st High	1050	315	Active
Well No. 10	578948	2001	Normal	1025	800	Active
Well No. 11	611084	2001	1st High	1000	312	Active
Well No. 12	626775	2001	1st High	810	352	Active
Well No. 13	674456	2002	1st High	1036	338	Active
Well No. 14	694904	2004	1st High	381	597	Active
Well No. 15	694921	2005	Normal	1150	295	Active
Well No. 16	731139	2006	Normal	1450	285	Active
Well No. 17	731140	2007	Normal	1400	290	Active
Well No. 20	722624	2005	1st High	1142	275	Active
Well No. 21	722625	2005	1st High	1175	275	Active
Well No. 23	877418	2022	2nd High	800	321	Active

Source: SPU Records and MPARS

Additional information related to the wells included in the aquifer sustainability study.

2.1.1 Water Pumpage

Historical water pumping data for SPU's water supply wells, including the 2021-2023 production years, is summarized in the table below. The wells pumping from the Prairie du Chein-Jordan aquifer supplies a significant quantity of water to the SPU's water system and is expected to provide the majority of the water in the future. Based on pumping records, and information from the aquifer sustainability study approximately **96% of the water supplied is from the Prairie du Chien-Jordan aquifer** and less than 4% from the Tunnel City-Wonewoc and nearly no use from Mount Simon aquifer as Well No.10 is considered an emergency backup well.

If one of the SPU wells is discovered to have a water quality parameter that does not meet water quality standards, SPU takes necessary steps to ensure the well is either rarely used for supply and/or properly blended with a "cleaner" well prior to distribution. This was the case for Well No. 3 and Well No. 14, which are essentially not used for supply, and Well No. 10, which is used for less than 0.17% (3 year average) of the total water pumped annually.

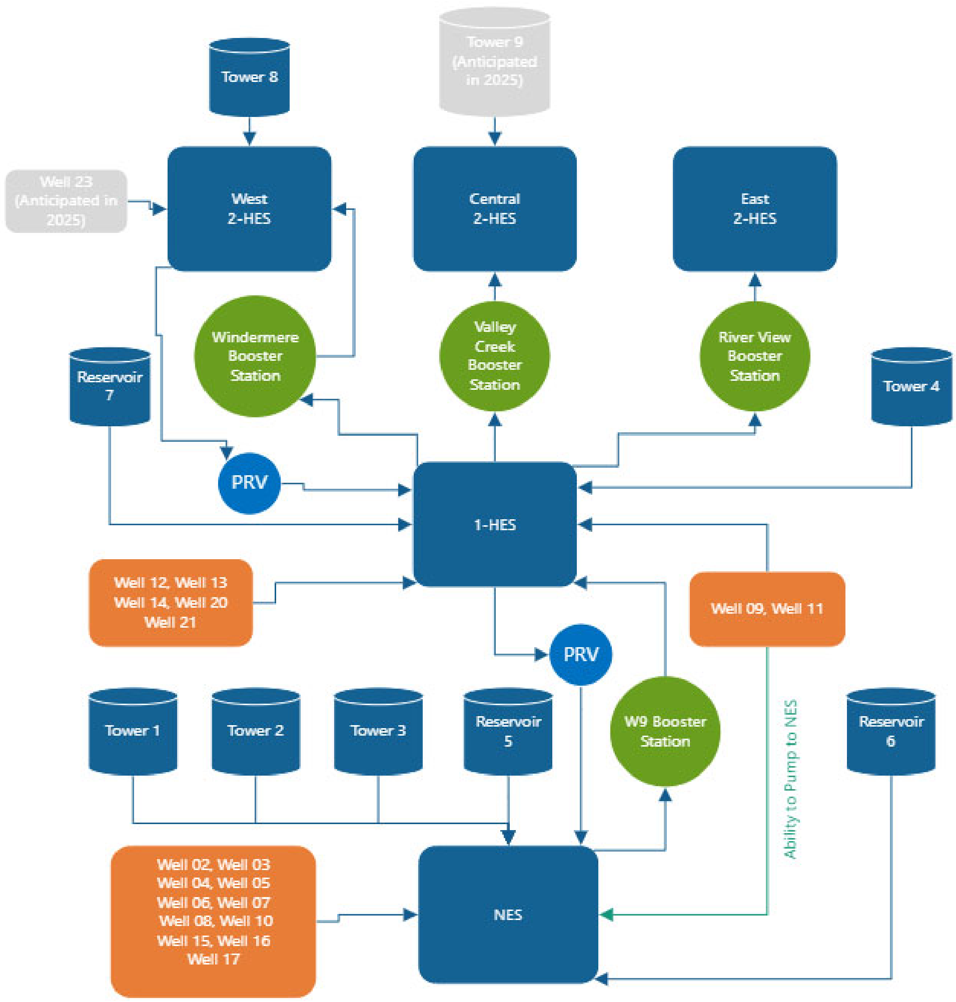
The table below provides a pumping summary of each well for 2021 to 2023.

Table 3 – Historical Water Pumpage (2021-2023)

Well No.	2021		2022		2023	
	Total (1,000 gal)	% of Total	Total (1,000 gal)	% of Total	Total (1,000 gal)	% of Total
2	41,935	2.0%	39,431	2.0%	84,983	3.8%
3	0	0.0%	0	0.0%	0	0.0%
4	102,867	5.0%	75,888	3.8%	81,281	3.6%
5	73,353	3.5%	45,169	2.3%	43,950	2.0%
6	202,360	9.7%	210,976	10.5%	218,930	9.8%
7	276,081	13.3%	265,080	13.2%	296,754	13.2%
8	221,555	10.7%	215,399	10.7%	209,802	9.4%
9	163,669	7.9%	174,398	8.7%	136,889	6.1%
10	8,362	0.5%	707	0.0%	230	0.0%
11	129,262	6.2%	161,654	8.1%	181,496	8.1%
12	159,960	7.7%	162,360	8.1%	110,266	4.9%
13	49,068	2.4%	64,976	3.2%	185,182	8.3%
14	0	0.0%	0	0.0%	0	0.0%
15	102,531	4.9%	90,075	4.5%	69,293	3.1%
16	157,716	7.6%	143,738	7.2%	185,466	8.3%
17	152,089	7.3%	103,593	5.2%	148,269	6.6%
20	115,875	5.6%	171,423	8.5%	150,003	6.7%
21	123,499	5.9%	82,076	4.1%	138,457	6.2%
Total (1,000 gal)	**20,801,820**		**20,069,430**		**22,412,510**	

2.2 Treatment

Shakopee does not utilize filtration plants water is supplied directly from the wells. The water pumped from the Prairie du Chien-Jordan aquifer is generally considered to be of such high quality, with respect to the Environmental Protection Agency's (EPA) enforceable National Primary Drinking Water Regulations (NPDWR), that SPU has not had a reason, nor have they been required to actively remove anything from their groundwater source. SPU only operates and maintains fluoridation and chlorination treatment systems for the prevention of tooth decay and residual disinfection through the distribution system piping. Shakopee additionally has the ability to feed polyphosphates (PO_4) at Wells No. 12 and 15 to help reduce the chance of aesthetic issues caused by iron and manganese. Each well is equipped with its own chemical feed equipment.



2.3 Storage

Water storage tanks play a significant role in the operation of a water system by sustaining system pressure and supplying water when needed. Six elevated tanks and three ground level reservoirs provide distribution storage for the SPU water system. These facilities are noted in the table below. All facilities provide "floating" storage for the system, meaning they supply flow from the tank via gravity.

Table 4 – Existing Water Storage Facilities

Structure Name	Type of Storage Structure	Year Constructed	Primary Material	Overflow Elevation (ft)	Storage Capacity (Gallons)
Tank No. 1	Elevated	1966	Steel	933.00	2,000,000
Tank No. 2	Elevated	1940	Steel	933.00	250,000
Tank No. 3	Elevated	1980	Steel	933.00	1,500,000
Tank No. 4	Elevated	2002	Steel	1015.00	500,000
Tank No. 5	Ground	2005	Steel	933.00	2,500,000
Tank No. 6	Ground	2005	Steel	933.00	2,500,000
Tank No. 7	Ground	2015	Steel	1015.00	2,000,000
Tank No. 8	Elevated	2019	Steel	1115.00	750,000
Tank No. 9	Elevated	2025	Steel	1115.00	500,000
				TOTAL (MG)	**12.50**

Source: SPU Records and MPARS

2.4 Pressure Zones

Due to the nature of the land elevations served within the service are of the SPU 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 less 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 pressured within a range of minimum to 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 pounds per square inch (psi) and maximum pressure of 80 psi be provided to all locations in the service area under normal operating conditions. If service pressures exceed 80 psi State Plumbing Code calls for pressure reducing valves (PRV's) to be installed at services lines where pressure monitored in the street 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 Shakopee water system has been designed with three Hydraulic Grade Levels (HGL) and three pressure zones in order to sustain adequate system pressures. A summary of each pressure zones is identified in the table below. Due to geographic separation and development timing of the Second High pressure zone (2-HES) this zone is currently divided into two subregions. The West zone currently has pressure sustained by Tank 8 and soon the 2HES central zone will be served by Tank 9 (tank anticipated to be online in 2025). Though these two sub pressure zones will operate at the same hydraulic grade, they are not currently connected and do not receive water from the same sources. The long term vision for this water system has these two zones connected to a common 2-HES pressure zone.

Table 5 – Existing Pressure Zones

Service Area	Hydraulic Grade Line (HGL)	Lowest Elevation Served (ft)	Highest Elevation Served (ft)
Normal Elevation Service (NES)	933	740	840
First High Elevation Service (1-HES)	1015	800	920
Second High Elevation Service (2-HES)[1]	1115	900	1030
Second High Elevation Service East (2-HES)[1]	1115	900	1030
[1]2-HES is currently separated geographically into three stand-alone pressure zones (West, Central, and East)			

Source: SPU Records

2.5 Booster Stations

The Shakopee water system currently has four booster stations, with one additional station in either the planning or construction phase. The Valley Creek Booster Station transfers water from one pressure zone to another while the other stations transfer water as well as sustain pressure in the corresponding pressure zone. The table below shows the capacities of the booster pumps at each of the interzone booster pumping stations.

Table 6 – Existing Booster Stations

Facility	Function	From Pressure Zone	To Pressure Zone	Pump No.	Capacity (gpm)	Total Station Capacity (MGD)
Well No. 9 Booster	Zone Transfer	NES	1-HES	1	1000	2.9
				2	1000	
Valley Creek	Zone Transfer/ Pressure Sustain	1-HES	2-HES – Central	1	1000	2.9
				2	1000	
Windermere (West)	Zone Transfer/ Pressure Sustain	1-HES	2-HES - West	1	1000	2.9
				2	1000	
Riverview (East)	Zone Transfer/ Pressure Sustain	NES	2-HES - East	1	1000	2.9
				2	1000	

Source: SPU Records

2.6 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 Shakopee water system is comprised of approximately 226 miles of water mains ranging in size up to 18 inches in diameter as illustrated in figure 2-1. The current water main size inventory is summarized in the table below. Of the 226 miles of water main, 34% is 12 inches in diameter or larger which represent the transmission mains in the system. Transmission water mains typically do not have water services connected to the main. The presence of large water main as exists in the Shakopee water system supports the ability of the water system to transmit large system flows.

The trunk water mains connect the supply and storage facilities with the lateral water mains. The City's current policy requires a trunk water main grid of 12-inch diameter water main in each direction of a half-mile spacing or the equivalent. In general, this policy has been followed south of CR 69/101. Lateral water mains are typically 6, 8 or 10 inches in diameter in residential areas where water usage and fire flows are minimal. In industrial areas, where there is potential for large volume users and higher fire flows, larger lateral mains are required. City policy requires minimum 12-inch diameter mains in industrial areas and 8-inch diameter in commercial areas.

Table 7 – Existing Water System Piping

Pipe Size (inches)	Percent of Total (%)	Length (feet)	Length (Miles)
6	23.2%	276,700	52.4
8	40.8%	486,900	92.2
10	1.8%	21,000	4.0
12	26.7%	319,000	60.4
16	4.9%	58,300	11.0
18	2.7%	32,800	6.2
Total	**100%**	1,194,800	226.3

Source: SPU Records

3 Population and Community Growth

This section summarizes the planning assumptions made regarding future service area characteristics for SPU water service area. Since 2018, new population projections and land use information is available, below is a summary of the new data which will be utilized for this report.

3.1 Population Forecast

There is generally a closer 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.

The City's estimated population in 2022 was 45,961 according to the State of Minnesota Demographers. The table below summarizes historical population of the City as provided by the State Demographer.

Table 8 – Historical Population Data

Year	Population	Annual Growth Rate
1970	7,715	-
1980	9,941	2.5%
1990	11,739	1.7%
2000	20,568	5.6%
2010	37,366	5.9%
2015	39,981	1.5%
2020	43,698	5.8%
2021	44,526	1.0%
2022	45,961	2.7%

Source: State Demographer

The City of Shakopee has experienced an exponential increase in population in the last 20 years with the population nearly doubling since the year 2000. The City's estimated population in 2020 was 43,698 according to most recent census data. The table above summarizes past trends, and the table below summarizes projected future population of the City. Future population estimates are based on projections provided by the Metropolitan Council and the City's 2040 Comprehensive Plan through the year 2040. Upon review and/or suggested modifications of the population projections by City comprehensive planning staff, future water use projections cited in this report can be updated.

Table 9 – Projected Population Data

Year	Population	Annual Growth Rate
2025	47,250	0.9%
2035	55,750	1.7%
2045	63,300	1.3%

Source: City of Shakopee 2040 Comprehensive Plan, and Metropolitan Council

Projections noted above indicated SPU's service area total population has the potential to increase to approximately 63,300 people by the year 2045. This estimate was developed by extrapolating the City's comprehensive plan population projection for 2040. This estimate includes areas of the City expected for expansion as cited in the comprehensive plan. For this study, in calculation per capita water use, it is estimated that approximately 3,000 people are served by private wells in rural residential areas. It is assumed that as the boundaries of the City grow and rural areas are annexed, a similar percentage of residents (7%) may remain on private wells through the planning period. As a result, future water users are expected to grow at a rate similar to the population growth.

3.2 Existing Land Use

For this study, existing City land use data was reviewed. Figure 3-3 illustrates current land uses and represents the nature and extent of existing development within the City, future growth, and land use. The City's existing land use is a diverse mix of historical development patterns flanked by commercial, industrial, entertainment, and residential developments. Previously, Shakopee was considered a freestanding growth center, but recent developments have caused suburban development to stretch into Shakopee. This makes Shakopee a unique community in that though it includes suburban development, its primary core includes a historic downtown and long established residential, industrial, and commercial areas. In addition, the City includes major entertainment venues including the Valley Fair Amusement Park and Canterbury Park which attracts visitors from across the Midwest. The seasonal characteristics of these facilities can create challenges during the summer months, due to single season use.

3.3 Water Service Area

The extent of this study includes the existing water service area and potential annexation areas. The water system will be discussed in more detail in Section 4. The majority of the land within existing City limits is served by water main with the exception of a few undeveloped areas, as well as tribal held lands. The SMSC community operates a separate water system for its own needs. The water system is first expected to grow in the Western portion of the City as portions of Jackson Township are annexed into Shakopee City limits with the potential for additional growth in Louisville township.

4 Water Requirements

This section updates water use history with current information and provides for new water use projections based on new population data.

4.1 Water Consumption History

As previously completed in the Water Comprehensive Plan, an analysis was made of past water consumption characteristics by reviewing annual pumpage and water sales records for the period from 2000 to 2023. Average and maximum day water consumption during this period was analyzed with the amount of water sold in each customer category. Projections of future water requirements are based on the results of this analysis, coupled with estimates of population and community growth.

Table 10 – Historical Water Use

Year	Estimated City Population	Estimated Water Service Population	Average Day (AD) Water Pumped (MGD)	Maximum Day (MD) Water Pumped (MGD)	MD : AD Ratio	AD Per Capita Water Use (gpd)	MD Per Capita Water Use (gpd)
2010	37,366	34,750	4.71	10.62	2.26	137	309
2011	38,000	35,000	4.81	10.80	2.25	137	309
2012	38,730	35,730	5.87	16.26	2.77	164	455
2013	39,167	36,167	4.94	13.38	2.71	137	370
2014	39,448	36,448	4.59	10.88	2.37	126	298
2015	39,981	36,981	4.52	9.94	2.2	122	269
2016	40,743	37,743	4.74	11.58	2.44	126	307
2017	41,125	38,125	4.87	13.23	2.71	128	347
2018	41,506	38,506	5.05	10.57	2.09	131	275
2019	41,528	38,528	4.56	11.15	2.45	110	268
2020	43,698	40,698	4.93	10.11	2.05	113	231
2021	45,593	42,593	5.70	14.66	2.57	125	322
2022	45,961	42,961	5.50	13.25	2.41	120	288
2023	47,408	44,408	6.14	14.19	2.31	130	299
5 Year Average			5.37	12.67	2.37	119.60	281
Maximum			6.14	**16.26**	**2.77**	164	455
Service Population = City Population less 3,000+ rural residential residents on private wells							

Source: SPU Records

4.2 Water Consumption and Pumpage Projections

Population growth, development, customer water needs, conservation, and climate all affect future water needs. This section provides a projection of water needs to the year 2040 based on these factors. Projections are based on anticipated population growth and conservation, as well as on buildout of all service areas, which represents ultimate system demand potential.

4.2.1 System Wide Water Needs Projections

4.2.1.1 Projected Water Use By Population

The tables below summarize the population based water needs projections for current water use in a drought year. With the assumptions shown in the table, by 2045 SPU could experience a maximum day demand of **24.0 MGD** if year 2045 were a drought year.

Table 11 – Future Water Needs Projections

	Year	2025	2035	2045
	Population	47,250	55,750	63,300
	Current Practices for Drought Year (Based on Drought Year 2012)			
Demand Type	Assumption	Demand (mgd)		
Residential	84 gpcd	3.97	4.68	5.32
Non-Residential				
Largest Customers	0.61 mgd	0.61	0.61	0.61
Other Population Based	36 gpcd	1.70	2.01	2.28
Average Day Sales		*6.28*	*7.30*	*8.21*
Unaccounted Water	5.3%	0.35	0.41	0.46
Projected Average Day Demand		**6.6**	**7.7**	**8.7**
Projected Maximum Day Demand	**277%**	**18.4**	**21.3**	**24.0**

Table 12 – Projected Water Use – By Population

Year	Population	Projected (AD)	Maximum Day (MD) Water Pumped (MGD)
2025	*47,250*	6.6	18.4
2035	*55,750*	7.7	21.3
2045	*63,300*	8.7	24.0

4.2.1.2 Projected Water Use By Pressure Zone (Population Based Projection)

Similar to the system wide water needs projection, each supply service area was projected for its individual water needs. This analysis was based on population and also by land use. Historical water use billing data from meters was used to determine each pressure zone and allocated demands based on land area.

The planned pressure zones are shown in Figure 1 – 2024 Existing Water System Map. The pressure zones were shaped in a manner consistent with utility planning, also in a way where zones could be reasonably connected by water mains.

Table 13 – Projected Water Use – By Pressure Zone

Zone	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Portion of Total Demand
2035			
Main Zone	5.04	13.93	65.3%
1st High Zone	1.80	4.99	23.4%
2nd High Zone Central	0.14	0.40	1.9%
2nd High Zone West	0.77	2.13	10.0%
2nd High Zone East	0.11	0.30	1.4%
Total	**7.71**	**21.3**	**100%**
2045			
Main Zone	5.41	14.97	62.4%
1st High Zone	2.00	5.54	23.1%
2nd High Zone Central	0.18	0.50	2.1%
2nd High Zone West	1.09	3.01	12.6%
2nd High Zone East	0.13	0.37	1.6%
Total	**8.67**	**24.0**	**100%**

4.3 Potential Large Water Users

The current water user projections are based on existing customer types. However, in recent years, large prospective water customers have approached SPU regarding water availability. These customers, including those with significant power needs, have requested up to 2.0 MGD of water. With the rise of technology, data centers requiring water for cooling operations have been emerging nationwide. A data center is one example of such a large water user. If a customer of this scale were to connect to the system, it would raise concerns about the water system's ability to provide reliable service to both the new user and neighboring customers. For planning purposes, an impact analysis for up to 2.0 MGD at a single point is included, with a hypothetical connection on the west side of the 1st high zone.

4.4 Potential Expansion Areas

4.4.1 Louisville Township

As part of the overall comprehensive plan effort, we have completed a preliminary high-level estimate of additional water needs for Louisville Township. Although this area is not included in the immediate-term plan, understanding the potential demand implications if this area were to develop is crucial. This section provides a brief analysis of Louisville Township's ultimate demand potential.

Key Assumptions for the Analysis:

1. County Land use Mapping referenced for potential development characteristics including industrial, commercial and residential land uses
2. Development Assumption: Residential: Mix of Single-family residential with ½ acre lots (Urban expansion) and 1 acre lots (transition area)
3. Development Allocation: 80% of the developable area assumed in calculations
4. Demand Load: See Table B1 for lead assumptions based on historical Shakopee water use.

Analysis Summary:

1. Potential Developable Area: 5,900 acres in Louisville Township (Excludes public Lands).
2. Using the above assumptions, the potential service area in Louisville Township could add an additional average day demand of 2.6 MGD and a maximum day demand of 4.9 MGD at full buildout. These volumes are considered later in the report analyzing additional SPU infrastructure that may be required to serve Louisville from the main SPU water system.

Future Considerations:

1. The Metropolitan Council may install a new treatment facility by 2050, potentially driving development in Louisville Township. This facility would be located across State Highway 169.
2. Additional water use from the potential Met council facility should be considered as the existing Met Council facility served by SPU has a daily water use of 170,000 – 200,000 gallons per day. Proposed facilities have been sized to accommodate this potential need.
3. It is essential to examine pressure zone and storage needs, including the feasibility of serving this area from the existing Shakopee pressure system.

Water System Needs

If the Louisville township area were to fully develop as described in the land use assumption calculation for future water use, it assumed that an additional 3 – 4 water supply wells (800 – 1,000 gpm) each and 2.5 MG of elevated storage would be required at full buildout. In the interim, as there is initial expansion, the system could be partially served by the current East 2nd High zone. The recommendations developed from the Aquifer sustainability study as well as this report indicate that future wells within the bounds of the current SPU service area would be the most likely source for service to Louisville. In light of this, the overall system recommendations include consideration on how water can be delivered from new wells within the SPU water system to Louisville Township.

4.4.2 Canterbury Redevelopment

The City has been proactive in encouraging redevelopment around Canterbury Park. The Canterbury Commons project is a significant mixed-use development initiative aimed at transforming the area into a vibrant community hub with residential, commercial, and recreational spaces. This may lead to added infill development, which would result in added demand on the Normal elevation service district, this expected demand is accounted for in current water system demand projections.

5 Water System Evaluation

In the previous comprehensive water plan, the water system was evaluated regarding numerous system criteria. Considering the updated water system demands, the system has been re-evaluated to provide for an updated set of recommended alternatives. Additionally, this study includes a summary of previous evaluations regarding the need for future treatment.

5.1 Water Supply Sources and Water Quality

The Utility utilizes three different aquifers as the water source for their public water supply. These aquifers are the Prairie du Chien-Jordan Sandstone, Tunnel City-Wonewoc, and Mt. Simon/Hinckley Bedrock.

In the Shakopee area, the Prairie du Chien-Jordan Sandstone aquifer is close to the ground surface and is soft in structure. Wells constructed in this area have removed sandstone surrounding the well to prevent copious quantities of sand from entering the well with the water.

Prairie du Chien-Jordan Sandstone Aquifer
The Prairie du Chien-Jordan Sandstone Aquifer supplies a significant quantity of water to the City's water system and is expected to provide most of the water in the future. Wells No. 4, 5, 6, 7, 8, 9, 11, 12, 13, 15, 16, 17, 20, 21, and 23 utilize water from the Prairie du Chien-Jordan Sandstone Aquifer.

Tunnel City-Wonewoc
Wells No. 2 and 14 utilize water from the Tunnel City-Wonewoc aquifer. This aquifer also supplied water to Well No. 1 before it was abandoned and sealed.

Mt. Simon/Hinckley
Wells No. 3 and 10 utilize water from the Mt. Simon aquifer. This aquifer also supplied water to Well No. 1 before it was abandoned and sealed. A portion of Well No. 3 used to access the St. Lawrence aquifer, however this section of the well has since been sealed off.

The quality of water delivered by the community water supplied must meet legislated water quality standards and should meet other standards recognized as desirable by the water industry. Desirable water quality implies water that is clear, tasteless, odorless, and free of chemical and microbiological contaminants.

5.1.1 Aquifer Sustainability Study

An aquifer sustainability study was completed as part of the 2024 Comprehensive Water System Plan Update and is included in Appendix A. The Prairie du Chien-Jordan bedrock aquifer is the primary source of water for SPU and other surrounding communities. The study evaluates the current and future groundwater demand, recharge, and drawdown of the aquifer using a three-dimensional groundwater flow model and various scenarios of pumping and climate conditions. The study finds that the source water aquifer will remain in a fully saturated condition even under increased pumping and reduced recharge, but there may be some impacts on surface water features due to decreased outflows from the aquifer. Precipitation forecast, a major input into the model is complex, but regional modeling discussed that while droughts are likely to occur overall precipitation trends are likely to increase. An increase to precipitation may lead to an increase in infiltration and input into the source water aquifer; however, land use changes as well as timing of precipitation is being further studied to understand its influence on infiltration to the source water aquifer. Balancing well pumping and the resulting drawdown with recharge is essential to prevent overexploitation and depletion of aquifers or potential impacts to surface water features. Effects from drawdown can be alleviated by managed pumping schemes and optimal well spacing. The study looked at three scenarios to assess development of future wellfields.

The study identified four potential well feasibility areas for future development, with areas A (including Well 23 and future wells 22 & 24) and area B (including future wells 18, 19, and 21) being the priority due to existing infrastructure, modeling results, and higher aquifer availability. Additionally, there is a potential for the SPU to acquire a production well from an entity within Well siting area B. SPU should consider this if the opportunity arises; however, multiple DNR and MDH regulations may apply for acquiring a well in such a manor. SPU should consider dialogue with relevant State agencies prior to obtaining the well. Water Quality, well construction, well condition, as well as an Inner Wellhead Management Zone Survey should be evaluated during a State review process. The study recommends that SPU monitor the groundwater levels and quality in the aquifer, update the groundwater flow model with new data, work with the Met Council and the DNR on water planning and conservation efforts, and conduct comprehensive aquifer pumping tests for new wells.

5.1.2 Water Quality Standards

SPU and all public utilities are required to meet water quality rules and regulations under the Safe Drinking Water Act. SPU must meet all regulations and participate in required programs established by the governing bodies, the U.S. Environmental Protection Agency (EPA), and the Minnesota Department of Health (MDH).

5.1.3 Water Supply Challenges

Water use restrictions have been placed on the Mt. Simon/Hinckley bedrock aquifer. These restrictions only allow usage of the aquifer when there is no alternate water supply available, and the water may only be used for drinking water purposes. Wells No. 3 and 10 are supplied with water from this aquifer. Well No. 10 has low nitrate concentrations and was established to dilute the moderate levels of nitrates in water from Wells No. 6 and 7.

Multiple aquifer wells are wells that utilize water from multiple aquifers. These types of wells are no longer allowed to be constructed in Minnesota because of the increased potential for spreading contamination to multiple aquifers. Well No. 3 is a multiple aquifer well and was once supplied with water from all three aquifers. Eventually, the Prairie du Chien-Jordan sandstone aquifer was cased off due to the large quantity of sand that was entering into Well No. 3. Well No. 2 was also a multiple aquifer well that received water from all three aquifers. Two of the aquifers have been cased off and it currently only receives water from the Tunnel City-Wonewoc aquifer.

5.1.4 Existing Drinking Water Quality

SPU's drinking water is supplied directly from the naturally safe wells and has consistently tested below levels that would require filtration or other extensive treatment (with the use of blending). SPU regularly monitors their wells to ensure they stay in compliance with the EPA's NPDWRs, as well as make a clear effort to meet the NSDWRs and other non-enforceable water quality standards. If one of SPU's wells is discovered to have a water quality parameter (iron, manganese, nitrate, arsenic, radium, etc.) that has surpassed a drinking water standard, SPU takes the necessary steps to ensure the well is either rarely used for supply and/or properly blended with a cleaner well. Any blending that is done and reported within the SPU water system is done at the well house prior to entering the distribution system.

A further description of the parameters of potential concern are described below in more detail.

5.1.4.1 Water Quality Challenges

Nitrates: None of the levels of nitrate in SPU's wells are currently exceeding the EPA's MCL of 10 mg/L, but many have reported levels around or above 5.0 mg/L, which has raised some concerns throughout their customers. From 2018 to 2020, SPU's Well No. 2, Well No. 4, Well No. 5, Well No. 6, Well No. 7, Well No. 8, Well No. 15, Well No. 16, and Well No. 17 reported levels above .0 mg/L of nitrate, with Well No. 5, Well No. 6, Well No. 8, and Well No. 17 averaging above 5.0 g/L of nitrate. SPU will continue to monitor these wells to ensure that they remain below the MCL of 10 mg/L and that the water is safe for their customers.

It should be noted that the monitoring results have shown nitrate levels, in all of SPU's wells, have mostly stayed the same or gotten lower over the past 20 years. It is expected that this downward trend will continue as agriculture land is developed into residential and commercial properties throughout the watershed, reducing leaching into the aquifer.

Iron: Iron is naturally present in Minnesota's rocks and soil and is commonly found in groundwater. Although not a health risk, iron can cause discolored water, stained fixtures, and a metallic taste. The EPA's NSDWR sets a guideline of 0.3 mg/L for iron in drinking water, which SPU adopts as its water quality goal. SPU closely monitors wells exceeding this limit. Only three SPU wells (14, 3, and 10) have iron levels above 0.3 mg/L. Well 14 is used only in emergencies and blended with lower-iron water. Well 10 is used sparingly, blended with other wells, and operates less than 1% annually. Well 3, with an iron concentration of 1.75 mg/L, is also reserved for emergencies. SPU manages iron levels by limiting the use of high-iron wells, blending water, and using chemical treatment (sequestration with polyphosphate).

Manganese: Manganese, found naturally in Minnesota's soil and groundwater, is essential for health but harmful in excess. Long-term exposure can affect memory, attention, and motor skills, with infants being particularly vulnerable. The MDH recommends water for infants under one year old contain no more than 0.1 mg/L of manganese. The EPA has a non-enforceable lifetime health advisory of 0.3 mg/L and a short-term advisory of 1.0 mg/L, but suggests 0.3 mg/L for infants under six months. For households without infants, 0.3 mg/L is deemed safe. To address aesthetic concerns, the EPA's NSDWR for manganese is 0.05 mg/L, which SPU uses as their water quality goal. Only two SPU wells exceed this, with Well 12 and Well 15 having slightly higher levels managed by polyphosphate treatment. None of SPU's wells exceed the health advisory limit for manganese. Wells with elevated manganese are used sparingly, and future well sites may need filtration plants if they exceed recommended manganese levels.

Radium: Radium, which can accumulate in drinking water from eroding rock deposits containing radioactive elements, has an EPA MCL of 5 pCi/L. SPU's emergency wells No. 3 and No. 14, along with Well No. 10, have radium levels exceeding this limit. However, since Wells No. 3 and No. 14 are not in use, they pose less concern. Well No. 10, used sparingly, is blended with water from Wells No. 6 and No. 7 to ensure the radium concentration is below the MCL before distribution.

Arsenic occurs naturally in Minnesota's rocks and soil, and can dissolve into groundwater. Long-term exposure to low levels of arsenic in drinking water is linked to diabetes and increased cancer risk. The EPA's MCL for arsenic is 10 µg/L. From 2018 to 2020, Well No. 14 reported arsenic levels between 18.4 and 25.30 µg/L, exceeding this limit. As explained above, SPU regards Well No. 14 as an emergency well and rarely uses it for supply.

Sodium is a naturally occurring element that is found widely throughout the environment. Due to issues with hypertension and other health concerns, some people have a sodium restricted diet. A goal of 2,400 mg per day of dietary sodium has been proposed by several government and health agencies. Drinking water containing between 30 and 60 mg/L is unlikely to be perceived as salty by most individuals and would contribute only 2.5% to 5% of the dietary goal if tap water consumption is 2 liters per day. Historically the sodium concentrations in SPU's wells ranged from 8.27 mg/L to 63.6 mg/L. These sodium concentrations indicate that SPU's water is not likely to contribute a significant amount of sodium to a resident's diet.

Hardness: Water Hardness: Monitoring indicates that total hardness is the most common nuisance for NSDWRs. Impacts from total hardness can be offset by implementing hardness removal at the well house, which ultimately may be very costly, or the addition of in-home water softeners. Water above 100 mg/L of hardness is considered hard. Water that is considered "hard" has a hardness of approximately 150 to 300 mg/L as $CaCO_3$ and is considered "very hard" with $CaCO_3$ above 300 mg/L. It can be assumed that much of the water supplied by SPU is considered "very hard" (21 gains of hardness equivalent to 360 mg/L as $CaCO_3$) and requires softening to prevent calcium buildup in home plumbing including on appliances and at the tap.

5.1.4.2 Emerging Water Quality Issues – PFAS

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals used in products like non-stick cookware, water-repellent clothing, and firefighting foams. These chemicals can enter groundwater through industrial discharges, landfill leachate, and the application of contaminated biosolids in agriculture. Once PFAS enter groundwater, they are difficult to remove and can accumulate over time, posing health risks such as cancer, liver damage, and developmental issues. Ensuring the water quality in Shakopee's wells involves monitoring PFAS levels and implementing treatment solutions (if needed) to reduce their presence, safeguarding public health and maintaining a safe water supply.

SPU has collaborated with MDH to take proactive steps to monitor the presence of PFAS in SPU's water supply wells. Appendix E includes results of these monitoring efforts and provides an overview of the efforts to monitor and manage per- and polyfluoroalkyl substances (PFAS) in Shakopee's water supply. Initially, Shakopee conducted PFAS sampling in 2014 and 2015 as part of the UCMR3 initiative, which did not detect any PFAS compounds. Recent sampling, starting in 2021, is part of the Minnesota Department of Health's (MDH) statewide PFAS sampling program aiming to test all public water systems.

MDH develops health-based guidance values (HBVs) for PFAS concentrations that are considered to pose little or no risk to human health, though these values are not enforceable and do not consider cost or treatability. The Health Risk Index (HRI) is used to assess the additive risk of co-contaminants with similar health effects, with an HRI greater than 1 considered an exceedance.

In Shakopee, multiple wells were tested for PFAS, including PFOA, PFOS, PFBA, PFBS, PFHxS, and PFHxA. The results showed low levels of these compounds, with the **highest HRI recorded at 0.33 in Well #5, well below the threshold of 1**. The concentrations in other wells also remained within safe limits. Specific wells, such as Well #9, Well #11, Well #12, Well #15, Well #16, Well #17, and Well #21, showed either no detection or very low levels of PFAS.

Figure 1 – MDH PFAS Testing Results

Well	PFOA	PFOS	PFBA	PFBS	PFHxS	PFHxA	HRI
Well #2	0.0008	0.0016	0.011	0.0015	0	0.0019	0.14
Well #4	0.002	0.0012	0.03	0.0026	0.0009	0.02	0.26
Well #5	0.0027	0.0018	0.036	0.0031	0.001	0.021	0.33
(Wells 6, 7 & 10)	0.0017	0.0028	0.017	0.0017	0	0.0024	0.25
Well #8	0.0012	0.0027	0.017	0.0015	0.002	0.0029	0.27
Well #9	0	0	0.01	0.0009	0	0	0.00
Well #11	0	0	0.005	0	0	0	0.00
Well #12	0	0	0.002	0	0	0	0.00
Well #15	0	0	0.009	0.0012	0	0.0011	0.01
Well #16	0	0	0.011	0.0015	0	0	0.00
Well #17	0	0	0.011	0.0016	0	0	0.00
Well #20	0.0011	0	0.011	0.001	0	0.0014	0.04
Well #21	0.0017	0	0.014	0.0015	0	0.0043	0.07

The MDH did not plan immediate follow-up sampling in Shakopee but will include the City in future testing rounds scheduled for December 2024 and June 2025 under the UCMR5 program. Although PFAS results are not required in the Consumer Confidence Report (CCR), MDH recommends their inclusion and offers resources for contextualizing these results. The data will also be available on MDH's PFAS Dashboard to maintain transparency and public awareness.

5.1.5 Water Supply Well Challenges

Well No. 3, which is not currently operated (Considered an emergency well), has had a history of containing radionuclides. This well is available to the SPU water system for emergency purposes only. This well also has higher levels of iron. The pumphouse facility that serves this well is relatively new, potential for using the facility to blend water from Wells 2 & 8 to fortify a reliable peaking well supply/backup system is discussed later in this report.

Well No. 5 has historically been a problematic well related to nitrate water quality. SPU has managed the use of this well by blending water pumped from this well with Well No. 4, which has a considerably lower monitored nitrate level. Both wells have been trending downward with regards to monitored nitrate levels. However, if levels in these wells eventually rise or the enforceable MCL is lowered, decisions will need to be made with regard to the use of Well No. 5. In addition, though the amount of PFAS detected in well No.5 is well below the Health Risk Index (HRI) level, (measured at 0.33 with the health risk index of 1.0), this well has the greatest potential for having issues with PFAS. The presence of these issues may impact future decisions regarding the long term use of the well and potential abandonment. Well No.4 is closely linked to Well No.5, with similar water quality results related to PFAS, as such the future of well No.4 will likely be driven by well No.5.

Well No. 10 has a history of containing moderate concentrations of radon, and radium 226/228. SPU has been proactive in monitoring all regulated contaminate levels. Data collected has revealed these levels have been steadily dropping over time. The Utility will continue to sample and monitor water production wells to ensure they are staying under the NPDWR MCLs. This well also has higher levels of Iron. PFAS testing at **Wells 6, 7 & 10** indicted levels well below the HRI, if these were to rise over time, or if health limits were to change – PFAS treatment could be considered in conjunction with the planned WTP that these wells may potentially feed.

Well No.12 has elevated levels of manganese that can be managed with chemical sequestration.

Well No. 14 has higher levels of iron present and is used only in emergencies and blended with lower-iron water.

Well No.15 has elevated levels of manganese that can be managed with chemical sequestration.

Given the water quality challenges present in Well No.5 and the long proximity to a proposed water treatment plant, Well No.5 and Well No.4 would be prime candidates for abandonment and replacement. Well No.3 can continue to be used as a redundant facility for emergency backup with the pumping facility modified to serve Wells 2 & 8. As such, SPU should continue to pursue additional water supply wells to supply future City growth as well as well as replacement of problematic wells.

5.2 Water Treatment Options

SPU's current water quality and blending practices ensure that no additional treatment beyond fluoridation and disinfection is required. However, SPU is dedicated to public health and high-quality water, prompting a water treatment feasibility study to address future regulatory and water quality challenges. The study evaluated various treatment systems, including chemical oxidation and filtration for iron and manganese removal, anion exchange and reverse osmosis for nitrate removal, and potential municipal water softening options like lime and ion exchange softening. While these treatments are effective, they are also costly in terms of capital, operations, and maintenance. SPU's proactive approach helps in planning and managing water quality to maintain safe and reliable drinking water for their customers. As a vision for the future SPU water system continues to develop, decisions related to future trunk main, water supply well locations and overall system facilities should be made such that a future WTP can be accommodated, with support infrastructure sized to allow for optimal operations.

5.3 Water Treatment Options and Location

According to the water treatment feasibility report, SPU has determined that a hybrid alternative best suits their future needs this would include up to 4 water treatment plants that will treat the majority of the water consumed in the system with a handful of wells remaining to be used as peaking facilities. SPU has started planning to identify property requirements for each proposed hybrid water treatment plant (WTP) locations. For the WTP in the Normal Zone (NES Zone WTP) which is intended to treat water from the major Normal zone wells (Well No. 6, 7, 9, 10, 11, 15, 16, and 17) as well as three new wells (Well No. 18, 19, and 22), a large site with good vehicular accessibility is needed. After evaluating several sites for the **NES Zone WTP**, two properties have been identified (Mac Equities' property & Hawkins' Property) as the most feasible site options. For purposes of long range planning, the Hawkins property is used as the assumed location for system modeling and planning maps.

The three other WTP sites include:

- Tank 8 – 2nd HES WTP: Located on the far west end of the system, this with would be fed by New Well 23, and additional wells (Well 22 and 24)
- Pump House 12 WTP – Serving Wells 12, 13 and 14
- Pump House 20 WTP – Serving Wells 20 and 21.

If SPU pursues the development of water treatment, it is recommended that the focus be on the development of the NES zone WTP which would serve the majority of SPU's water supply needs through the planning period with the other wells acting as backup as peaking facilities.

5.4 Total System Reliable 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 supply pumps must be periodically taken out of service for maintenance. These water supply pumps can be off-line for periods of days to several weeks, depending on the nature of the maintenance being performed. For a system as large as Shakopee with 19 high capacity wells, it is somewhat likely that for two wells to be offline at the same time comprising approximately 10% of the total supply capacity. Because off this, system wide well supply requirements will assume that the SPU water supply system should be capable of meeting maximum day demands with the Utilities' largest two wells out of service.

Under present operating conditions, the existing wells have a combined total capacity of about 25.5 MGD when operating 24 hours per day. However, the **reliable capacity** of the supply is approximately **22.8 MGD** with the two highest yielding wells out of service. The availability of this reliable supply capacity assumes there will be no significant declines or changes in the water supply capacity over the next 20 years.

As discussed in previous reports and shown in Table 12, SPU's maximum day demand in 2045 is approximately 24.0 MGD. This indicates a potential need for 1.2 MGD of additional reliable supply capacity to meet projected water system demand growth. This would equate to roughly two new wells by 2045, as dictated by previous studies. It should also be noted that future demands are estimated projections (not records) and thus should be re-evaluated frequently (every five years ä) as water use trends can change over time.

In addition to two new wells required for growth, it is recommended that Wells No. 4 & 5 be replaced with new wells that would feed one of the proposed water treatment facilities. In all, 4 new wells are recommended to be installed over the planning period (Through 2045)

5.5 Reliable Pumping Capacity and Storage

The previous reports developed sizing criteria for reliable pumping capacity. This plan updates that analysis in relation to revised projected water demands.

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

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

Because there are multiple pressure zones in the SPU water system, served by elevated storage, it is important to evaluate the needs of each zone separately.

5.5.1 Total System Pumping and Storage

The previous Water Comprehensive Plan evaluated the total water system storage needs as well as each individual pressure zone. The plan did not identify any total water system storage needs, meaning when analyzed as a completer system, additional storage is not recommended. Rather each individual pressure zone needs to be analyzed for storage needs within that zone. To determine the water storage needs of a community, average daily demands, peak demands, and emergency needs must be considered. The storage tanks of the water system are listed in the table below. The volumes in the table are compares to the projected storage needs within each pressure zone.

Table 14 – Existing Water Storage Facilities

Structure Name	Type of Storage Structure	Year Constructed	Primary Material	Overflow Elevation (ft)	Storage Capacity (Gallons)
Tank No. 1	Elevated	1966	Steel	933.00	2,000,000
Tank No. 2	Elevated	1940	Steel	933.00	250,000
Tank No. 3	Elevated	1980	Steel	933.00	1,500,000
Tank No. 5	Ground	2005	Steel	933.00	2,500,000
Tank No. 6	Ground	2005	Steel	933.00	2,500,000
1st High Zone					
Tank No. 4	Elevated	2002	Steel	1015.00	500,000
Tank No. 7	Ground	2015	Steel	1015.00	2,000,000
2nd High					
Tank No. 8	Elevated	2019	Steel	1115.00	750,000
Tank No. 9	Elevated	2025	Steel	1115.00	500,000
				TOTAL (MG)	**12.50**

5.5.2 Individual Pressure Storage Analysis Summary

Water pumping/transfer needs as well as water storage needs were calculated for each pressure zone. In essence, each pressure zone was analyzed individually in relation to water pumping and storage needs. For example, if a pressure zone is short on transfer/pumping capacity, it is feasible that can borrow water from a neighboring zone. The primary purpose of this analysis is to assure each pressure zone has sufficient storage capacity as well as supply capacity whether it be an internal zone supply well or pumping station.

Table 15 – Summary of Future Water Storage Needs – By Pressure Zone

	Main	1st High	2nd High Central	2nd High Zone West	Combined 2nd High (C+W)	2nd High Zone East
Existing Firm Pump Cap. (MGD)	14.1	6.5	1.4	2.6	5.5	1.4
Existing Storage Volume MG)	6.8	2.5	0.5	0.75	1.25	-
2035 Planning Period						
Assumed Firm Pump Cap. (MGD)	14.1	6.5	1.44	2.59	5.5	1.4
Average Day Demand (MGD)	4.6	1.6	0.10	0.41	0.5	0.08
Max Day Demand (MGD)	12.8	4.7	0.25	0.75	1.0	0.22
Recommended Storage Volume (MG)	4.9	1.8	0.24	0.26	1.0	N/A
Additional Storage Recommended	**-**	**-**	**-**	**-**	**-**	**N/A**
2045 Planning Period						
Assumed Firm Pump Cap. (MGD)	14.1	6.5	1.4	4.3	5.5	1.4
Average Day Demand (MGD)	5.4	2.0	0.18	1.1	1.3	0.13
Max Day Demand (MGD)	15.0	5.5	0.50	3.0	3.5	0.37
Recommended Total Storage Volume (MG)	4.9	2.3	0.4	1.1	0.1	N/A
Additional Storage Recommended	**-**	**-**	**-**	***0.4**	**-**	**N/A**
Table Notes: Interzone Supply/Pumping Recommended represents water that would need to flow from a higher elevation zone - *Need for added storage in 2nd High West mitigated when combined with 2nd High Central						

5.5.3 Pressure Zone Pumping/Transfer Analysis

This section summarizes the pumping capacity needs of each pressure zone as they relate to both supply and inter-zone pumping. While the total supply section determines the adequacy of supply at a total system level, this section aims to ensure each pressure zone can move water internally to satisfy the system demand from either an internal supply source or through transfer of water from a neighboring zone. An individual pressure zone analysis for each pumping capacity is included in the table below. This table summarizes the assumed firm pumping capacities for each pressure zone including unit wells and booster pumping station units which deliver water to water demand within each pressure zone.

Table 16 – Summary of Future Water Supply Needs – By Pressure Zone

	Main	1st High	2nd High Central	2nd High Zone West	Combined 2nd High (C+W)	2nd High Zone East
Existing Firm Pump Cap. (MGD)	14.1	6.5	1.4	2.6	5.5	1.4
2035 Planning Period						
Max Day Demand (MGD)	12.8	4.7	0.2	0.7	1.0	0.2
Pumping/Transfer Surplus/Shorfall	1.4	1.9	1.2	1.8	4.5	1.2
Additional Transfer/Pumping Recommended (MGD)	**0**	**0**	**0**	**0**	**0**	**0**
Transfer/Pumping Type	**-**	**-**	**-**	**-**	**-**	**-**
2045 Planning Period						
Max Day Demand (MGD)	15.0	5.5	0.5	3.0	3.5	0.4
Pumping/Transfer Surplus/Shorfall	-0.8	1.0	0.9	-0.4	2.0	1.1
Additional Transfer/Pumping Recommended (MGD)	**1.0**	**0.0**	**0**	**0.4**	**0**	**0**
Transfer/Pumping Type	**G**	**P**	**-**	**-**	**-**	**-**
Table Notes: Interzone Supply/Pumping Recommended represents water that would need to flow from a higher elevation zone, P=Pumped from lower connected zone, or new well, G=Gravity flow from higher connected zone						

5.5.4 Pressure Zone Pumping/Transfer Analysis with Added Louisville Demand

An additional water supply and storage analysis was conducted for the 2nd-HES to analyze the impacts of potential added demand from Louisville township. The results of this analysis are documented in Appendix B. In Summary, if SPU were to serve Louisville from the existing planned SPU infrastructure, and added wells within the SPU system that would supplement to serve Louisville, additional pumping considerations would be needed to deliver an additional 4.6 MGD of water from the 1-HES to the 2nd-HES and Louisville. Options and alternatives to achieve this are discussed further in section 6.

5.6 Water Distribution System Analysis

A hydraulic computer model was generated/updated to evaluate the performance of the SPU's current water distribution system. The model used the most recent geographical information system (GIS) data for SPU's water system assets, and was created using WaterGEMs®, a pipe network program developed by Bentley®. The previously calibrated model was verified using hydraulic and pumping data supplied by SPU.

Since pressures in the current system are not of concern, the model was utilized to assess water delivery throughout the system. Using both average day and maximum day demand and utilizing four (4) pump priority or "steps" used by SPU, the system was modeled for water distribution pressure and fire flow throughout the system. Results of the system modeling is documented in the figures included in this report.

Information revealed in this analysis will be accounted for in the recommended improvements section.

5.6.1 Delivery of Water to Large Water Use Customers

As noted earlier, the current water projections are based on existing customer types, with projected water user distributed across the water system model according to potential development. However, large potential customers, such as data centers requiring up to 2.0 MGD, have approached SPU. To ensure system reliability, an impact analysis for these high-demand users has been included, focusing on a hypothetical connection on the west side of the 1st high zone. Alternative water supply delivery methods to serve such a user are discussed further in section 6 of this report.

6 Recommended Improvements

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

The purpose of this section of the report is to review and recommend facility improvement priorities for the water system moving forward. With growth of the City, and therefore the water system expected during the next planning period, additional water system to facilities should be planned for so all customers receive exceptional water service. As previously mentioned, the new growth and expansion of the water system is expected to occur in the western portions of the first and second pressure zones. While it is impossible to know exactly how the area will grow in terms of specific users and road alignment, so general estimates in relation to future land-use can be made and facilities planned for based on these assumptions.

The ultimate water system planning map, presented in Figure 6-1 represents a guiding document for the growth and expansion of the water supply, distribution, and storage systems. Expansion of the water system in a manner outlined in this document will help to assure that exceptional and robust water system is provided to all customers in the future.

This section will provide recommendations to remediate deficiencies and to prepare the system for future growth. A map of planned improvements is shown in Figure 6-1 and will be referenced throughout this section.

6.1 Supply Improvements

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 for SPU is 26.9 MGD, and the firm pumping capacity is 22.2 MGD. Maximum day demands reached a peak of 16.3 MGD in 2012. That rate has fluctuated since then but could reach that level during an extreme drought year.

Based upon the peak demand projections in Table 12 and the well analysis discussed in section 5.5, it is estimated that projected maximum daily demand may exceed firm/reliable well supply capacity. For that reason, additional capacity is recommended in the future. The previous section of this report identified the need for approximately 1.2 MGD or more in reliable supply capacity to meet projected water system demand growth through the 2045 planning period. In Addition, replacement wells for some of the more problematic facilities is recommended.

6.1.1 New Water Production Wells

SPU has an established need to increase water production for future demand, but also for replacement of existing wells with various concerns (i.e., sand, high contaminant levels, etc.). The following concerns exist that may necessitate the need for new production wells:

- Wells No. 4 and 5 have sand issues in addition to quality concerns in related to PFAS
- Wells No. 6 and 7 have potential PFAS concerns, however they do not exceed current limits.
- Wells No.3 is not operated regularly and is considered an emergency backup well. If Well No.3 needs to operate, SPU has provisions in place to operate it with Well No.2 and 8 for blending.

Currently, Well No. 23 is planned to be online by 2025. The Minnesota Department of Natural Resources (MN DNR) has requested that Shakopee not install wells east of County Road 83. Additionally, SPU has expressed interest in resting wells by opting for a higher level of redundancy, which would require a greater quantity of wells to allow some wells to be offline.

SPU owns two (2) parcels for future wells in the Church Addition. Well siting in relation to future water treatment plant locations must be considered.

6.1.2 Potential Future Well Locations

SPU has been proactive to identify future well sites in order to sustain and maintain reliable water supply to Shakopee and the water system. These future well sites are anticipated to fulfill needs related to future capacity needs related to growth, replacement of aging and problematic wells as well as for additional supply needs that may emerge. In the section below, up to 10 potential well site installations are described. These well sites are consistently within the confines of the “likely” locations for wells identified in the aquifer sustainability study.

6.1.2.1 Future Well 18 & Well 19

Well 18 and 19 are proposed to be located near the 17th Ave Sports complex. SPU has previously secured these sites and they are available for future development as water supply wells and could also be piped to the proposed nearby WTP

6.1.2.2 Future Well 22 and Future Well Site A (Well 24)

Near new well No.23, additional well sites have been identified and secured by SPU. Long range, these two sites would feed the west 2nd high zone, in addition these wells would have the potential to supply the Tank 8 WTP.

6.1.2.3 Church Addition – (Future Well Sites B & C)

SPU has acquired land, known as the “Church Addition”. This site has the potential to be home to two wells. The previous iteration of the comprehensive water plan also identified this site for a booster station. With the potential for a future WTP providing water between zones, the need for this booster station is eliminated, thereby freeing up additional space for both wells.

6.1.2.4 Eagle Creek – Future Well Site D

SPU has acquired land along Eagle Creek Blvd South of US 169 – this location has the potential to serve as a well site and could feed the proposed water treatment plant.

6.1.2.5 Gravel Pit / WTP Site – Future Well Site E

One of the prospective sites for the water treatment plant includes an existing water production well. SPU is exploring the possibility of adding this well as a future system well or constructing a new municipal grade well near this site. Early water quality testing has shown promising results for anticipated water quality.

6.1.2.6 Windermere Booster Site – Future Well F

SPU has previously identified a location at the Windermere booster station that could provide a site for a future well. As a standalone well, this well would serve the 2HES (west), for long term planning, securing the ability to connect this well with a dedicated water main for delivery of water to the Tank 8 WTP would be required.

6.1.2.7 Pump House 12 East – Future Well Site G

Areas east of pump house 12 have the potential for future development. In light of this, SPU has the potential ability to secure additional land for a future well in this area. If this well were to be developed, it would primarily serve the 2HES (Central) with the later ability to feed to the Pump House 12 WTP.

6.1.3 Other Well Considerations

6.1.3.1 Decommissioning of Well 4 & Well 5

The location of Wells 4 & 5 combined with the sand issues present at in these facilities make them a prime candidate for decommissioning. It is recommended that these wells eventually be phased out of the of the water system with the capacity of these wells replaced by two of the proposed available well sites (depending on capacity).

6.1.4 Reconfiguration of Wells 2, 8 & 3

In the past decade, pump house 3 has been improved and upgraded. Pump house 2 (Serving wells 2 & 8) is in need of rehabilitation. As SPU proceeds toward a WTP option, these wells will be considered peaking wells. As such, rather than replacing Pump House 2, Well 2 and Well 8 could be pumped to a common location at Pumphouse No.3 This would allow the water at these facilities to blend for more constant quality and would also reduce O & M costs related to extra facilities. As the City plans for a road project along this route, the required dedicated water main to deliver water from Well 2 & 8 to Pumphouse No.3 can be installed.

6.1.5 Existing Well Maintenance

Regular maintenance and rehabilitation of municipal wells are essential to sustain production capacities and ensure a reliable water supply. Over time, wells can experience reduced efficiency due to factors such as clogging, corrosion, and mechanical wear. Routine inspections and upkeep help identify and address these issues early, preventing significant declines in water output. By investing in proactive well maintenance, municipalities can extend the lifespan of their wells, optimize water production, and avoid costly emergency repairs or replacements. SPU has been proactively inspecting and maintaining the wells as required.

6.2 Interzone Transfer Improvements

6.2.1 1st-HES Pressure Zone Transfer from NES

The previous comprehensive water plan had identified a potential Church addition booster station that would move water from the Normal HES to the 1HES. With the emergence of the NES WTP, the ability to deliver water directly from the WTP to the 1st-HES would be recommended and is assumed as the logical solution for future planning.

6.2.2 Riverview (East 2nd-HES) Pressure Zone Redundancy

In years past it was believed that the East pressure zone might eventually require an elevated water storage tank. However, current land use trends suggest that the number of connections in this area will be limited, making a long-term solution with a booster station more viable. Consequently, the construction of a secondary, redundant booster station is advised to maintain system pressure in the event of a primary booster station failure. The primary station is equipped with two 1,000 gpm service pumps for fire protection. However, it is sensible to design the secondary station on a smaller scale, with two 100 gpm pumps, to meet the usual system demands. A smaller booster station could be installed in a below-grade vault or a small flip-top enclosure, enhancing system redundancy and aiding water circulation by allowing water supply from two different entry points to the pressure zone. This facility would also address water quality concerns in the existing ½ mile long dead end trunk water main to be installed on Horizon Drive, allowing water to circulate though the main.

6.2.3 2nd-HES Booster Stations – Impact of Louisville Service.

If Louisville Township were to fully develop before the anticipated connection of the 2nd-HES West and 2nd-HES central zones – A dedicated Booster Station should be planned that can move water from the 1st-HES to the 2nd-HES (West) Absent of the connection with the Central portions of the 2nd-HES, this station would need to have a capacity of 4.6 MGD, however this capacity requirement would drop to 2.5 MGD if the West and Central portions of the 2nd-HES were connected and if an additional booster station were constructed in Arbor Bluffs, adding additional supply to the combined 2nd-HES. The benefit of an added booster station at Arbor Bluffs would be more fully realized with the connection of the two pressure zone areas, with the booster station supporting delivery of water across the system to Louisville, in concert with the Louisville Township dedicated Booster Station. For long-range planning a 3.0 MGD Booster pumping facility is envisioned for Arbor Bluffs and a 3.0 MGD facility (Expandable to 5.0 MGD) is envisioned to serve Louisville. While these facilities are not needed immediately, land should be set aside to accommodate the future possibility that they will be needed if and when Louisville is served by SPU.

6.3 Water Quality Improvements

6.3.1 Water Treatment – Hybrid WTP Development

The long-term vision for potential water treatment in Shakopee includes a large 18.0 MGD NES zone treatment facility that would receive water from up to 12 wells with this facility would be the largest and first to be built with to potential to build 3 additional 3.0 MGD water treatment facilities to serve other well clusters in other pressure zones. This will reduce the infrastructure for treatment processes and equipment required by only treating at four (4) different sites, rather than up to seven (7) if each well cluster had its own water treatment plant. Also considered in the previous Water Treatment Feasibility study. It will also reduce the amount of transmission mains required to provide systemwide treatment.

The table below describes the proposed treatment facilities. The proposed facilities are described in more detail in the following sections.

Table 17 – Hybrid Proposed Water Treatment Facilities

Satellite WTP Location	Supply Wells		
	Existing Wells	New Wells	WTP Capacity (MGD)
NES WTP (Gravel Pit)	Wells No. 6, 7, 9, 10, 11, 15, 16, and 17	3 -4 Additional	18.0
Pump House 12 - WTP	Wells No. 12, 13, and 14	NONE	3.0
Pump House 20 - WTP	Wells No. 20 and 21	NONE	3.0
Tank 8 - WTP	Well 22	2 Additional	3.0

6.3.1.1 NES Zone WTP (Gravel Pit Site) – Primary 18.0 MGD WTP

The proposed WTP will treat water supplied from all the SPU's NES zone wells (Well No. 6, 7, 9,10, 11, 15, 16, and 17) as well and three (3) new wells (Well No. 18, 19, and 22). If all the wells were running, the plant's capacity would need to be designed to treat 18.8 million gallons per day. A water quality analysis of water is difficult to determine, since not all the wells will be running at the same time and three (3) of the eleven (11) supply wells are new wells. To allow for changing water conditions and full operational control, the WTP should be designed to reduce the levels of iron, manganese, and nitrate.

The WTP has the potential to be to be located on the gravel pit site (1650 Co Rd 83, Shakopee, MN), which is southwest of the intersection of Mystic Lake Dr and 17th Ave E. An extension of Philipp Ave will eventually run through the gravel site parallel to 17th Ave E. The proposed WTP should be located south of the future road to allow enough room for future development. If SPU decides that this location is not the most advantageous for the WTP, a similar site between Pump House 15 and Mystic Lake Dr (Co Rd 83) should be selected due to the proximity to nearby wells. And reach to pressure zones. This would have to be worked out during the design phase of the project.

If SPU pursues water treatment, this facility would likely be the first and primary water treatment facility built for Shakopee. Given the potential capacity of the WTP, the facility would be capable of serving most SPU's daily water supply needs. When daily demand exceeds the plant capacity, SPU could choose to operate the other wells which would be used as peak day wells. Eventually these other wells may benefit from added filtration plants, however, the hydraulic analysis completed for this report assumes the use of this facility as a primary water supply point for the entire community with the other wells operating during peak demand conditions to sustain water storage levels.

In addition, given the potential for this facility to be located in the NES but near the 1st HES, the WTP should be configured that the discharge from the WTP could feed either pressure zone through dedicated water main.

6.3.1.2 Pump House 12 WTP (1HES East)

The proposed satellite treatment plant will be within the Pump House 12 site and will treat water supplied from Well No. 12, Well No. 13, and Well No. 14. As noted previously in the report, existing Well No. 14 is not operated frequently due to subpar water quality and will remain as a last resort emergency well that would require blending when operating. Due to the pumping capacity of Well No. 14, it may be more economical to decommission the well rather than pay for the upkeep.

If Well No. 12 and Well No. 13 were both running, the plant's capacity would need to be designed to treat 2.7 MGD (3.2 MGD with Well No. 14 running). A water quality analysis of water from Well 12 and Well 13 estimates that manganese could range from 0.01 mg/L to 0.08 mg/L, depending on which well is running, and expect iron and nitrate levels to be near zero. To achieve reduced levels of manganese, the proposed satellite WTP should be designed as an iron and manganese removal facility. These processes will also remove the elevated levels of iron from Well No. 14 if it was required to supply the WTP.

Though PFAS is not an immediate concern for the wells associated with this facility, emerging regulations may require for the eventual treatment of PFAS or other emerging contaminants. With this in mind, the future WTP should be designed to be able to accommodate additional treatment features if they are needed in the future.

6.3.1.3 Pump House 20 WTP (1HES West)

The proposed treatment plant will be within the Pump House 20 site and will treat water supplied from Well No. 20 and Well No. 21. If both wells were running, the plant's capacity would need to be designed to treat 3.3 million gallons per day. A water quality analysis of water from Well No. 20 and Well No. 21 estimates that nitrate could range from 1.1 mg/L to 3.6 mg/L, depending on which well is running, and expect iron and manganese levels to be near zero. To achieve reduced levels of nitrate, the proposed satellite WTP should be designed as a nitrate removal facility.

Additionally, while Wells 20 and 21 have detected trace amounts of PFAS well below the Health Risk Index (HRI) thresholds, evolving regulatory requirements might necessitate the adoption of treatment technologies for complete PFAS removal. Although PFAS currently poses no immediate concern for the wells at this facility, forthcoming regulations could mandate treatment for PFAS and other emerging contaminants. Therefore, it is advisable that the future Water Treatment Plant (WTP) be designed with the flexibility to incorporate additional treatment capabilities as needed

6.3.1.4 Tank 8 WTP (2HES West)

The proposed satellite treatment plant will be at the new Tank 8 site on the west side of town. The proposed WTP will be supplied by two (2) new wells (Well No. 23 and Well No. 24). It is anticipated that the capacity would need to be designed to treat 3.0 million gallon per day. Since there has not been a water quality analysis done at the proposed site, it should be assumed that the WTP should be designed to treat for iron, manganese, and nitrates. To achieve reduced levels of iron, manganese, and nitrates, the proposed satellite WTP should be designed as an iron and manganese, and nitrate removal facility.

It is proposed that Well No. 23 and Well No. 24 be constructed to supply this area. The proposed location of the wells would be on the same site as new Tank 8 in the 2HES zone (west) and would work in conjunction with Tank 8. Due to their location in a higher pressure zone, they could also easily feed water to the lower pressure zones by gravity. Additionally, the construction of these wells near each other, as well as the proposed WTP, would allow for shorter watermains to be constructed.

The limited water quality data from the well currently under construction and potential future wells supplying this Water Treatment Plant (WTP) do not indicate an immediate need for PFAS treatment. However, evolving regulatory requirements might require the implementation of technologies for complete PFAS removal. While PFAS does not currently pose an urgent concern for the wells at this facility, upcoming regulations may demand treatment for PFAS and other emerging contaminants. Consequently, it is recommended that the future WTP be designed with the capability to integrate additional treatment features as necessary

6.4 Storage Improvements

With two new elevated storage tanks constructed in the past 5 years, water storage needs will not be a concern for the current planning period (through 2045). In the long term, this recommendation is based on the assumption that the West and Central portions of the 2nd High zone will eventually be connected to each other, allowing storage tanks No.8 and No.9 to work with one another. Provided water use trends continue as expected, the City should have adequate storage for the current planning period. If the system were to expand to serve additional portions of Louisville township, additional storage may be required. The various CIP alternatives identified two potential water storage facilities for Louisville Township if SPU were to fully expand to serve the entire township. (See Appendix C)

6.5 Water Main Improvements

Key trunk water mains have been identified through system modeling and planning in order to support future system operations. With a potential shift to a hybrid water treatment system, adequately sized trunk water main will be essential moving forward. In Addition, key raw water mains to deliver water to proposed treatment facilities will be required if water treatment facilities are constructed. Figure 6-1 presents recommended future pipe sizing for service within the current City planning area. Appendix B & C present options for providing service to Louisville township and the

6.6 Large Water Customer Accommodations

As previously discussed, part of the comprehensive planning effort considers the integration of large water users into the existing infrastructure, specifically in the 1st high pressure zone. Two primary options are available to serve these users, each with distinct advantages and considerations.

Distribution System Feed Option: The most apparent option involves serving the large water user directly from the current distribution system, which includes water sourced from both the 1st

High Elevation Storage (1HES) and the 2nd High Elevation Storage (2HES). Pressure reducing valves (PRVs) would be strategically used to manage the pressure differences between these zones and ensure a consistent supply at the required pressures. This method leverages existing infrastructure, minimizing the need for significant new constructions and allowing quick integration of the user into the water supply network. Additional system modeling indicates that this method would be feasible if developed carefully so that nearby customers would not be negatively impacted by the large uses. The accommodation of such a user would impact the overall future well needs of the complete SPU system increasing the future well needs by 1 or 2 wells depending on ultimate demand requirements. At a minimum such a user would need to be fed on a looped 12-inch line, fed from both pressure zones.

Dedicated Water Supply Option: This alternative proposes the installation of two dedicated wells to serve the large water user directly. This approach would be particularly viable if the water is required primarily for cooling purposes, where the quality of water, in terms of aesthetic and minor chemical constituents, might not be as critical. Direct well service would isolate the user's supply from the main system, thus not impacting the water pressure and quality for other consumers. This setup could provide a more reliable and controlled water supply to the user, as it eliminates dependency on the broader system's dynamics, which might fluctuate due to seasonal demands or maintenance activities, the development of such wells would only serve to benefit the dedicated user(s)

6.7 System Planning

Figure 6-1 illustrates the water system comprehensive plan to meet current and projected water system needs through the 2040 planning period. As mentioned previously, these improvements are intended to correct existing deficiencies as well as meet the needs for future growth and development. To demonstrate the effectiveness of the recommended improvements, Figures 2 and 3 illustrate the anticipated maximum day demand pressures and maximum day fire flows, respectively, with the recommended improvements under projected 2045 demands conditions.

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

The improvement plan serves as a guiding document that outlines current conditions and provides recommendations for future development. It is based on projected conditions for the year 2045. As time moves forward, new information and events will influence the development of the SPU service area. Therefore, the plan must remain flexible and adaptable; it should be regularly reviewed and utilized but also adjusted to reflect changes and new insights. Updates should ideally occur every five to ten years. Alternative versions of Figure 6-1 can be found in Appendix B and Appendix C, which present different visions for the SPU water system if Louisville Township were to receive water service. Alternative B (Appendix B) envisions Louisville being served as a wholesale customer, while Alternative C (Appendix C) shows a system layout for potential SPU water system expansion into Louisville Township

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.

The previous section summarizes the recommended water system improvements anticipated throughout the planning period. This section summarizes the recommended water system improvements and presents a proposed Water Utility capital improvements program. The recommended Capital Improvements Plan prioritizes system improvements and provides a schedule for the timing of construction. Budget cost estimates for each improvement are also summarized.

In developing a Capital Improvement Plan (CIP) for Shakopee Public Utilities (SPU), three alternative approaches are considered. Alternative A focuses on SPU serving only Shakopee's current and known expansion limits, excluding Louisville Township. This approach assumes no significant changes beyond current planning boundaries and aims to optimize infrastructure within those limits. Alternative B introduces the possibility of serving Louisville Township as a wholesale customer, requiring modifications and upgrades to SPU's water system to facilitate the delivery of water, but without expanding the system's service area fully into the township. Finally, Alternative C proposes a more comprehensive expansion, where SPU would extend its water system infrastructure into Louisville Township, integrating it fully into SPU's service area, requiring significant investments in distribution and supply facilities to accommodate the new demand. These alternatives provide varying levels of investment and service scope, addressing both immediate needs and potential growth scenarios.

The results of Alternative A are incorporated into this main report while Appendix B and Appendix C present the same information for each Alternative B and Alternative C respectively. This approach is intended to help identify the cost implications to providing water service to Louisville Township, beyond Shakopee's current planning boundaries.

7.1 Supply

Based upon the current and projected water system needs, additional wells will be required to provide reliable supply capacity for current and future water demands. While near term water system demands can be supplied by current well capacities, additional wells will be required to support growth and development. Two new wells are identified to support water system growth and replace aging wells through the 2045 planning period with two additional wells identified and planned for as replacement wells for Wells 4 & 5.

7.2 Treatment

Up to four water treatment plants are considered in planned for to serve Shakopee long term. The primary focus moving forward would be to first establish the NES WTP (18 MGD Capacity) which would be a central facility capable of providing daily water supply for the majority of Shakopee which the other sites acting as supplemental and peak wells.

7.3 Storage

The current water system is support by robust water storage volumes, however, as the water system grows additional storage will be necessary. Historically, it has been a practice to add elevated storage to a pressure zone when the number of users connected approaches 250 homes. Most recently Tanks No. 8 and 9 were added to the second high pressure zones which has satisfied expected long term storage needs. If expansion were to take place beyond the current planning area, or if an unforeseen large water user were added to the system, additional storage may be required.

7.4 Water Booster Stations and Flow Control

Movement of water between pressure zones is important for redundancy. As new wells are added throughout the system, a demand to move the supplied water from zone to zone will be required. As a result additional booster stations are planned to move water from the lower services zones to higher zones. In similar fashion, flow control valves located at the booster station facilities are beneficial to move water in a controlled fashion from the higher zones to lower zones.

7.5 Distribution

Figure 6-1 is the proposed SPU 2045 Water System Master Plan Map. The figure illustrates the recommended improvements to the existing distribution system to serve the current and potentially expanded service area. The improvements have been recommended to strengthen the existing water distribution network, and support system expansion into future service areas. The figure also shows how long range trunk mains may be installed. Trunk main looping should be a priority in the expansion of the service area and in water main replacement projects. The proposed layout of trunk mains in this report would provide water supply and fire protection capabilities to existing and projected service areas. In addition, recommended trunk mains will connect water supply and storage facilities with points of use on the system.

7.6 CIP Costs

The table below provides a high-level summary of short and long range water system facility capital costs. These costs are based on recent projected history and anticipated system growth.

Table 18 – Proposed Water System Improvements – Through 2045

Type	Improvement	Planning Period	Estimated Cost
Supply	New Replacement Well (Replace Well No.5)	2025-2030	$3,000,000
Supply	New Replacement Well (Replace Well No.4)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2035-2040	$3,000,000
Transfer	Secondary East Booster Station	TBD	$900,000
Transfer	Well No.9 Flow Control Valve Upgrades	2025-2030	$400,000
Transfer	HWY 169 Flow Control Station	TBD	$600,000
Transfer	Arbor Hills Booster Station (w/NES WTP)	TBD	$5,000,000
Treatment	NES (Primary) Water Treatment Plant (18 MGD)	TBD	$60M-$150M
Treatment	Pump House 12 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Pump House 20 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Tank 8 WTP (3.0 MGD)	TBD	$20M-$40M

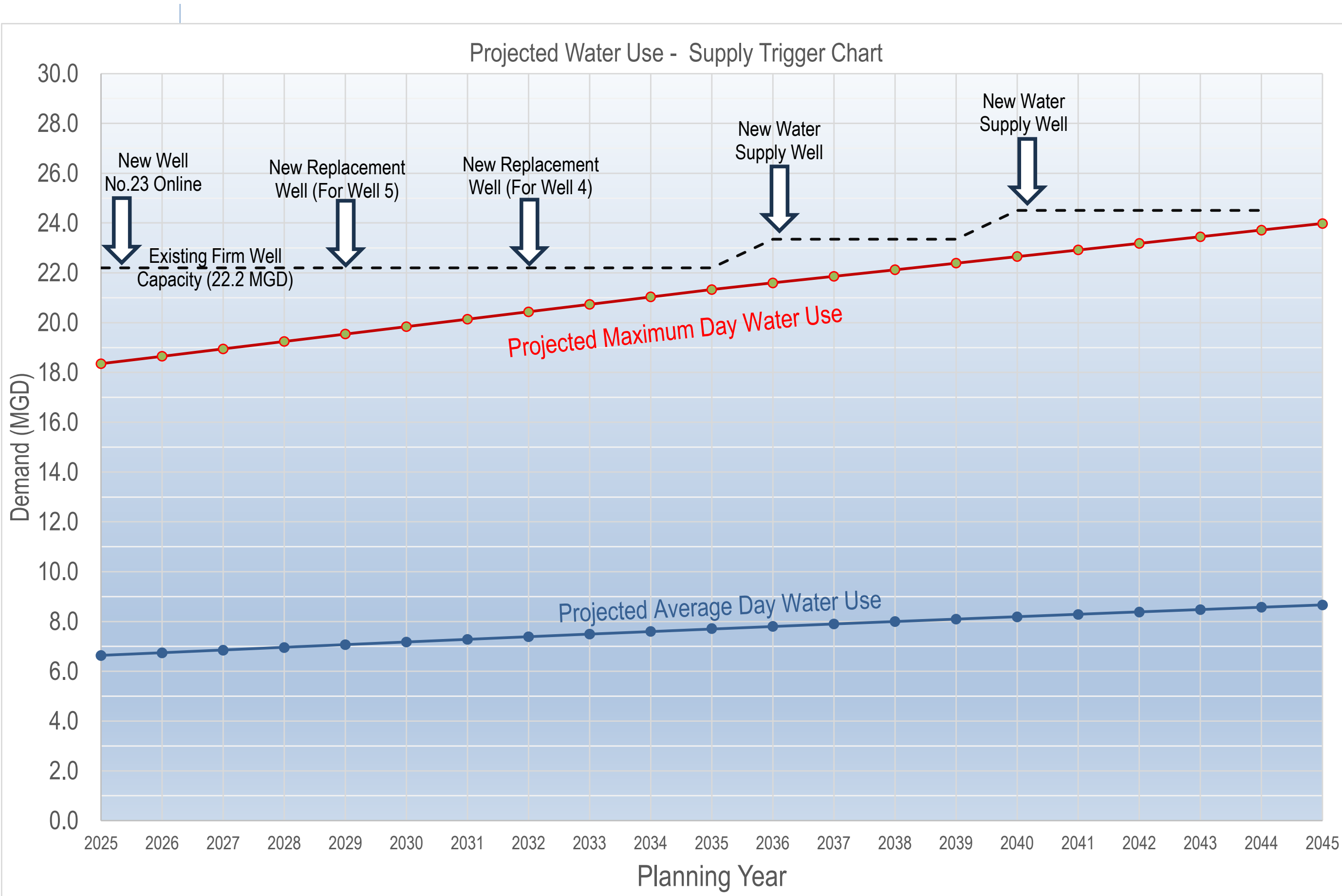
		Qty	Unit	Price	Planning Period	Estimated Cost
Distribution	Upsize 6 to 12-Inch Trunk Main	96,000	LF	$110	TBD	$10,560,000
Distribution	Upsize 6 to 16-Inch Trunk Main	32,000	LF	$200	TBD	$6,400,000
Distribution	Upsize 6 to 18-Inch Trunk Main	4,000	LF	$225	TBD	$900,000
Distribution	Upsize 6 to 24-Inch Trunk Main	1,500	LF	$280	TBD	$420,000
Distribution	Zone Boundary PRV's	8	EA	$350,000	TBD	$2,800,000
Distribution	Highway Crossing / Casing	800	LF	$1,500	TBD	$1,200,000

7.7 Trigger Chart

The timing of future water improvements will be influenced by many parameters. Items such as development pressure in specific areas, aging facilities and/or facilities which are undersized, and availability of funds. 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 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.



7.8 Alternative B CIP– Louisville as a wholesale customer

Alternative B envisions Shakopee Public Utilities (SPU) serving Louisville Township as a wholesale water customer. In this scenario, SPU would not directly manage or operate the water distribution system within Louisville Township but would instead supply water to a local distribution network managed by the township or a separate entity. The infrastructure improvements required for this alternative would focus on upgrading and expanding SPU's existing water system to ensure reliable water delivery to the township. This would include the addition of added water supply wells and possible treatment, interconnection metering stations, construction or enhancement of transmission mains, an added pump station to handle the increased water demand from Louisville Township. However, since the responsibility for local distribution within the township remains external to SPU, this approach minimizes SPU's operational footprint while still allowing for service expansion and a new revenue stream through wholesale water sales. A supporting figure summarizing this scenario option is included in Appendix B

Table 19 – Proposed Water System Improvements w/Louisville Twp. As Wholesale Customer – Through 2045 (Alternative B CIP)

Type	Improvement	Planning Period	Estimated Cost
Supply	New Replacement Well (Replace Well No.5)	2025-2030	$3,000,000
Supply	New Replacement Well (Replace Well No.4)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2035-2040	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Transfer	Secondary East Booster Station	TBD	$900,000
Transfer	Well No.9 Flow Control Valve Upgrades	2025-2030	$400,000
Transfer	HWY 169 Flow Control Station	TBD	$600,000
Transfer	Louisville Booster Station (5.0 MGD)	TBD	$6,000,000
Transfer	Arbor Bluffs Booster Station	TBD	$5,000,000
Transfer	Louisville Township Metering Station No.1	TBD	$1,000,000
Transfer	Louisville Township Metering Station No.2	TBD	$1,000,000
Treatment	NES (Primary) Water Treatment Plant (18 MGD)	TBD	$60M-$150M
Treatment	Pump House 12 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Pump House 20 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Tank 8 WTP (3.0 MGD)	TBD	$20M-$40M

		Qty	Unit	Price	Planning Period	Estimated Cost
Distribution	Upsize 6 to 12-Inch Trunk Main	80,000	LF	$110	TBD	$8,800,000
Distribution	Upsize 6 to 16-Inch Trunk Main	48,000	LF	$200	TBD	$9,600,000
Distribution	Upsize 6 to 18-Inch Trunk Main	4,000	LF	$225	TBD	$900,000
Distribution	Upsize 6 to 24-Inch Trunk Main	1,500	LF	$280	TBD	$420,000
Distribution	Zone Boundary PRV's	8	EA	$350,000	TBD	$2,800,000
Distribution	Highway Crossing / Casing	800	LF	$1,500	TBD	$1,200,000

7.9 Alternative C CIP– Expansion of SPU Water System info Louisville Township

Alternative C involves a full expansion of Shakopee Public Utilities (SPU) into Louisville Township, where SPU would not only supply water but also manage the distribution system within the township. This scenario requires a significant investment in infrastructure, including the addition of added water supply wells and possible water treatment, extension of transmission mains, construction of new pumping stations, and development of additional storage capacity to meet the demands of the expanded service area. SPU would be responsible for ensuring that all regulatory standards are met, and the system would be fully integrated with Shakopee's existing water infrastructure. This approach supports long-term growth in both Shakopee and Louisville Township, allowing for a more direct and controlled service expansion. While it presents higher costs and logistical challenges, Alternative C offers SPU greater control over service delivery, customer service, and system reliability in Louisville Township, supporting comprehensive regional growth. A supporting figure summarizing this scenario option is included in Appendix C.

Table 20 – Proposed Water System Improvements w/ SPU Providing water service to Louisville Twp. (Alternative B CIP)

Type	Improvement	Planning Period	Estimated Cost
Supply	New Replacement Well (Replace Well No.5)	2025-2030	$3,000,000
Supply	New Replacement Well (Replace Well No.4)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2030-2035	$3,000,000
Supply	New Water Supply Well (Capacity)	2035-2040	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Supply	New Water Supply Well (Louisville Capacity)	TBD	$3,000,000
Transfer	Secondary East Booster Station	TBD	$900,000
Transfer	Well No.9 Flow Control Valve Upgrades	2025-2030	$400,000
Transfer	HWY 169 Flow Control Station	TBD	$600,000
Transfer	Louisville Booster Station (5.0 MGD)	TBD	$6,000,000
Transfer	Arbor Bluffs Booster Station	TBD	$5,000,000
Treatment	NES (Primary) Water Treatment Plant (18 MGD)	TBD	$60M-$150M
Treatment	Pump House 12 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Pump House 20 WTP (3.0 MGD)	TBD	$20M-$40M
Treatment	Tank 8 WTP (3.0 MGD)	TBD	$20M-$40M
Storage	Louisville Storage Tank No.1 (1.0 MG)	TBD	$8,000,000
Storage	Louisville Storage Tank No.1 (1.5 MG)	TBD	$12,000,000

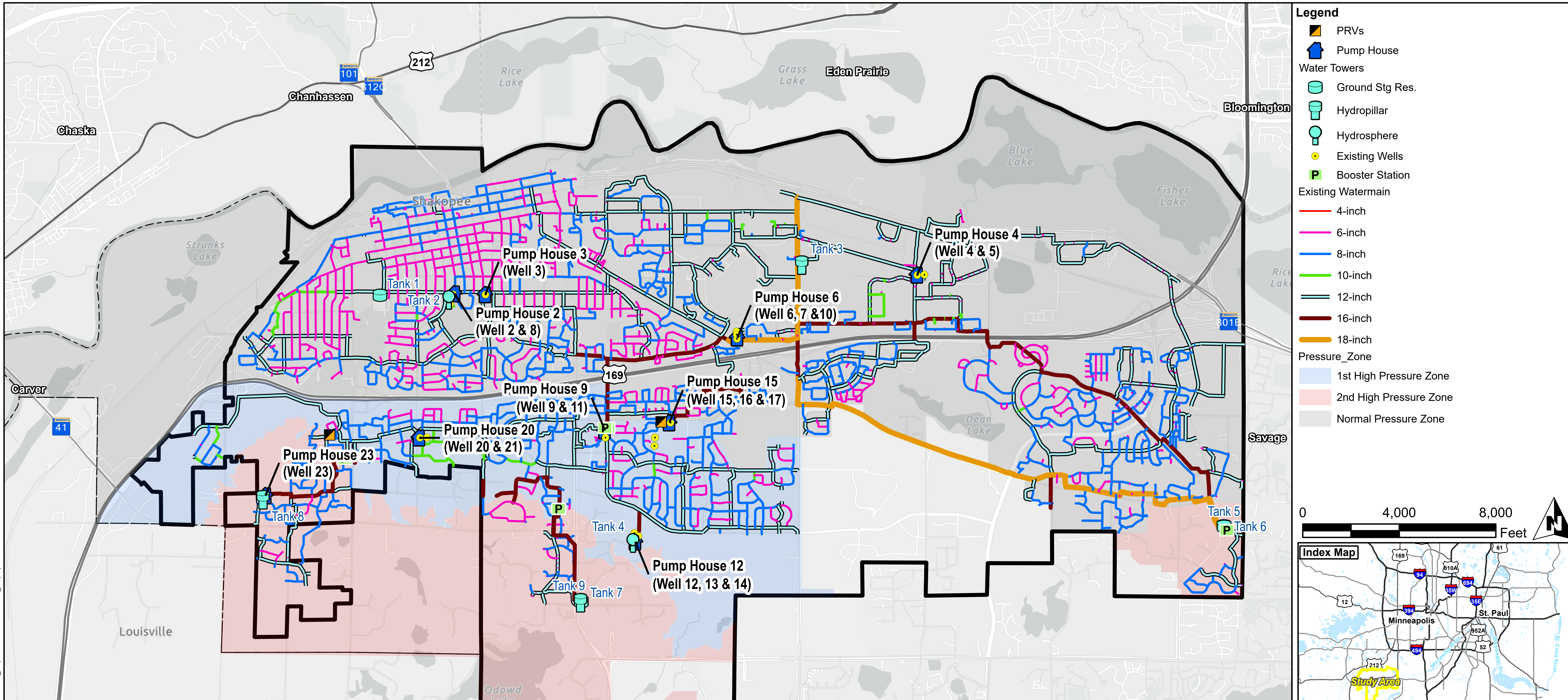
		Qty	Unit	Price	Planning Period	Estimated Cost
Distribution	Upsize 6 to 12-Inch Trunk Main	153,000	LF	$110	TBD	$16,830,000
Distribution	Upsize 6 to 16-Inch Trunk Main	73,000	LF	$200	TBD	$14,600,000
Distribution	Upsize 6 to 18-Inch Trunk Main	4,000	LF	$225	TBD	$900,000
Distribution	Upsize 6 to 24-Inch Trunk Main	1,500	LF	$280	TBD	$420,000
Distribution	Zone Boundary PRV's	11	EA	$350,000	TBD	$3,850,000
Distribution	Highway Crossing / Casing	800	LF	$1,500	TBD	$1,200,000

7.10 Conclusion

The 2024 Comprehensive Water System Plan Update for SPU provides a strategic framework to ensure the City's water system can effectively meet the demands of its growing population through 2045 as the system grows towards ultimate buildout. The plan identifies the need for additional water supply, treatment, storage facilities, and improved distribution networks to accommodate both current and future growth scenarios, including the potential expansion into Louisville Township. By evaluating various alternatives for system expansion, such as maintaining the current service area, wholesale service to Louisville, or full expansion into the township, the plan ensures that SPU remains adaptable to changing needs while maintaining a high level of service reliability. Active planning, regular updates, and flexible implementation strategies are key components of this comprehensive approach, ensuring that SPU can sustainably manage its water resources for years to come

dmk

Figures



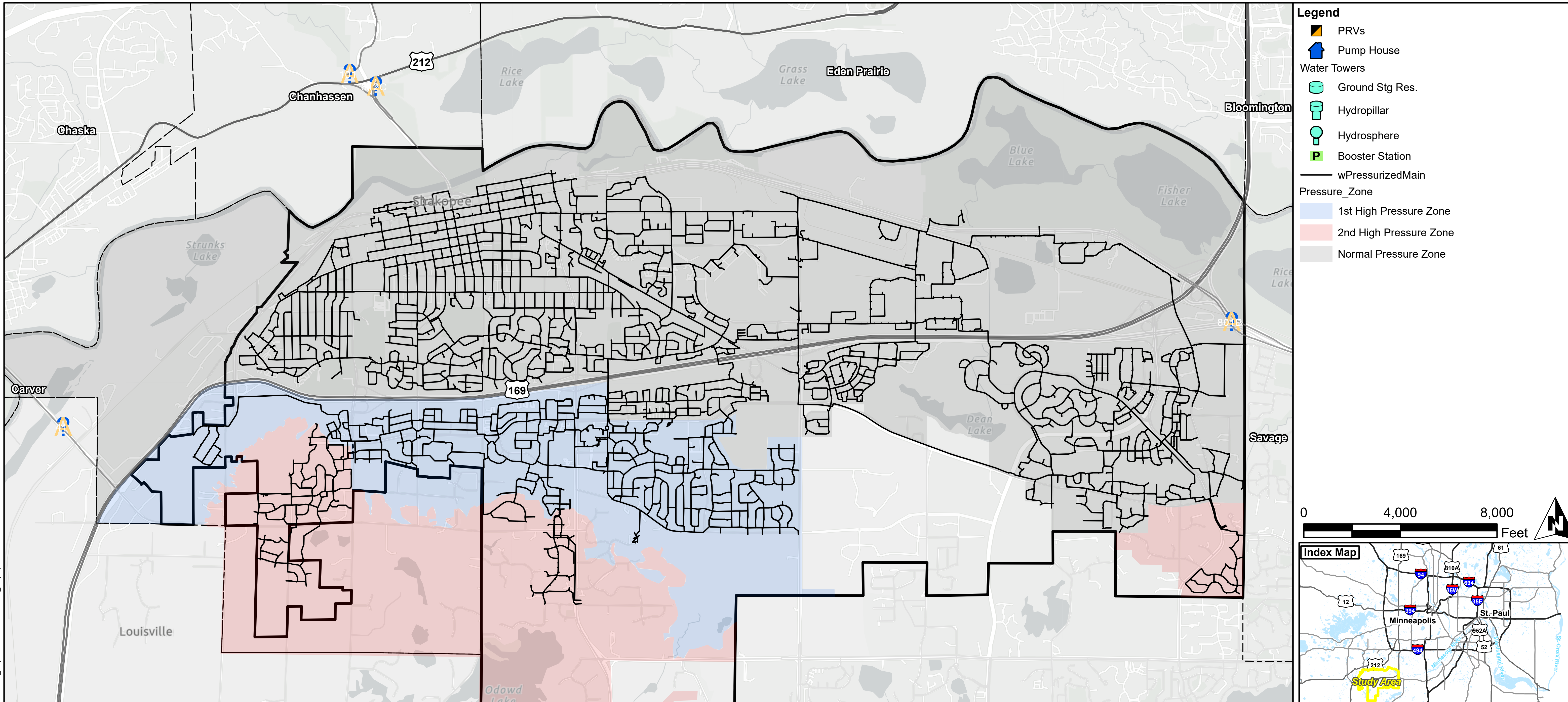
2024 Existing Water System Map

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 7/29/2024
Map by: msteuernagel
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 2-1



Planned Pressure Zones

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 7/25/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 2-2

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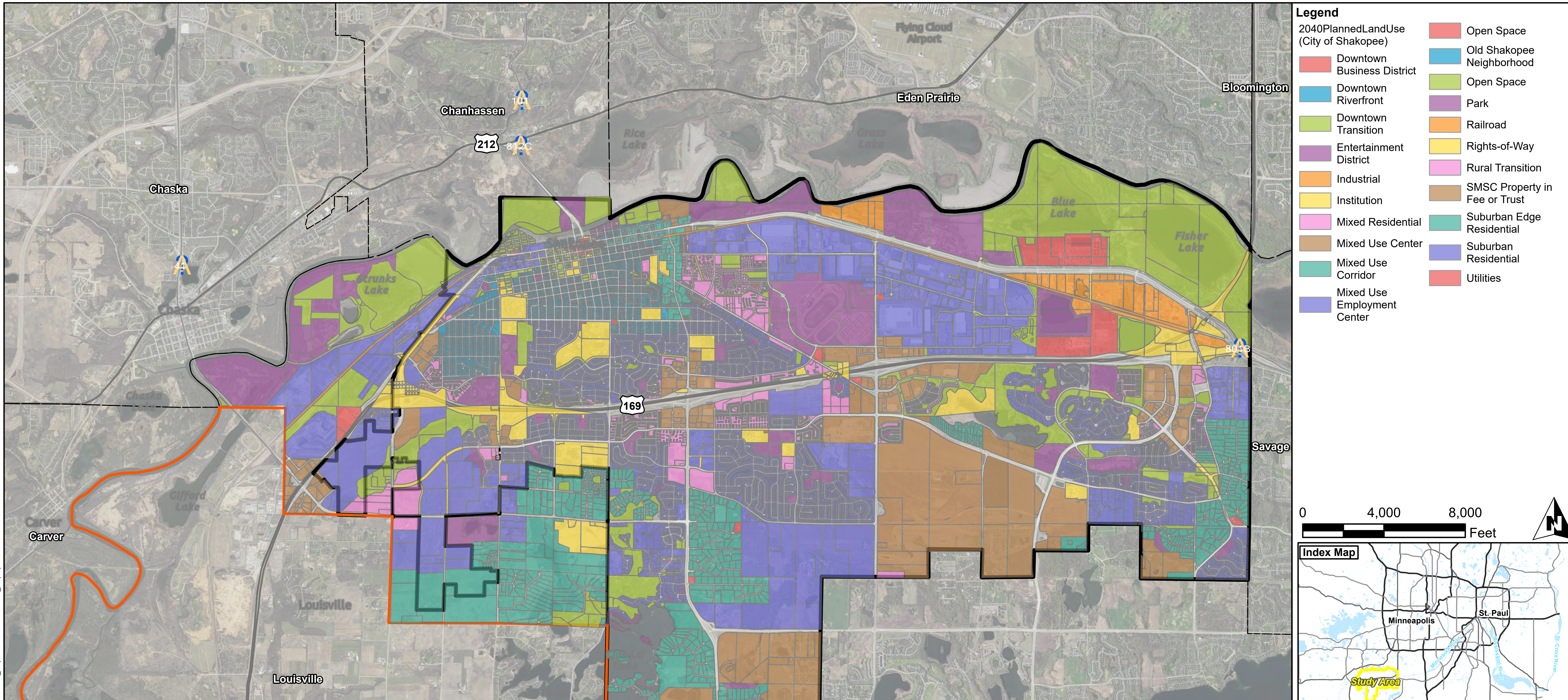


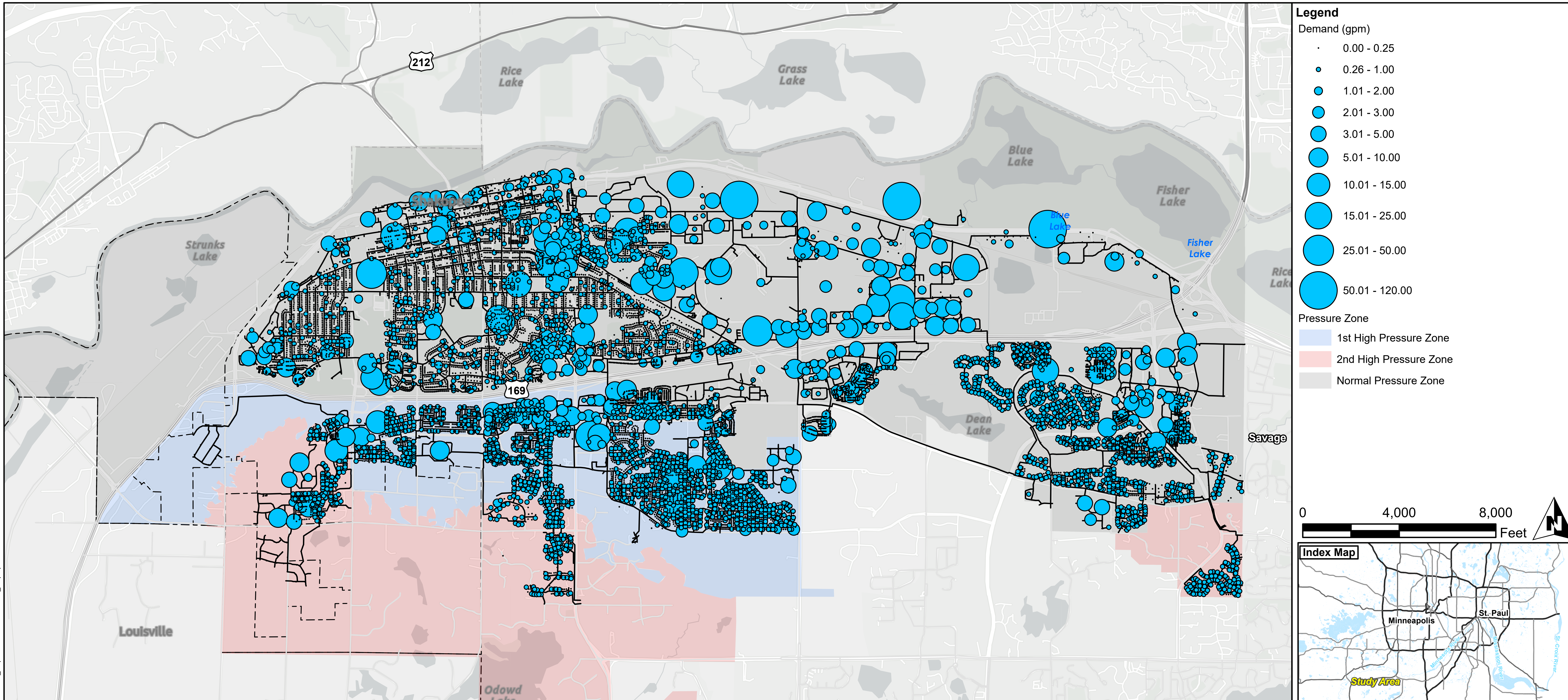
Future Land Use Planning

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 7/30/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 3-1



Water Sales Distribution Demand Intensity

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 7/31/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 4-1

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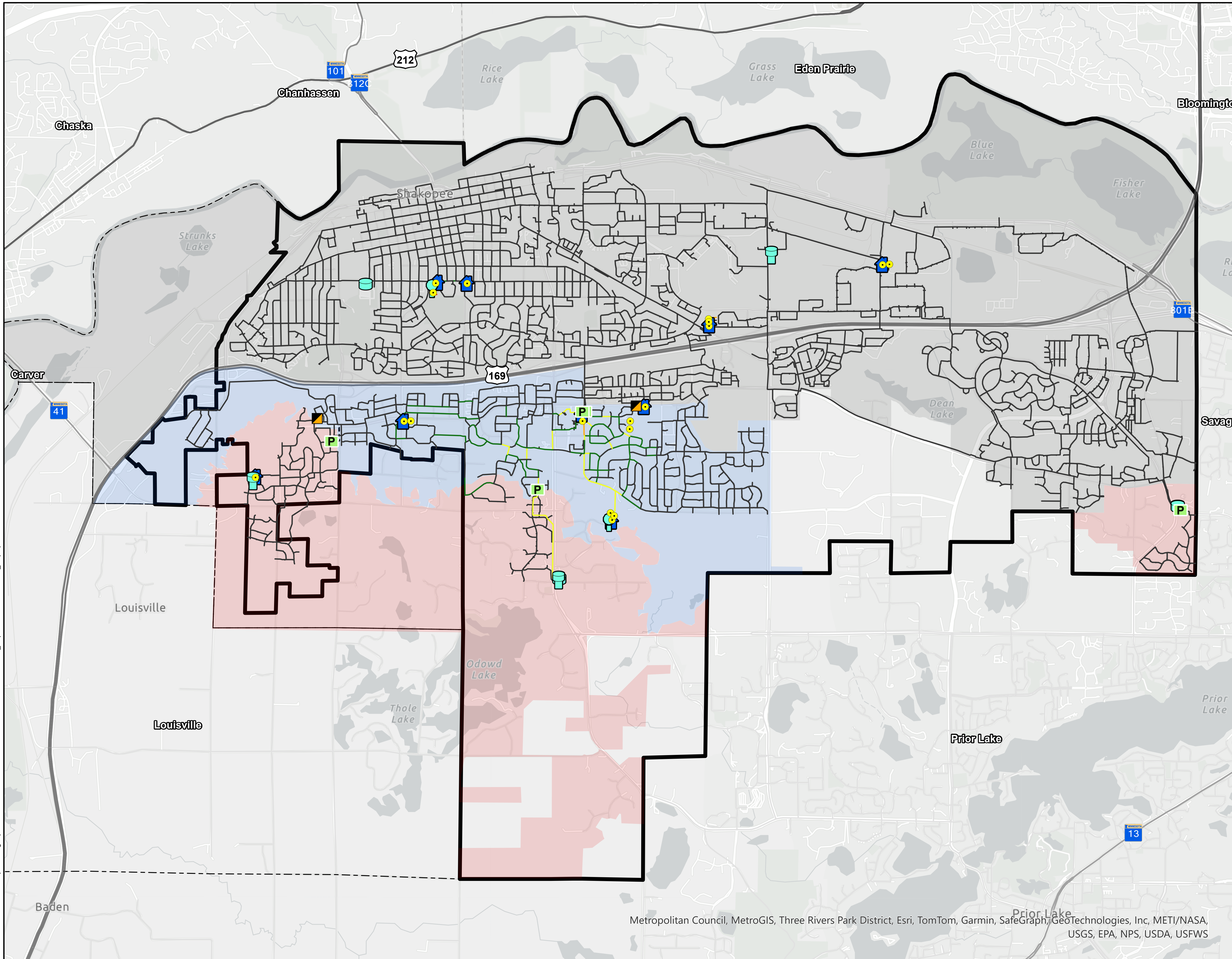
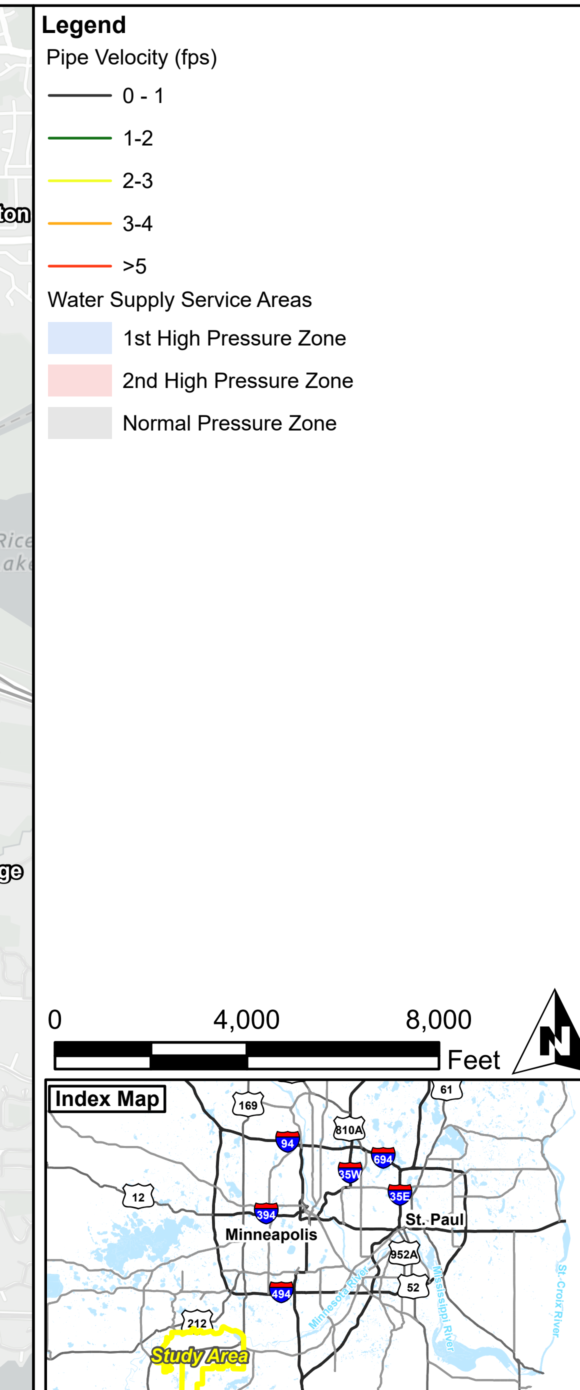




Existing Water System Model MD Peak Hour Pipe Velocity

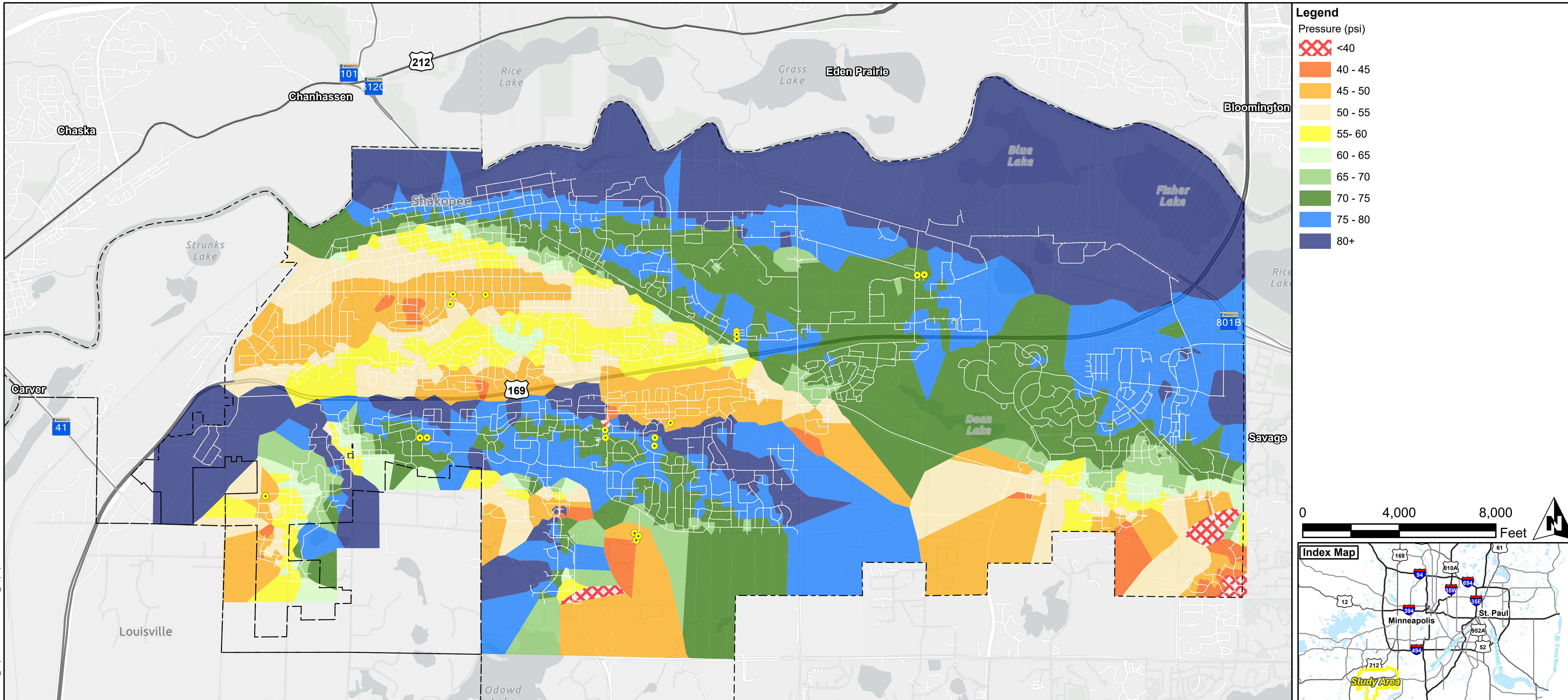
2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 7/29/2024

Map by: msteuernagel
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 4-8



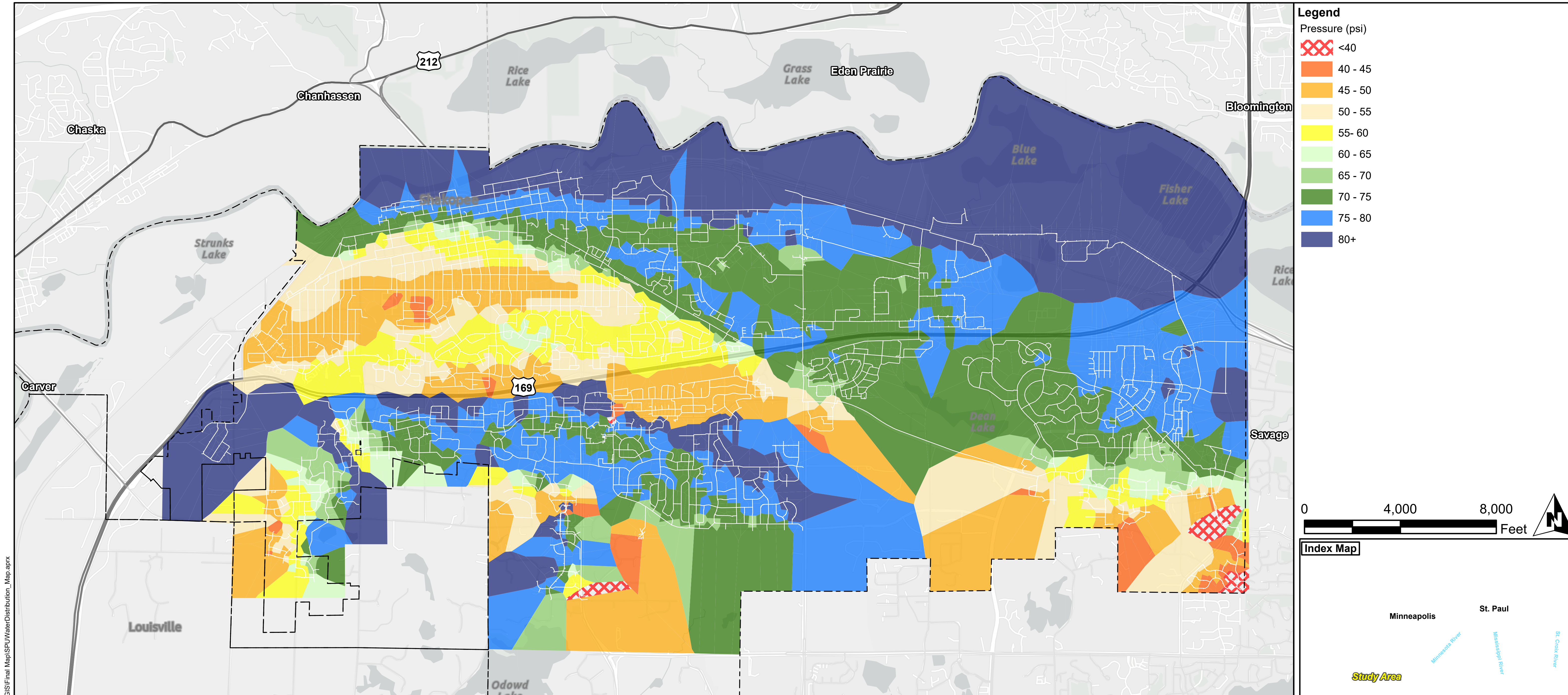
Existing Water System Model
Average Day Demand Pressure

2024 Comprehensive
Water Plan Update
Shakopee, Minnesota

Print Date: 7/29/2024

Map by: msteuernagel
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure
5-1



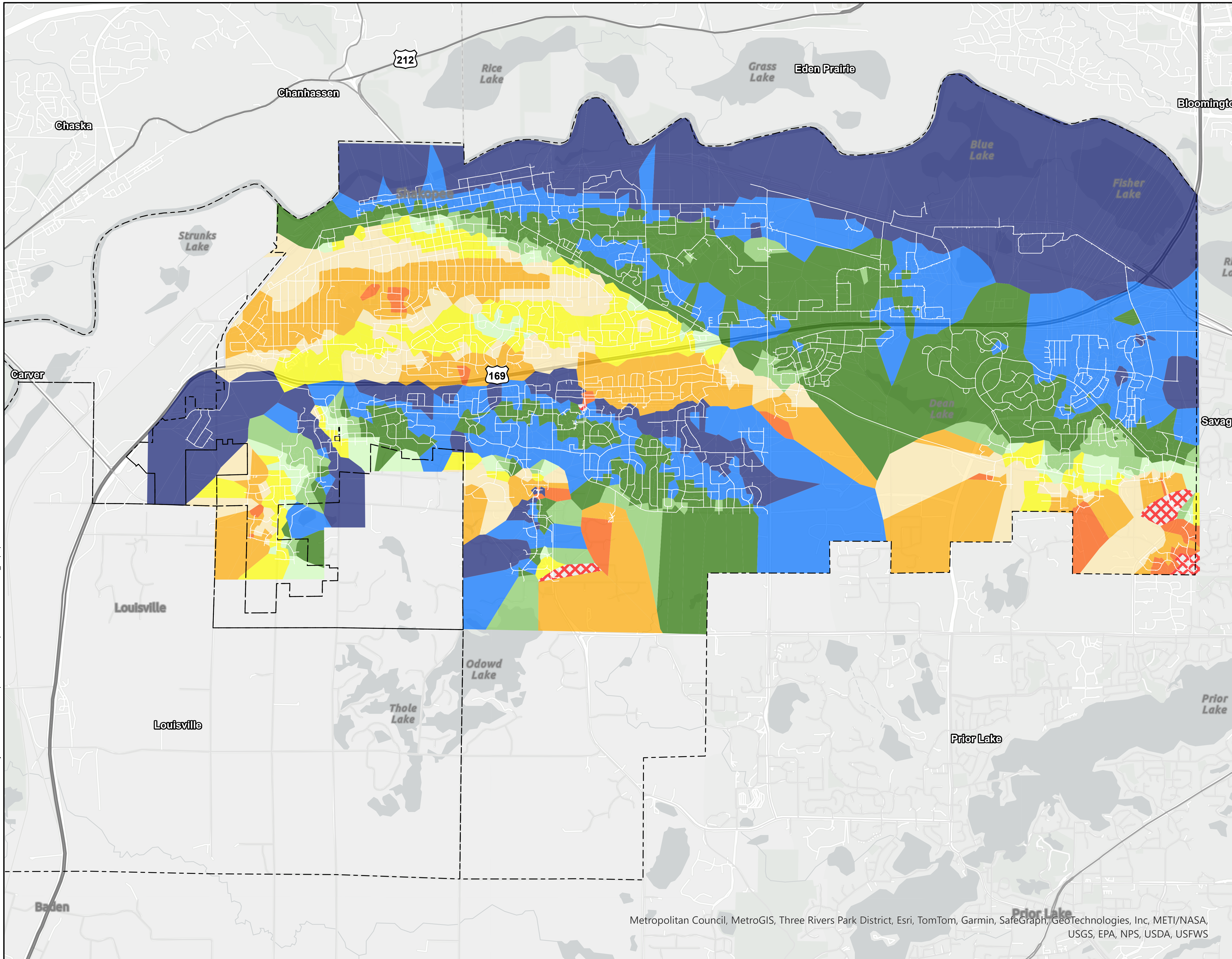
Existing Water System Model Max Day Demand Pressure

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

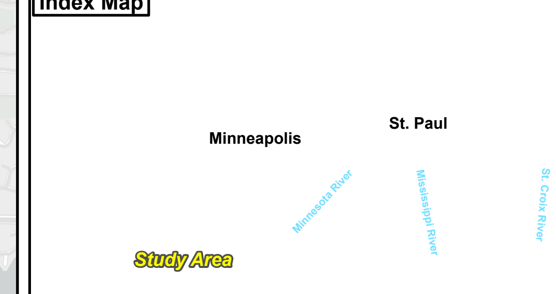
Print Date: 9/5/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 5-2



Index Map



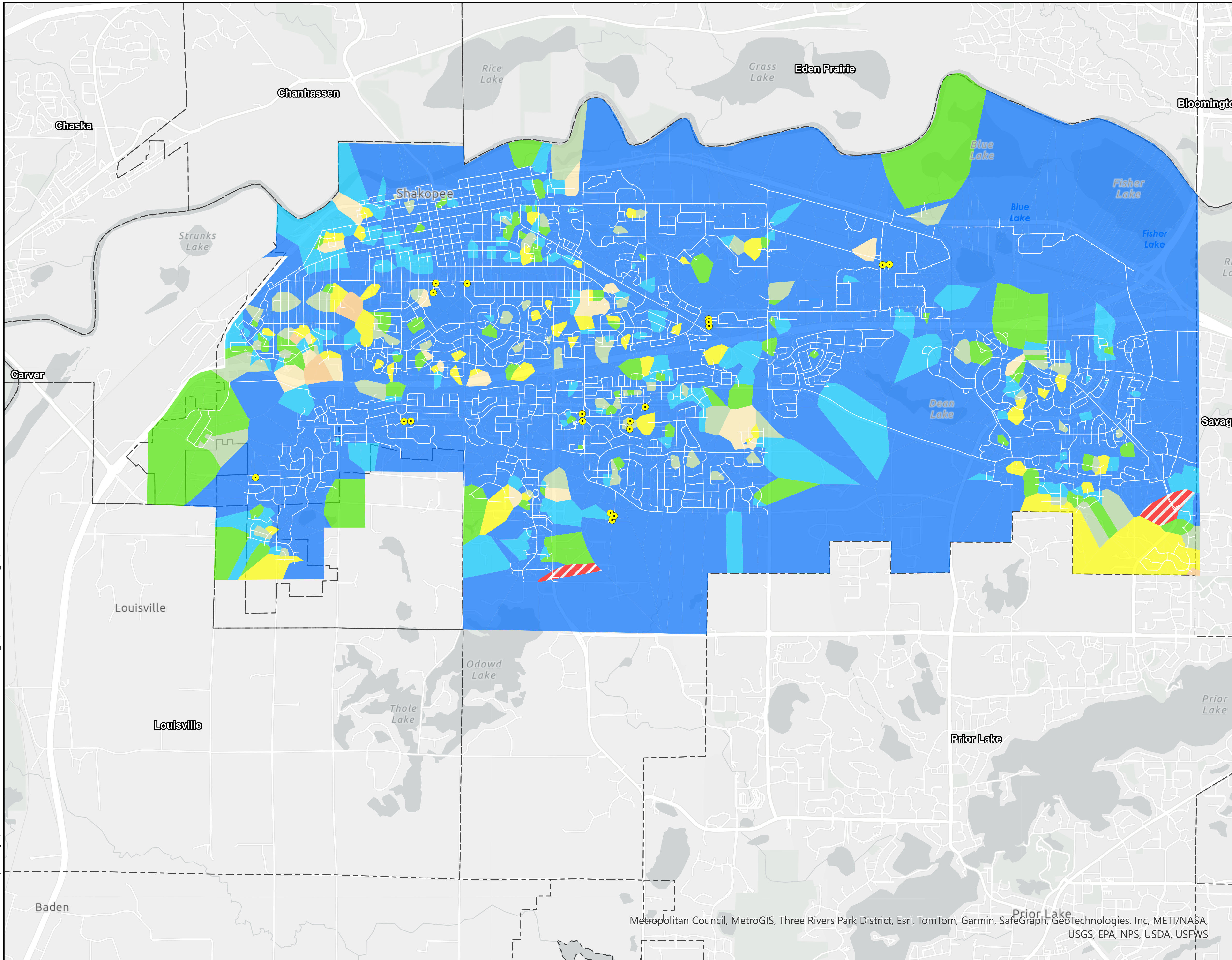
Existing Water System Model
MD Peak Hour Demand Pressure

2024 Comprehensive
Water Plan Update
Shakopee, Minnesota

Print Date: 9/5/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

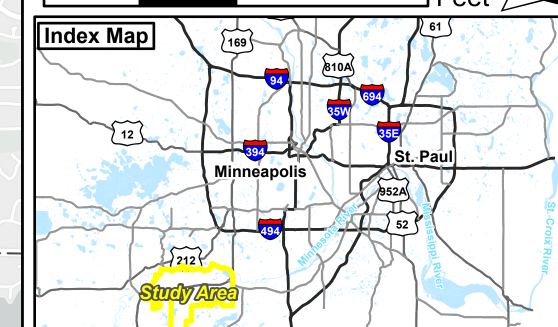
Figure
5-3



Legend

Fire Flow Available (gpm)

- <500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 3000
- 3000 - 4000
- > 4000



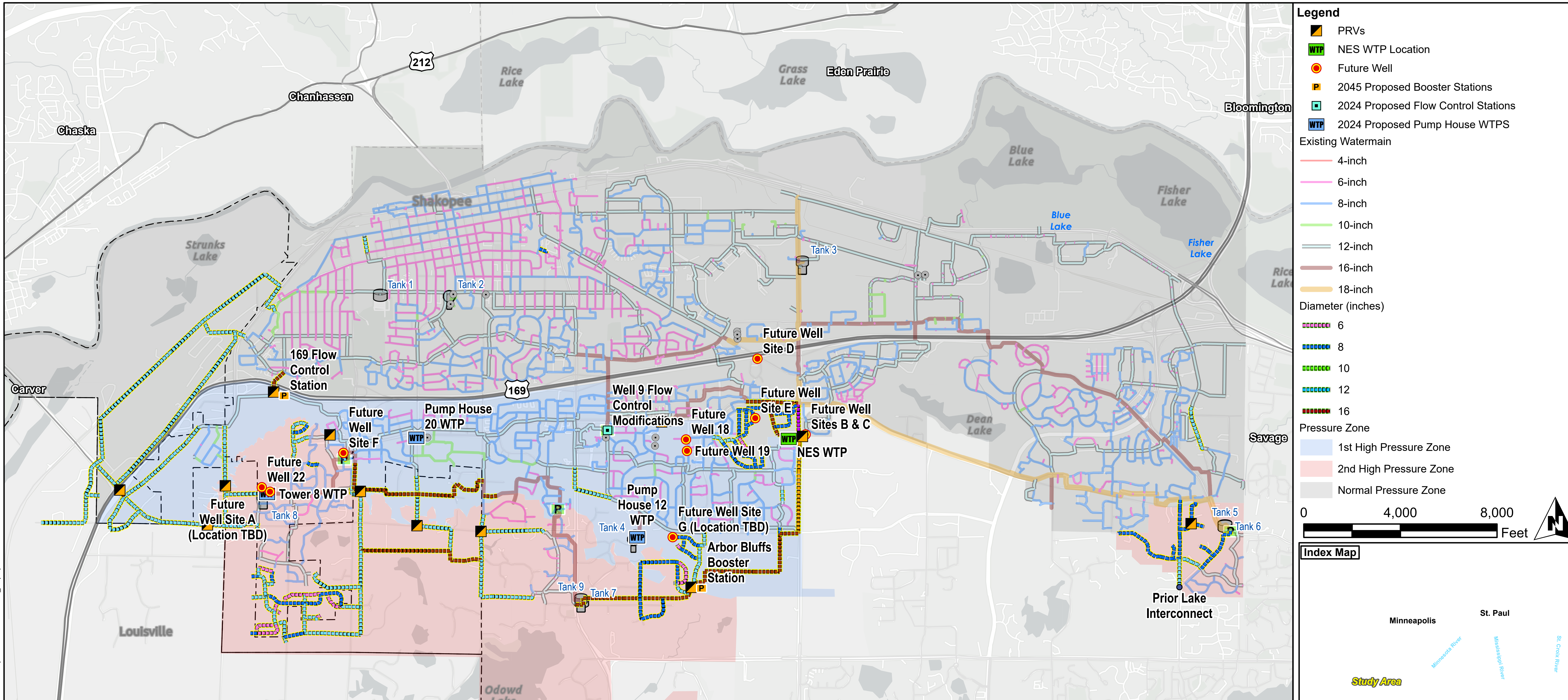
Existing Water System Model Max. Day Calc Avail Fire Flow

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 7/29/2024

Map by: msteuernagel
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 5-6



Proposed 2045 Water System Improvements

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 9/4/2024
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-1

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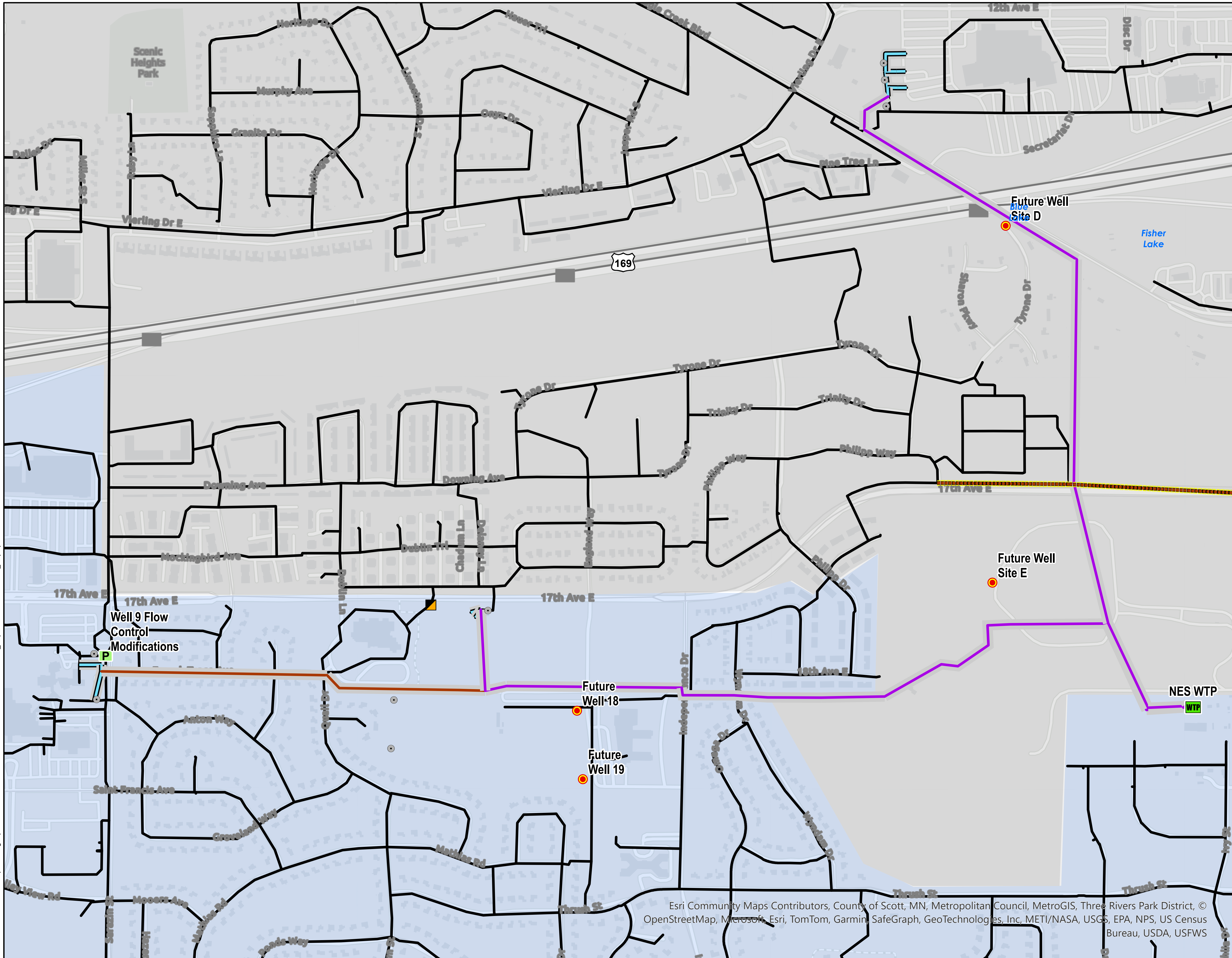


Legend

- Existing Wells
- Future Well
- PRVs
- Booster Station

Raw Water Main Diameter (inches)

- 12
- 16
- 24

Ultimate System Diameter (inches)

- 6
- 8
- 10
- 12
- 16

Index Map: Minneapolis, St. Paul, Study Area

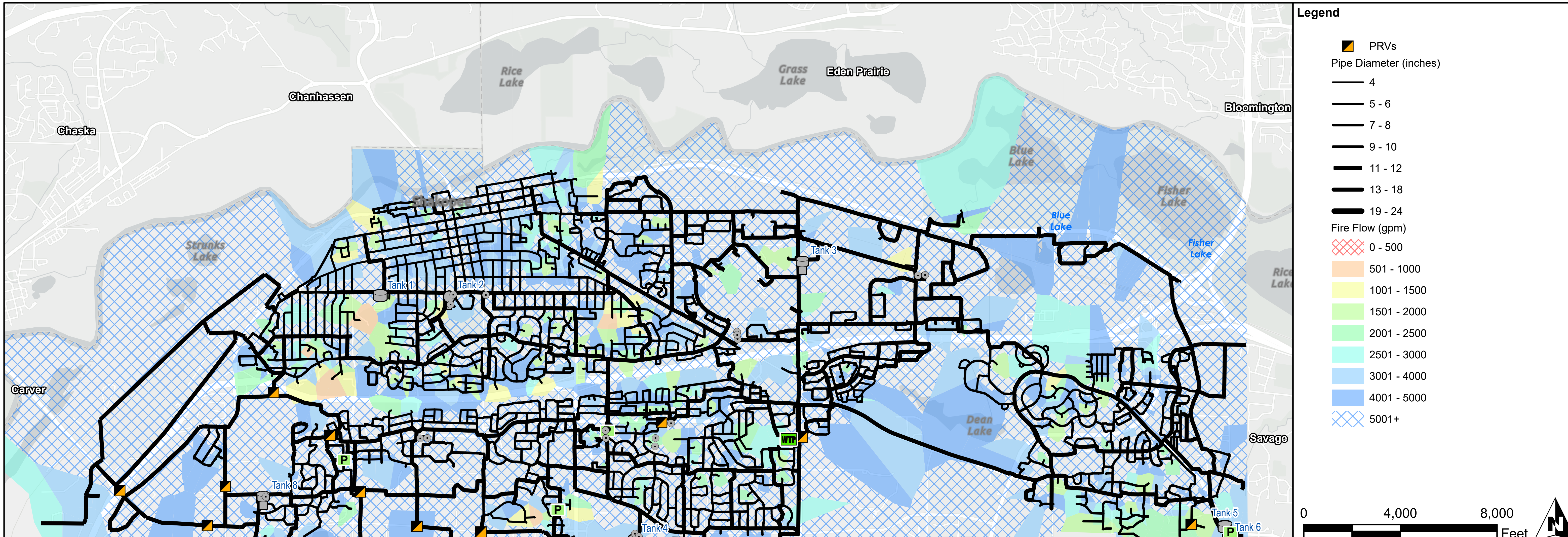
Proposed WTP & Raw Water Transmission System

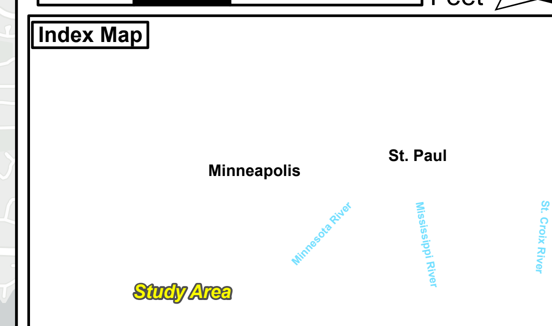
2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 7/31/2024
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-2





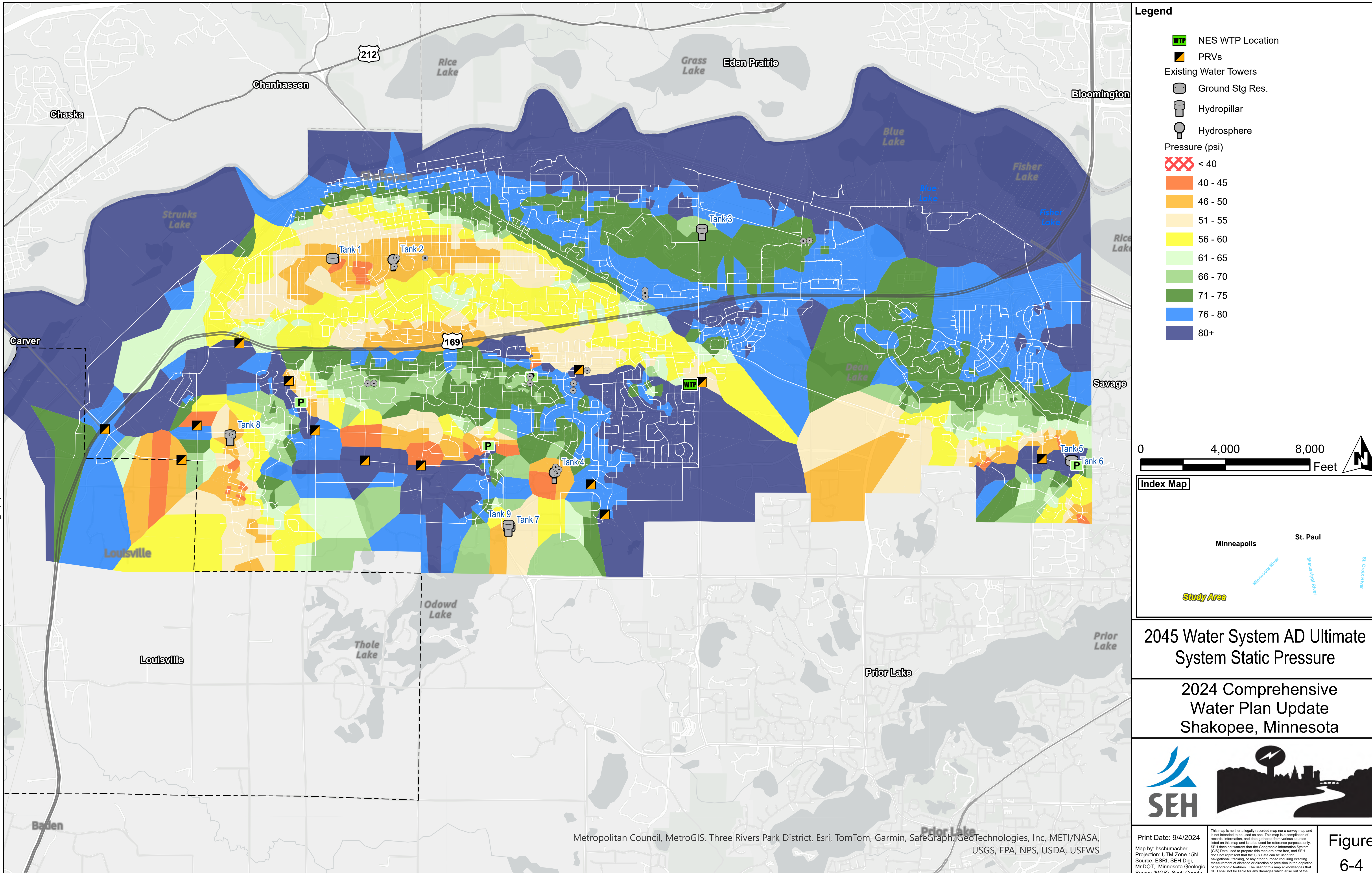
2045 System Fire Flows
Ultimate System Fire Flow

2024 Comprehensive
Water Plan Update
Shakopee, Minnesota

Print Date: 9/4/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-3



2045 Water System AD Ultimate System Static Pressure

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 9/4/2024
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-4

Path: C:\Users\hschumacher\OneDrive - Short Elliott Hendrickson Inc\Project Folders\WMs\Shakopee\GIS\Final Map\SPU\WaterDistribution_Map.aprx

Appendix A

Aquifer Sustainability Study

Prairie du Chien - Jordan Aquifer

Aquifer Sustainability Study

Shakopee, Minnesota

SHPUC 177653 | June 13, 2024

Building a Better World for All of Us®

Engineers | Architects | Planners | Scientists

Prairie du Chien - Jordan Aquifer

Shakopee, Minnesota

SEH No. SHPUC 177653

June 13, 2024

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

Mark Sherrill
____

Mark Sherrill, PG

Date: 04/15/2024 License No.: 58626

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SEH

Executive Summary

Short Elliott Hendrickson, Inc. (SEH®) was retained by the Shakopee Public Utilities Commission (SPUC) to update the 2005 aquifer sustainability study for the Prairie du Chien-Jordan bedrock aquifer. This aquifer is the primary source water aquifer utilized by the SPUC for its public water supply system serving the City of Shakopee. In the Shakopee area, other options for water supply are limited – the deeper Tunnel City bedrock aquifer is not highly productive and the Mount Simon-Hinckley Aquifer cannot be used under current state law. Shallow sand and gravel aquifers are not prolific, and surface waters and their required treatment are cost prohibitive. Within the study area, the Prairie du Chien-Jordan Aquifer is also used for public water supply by the City of Savage, Prior Lake, and the Mdewakanton Sioux Community, in addition to non-municipal uses (e.g. commercial and industrial businesses, golf courses, and individual domestic-supply wells).

The demand for public water supply in Shakopee is likely to increase over the next 20 years to meet the growth and development of the City and surrounding communities. This growth is projected not only for the city proper, but within neighboring communities such as Jackson and Louisville Townships that will likely depend on the SPUC to supply water for public, commercial, and industrial use.

The purpose of this study was to evaluate whether the Prairie du Chien-Jordan Aquifer in the Shakopee area will be able to sustain these projected increases in its development and use. The secondary purpose of the study was also to assess how potential increases in future pumping of this aquifer may impact its capabilities, productivity, and long-term capacity to provide a source of groundwater including new wellfields. The report discusses four potential well feasibility areas to consider for future development. Sustainable water use is defined by the Minnesota Department of Natural Resources (MnDNR) as the use of water for the needs of society, now and in the future, without unacceptable social, economic, or environmental consequences.

This study involved a detailed review of the hydrogeological conditions in the study area and a compilation and analysis of future precipitation and water use trends. The report utilized a three-dimensional (3-D) groundwater flow model that was used in simulating the Prairie du Chien-Jordan Aquifer in the study area and utilizing it to perform various future pumping and hydrogeologic scenarios. This method provided a measurement of the predicted decrease in groundwater elevation of the aquifer given the higher pumping rates and additional municipal wells necessary to meet the projected public water supply demands. Under this approach, the key observations from the modeling would include whether the elevations of the groundwater in the aquifer decrease below the top of the aquifer, or whether any portion of the aquifer in the model goes dry.

The model indicates decreases in groundwater head ranging from less than 1 foot to nearly 68 feet under future 2040 pumping conditions. Drawdown scenarios are improved by approximately 10 feet with the development of future wells #18, 19, 22, and 24. Under the given assumptions and scenarios, it does not appear that the groundwater elevations of the Jordan Sandstone decrease to below the top of the aquifer, nor do any of the cells of the aquifer model representation of the Prairie du Chien-Jordan Aquifer go dry. Figures are included depicting the results of modeling the various pumping scenarios.

The groundwater flow modeling appears to suggest that the Prairie du Chien-Jordan Aquifer will remain in a fully-saturated condition (groundwater heads at or above the Jordan Sandstone), even under reduced recharge and aquifer capacity conditions. Outflows from wells within the model domain currently make of 6% to 14% of water inflows. Because outflows were increased by wells it is a likely presumption that the increase in pumping is balanced by a decrease in aquifer outflows to surface water features.

The following findings and opinions have been derived from this study, and are offered to the SPUC:

- The Prairie du Chien-Jordan Aquifer in the study area is approximately 30,709 acres (1.34 billion square feet) and is typically 200-300 feet thick.
- Recharge to the aquifer is estimated to range from 7.6 to 12.2 billion gallons per year (SEH, 2005). Modeling from the Metro Model 3 during this study indicate recharge over city limits is closer to 12 billion gallons per year. Precipitation trends under current climate scenarios indicate that Minnesota is likely to increase. Additionally, the aquifer is recharged over a much larger regional area, even outside of the Twin Cities area.
- Studies suggest that recharge to the aquifer is complicated and may increase or decrease depending on land use changes, climate, and timing/frequency of precipitation (Scott County, 2009 and Met Council, 2022). Droughts in Minnesota are expected to decrease with current climatic models (Blumenfeld, 2021).
- Based on information from the SPUC Comprehensive Water Plan and data from the Met Council Master Water Supply (2015) the following ultimate groundwater demand projections are forecasted for the Prairie du Chien-Jordan Aquifer in the study area:
  - City of Shakopee 6.1 million gallons per day (MGD) to 9 MGD in 2040
  - City of Prior Lake: 2.9 MGD to 4.32 MGD in 2040
  - City of Savage: 2.52 MGD to 3.12 MGD in 2040
  - Mdewakanton Sioux Community: 0.5 MGD to 1 MGD in 2040 (estimated)
  - Non-municipal use: 4.09 MGD to 6 MDG (estimated)
  - **Total**: ~23 MGD.
- Groundwater flow modeling was performed to simulate various future aquifer pumping scenarios. Four scenarios of current and future water use were modeled to assess water recharge and drawdown within the Prairie du Chien-Jordan Aquifer within the study area.
- The groundwater flow modeling appears to suggest that the Prairie du Chien-Jordan Aquifer will remain in a fully-saturated condition (groundwater heads at or above the Jordan Sandstone), even under reduced recharge and aquifer capacity conditions. Outflows from wells within the model domain currently make of 6% to 14% of water inflows. Because outflows were increased by wells it is a likely presumption that the increase in pumping is balanced by a decrease in aquifer outflows to surface water features.
- Well drawdown refers to the decline in water level within a well due to pumping, the ability of the aquifer to recharge once pumping stops is crucial for maintaining sustainable groundwater resources. Balancing drawdown with recharge is essential to prevent overexploitation and depletion of aquifers.
- Four potential future well feasibility sites were discussed in this report. Potential well sites within the northern portion of the City were not assessed due to potential lower yields and an increase number of potential contaminant sites. Potential Well Sitting Area A and B are currently planned for future wells due to existing infrastructure and should be the priority for pursuing additional wells. This study cannot definitely provide a justification for or against the SPUC developing these sites; however, modeling efforts and available public data support that they could be viable sites. Modeling for potential well sitting Area A indicate the least amount of well interference between SPUC wells due to different upgradient flow paths and spacing away from existing well fields. This wellsite is upgradient from a known superfund site and as a conservative approach additional monitoring would be preferable at this well field. Potential Well Siting Area C and D are also discussed as potential future options for SPUC. Potential Well Siting Area D is in the proximity of the Savage Fen and Potential Well Siting Area C is in the proximity of O'Dowd Lake where water use restrictions will likely apply now and in the future. SPUC should work with the DNR prior to assessing these locations for future well sites.

Based on the results of this study, the following recommendations are offered to the SPUC:

- Over the next several years and decades, groundwater levels in the SPUC municipal wells should be monitored frequently and on a regular schedule during both static and pumping conditions to determine whether the Prairie du Chien-Jordan Aquifer elevations are decreasing over time. This data can be used to identify long-term trends on recharge in the aquifer.
- SPUC should continue to work with Met Council and their partners on water planning efforts. Recharge to the aquifer is vital for long term potable water supply. Met Council continues to evaluate and implement strategies to address these concerns and SPUC should remain open to their efforts in this regard. SPUC could work with City of Shakopee to promote and implement their education material, findings, and solutions.
- As additional publications are made available from the Met Council on recharge, precipitation rate, and leakage rates to the aquifer the groundwater flow model should be updated to re-assess the overall mass balance of the Prairie du Chien-Jordan Aquifer.
- SPUC should remain aware that the Minnesota Department of Natural Resources drawdown thresholds are described in MN Rule 6115.0630 Definitions Subps.15 and 16. Two thresholds are in place and regulate that wells must not drawdown DNR assigned static water levels to within 50% and 25% to the top of aquifer. These threshold values are set by a DNR observation well and would typically be enforced if long term issues are observed. At present, no DNR threshold values were identified for the area. If excessive drawdown and well interference is observed by SPUC, SPUC may want to reach out to the DNR to set up threshold values for the aquifer.
- As additional municipal wells are constructed, the SPUC should continue to collect hydrogeologic data through comprehensive aquifer pumping tests. This data can supplement existing data and could be useful in refining the groundwater flow model. A 72-hour pump test should be conducted for new municipal wells including at least one observation well.
- As a conservative approach, SPUC should consider additional groundwater monitoring be conducted around Well 23 for the potential of the Louisville Landfill Superfund site contamination to reach the site. Additionally, SPUC could contact the Minnesota Pollution Control Agency (MPCA) site manager to discuss the likelihood of contamination reaching the site in the case that flow modeling of the site has already been completed.
- As additional wells or wellfields are pursued, it is recommended that before a well site is selected to request recent environmental documentation from the relevant agencies (MPCA, MDA, EPA) to assess for known groundwater contamination.
- The SPUC should continue to cooperate and collaborate with the Southwest Metro Ground Water Group to identify strategies and best management practices to minimize the groundwater use and pumping development pressure on the aquifer.
- The SPUC may want to consider reaching out and opening dialogue with the DNR on their local monitoring stations for sensitive natural resources (e.g. springs, trout streams, and calcareous fens). The DNR routinely sets up monitoring networks and may already have monitoring locations close to City limits. These features have the potential to be impacted by increasing water demand increases in the region. Working collaboratively with the DNR before problems arise could help alleviate any potential future appropriation permit issues.

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Aquifer Sustainability Study

Prepared for City of Shakopee, Minnesota

1 Introduction

Short Elliott Hendrickson Inc. (SEH®) was retained by the Shakopee Public Utilities Commission (SPUC) to **update** the 2005 aquifer sustainability study completed by SEH for the Prairie du Chien-Jordan bedrock aquifer. This aquifer is the primary source water aquifer utilized by the SPUC for its public water supply system serving the City of Shakopee. The update includes review of numerous new publications and data sources that have been utilized to update this study and to help plan SPUC future groundwater projects. The primary sources for the updated report use the following sources:

- In 2006, the Minnesota Geologic Survey (MGS) completed a detailed Part A and Part B Geologic Atlas for Scott County, Minnesota (Setterholm, 2006).
- In 2008, the MGS completed a Hydrogeology study of Scott County (Tipping, R.G.; Runkel, A.C, 2008)
- In 2009, Scott County published findings on impacts to groundwater supply and their modeling results.
- In 2014, the Metropolitan Council (Met Council) created the Twin Cities Metropolitan Area Flow Model Version 3. This is a public access groundwater flow model that can be utilized in water planning within the Twin Cities Area. The model was utilized in this Aquifer Study to assess the Prairie-du-Chien/Jordan Aquifer and is discussed in the sections below.
- Updated 2040 Comprehensive Plans with projected water use.

1.1 Background

The City of Shakopee is located in Scott County, Minnesota within the Twin Cities Metropolitan Area. As shown in **Figure 1**, the specific area of interest for this study included the Cities of Shakopee and Prior Lake, the Mdewakanton Sioux Community, and Jackson and Louisville Townships.

Currently, the SPUC has nineteen total municipal wells with fourteen of the wells completed in and utilizing the Jordan Aquifer. According to its own projections, the SPUC forecasts the need to construct four or five additional municipal wells to meet its future, ultimate development, water demand over the next twenty years. The future wells are intended to utilize the Jordan Aquifer.

Table 1 provides a summary of each well.

Table 1 – SPU Well Information

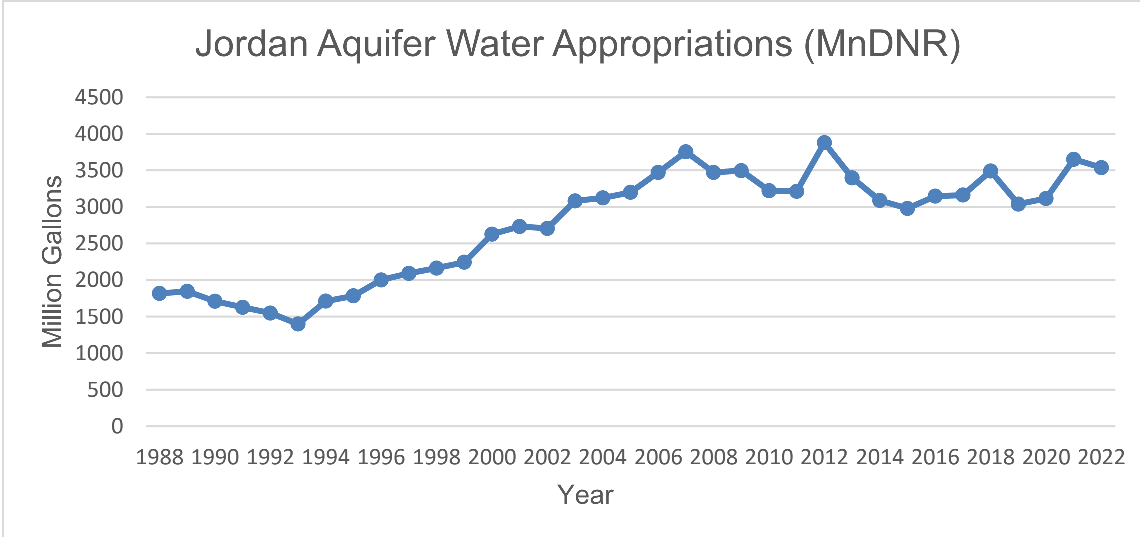
Well No.	MN Unique Well #	Year Installed	Zone	Pump House No.	Capacity (gallons per minute [gpm])	Well Depth (Feet)	Status	Aquifer
Well 2	206803	1944/ 2002	NES	Pump House 2	300	525	Active	Tunnel City-Wonewoc
Well 3*	205978	1956	NES	Pump House 3	900	755	Out of Service	Mount Simon
Well 4	206854	1971	NES	Pump House 4	715	254	Active	Jordan
Well 5	206855	1971	NES	Pump House 4	850	253	Active	Jordan
Well 6	180922	1981	NES	Pump House 6	1175	222	Active	Jordan
Well 7	415975	1986	NES	Pump House 6	1100	218	Active	Jordan
Well 8	500657	1989	NES	Pump House 2	1100	262	Active	Jordan
Well 9	554214	1994	1HES	Pump House 9	1050	315	Active	Jordan
Well 10**	578948	2001	NES	Pump House 6	1125	800	Active	Mount Simon
Well 11	611084	2001	1HES	Pump House 9	1000	312	Active	Jordan
Well 12	626775	2001	1HES	Pump House 12	810	352	Active	Jordan
Well 13	674456	2002	1HES	Pump House 12	1036	338	Active	Jordan
Well 14	694904	2004	1HES	Pump House 12	381	597	Emergency	Tunnel City-Wonewoc
Well 15	694921	2005	NES	Pump House 15	1150	295	Active	Jordan
Well 16	731139	2006	NES	Pump House 15	1450	285	Active	Jordan
Well 17	731140	2007	NES	Pump House 15	1400	290	Active	Jordan
Well 20	722624	2005	1HES	Pump House 20	1142	275	Active	Jordan
Well 21	722625	2005	1HES	Pump House 20	1175	275	Active	Jordan
Well 23	877418	2022	1HES	Pumphouse 23	800	403	Active	Jordan

* Well No. 3 is no longer used and merely serves as an emergency, standby well

** Well No. 10 is used less than 1% of the total water pumped annually

A number of adjacent entities utilize the Prairie du Chien-Jordan Aquifers. The City of Prior Lake, located southeast of Shakopee, also relies on wells open to the Prairie du Chien-Jordan Aquifer for public water supplies as well as the Mdewakanton Sioux Community, located adjacent to and within the Shakopee city limits. This aquifer is also a groundwater source for several commercial and industrial businesses, as well as a key resource for private, domestic-supply wells and irrigation wells throughout the area.

The Minnesota Department of Natural Resources (MnDNR) approves and permits large scale water use through their appropriation permits. Data from appropriation permits for wells within three miles of the City of Shakopee utilizing the Jordan Aquifer dating back to 1988 are presented in the graph below. Since 1993 water appropriations in the Jordan have increased from 1,400 million gallons per year to a maximum of 3,900 million gallons per year in 2012. Appropriations between 2012 through recent years have remained somewhat constant. Many of the surrounding Cities have completed their 2040 Met Council comprehensive plans indicate population growth and therefore the need for additional water use is likely.



Furthermore, the Prairie du Chien-Jordan Aquifer is considered a significant natural resource for sustaining springs, trout streams, and calcareous fens within the local and regional Minnesota River valley. Calcareous fens are complexes of highly-sensitive wetlands, comprised of unique and endangered vegetation which exclusively rely on the chemistry and supply of upwelling groundwater to survive.

Finally, deeper bedrock aquifers are not highly attractive options to the SPUC for public water supplies. In the Shakopee area, the Tunnel City and Wonewoc Aquifers (formerly the Franconia-Ironton-Galesville Aquifer), underlying the Prairie du Chien-Jordan Aquifer, is not as productive as in other areas of the eleven-county Twin Cities Metropolitan Area. Additionally, due to its past heavy use, extremely slow recharge, and its resulting severe decreases in groundwater elevations, the deepest, regional sandstone aquifer, the Mount Simon-Hinckley, is unavailable to the SPUC for public water supply under the current state regulation and political climate. Aquifers in sand and gravel deposits overlying the bedrock are not prolific in the area because the bedrock is at relatively shallow depths where they are present and available, they are not feasible for public water supplies due to capacity and/or chemistry issues. Therefore, the SPUC has a heavy reliance on the Prairie du Chien-Jordan Aquifer for public water supplies.

1.2 Aquifer Sustainability Overview

Sustainable water use is defined by the MnDNR as the use of water for the needs of society, now and in the future, without unacceptable social, economic, or environmental consequences.

Completing an aquifer sustainability study can not be accomplished without a discussion regarding key hydrogeological concepts and addressing critical groundwater balance issues. On a regional or large scale, an aquifer regime can be described and defined in relatively simple terms. However, on a smaller scale, an aquifer is a complex system of hydrologic interconnections with and between other groundwater bearing units and surface water bodies. The movement of groundwater is also complex at smaller scales where it is influenced by intergranular and fracture flow.

Under natural conditions, whether it is confined or unconfined, an aquifer is usually in a state of dynamic equilibrium (or “steady state”) such that a volume of water recharges the aquifer and an equal volume is discharged. Groundwater moves from areas of recharge to areas of discharge. The surface of the groundwater within the aquifer is relatively steady and the amount of groundwater storage in the aquifer is constant. Should an aquifer be transmitting a maximum volume of groundwater, it is more than likely that some potential recharge is being rejected in the recharge area, and may be discharging to other aquifers or surface water bodies.

In general, the amount of recharge to an unconfined aquifer is dependent upon: a) the amount of precipitation that is not lost by evapotranspiration and runoff; b) the vertical permeability of the geologic deposits; and c) the transmissivity of the aquifer and its potentiometric surface. Recharge to a confined aquifer (usually referred to as “leakage”) is highest where the aquifer is unconfined and/or missing its confining layer(s) and often occurs in bedrock valleys (e.g. areas where the aquifer outcrops or subcrops directly beneath highly permeable overburden). Leakage to the aquifer will also occur slowly through the bedrock geologic formations present above and below the aquifer, but in much smaller volumes.

The amount of groundwater available for use from an aquifer is not the natural recharge. It is the increase in recharge or leakage from adjacent strata induced by development (i.e. pumping), along with the reduction in discharge. As groundwater levels fall due to pumping, there will also be some groundwater made available from storage.

Other hydrogeologic terms include *Basin yield* which is defined as the maximum rate of withdrawal that can be sustained by the complete hydrogeologic system in a groundwater basin without causing unacceptable declines in hydraulic head in the system or causing unacceptable changes to any other component of hydrologic cycle in the basin. The terms *safe yield* and *optimal yield* are similar concepts and are defined as the scheme that best meets a set of economic and/or social objectives associated with the uses to which the groundwater is to be allocated. As discussed at length in Freeze and Cherry’s Groundwater text (Freeze and Cherry 1979), it is incorrect to define safe yield as the annual extraction of groundwater that does not exceed the average annual recharge to an aquifer. Major development and use of groundwater may significantly change the recharge-discharge regime as a function of time. The basin yield depends both on the manner in which the effects of withdrawal are transmitted through the aquifers and on the changes in rates of groundwater recharge and discharge induced by the withdrawals. That is to say, if a groundwater basin were developed to its maximum yield, the potential yields of surface water components of the hydrologic cycle in the basin would be reduced. Therefore, the optimal uses of the groundwater resources of a watershed or aquifer depend on the conjunctive use of surface water and groundwater (Freeze and Cherry 1979).

Given the varying complexities and heterogeneities of all natural systems, in this case specifically, the groundwater regime, and the difficulty of accurately predicting future conditions and community development, several assumptions had to be made in the course of completing this project. Assumptions have been identified in section 5 to identify, explain, and justify the main assumptions used to derive the conclusions of this report. Inherently, the use of assumptions likely oversimplifies the intricacies of the problems and questions that this study is to address. Therefore, the findings of this study should be considered relatively accurate and reliable, but not precise. Furthermore, the reader is encouraged to exercise caution in relying too heavily on the findings and conclusions of this study in making broad-based decisions or policy.

1.3 Project Purpose and Scope

The demand for public water supply in Shakopee is likely to increase over the next 10-20 years to meet the forecasted growth and development of the City and surrounding communities per the Shakopee 2040 Comprehensive Plan. This growth is projected not only for Shakopee, but within neighboring communities such as Jackson and Louisville Townships that will likely depend on the SPUC to supply water for public consumption as well as commercial and industrial use. In addition, due to significant limitations in its ability to utilize local and regional aquifers for public water supplies, the City of Savage may purchase additional water from the SPUC. The populations of the Mdwakanton Sioux Community and the City of Prior Lake will also likely increase over time, and will therefore, require additional public water supply.

The purpose of this study was to evaluate whether the Prairie du Chien-Jordan Aquifer in the Shakopee area will be able to sustain these projected increases in its development and use. The secondary purpose of the study was also to assess how potential increases in future pumping of this aquifer may impact its capabilities, productivity, and long-term capacity to provide a source of groundwater.

As outlined in a proposal to the SPUC, SEH's scope of work included an update to the 2005 aquifer study and encompassed the following tasks:

- A review of the local and regional hydrogeological conditions and recent publications.
- Assessing the Met Council's Metro Model 3, a regional groundwater flow model for the Twin Cities area. The model was used in simulating the Prairie du Chien-Jordan Aquifer under current and future use.
- Analyzing the recharge rate of the Prairie du Chien-Jordan Aquifer.
- Projecting and predicting future populations and water use in the Shakopee area.
- Modeling the Prairie du Chien-Jordan Aquifer with computer simulations under 2023 and predicted 2040 pumping conditions.
- Completing this report to summarize the findings of the study and offer conclusions and recommendations to the SPUC.

1.4 Approach and Methods

The approach involved selecting an existing and recent computer-based groundwater flow model (Metro Model 3) simulating the Prairie du Chien-Jordan Aquifer in the study area, refining it to a limited degree, and utilizing it to perform various future pumping and hydrogeologic scenarios. This method provided a measurement of the predicted decrease in groundwater elevations of the aquifer given the higher pumping rates and additional municipal wells necessary to meet the projected public water supply demands. Under this approach, the key observations from the modeling would include whether the elevations of the groundwater in the aquifer decrease below the top of the aquifer, or whether any portion of the simulated aquifer in the model goes dry.

2 Hydrogeologic Setting

This section describes and discusses in detail the geologic and hydrogeologic conditions in the Shakopee area. Specifically, the review of hydrogeologic conditions was primarily focused on the study area as presented in **Figure 1**.

2.1 Regional Geologic Conditions

The bedrock geology of the Shakopee area consists of sedimentary rocks deposited in a shallow basin during the transgression and regression of shallow seas throughout the Paleozoic Era. The Paleozoic rocks of the study area were deposited in the Hollandale Embayment, a shallow depression that existed between the transcontinental arc and the Wisconsin arc and dome. The Paleozoic strata were deposited in thin, relatively horizontal layers and were subsequently warped during faulting that caused the formation of the Twin City basin. The Twin City basin forms a bedrock depression in Hennepin, Ramsey and northern Dakota Counties and a structural high in southern Scott and southern Dakota Counties. The Paleozoic rocks within the Shakopee area dip slightly to the northeast away from the structural high towards the center of the Twin City basin (MGS Part A, 2006).

Glacial deposits overlie bedrock units in the Hollandale Embayment and are depicted on **Figure 2**. The glacial deposits are relatively thin in the Shakopee area (approximately 50-100 feet thick or less as depicted on **Figure 3**. Surficial sand thickness increases up to 400 feet in thickness on the eastern portion of the City where a bedrock valley has been filled. The surficial geology of the Shakopee area consists of alluvium, Holocene and Pleistocene terrace deposits, and outcrops of bedrock along the Minnesota River. The terrace deposits are undulating erosional and depositional surfaces covered by at least 1.5 feet of fine, wind deposited sand and silt locally by stream-deposited sandy, silty clay. These deposits are mainly comprised of sands and gravels. Terraces were cut into outwash deposits, drift, till, and bedrock as glacial melt water surged through the existing river valley (MGS Part A, 2006).

Farther south of the Minnesota River, the surficial geology is comprised of till. The till is less permeable than the terrace deposits located along the river. The till acts as a semi-confining unit in some areas creating confined aquifers within surficial deposits and bedrock units.

The uppermost bedrock in most of the City and study area is the Prairie du Chien Group. However, within buried bedrock valleys, older and deeper bedrock units such as the Jordan Sandstone, St. Lawrence Formation, and Tunnel City Group are the first bedrock types encountered in the subsurface. **Figure 4** depicts the uppermost bedrock units in the area and **Figure 5** and **Figure 6** present generalized geologic cross-sections through the City of Shakopee.

While variation and extent of bedrock aquifers occur, in general four regional aquifers are described and support much of the potable water for the Twin Cities region, from oldest to youngest:

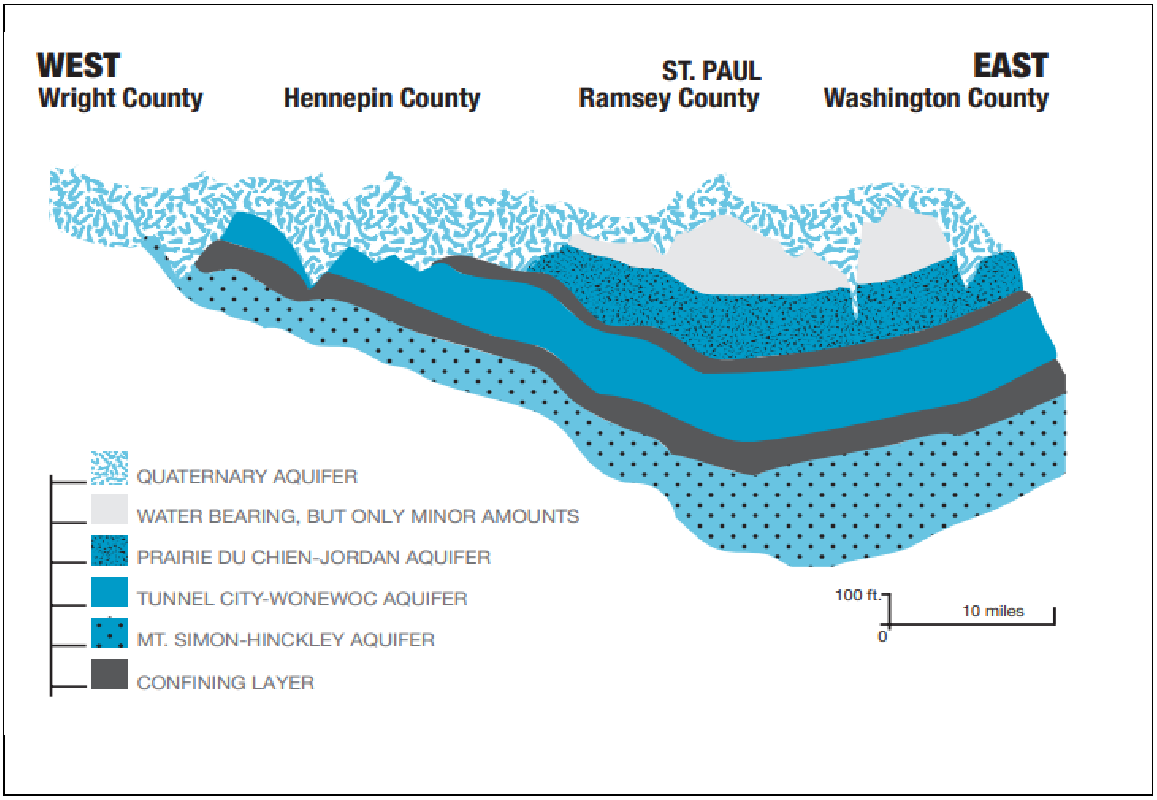
1. Mt Simon-Hinckley Aquifer
2. Tunnel City-Wonewoc Aquifer
3. Prairie du Chien-Jordan Aquifer
4. Quaternary Aquifer(s) consisting of water-table or buried sand/gravel aquifers.

These aquifers are often hydrologically disconnected by a variety of interbedded confining layers. Regional aquifers can also be subdivided further; for example, the Prairie du Chien and Jordan Aquifers may be hydraulically disconnected if the lower member of the Prairie du Chien (Oneota Dolomite) acts as a confining unit. Primary lithology, and hydrogeologic designations are summarized in below, from **oldest to youngest**, for the area around SHUC well fields.

Table 2 – Bedrock Formations

Geologic Formation	Age	Primary Hydrogeologic Designation	Approximate Thickness	Primary Regional Lithology
Hinckley Sandstone	Pre-Cambrian	Aquifer	Not Available	Quartzose sandstone overlying the Precambrian bedrock
Mt Simon Sandstone	Middle Cambrian	Aquifer	~ 200 to 336 feet (ft)	Quartz sandstone that contains interbedded siltstone and very fine sand.
Eau Claire Formation	Middle to Upper Cambrian	Confining	~ 60 to 90 ft	Fine grained sandstone, siltstone, and shale.
Wonewoc Sandstone	Upper Cambrian	Aquifer	~ 50 to 75 ft	Very fine to very coarse-grained sandstone.
Tunnel City Group	Upper Cambrian	Aquifer / Confining	~ 0 to 100 ft	Lower is massively bedded very fine to fine-grained sandstone; upper is coarse-grained sandstone.
St Lawrence Formation	Upper Cambrian	Confining	~ 0 to 60 ft	Dolomitic siltstone with interbedded very fine-grained sandstone and shale.
Jordan Sandstone	Upper Cambrian	Aquifer	~ 0 to 100 ft	Upward sequence of fine to coarser grained sandstone.
Prairie du Chien Group	Lower Ordovician	Aquifer / Confining	~ 0 to 200 ft	Upper Shakopee Formation is a heterolithic unit of dolostone, sandy dolostone, and sandstone; lower Oneota Dolomite is medium to thick dolostone beds.

Figure 7 through **Figure 20** depict the predicted elevation top and aquifer thickness of each of these geologic formations. Data was derived from a publication completed by the MGS in 2007 titled the Hydrogeology of Scott County.



The image above was developed by the Met Council in their Water Supply Planning in the Twin Cities Metro (2020) as a general depiction of bedrock aquifers. The Met Council reports that quaternary aquifers supply 24 city systems, the Prairie Du Chien-Jordan Aquifer supplies 83 city systems, the Tunnel City-Wonewoc supplies 30 city systems, and the Mt. Simon-Hinckley supplies 35 city systems.

SPUC primarily obtains water from the Prairie Du Chien-Jordan aquifer and detailed descriptions and their hydrogeologic characteristics are provided in the following sections. The deeper bedrock units below the Jordan Sandstone have not been discussed or described in the same detail because they are not the primary source water aquifer.

2.2 Prairie du Chien Group

The uppermost bedrock unit in the Shakopee/Scott County area is Ordovician Prairie du Chien Group (OPDC). The OPDC is described as a fine-grained dolostone, sandstone, and shale. The lower 60 to 100 feet (Oneota Dolomite) is primarily dolostone, while the upper 75 to 100 feet (Shakopee Formation) is composed of mixed dolostone and fine-to coarse-grained quartz sandstone (MGS, 2007). The approximate thickness of the unit is up to 200 feet, although the thickness of the OPDC is highly variable due to an erosional surface at the top of the formation (**Figure 4**). The average surface elevation of the OPDC is approximately 800 feet above mean sea level (amsl) in the central portion of the study area, and as low as 634 feet amsl near the local bedrock valleys.

The OPDC is subdivided into two formations, the Oneota Dolomite and the Shakopee Formation. The Oneota dolomite is a finely-crystalline dolomite that locally is sandy, particularly near the base. It is sparingly fossiliferous and rarely contains oolites or chert. The overlying Shakopee

Formation is composed of two members, the New Richmond Member sandstone and the Willow River Member dolomite. The New Richmond Member is a thin (0 to 25 feet thick) basal unit of well sorted, fine- to medium-grained, quartz sandstone with abundant carbonate cement. The Willow River Member overlies the New Richmond Member and consists of finely crystalline dolomite that is commonly sandy or oolitic with abundant chert. Sandstone stringers of composition similar to the New Richmond Member occur throughout the Willow River Member (MGS, 2007).

2.3 Jordan Sandstone

The Jordan Sandstone is described as a white, fine- to coarse-grained, poorly cemented sandstone; the fine clastic component is moderately- to tightly cemented with minor siltstone and shale. The MGS, in the 2007 Hydrogeology of Scott County publication, noted that the Jordan is typically thought of as a homogenous unit; however, a more accurate description is two interlayered facies with a coarse unit underlain by a fine grained unit. The coarse and fine components of the Jordan Sandstone are preferentially located in vertical horizons. The fine component is typically found in the lower 5 to 50 feet and the coarse component in the upper 50 to 80 feet of the formation. In addition, the units are intercalated, and tongues of the fine clastic unit are found rising diagonally up-section. Uneroded thickness of the Jordan Stone in the Shakopee area is around 100 feet. In areas where erosion has taken place (thickness is less than 100 feet) a larger portion of the unit will be comprised of the fine-grained unit (MGS, 2007).

2.4 Prairie du Chien-Jordan Aquifer Properties

The Prairie du Chien group within Scott County is composed of a high yielding upper portion (Shakopee aquifer) that is hydraulically connected to shallow water table aquifer systems including surface water features such as fen’s throughout the area. The Shakopee is underlain by a less permeable, massively bedded, confining unit (Oneota Dolomite) that provides confinement to the underlying Jordan Sandstone. The Prairie due Chien-Jordan Aquifer is generally considered one aquifer due to leakage through the Oneota through the combination of systematic joints in the areas distal to buried bedrock valleys and bedding plane fractures (MGS, 2007).

The stratigraphic units encountered in the Shakopee area are not laterally extensive throughout the southwestern portion of the Twin Cities. Buried bedrock valleys, filled with glacial and alluvial deposits, completely encompass the Prairie du Chien-Jordan aquifer in the study area, creating a buried isolated dome of these bedrock formations. The locations of bedrock valleys are depicted in **Figure 4** and define the boundaries of the local extent of the Prairie du Chien-Jordan Aquifer and the area of study. The valleys incise through the Prairie du Chien Group and Jordan Sandstone, into the Tunnel City, Wonewoc, and the Eau Claire Formation. The bedrock valleys are assumed to hydraulically disconnect the local Prairie du Chien-Jordan Aquifer from surrounding areas with these same formations. Permeabilities and groundwater flow in the deposits within the bedrock valleys are likely higher than within the adjacent and underlying bedrock formations but are more prone to surface contamination.

Due to carbonate lithology of the Prairie du Chien Group (OPDC), this aquifer has low matrix porosity and very low to low permeability. Permeability is greater in the horizontal directions, due to the occurrence of fine to coarse clastic interbeds. Secondary porosity is very well developed in both the Shakopee Formation and Oneota Dolomite. Macroscale secondary porosity is well distributed in the Shakopee Formation and occurs along discreet horizons in the Oneota Dolomite. Some horizons within the Oneota Dolomite have high porosity, but these horizons are separated by strata of very low secondary porosity. Fractures occur ubiquitously and most extensively within the shallow bedrock of the Shakopee Formation. Dissolution features occur in all areas within the OPDC where secondary porosity is high. Phreatic caves are present from the lower Shakopee Formation to the upper Oneota Dolomite.

Secondary porosity largely controls the permeability of the OPDC. The OPDC displays high variability of permeability typical of carbonate aquifers. In general, the permeability of a carbonate unit is primarily controlled by local secondary porosities, and therefore is difficult to quantify over large areas. Recent research conducted on the OPDC provides additional information on the hydrogeologic framework of the aquifer.

A wide range of hydraulic conductivities have been observed for the shallow bedrock of the OPDC. Typically, the lower Oneota Dolomite acts as a leaky confining unit between the OPDC and the underlying Jordan Sandstone (MGS, 2007). However, evidence exists throughout Minnesota suggesting a hydrologic separation of the OPDC and the Jordan Sandstone. In Rochester, Minnesota, the two units have displayed different hydraulic gradients and flow directions - no groundwater drawdown occurred in the OPDC when pumping was initiated from the Jordan Sandstone, and there were indications of hydrochemical separation. Although regionally there is no evidence to support or contradict the lateral extensiveness of the lower Oneota confining unit, there is sufficient data that supports that the Oneota acts as a confining unit on a local scale extensively throughout Minnesota. However, for the purposes and limitations of this study, it was assumed that the Prairie du Chien Group and Jordan Sandstone behave as one, hydraulically-connected, hydrogeologic unit. Additionally, pump tests from SPUC wells were analyzed as part of the 2007 MGS hydrogeology report that suggest that PDC and Jordan aquifer are hydraulically connected.

In Shakopee, two city wells that draw water from the Jordan aquifer were tested. At Shakopee No. 6 (unique well number 180922), the Jordan aquifer is overlain by the Prairie du Chien Group, which in turn is overlain by three to eight feet of drift. At this site, the Jordan aquifer appears to be in good hydraulic connection with the land surface and PDC; water levels in the pumping and observation well responded to changes in atmospheric pressure which was also monitored during the test. Well response during the test indicates semi-leaky confined conditions within the Jordan. Shakopee No. 12 (unique number 626775) is located near the edge of the terrace/base of the bluff along the Minnesota River. Shakopee No. 9 and No. 11, both completed in the Jordan Sandstone were used as monitoring wells for this test. They are located downgradient from Well No. 12, under the river terrace deposits. No response was documented in either of these wells due to pumping of Well No. 12 (MGS, 2007).

The clastic lithology of the Jordan Sandstone causes intergranular flow through primary porosity to dominate. The lithological differences between the coarse clastic component and the fine clastic components of the sandstone contribute to a wide range of porosity and permeability of the formation. The coarse clastic component displays permeabilities of greater than 3,200 feet per day (ft/d) (1,000 meters per day (m/d)), whereas the fine clastic component has permeabilities ranging from $2X10^{-6}$ to $2X10^{-8}$ ft/d. Bulk hydraulic conductivities of this portion of the aquifer is estimated to be 65 ft/day (MGS, 2007). An aquifer test completed on SPUC Well No. 12 was estimated to be 125 ft/day, assuming an aquifer thickness of 90 feet. Specific capacity was calculated for 170 Jordan wells in Scott County and ranged from 11.2 gpm/foot of drawdown to 20.8 gpm/foot of drawdown, noting better yields where the Jordan was found with greater thickness (MGS, 2007). Hydraulic properties of this formation are highly variable for shallow bedrock conditions. The conductivities and specific capacity measured in these settings may be controlled, in part, by the presence or absence of fracture flow. Although evidence exists for the occurrence of systematic fractures in deep bedrock conditions, the fractures are narrow or closed, and poorly connected. It is suspected that fracture flow in deep bedrock conditions does, however, occur on at least the local scale. In general, unless fractures are observed, the lower portion of the Jordan should be considered with less water yield (MGS, 2007).

Groundwater flow in the Prairie du Chien-Jordan Aquifer in the study area is generally north-northwestward towards the Minnesota River. The potentiometric surface of the Prairie du Chien-Jordan Aquifer is 700 to 820 feet amsl in the Shakopee area, decreasing to the northwest. The bedrock aquifer is highly susceptible to contamination in the area due to the thin and permeable nature of local glacial and alluvial deposits (**Figure 22**).

Aquifer transmissivities for the Prairie du Chien-Jordan Aquifer of 3,500 to 8,200 square feet per day (ft^2/d) were calculated for wells in Scott County open to the Jordan or the Jordan and the OPDC. The wells that were open to both units had greater transmissivities than those open only to the Jordan Sandstone. The transmissivity of this aquifer appears greatest in the central portion of the study area and may be as high as 11,250 ft^2/d. Several aquifer pumping tests have been performed recently in the study area to characterize the Jordan Sandstone portion of the Prairie du Chien-Jordan Aquifer. These tests have been performed by the City, the USGS, and the Minnesota Department of Health (MDH). Based on the results of these tests and others, the mean transmissivity and storativity values for the aquifer were calculated to be 5,084 ft^2/day and 0.00016, respectively. The MGS indicates that the Jordan Aquifer, where uneroded, may have a transmissivity five to six times that of the Wonewoc Aquifer likely due to leakage through the Oneota dolomite (MGS, 2007).

2.5 Potential Recharge to the Prairie du Chein-Jordan Aquifer

The potential recharge to the Prairie du Chien-Jordan Aquifer is primarily facilitated by three key components:

1. Recharge/leakage through surficial units, primarily influenced by the rate and volume of precipitation.

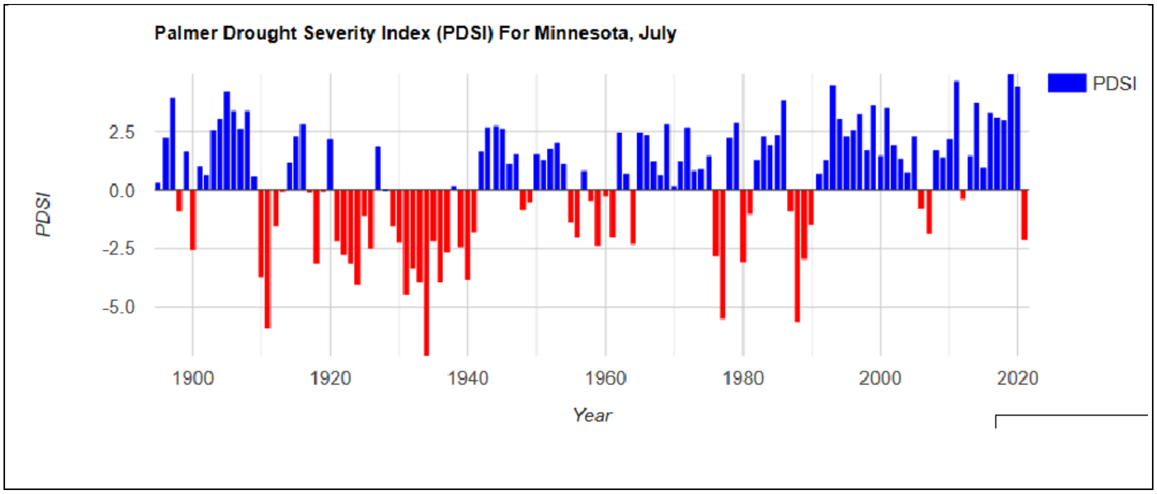
2. Recharge/leakage from hydraulically connected surface water features.

3. Upwelling from underlying units under elevated pressure conditions.

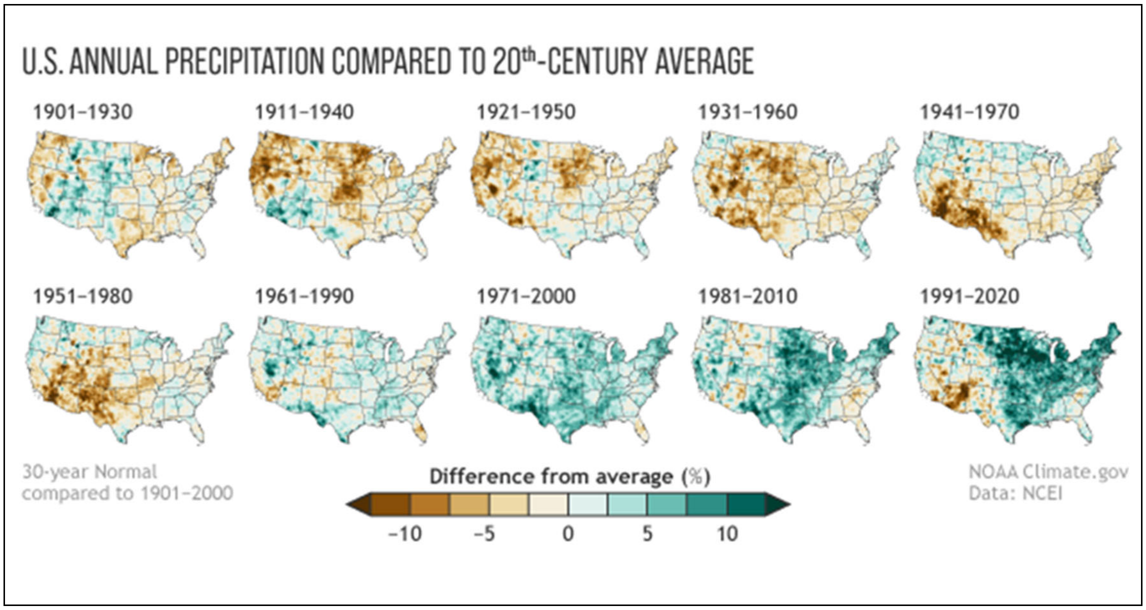
The predominant inflows to the aquifer, as determined by The Met Council's Metro Model 3, stem mainly from precipitation and surface water interactions described in components 1 and 2 above. Conversely, outflows from the aquifer via wells within the region are significantly lower, nearly two orders of magnitude less, compared to the total inflows from these two sources. Hence, the long-term recharge capacity of the aquifer post-withdrawal from wells is expected to correlate closely with regional precipitation and infiltration patterns. However, it's important to note that increased precipitation does not necessarily equate to higher recharge rates.

A study conducted by The Met Council, as presented in their 2022 Water Supply Planning Atlas for the Twin Cities Metropolitan Area, highlights various factors such as timing of precipitation, length of growing season, and frequency/extent of precipitation events, all of which can influence the rate of infiltration into the bedrock aquifers. Present climate models, as outlined by The Met Council, project a temperature increase within the Twin Cities region, estimating an annual rise between seven and 9.6 degrees Fahrenheit by 2050-2070. This climatic shift is anticipated to lengthen growing seasons, subsequently intensifying evapotranspiration rates while diminishing infiltration rates.

Kenny Blumenfeld, Senior Climatologist at the MnDNR, discussed climate trends across Minnesota at the October 2021 American Institute of Professional Geologists event. Historically, Minnesota has experienced more frequent droughts, although over the past two decades, there has been a decrease in drought occurrences, a trend likely to persist. The chart provided below depicts wet years in blue and drought years in red.



Normal annual U.S. precipitation as a percentage of the 20th-century average for each U.S. Climate period from 1901-1930 to 1991-2020 has had a measured increase in the Midwest Region. Areas where the normal annual precipitation deviates by 12.5 percent or more from the 20th-century average are depicted in the darkest brown or green hues. The chart below, is based on analysis by Jared Rennie of the North Carolina Institute for Climate Studies/NCEI (2021) and presented by the National Oceanic and Atmospheric Administration (NOAA) Climate.gov.



The Met Council predicts that between 2050-2070 precipitation is likely to increase 4.4 inches to 5.0 inches (a 13% increase) while early fall precipitation is unlikely to increase. This is roughly in line with the average difference in precipitation since 1901 as depicted by NOAA (above).

A study completed by Barr Engineering for Scott County for the Impacts to Groundwater Supply from Development of the Detailed Area Plan Study Area in 2009 concluded that the development of rural land into urban areas noted an increase in recharge. This increase in recharge was noted as primarily a function of reduced runoff a greater potential for water to infiltrate beyond the root zone.

Additionally, underneath the root zone, the land surface along the Minnesota River Valley north of Shakopee consists of surficial sands and gravel (terrace deposits). These deposits likely provide greater precipitation recharge to the aquifers due to relatively high permeabilities.

The Minnesota State Climatology Office maintains records of precipitation across the State. Average yearly dating back to 2000 is presented in **Table 3** below.

Table 3 – Yearly Precipitation Totals 2000 to 2023

Year	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Precipitation (inches)	26.7	32.2	39.9	23.6	32.2	38.8	26.5	31.0	25.6	27.9	37.2	25.7
Year	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*
Precipitation (inches)	32.3	35.5	37.9	35.6	38.2	35.6	34.6	43.8	31.4	25.1	23.1	30.5

A study on Leakage rates to aquifers throughout the Twin Cities was completed by the USGS in 2002. The study found that recharge to the Prairie du Chien-Jordan Aquifer in this area, based on vertical hydraulic gradients applied to the Darcy flow equation, are reported to range from eight inches per year (in/yr) to more than 12 in/yr. These rates of recharge are relatively high compared to surrounding areas due to the occurrence of thin permeable glacial deposits overlying the aquifer.

The bedrock valleys within the study area are filled with till in the southern and eastern portion of the area, and predominantly sand and gravel deposits near the Minnesota River (MGS, 2007). Previous studies have been conducted on the properties of the Prairie du Chien-Jordan Aquifer in proximity to the southeastern bedrock valley in the study area; however, the relative contribution from lateral recharge through buried bedrock valleys was inconclusive (USGS, 1996).

3 Groundwater Use Projections

To estimate the total potential demand from the Prairie du Chien-Jordan Aquifer in the study area, groundwater use projections were compiled and evaluated. Municipal and non-municipal uses of the aquifer were calculated and summarized. Within the study area, projections for public water supply were completed for the City of Shakopee, the City of Prior Lake, the Mdewakanton Sioux Community, Jackson Township, and Louisville Township. The following subsections describe and discuss how the Prairie du Chien-Jordan Aquifer groundwater use projections were determined. The estimations were based on predicted future populations and land uses under ultimate development conditions, per capita water usage, typical unit demands for given land uses, and history well pumping activity.

The Met Council's Master Water Supply Plan completed in 2015 notes that there is a potential for water us conflicts and well interference throughout the region. Regional groundwater modeling indicates significant aquifer decline under pumping rates that meet the projected range of 2040 demand and that the potential for impacts of groundwater pumping on surface water features such as

3.1 Shakopee Municipal Use with Jackson and Louisville Townships

The SPUC recently published its 2040 Comprehensive Water Plan Update. In the Plan, current and future municipal demands were developed. These demands were based on the assumption that a portion of Jackson Township would be annexed into the City. SPUC as a result will provide water to portions of Jackson Township to be annexed. Additional areas beyond Jackson Township may also be annexed and it is postulated that the SPUC would be the most likely utility to provide public water supplies to these annexed areas. **Table 4**provides a pumping summary of each well for 2023 and project use into 2040. Total water usage is expected to increase from 2,241,251,000 gallons a year to 3,285,000,000 gallons a year by 2040.

In 2023, 2,156,038,000 or 96% of the City's public water supply was derived from the Jordan Aquifer based on information provided by SPUC. By 2040 an increase in usage of the Jordan Aquifer is likely to increase by 1,043,749,000 gallons or 97.4% of total water demand (Assuming all new wells are completed in the Jordan Aquifer).

Currently, the SPUC has nineteen total municipal wells with fourteen of the wells completed in and open to only the Jordan Aquifer. According to its own projections, the SPUC forecasts the need to construct four or five additional municipal wells to meet its future, ultimate development, water demand. The future wells are intended to utilize the Jordan Aquifer.

Table 4 **– Historical and Project Water Pumpage (*Current and 2040*)**

Well No.	2023		Projected 2040		2040 with new wells	
	Total (1,000 gal)	% of total	Total (1,000 gal)	% of total	Total (1,000 gal)	% of total
2	84983	3.79%	124559.5	3.79%	94665.2	3.79%
3	-	-	-	-	-	-
4	81281	3.63%	119133.5	3.63%	90541.5	3.63%
5	43950	1.96%	64417.5	1.96%	48957.3	1.96%
6	218930	9.77%	320885.5	9.77%	243873.0	9.77%
7	296754	13.24%	434952.1	13.24%	330563.6	13.24%
8	209802	9.36%	307506.6	9.36%	233705.0	9.36%
9	136889	6.11%	200638.1	6.11%	152485.0	6.11%
10	230	0.01%	337.1	0.01%	256.2	0.01%
11	181496	8.10%	266018.6	8.10%	202174.1	8.10%
12	110266	4.92%	161616.8	4.92%	122828.8	4.92%
13	185182	8.26%	271421.1	8.26%	206280.1	8.26%
14	-	-	-	-	-	-
15	69293	3.09%	101562.7	3.09%	77187.7	3.09%
16	185466	8.28%	271837.4	8.28%	206596.4	8.28%

17	148269	6.62%	217317.8	6.62%	165161.5	6.62%
20	150003	6.69%	219859.3	6.69%	167093.1	6.69%
21	138457	6.18%	202936.3	6.18%	154231.6	6.18%
23	-	-	-	-	262800	8.00%
18 (future)	-	-	-	-	131400	4.00%
19 (future)	-	-	-	-	131400	4.00%
24 (future)	-	-	-	-	131400	4.00%
22 (future)	-	-	-	-	131400	4.00%
Total (1,000 gal)	**2,241,251**		**3,285,000**		**3,285,000**	

3.2 Prior Lake Municipal Use

The City of Prior Lake is located adjacent to the City of Shakopee and has its own public water supply system that is dependent upon municipal wells open to the Prairie du Chien-Jordan Aquifer. According to the Met Council's Master Water Supply Plan in 2015, Prior Lake currently has six municipal wells utilizing the Prairie du Chien-Jordan Aquifer. Based on the Met Council's 2040 estimates, the City of Prior Lake's ultimate average day demand for groundwater from the Prairie du Chien-Jordan Aquifer will increase from 2.93 million gallons per day (MGD) in 2020 to 4.32 MGD in 2040.

3.3 Savage Water Supply Proposal

The City of Savage is located to the east of Shakopee and has its own public water supply system that is dependent upon eight bedrock municipal wells, of which two are open to the Prairie du Chien-Jordan Aquifer. Based on the Met Council's 2040 estimates, the City of Savage's ultimate average day demand for groundwater from will increase from 2.52 MGD in 2020 to 3.12 MGD in 2040. As previously stated, the SPUC is considering a proposal to provide up to 3.0 MGD per day to the City of Savage.

3.4 Mdewakanton Sioux Shakopee Supply Proposal

The Mdewakanton Sioux is located to the southeast of Shakopee and has its own public water supply system that is dependent the Prairie du Chien-Jordan Aquifer utilizing a total of six wells. Information on the system was no available within the Met Council's 2040 Water Master Plan. Previous information indicates average day demand was approximately 0.5 MGD. A conservative estimate is to assume their average day demand will double to one MGD.

3.5 Non-Municipal Groundwater Use

While the volumes for municipal use are thought to be much greater than private groundwater use in the study area, there are some large groundwater users of the Prairie du Chien-Jordan Aquifer that had to be accounted. The MnDNR Water Appropriations and the Minnesota Geological Survey-MDH Minnesota Well Index (MWI) database were used to identify and quantify the number and locations of high-capacity wells within the study area and estimates their annual volumes of groundwater pumped from the aquifer. All persons, businesses, government units, and entities that use 10,000 gallons or more of water per day, or use more than 1,000,000 gallons of water per year are required to obtain a Water Appropriation Permit from the MnDNR. These permits are compiled and summarized in the MnDNR's Appropriations database. All water use wells are depicted on **Figure 21**. **Table 5** below depicts all MnDNR Appropriation permits for users within Shakopee City Limits for the from 2018 through 2022.

Table 5 – Appropriation Permits within Shakopee Limits

Property Owner	2022 mg	2021 mg	2020 mg	2019 mg	2018 mg
William Mueller And Sons Inc	0.00	0.00	0.00	0.00	0.00
Anchor Glass Container Corporation	34.88	31.01	35.23	29.64	30.92
Betaseed Inc	3.78	1.61	1.03	0.50	0.79
Biff's, Inc	3.79	2.62	1.56	0.00	0.00
Bonnevista Terrace MHP	11.35	10.89	7.90	11.45	8.41
Canterbury Park Holding Corp	27.38	28.07	17.71	22.52	23.43
Engelhaven Utilties Assoc	3.26	3.25	2.20	2.01	2.81
International Paper Company	7.83	0.61	2.85	6.61	6.92
Lloyds Construction Services	0.02	0.03	0.01	0.00	0.00
Met Council	657.86	564.04	849.31	1631.03	1091.92
O'Loughlin, MaryAnn	2.26	0.00	2.43	0.00	0.00
Preserve At Stonebrooke	7.56	7.58	6.04	1.70	3.27
Rahr Malting Company	663.20	650.50	587.18	832.72	978.43
Restan Llc	46.94	45.00	31.00	22.00	28.00
Sever Peterson Farm	0.35	0.00	0.00	0.00	0.00
Shakopee Acquisition LLC	4.18	4.14	4.53	4.50	4.38
Shakopee Gravel Inc.	4.21	2.43	0.59	0.00	1.65
Shakopee Mobile Home Park, LLC	5.34	4.17	4.48	4.84	4.17
Shakopee School District 720	15.25	16.87	13.32	12.89	4.16
Stonebrooke Golf Club	35.46	37.69	29.91	7.69	13.12
USFWS-Minnesota Valley NWR	0.00	0.00	0.00	0.00	0.00
Westridge Bay Company	14.56	16.32	9.29	6.31	8.64
Xcel Energy	0.10	0.20	0.38	0.10	0.14
Grand Total	**1552.93**	**1435.93**	**1610.26**	**2599.46**	**2214.69**

No well interference issues have been noted to date; however, SPUC should remain aware of potential interference issues caused from pumping from high capacity wells near their well field. Six high capacity well owners are listed in a close proximity to the SPUC's wellfield and include Betaseed Inc, MaryAnn O'Loughlin, Preserve At Stonebrooke, Shakopee Gravel Inc, Shakopee School District, and Stonebrooke Golf Course. It is not expected that these locations will cause noticeable drawdown in SPUC's wells; however, as water demand is increase SPUC should continue to assess if nearby high capacity wells are causing excess well interferance.

For this study it was assumed that the number of wells and volume of groundwater pumped from non-municipal, high-capacity wells open to the Prairie du Chien-Jordan Aquifer would not increase in the future beyond the current reported amounts. It was postulated that new private entities and businesses would rely upon the existing, local public water supply systems to provide water for commercial and industrial uses. The average day demand for groundwater from the Prairie du Chien-Jordan Aquifer for non-municipal uses in the study area was estimated to be 4.088 MGD.

Presently, there are numerous privately-owned, domestic-supply wells throughout the study area. Due to the relatively shallow depth to bedrock in the area, it is likely that most of these wells are open to the Prairie du Chien-Jordan Aquifer. However, for this study it was assumed that the volumes of groundwater pumped from these wells are insignificant compared to the other uses discussed in this section. Since these small-volume wells are dispersed, it was assumed that the total volume removed from the aquifer is relatively small.

3.6 Prairie du Chien-Jordan Aquifer Groundwater Use Projection Summary

Table 4 and **Table 5** summarizes the projected groundwater demand from the Prairie du Chien-Jordan Aquifer in the study area under three different scenarios 1) current 2023 demand, 2) 2040 demand using existing wells, and 3) 2040 demand using proposed wells.

Average day groundwater demands were used to estimate the projected total annual withdrawal of groundwater from the aquifer (please refer to **Section 5.0**). Maximum day water demands are significantly higher than average day demands, but are considered temporary conditions, and are therefore, not presented here. The average day demand estimates take these higher pumping volume days into account over the period of a year.

Without supplying three MGD to the City of Savage, the estimated ultimate average day demand on the Prairie du Chien-Jordan Aquifer in the study area is nine million gallons. If the SPUC decides to sell three MGD to Savage, this amount is expected to increase to 12 MGD, equivalent to 32.95 billion gallons per year (BGY).

4 Aquifer Sensitivity to Pollution and Potential Sources of Groundwater Contamination

4.1 Aquifer Sensitivity

Groundwater contamination is site specific based on a variety of factors including type of soil, depth to bedrock, and type of contaminant. Sandy soil transports chemicals at a faster rate than tightly packed soils, like clay. Published documents identify sand and gravel as the predominant soil type in the City of Shakopee (**Figure 2**). Confining soils or bedrock can act as a barrier for contaminants from deep aquifers. The MGS as part of the Scott County Geologic Atlas modeled the speed at which recharge may reach bedrock aquifers from very fast to very slow. These results are depicted on **Figure 22**. In generally, due to the sandy nature of the surficial soils most of Shakopee has very fast surface recharge to bedrock aquifers. In the south of City limits, corresponding to Wells 12, 13, 14, and 23 clays are the uppermost sediment and help to slow vertical recharge. Additionally, Chemicals have different fate and transport processes that allow the chemical to transport more vertically or horizontally in the subsurface and the natural attenuation of chemical breakdown.

4.1.1 USGS determined Groundwater Age

The United States Geologic Survey (USGS) conducted water age testing on Wells 2, 8, 9, 11, 16, 17, Berkly Spring, and Lewis Spring in 2023 and provided results to SPUC in 2024 and is included in **Appendix A**. Water age testing included dissolved gas analysis for N2, Ar, CO_2 CH_4, and O_2 is available to couple with SF_6 and or CFC for the determination of recharge temperature and excess air.

The USGS defines and determines groundwater age as the measurement of age “tracers”, chemical or isotopic constituents dissolved in the groundwater. These tracers include naturally occurring isotopes, which decay at a known rate; isotopes that were introduced into the atmosphere at known times relating to nuclear tests; and manufactured gases whose concentration in the atmosphere over time is known.

Young groundwater is commonly defined as water that entered the aquifer since about 1950 because several chemical and isotopic substances related to human activities were released into the atmosphere since that time. The presence of these substances in groundwater tell us that the water is young. These substances include tritium (3H), which was released into the atmosphere by detonation of nuclear bombs in the 1950s and early 1960s, chlorofluorocarbons (CFCs), which were released into the atmosphere from refrigeration and other uses from the 1930s through the 1980s, and sulfur hexafluoride (SF6), which is used primarily in electrical equipment and manufacturing semiconductors and whose use has been increasing steadily since about 1965. These age-dating tracers can help water-resource managers to develop management strategies for shallow groundwater systems that contain mostly young groundwater.

Old groundwater is defined as water that entered the aquifer before 1950 and more commonly refers to water older than 1,000 years. Many common and rare isotopes are produced naturally in the Earth’s atmosphere from the bombardment of cosmic rays or solar radiation, and their presence in groundwater can help determine the groundwater age. These isotopes are adsorbed by rainfall and can enter the aquifer with recharge. Argon-39 can be used to identify water that recharged between 50 and 1,000 years ago. Carbon-14 or radiocarbon is the most common method used to determine groundwater ages between 1,000 and 30,000 years. Groundwater older than 30,000 years can be determined using isotopes like helium-4, which is produced from the decay of uranium and thorium in aquifer solids, or by chlorine-36 and krypton-81, which decay over extremely long timescales and thus are useful for determining the age of ancient groundwater—hundreds of thousands of years old or more.

The testing completed by the USGs indicate water from tested wells date between 1990 to the early 2000s. This testing indicates recharge to the aquifer likely took place twenty to thirty years ago slightly slower than that predicted by the Scott County Geologic Atlas as depicted in **Figure 22**. Both of these sources indicate that recharge should be considered to be reaching the aquifer in relatively short time periods. The following table summarizes the results of the USGS testing.

Table 6 – USGS Age Dating Results

Sample Location	Test used for Age Dating	Predicted Water Age
Well #2	SF_6	Around 1990s
Well #8	SF_6	Around 2010s
Well #9	SF_6 and CFC	Early 2000s
Well #11	SF_6 and CFC	Early 2000s
Well #16	SF_6 and CFC	Early 2000s
Well #17	SF_6 and CFC	Early 2000s

4.2 Potential Sources of Groundwater Contamination

Known and potential sources of groundwater contamination exist throughout Shakopee and Scott County. Documented sources of groundwater impacts were identified from the following sources:

- Minnesota Pollution Control Agency (MPCA) What's In My Neighborhood (WIMN) online public map viewer;
- MPCA Spills (Incident Reports) public database;
- MPCA Groundwater Contamination Atlas; and
- Minnesota Department of Agriculture (MDA) WIMN online public map viewer.

Locations of sources are depicted on **Figure 22**. To fully understand a release and potential to impact municipal wells, investigation files need to be reviewed through the Freedom of Information Act (FOIA) data request system associated with the overseeing agency (i.e. MPCA or MDA). It is recommended that before a well site is selected to request recent environmental documentation from the relevant agencies to assess for groundwater contamination. Each of these sources are described in the sections below.

4.2.1 MPCA WIMN

The MPCA WIMN database compiles environmental information regarding sites actively or previously investigated for contamination, facilities with environmental permits, facilities with environmental violations, emergency management sites, and more. A listing in the MPCA WIMN database, on its own, is not indicative of a release or material threat of release of hazardous materials or petroleum products to the subsurface and groundwater. A desktop review of the MPCA WIMN listings was completed to assess the potential for these listings to impact the subsurface. SEH followed the Minnesota Department of Transportation (MnDOT) site ranking method for the potential of impacts. High, medium, and low rank sites were assigned based on the following definitions:

- ***High Environmental Risk*** – All active and inactive Voluntary Investigation & Cleanup (VIC) and Minnesota Environmental Response & Liability Act (MERLA)/Superfund sites, all active and inactive dump sites, all active Leak sites, all dry cleaners (with on-site or unknown chemical processing), all bulk chemical/petroleum facilities, all active agricultural release sites, railroad facilities (fueling, yards or maintenance), clandestine chemical/drug laboratory, and all historic industrial sites with likely chemical use (printing, photography, blacksmithing, plating, dentistry) on the premises, and per- and polyfluoroalkyl substance (PFAS) potential source areas

- ***Medium Environmental Risk*** – All closed Leak sites, all sites with underground storage tanks (USTs) or aboveground storage tanks (ASTs), machine shops, all sites with historic vehicle repair activities, all bulk grain/feed storage, all historical lumber yards, all closed agricultural release sites, historic USTs in roadway, graveyards, and all sites with detections of non-petroleum chemicals.

- ***Low Environmental Risk*** – Hazardous waste generators, railroad lines, current lumber yards, golf courses, and possibly some farmsteads, residences, or commercial properties with poor housekeeping practices.

These ranked sites are identified on **Figure 23**.

4.2.2 MPCA Spills

State law requires people to notify the MPCA through the Minnesota Duty Officer of a release of fie gallons or more of a petroleum product or any quantity of other substances released to the environment that could cause pollution of waters within the state. Based on the wide range of materials and quantities, as well as the location of spills (i.e. contained to pavement or directly to a water body), Spill listings have a wide range of potential impact to the subsurface.

All Spill listings identified in Shakopee are identified on **Figure 23**.

4.2.3 MPCA Groundwater Contamination Atlas

The MPCA Groundwater Contamination Atlas identifies known groundwater contamination plumes reported to the MPCA. The Atlas is not comprehensive and typically shows large scale groundwater plumes. One groundwater contamination site is listed within the City of Shakopee and is identified as the Pollution Controls Inc. Superfund Site (MPCA SR0000107) located at 7804 Country Road 101. The site operated a waste incinerator in the 1960s and early 1970s. Waste materials included hazardous waste, including solvents, petroleum wastes, paint sludge, and materials containing per- and polyfluoroalkyl substances (PFAS). In July 1973, an explosion occurred causing drums to leak and ash to release on site. Groundwater sampling conducted in the 1980s through early 2000s consisted of shallow groundwater sampling and the MPCA reports that not enough data was collected to determine the depth of contamination. Investigation is ongoing and groundwater contamination remains. Based on the 2023 modeled drawdown (**Figure 24**), the Superfund site is located outside of the drawdown zone for the nearest wells, Well 4 and 5. Based on the 2040 modeled drawdown (**Figures 25 and 26**), the Superfund site located within the drawdown zone. However, based on the distance from Wells 4 and 5 and natural groundwater gradient, there is low to medium risk to the wells.

Two additional sites are listed for groundwater plumes adjacent to the City of Shakopee. The Flying Cloud Sanitary Landfill is located north of Blue Lake and the Mississippi River. Groundwater contaminants of concern include perfluorooctanoic acid (PFOA) and 1,4-dioxane. Based on the location beyond the Mississippi River and outside of drawdown zones (**Figures 24 through 26**), this site is a low risk to the wells.

The Louisville Landfill is a closed landfill located at 3698 130th Street, Louisville Township, west of the City of Shakopee. The landfill operated between 1968 and 1990 and includes approximately 53 acres with 3.75 million cubic yards of waste. Primary groundwater contaminants of concern are PFOA, 1,4-dioxane, and trichloroethylene (TCE). Groundwater flow has been measured to the west toward the Minnesota River. Based on the 2023 and 2040 modeled drawdown for existing wells (**Figure 24 and 25**), the Superfund site is located outside of the drawdown zone for the nearest well, Well 23. Based on the 2040 modeled drawdown for new wells (**Figures 26**), the Superfund site located within the drawdown zone for Wells 23 and 24. Modeled drawdown is not expected to draw contamination toward the well field; however, this is not certain due to many variables, including actual future water use and pumping rates. Based on the distance from Wells 23 and 24 and natural groundwater gradient, there is low to medium risk to the wells.

4.2.4 MDA WIMN

The MDA has tracked spills of agricultural chemicals and sites contaminated with agricultural chemicals since the late 1970s. The data identified on the MDA WIMN public map viewer contains information on known and potential sources of agricultural chemical soil and ground water contamination. The MDA has categorized incidents into three categories: Old

Emergencies, Small Spills/ Investigations, and Incident Investigations Boundaries. Additionally, investigations that have been closed with contingencies attached to them are categorized as Contingency Areas. Spills and Old Emergencies could be limited in quantity and extent of release and is not indicative, on its own, as a release to the subsurface. The MDA WIMN sites are identified on **Figure 23**.

5 Groundwater Flow Modeling

Groundwater flow modeling was a method utilized for this study to evaluate and assess the potential impact on the Prairie du Chien-Jordan Aquifer from increased groundwater withdrawal in the study area. This report developed four model scenarios to assist in planning efforts for SPUC.

- A base model was developed to simulate the existing hydrologic and pumping withdrawal conditions utilizing pumping rates from 2023. Results from the model including steady state water levels within the aquifer and modeled drawdown for three days of average daily pumping demand are depicted on **Figure 24**.
- A scenario where existing wells were pumped using estimated 2040 water demand as depicted in **Table 3**. The scenario modeled drawdown in the aquifer for three days of average daily pumping demand. Results are depicted on **Figure 25**.
- A scenario where existing and proposed wells were pumped using estimated 2040 water demand as depicted in **Table 3.** The scenario modeled drawdown in the aquifer for three days of average daily pumping demand. Results are depicted on **Figure 26**.
- A scenario where Well No. 23 was pumped at 800 gpm over a three day period. This scenario was run to simulate drawdown in the proximity of the future wellfield and to assist with well placement. Results are depicted on **Figure 27**.

The following subsections describe and discuss the development, refinement, and calibration of the groundwater flow model, and present the results of the various scenario analyses.

5.1 Methodology

As part of the regional water supply planning effort, the Met Council developed the Metro Model 3, with the assistance of Barr Engineering Company. Metro Model 3 is used on a regional basis to assess groundwater withdrawal, groundwater availability, and identify areas possibly facing future water supply limitations. The model domain consisted of the eleven-county Twin Cities metropolitan area located in east-central Minnesota and encompassing Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, and Wright counties.

The Metro Model 3 utilizes the groundwater flow model was developed using the three-dimensional, finite-difference U.S.G.S. MODFLOW-2000 program in conjunction with the pre- and post-processing software Visual MODFLOW®. The model was run and solved using the graphical user interface Groundwater Vistas Version 6.

5.2 Hydrogeologic Conceptual Model

A detailed discussion on the hydrogeologic conceptual model is presented in the Metro Model 3 report and is available on the Met Councils website. A few key hydrogeological assumptions are provided below:

- The hydrogeological system of interest within the model consists of eight layers corresponding to major bedrock units presented in the sections above. Within the area around Shakopee, Layers 1 and 2 are quaternary sediments, Layer 3 is the PDC, Layer 4 is the Jordan aquifer, Layer 5 is the St. Lawrence bedrock, Layer 6 is the Tunnel City bedrock, Layer 7 is the Wonewoc aquifer, Layer 8 is the Eau Claire bedrock, and Layer 9 is the Mt. Simon aquifer.
- The source of nearly all of the water in the metro area's aquifers is from infiltrating precipitation. The amount of direct precipitation that is able to infiltrate at land surface and move below the root zone is the maximum amount of water available to recharge the underlying aquifers. This amount is dependent upon the rate and duration of precipitation, the soil type and soil cover, land use, evapotranspiration, and topography. Met Council (2012; Appendix A) estimated infiltration of water below the root zone using the Soil Water Balance (SWB) model for the Twin Cities metropolitan area for climatic and land use data from 1988-2011. The SWB model estimated infiltration on a 90 meter-square grid. The aerial average infiltration for the period 1988-2011 was 8.2 in/yr and ranged between 2.7 and 13.0 in/yr.
- In the Twin Cities area, groundwater flows toward the major discharge zones of the Mississippi, Minnesota, and St. Croix Rivers. Local discharge to the gaining portions of smaller streams and tributaries can also take place within the surficial aquifers.
- Significant discharge and recharge areas for the aquifers include large, local surface water bodies, including the Minnesota River, Upper and Lower Prior Lakes, and Thole - Schneider - O'Dowd Lakes.
- Bedrock valleys in the study area truncate the Prairie du Chien Group and Jordan Sandstone formations. The geologic materials in the valleys are assumed to have higher permeabilities than the surrounding bedrock.
- Thole - Schneider - O'Dowd Lakes are assumed to be hydrologically connected to the shallow aquifer(s), as well as the Prairie du Chien Group portion of the Prairie du Chien-Jordan Aquifer, since the depth to bedrock is relatively shallow. Leakage from these lakes recharges the Prairie du Chien-Jordan Aquifer and creates a groundwater high in the local, isolated dome of the aquifer in the study area.
- Within the study area, groundwater flow in the Prairie du Chien-Jordan Aquifer is westward and northward toward the Minnesota River valley. The flow directions in the two formations of the aquifer are assumed to be similar.

5.3 Model Design, Construction, Development, and Refinement

The Metro Model 3 was refined to a smaller area surrounding the City of Shakopee using a standard method of refinement known as Telescopic Mesh Refinement. The entire groundwater flow model domain included most of Scott County and North into Hennepin and Carver County. It approximately encompassed the area from Savage in the east to Chaska in the west, and from Eden Prairie and portions of St. Patrick in the south. However, for the purposes of this study, only the previously defined study area (incorporating the Shakopee, Prior Lake, Jackson Township, and Louisville Township areas) portion of the model was refined and closely analyzed.

The model domain was discretized into a grid spacing pattern with the finest grid located in the vicinity of the study area. Each grid space in the finely-discretized area represents approximately 10,000 square meters.

The model was constructed of eight layers described in the conceptual model above. The top and bottom elevations of the layers were based on the elevations of the respective hydrogeologic units they represented. Layer 3 and Layer 4 represented the Prairie du Chien Group and Jordan Sandstone, respectively.

5.4 Calibration and Base Model Results

The refined Metro Model 3 was designed and developed to represent only steady-state conditions and did not account for transient groundwater flow conditions. A full detail on model calibration is presented in the Metro Model 3 Report's Section 4 (Barr, 2013). In summary, Calibration targets were categorized into several different groups based on data-type, datasource, and data-accuracy. Residuals for each group were initially weighted based on the magnitude of the data. Unweighted residuals for baseflow will inherently be several magnitudes larger than unweighted residuals for hydraulic head, simply as a result of the units of measurement for each data type. Additionally, unweighted residuals for small streams will be lower than larger streams even if the relative percent errors are equal. Weights for each target group were adjusted so that individual target groups would not initially contribute disproportionally to the total objective function. As calibration progressed, if residuals from a target group began to contribute excessively to the objective function the weights were adjusted.

The root mean square error (RMSE) is the square-root of the average of the squared residuals. RMSE is a model-calibration statistic that is generally more sensitive to outliers than other model-calibration statistics and gives a better sense of the range of residuals. The RMSE for all hydraulic-head targets within the Metro Model 3 was 7.89 meters, and ranged from 2.70 meters to 8.51 meters for individual head-target groups. RSME is often compared to the ranges in Twin Cities Metropolitan Area Regional Groundwater-Flow Model Version 3 61 measurements; a small value for the ratio of RMSE to the range of measured values (typically less than 0.1) indicates good overall model fit (Spitz and Moreno, 1996). The ratio of RSME to the range in measurements was 0.04 for all head targets and ranged from 0.04 to 0.07 for individual target groups.

These calibration results appear acceptable for the purposes of this study in that the goal is to observe the decrease in groundwater heads in the study area under different pumping stresses, and not necessarily replicating the groundwater flow field to a precise degree.

The results of the base model suggest that the flow of groundwater within the Prairie du Chien-Jordan Aquifer is northwestward and northward toward the Minnesota River from an area of aquifer recharge and high groundwater heads in the vicinity of Thole-Schneider-O'Dowd Lake, in agreement with the conceptual hydrogeologic model and the previous groundwater model included in the original aquifer sustainability study. The calculated groundwater flow field for Layer 3 and 4, representing the Prairie due Chien-Jordan Sandstone is presented in **Figure 24** through **Figure 28**. This result corresponds and agrees with the groundwater flow direction for the aquifer published in the Scott County Geologic Atlas.

5.5 Sensitivity and Uncertainty Analysis

The feature representing the Thole-Schneider-O'Dowd Lakes in the original 2005 model had a much more profound effect on the groundwater heads in upper layers of the model. The original model noted a significant amount of aquifer recharge observed from the incorporation of this feature. In general, it appears that the Metro Model 3 uses a much smaller constant head boundary for this feature which appears to be a more conservative approach, especially if lake levels were to decrease over time. Additionally, the Metro Model 3 general had good fit with targets. No changes to the Metro Model 3 for this feature were made to increase recharge to the aquifer.

Assumptions had to be made in developing and refining the groundwater flow model, and therefore, unavoidable uncertainty exists in the model. In practical model application, parameters, aquifer characteristics, and hydrologic features used in the model are never completed defined or understood. Of particular concern for this model is the uncertainty related to how the Prairie du Chien-Jordan Aquifer is hydraulically connected to or influenced by local lakes (i.e. Thole-Schneider-O'Dowd Lakes) and the bedrock valleys filled with glacial and alluvial deposits.

The hydrogeologic parameter values used in models are always associated with various uncertainties no matter how many measurements have been made or how thoroughly the study area has been investigated. Due to inherent complexities in the hydrogeology of the study area, the reader should expect that the groundwater flow model only simulates the coarse and generalized flow fields.

The local groundwater flow directions of the aquifers appear to be accurately represented in the model according to available information, namely historical groundwater elevation data. For the intent of this model, it was assumed that the groundwater flow direction(s) would not significantly change enough over time to warrant using a varying groundwater flow field (transient conditions). New and updated local and regional hydrologic and hydrogeologic information collected in the future may indicate different groundwater flow conditions which may be due to transient flow conditions (i.e. seasonal changes and fluctuations or local groundwater pumping schedules), or aquifer heterogeneities.

Groundwater flow models can be accurate and useful, but never precise with unique solutions. The model developed and used for this study has its limitations in explaining, describing, and simulating all the complexities of the natural systems involved in hydrogeologic regimes. It was beyond the scope of this study to examine or evaluate fracture flow within the aquifer, structural deformation, subsidence, or compression of the aquifer due to groundwater withdrawal, hydrologic impacts on ecological resources, unique flow characteristics of and between the bedrock formations, groundwater-surface water interactions, or specific performance and interference issues related to the groundwater drawdown on wells.

5.6 Scenario Analysis and Interpretation

The refined Metro Model 3 was used to model current and predicted future pumping conditions and changes in the aquifer for the Prairie du Chien-Jordan Aquifer. Current and proposed well locations are depicted on **Figure 1**. Pumping rates for the various scenarios are listed in **Table 4** and **Table 5**.

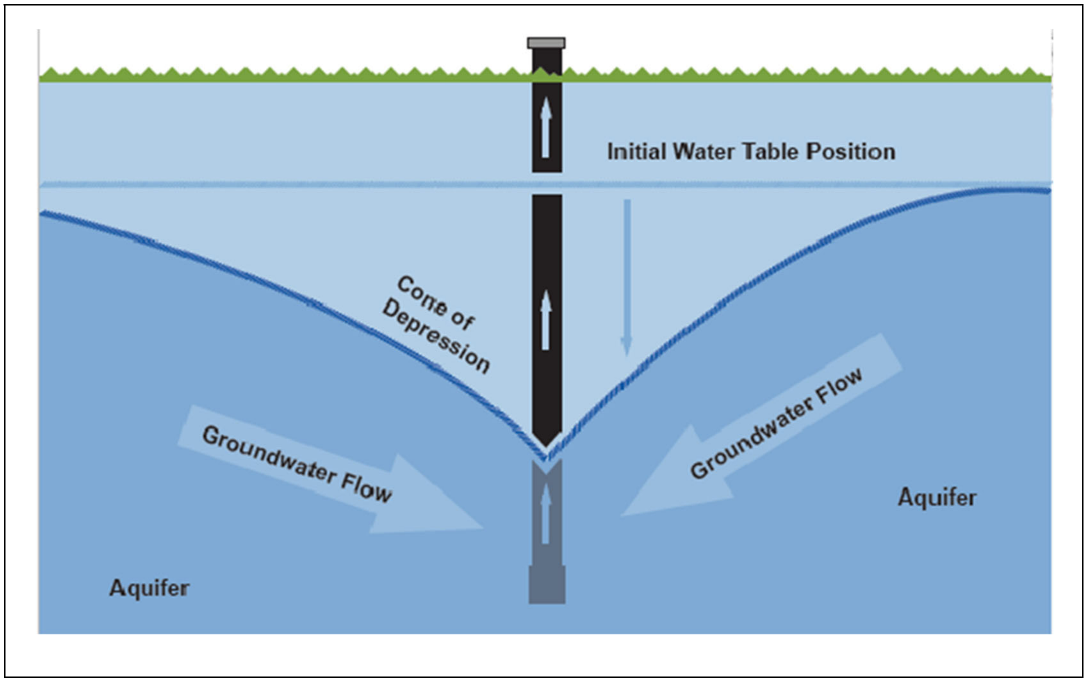
The three-dimensional (3-D) groundwater flow models water movement throughout the domain of water both entering and exiting the model. For an aquifer sustainability study such as this report a few hydrologic conditions in the scenario analysis will be discussed and reported including:

- Water Contours within Aquifers (reported as Water Level Height in feet amsl) – This can help evaluate water flow direction, upgradient water source/recharge, and potential sources of contamination.

- Basin Yield / Mass Balance – Water inflows versus outflows. This can help determine the overall aquifer flux (total water flowing in versus water flowing out).
- Drawdown – This can help evaluate the temporary impact to the aquifer from pumping wells and what kind of interference to other wells can we expect.

Modeled water elevation levels within the Prairie Due Chien-Jordan Aquifers range from 820 ft amsl to 705 ft amsl. In contrast the top of the aquifer (top of the Prairie Due Chien bedrock formation) is measured from 585 ft amsl to 790 ft amsl. Measured groundwater levels within wells above the top of the bedrock aquifers is a common occurrence in the Twin Cities and these modeled elevations match closely target/calibration heads within the model. In most cases, groundwater elevations are almost 100 feet above the top of the bedrock unit indicating that there is at least 200 to 250 feet of available water column to draw water from.

Well drawdown refers to the drop in the water level within a well as water is pumped out of it. When a pump is activated to extract water from an aquifer or underground reservoir through a well, the water level within the well declines. This decline in water level is termed drawdown. It's essentially the distance between the original water level in the well before pumping begins and the level during pumping. When wells are pumped in unison, the drawdown increases. The image below, courtesy of the Met Council, shows the typical drawdown in a water table well.



The picture does not always accurately depict drawdown within a bedrock aquifer. Bedrock aquifers that are confined (by an overlaying confining unit) are "under pressure". When drawdown is induced in a bedrock aquifer a similar decrease in water elevation is measured within wells; however, the bedrock formation remains fully saturated with water, as the decrease in measured water column in the well is a relief in pressure within the aquifer and a decrease in water column thickness.

Aquifer recharge and drawdown delves into the relationship between the drawdown caused by pumping from a well and the ability of the aquifer to recharge or refill itself once pumping stops. When water is pumped from a well, the drawdown occurs due to the removal of water from the aquifer. If pumping continues at a steady rate, drawdown may increase over time as the aquifer struggles to replenish the extracted water quickly enough. The aquifer may not be able to sufficiently recharge until the well has stopped pumping as the speed of the pumping may be faster than the rate of recharge to the aquifer.

Additionally. aquifers have an intrinsic ability to recharge through various mechanisms such as infiltration of precipitation, surface water bodies, or lateral flow from adjacent areas with higher groundwater levels. The rate at which an aquifer can recharge depends on factors such as precipitation patterns, soil permeability, surface water availability, and human activities such as land use changes (As described in the sections above). If the recharge rate exceeds the pumping rate, the aquifer can replenish the extracted water, maintaining sustainable groundwater levels.

The balance between drawdown and recharge determines the sustainability of groundwater extraction. If pumping rates exceed the recharge capacity of the aquifer over the long term, it can lead to declining water levels, depletion of the aquifer, and potentially adverse impacts on ecosystems and human water supplies. Therefore, sustainable management of groundwater resources requires careful consideration of pumping rates, recharge rates, and the overall hydrogeological characteristics of the aquifer to ensure that extraction does not exceed natural replenishment rates.

Pumping from a well and the drawdown that it creates is **not** akin to mining ore from a mine. Wells constitute an out*flow* of water from the overall “mass balance” of the water system that includes both inflows and outflows. Inflows and outflows within the model are not a static quantity like ore in a mine, but a rate of flow into the modeled system. The groundwater model indicates that the aquifer possesses a notable capacity for recharge. Wells extracting from the Prairie Du Chien-Jordan Aquifer represent only a modest fraction of, ranging from 6% to 14% of the total aquifer inflows over the model domain. Water outflows would have to increase to beyond total inflows (greater than 100%) for the total amount of the aquifer to start decreasing. In general, the aquifer extends far beyond SPUC limits and is recharged by precipitation falling over the greater twin cities region, even beyond the modeled domain, and the Metro Model 3 compensates for this by accounting for additional recharge at the edges of the model. However, locally an increase in water outflows has to be balanced to remain in a steady state condition, there will need to be an increase in recharge or another source or a decrease in discharge within the aquifer to meet the increased pumping from the wells. This can manifest as a decrease in other forms of outflows from the aquifer such as to the Minnesota River or other groundwater fed surface water features or it can manifest as additional flow within the aquifer to compensate a steeper groundwater gradient. Under current and future 2040 pumping rates the aquifer currently has sufficient ability to recharge without taking from aquifer storage. The ability of the aquifer to properly recharge may be impacted by the induced cone of depressions caused from pumping wells; however, this is typically managed by not continuously running wells and allowing water levels to recover.

Precipitation correlates to recharge to the aquifer by both direct leakage into the aquifer and through drainage to surface water features. Therefore, overall precipitation is the primary factor in mass balance analysis as it is the major inflows to the aquifer and its ability to recharge. Overall precipitation added to the aquifer system is modeled at 21.36 billion gallons a year, while pumping from SPUC is estimated between 2 – 3.3 billion gallons a year. This is not a direct 1 to 1 comparison because the aquifer also receives inflows from other geologic units and from hydraulically connected surface water features. Since precipitation is predicted to increase and droughts are predicted to decrease, the groundwater modeled mass balance of water through the Jordan Aquifer is not anticipated to decrease due to Well Pumping since the rate of inflows far exceed the rate of outflows through wells. However, it is imperative to continually reassess this assumption regarding precipitation patterns, as it constitutes a pivotal determinant in ensuring the long-term sustainability of the aquifer amidst evolving regional climates and advancements in climate modeling methodologies. As mentioned in previous sections, a conservative approach is to understand that an increase in precipitation does not always mean in increase to recharge; factors such as land use change, vegetation type, and precipitation type/timing can all be variables in it’s ability to recharge the aquifer.

Drawdown is the other factor that SPUC should consider in the aquifers ability to efficiently recharge. Effects from drawdown can be alleviated by managed pumping schemes and optimal well spacing. The Minnesota DNR recommends that the water elevation in a bedrock formation, such as the Jordan sandstone formation, does not go below the top of the unit. In the City of Shakopee’s case, while location dependent, this would likely correlate to over 100 to 150 feet in drawdown measured within a well.

To assess drawdown within the aquifer the following model scenarios were run:

- Scenario 1: a base model was developed to simulate the existing hydrologic and pumping withdrawal conditions utilizing pumping rates from 2023. Results from the model including steady state water levels within the aquifer and modeled drawdown for 3 days of average daily pumping demand are depicted on **Figure 24**. In current scenarios, the Jordan aquifer experiences the greatest drawdown of 38 ft around Wells No. 6 and 7. Other wellfields generally experience between 20 to 30 feet in drawdown. The largest lateral extent of drawdown is centered around Wells No. 9, 11, 16, 17 and 15 due to being surrounding by other wellfields.
- Scenario 2: existing wells were pumped using estimated 2040 water demand as depicted in **Table 4**. The scenario modeled drawdown in the aquifer for three days of average daily pumping demand. Results are depicted on **Figure 25**. Drawdown across the wellfields increased by an additional 20 feet on average. The Jordan aquifer experiences the greatest drawdown of 58 ft around Wells 6 and 7. Other wellfields generally experienced 40 to 50 feet of drawdown. The largest lateral extent of drawdown is centered around Wells No. 9, 11, 16, 17 and 15 due to being surrounding by other wellfields.
- Scenario 3: existing and proposed wells were pumped using estimated 2040 water demand as depicted in **Table 4.** The scenario modeled drawdown in the aquifer for three days of average daily pumping demand. Results are depicted on **Figure 26**. Overall, the additional wells improved Drawdown from the previous 2040 scenario. Drawdown across the wellfields from Scenario 1 (2023 model) only increased by an additional 10 feet on average. The additional future wells helped the total lateral extent of drawdown from Scenario 2 and reduced the overall future modeled well interference. The Jordan aquifer experiences the greatest drawdown of 48 ft around Wells No. 6 and 7. Other wellfields generally experienced 30 to 40 feet of drawdown. The largest lateral extent of drawdown remained centered around Wells No. 9, 11, 16, 17 and 15 due to being surrounding by other wellfields.

- Scenario 4: to assess localized drawdown around Well No. 23 for future wellfield build out. Well No. 23 was pumped at 800 gpm over a three day period. This scenario was run to simulate drawdown in the proximity of the future wellfield and to assist with well placement. Results are depicted on **Figure 27**. The results are also used in evaluation of potential contaminant sources in sections below. **Figure 28** shows drawdown from the wellfield in relation to a nearby Superfund site. The impacted groundwater plume is downgradient from the future well field, and additionally regional flow is away from the well field (towards the Minnesota River). Modeled drawdown is not expected to draw contamination toward the well field; however, because of many variables such as plume extent, actual future water use, pumping rates, etc. is uncertain, some aquifer monitoring (water level and water quality) would provide long-term peace of mind and a strategy for wellhead protection.

Drawdown in all scenarios primarily centers on the existing wellfields, particularly focusing on Wells No. 9, 11, 16, 17, and 15. The steepest drawdown was noted in all scenarios around Wells No. 6 and 7. As the model simulates the operation of all wells concurrently, induced drawdown is cumulative, especially given the proximity of this wellfield to others. This effect is magnified when wells or wellfields are positioned perpendicular to groundwater contours, aligning with areas replenishing water withdrawal zones. For instance, in all scenarios, the absence of operation in Wells No. 12 and 13 results in reduced drawdown for Wells No. 9, 11, 16, 17, and 15 over a three-day test period, which allowed more time for aquifer recharge during non-operational periods. In all model scenarios Wells No. 6 and 7 likely noted the most drawdown because they were approximately downgradient of Wells No. 9, 11, 12, 13, 15 16, and 17. Observation of diminished well yield or interference prompts consideration of pumping schemes optimizing drawdown within the aquifer between wellfields. With the introduction of future Wells No. 19, 18, and 22, expectedly less drawdown will be observed when Wells No. 12 or 13 are operational compared to wells more directly downgradient such as Wells No. 8, 11, 16, 17, and 15. Similarly, within a wellfield, such as Wells No. 6 and 7 which are perpendicular to water contours, are more susceptible to interference from cone of depressions than say Wells No. 20 and 21, which are parallel to contour lines. Though such placement considerations are marginal compared to the overall distance between wells. The farther pumping wells are from each other the less interference that will occur; however, optimal spacing between wells is always constrained by infrastructure, pressure zones, or land ownership concerns. **Figure 27** illustrates the cone of depression resulting from Well No. 23 pumping at 800 gpm over three days. A prospective well situated 300 feet away would experience a 3-foot drawdown, while one positioned over 600 feet away would experience a 2-foot drawdown. Future well placement within this wellfield is generally recommended to align northeast or southwest, paralleling groundwater contours for optimal performance.

6 Future Well Feasibility

The purpose of well feasibility was to identify potential well sites within the study area that are suitable for a municipal well and evaluate the suitability of the aquifer for long-term pumping at the sites. The magnitude of interference drawdown from any new site has the potential impact existing wells including other private well owners. It is recommended that potential impacts on private wells be evaluated during test well performance testing for any potential well site.

Future well site feasibility for this report considered the aquifer, model results, other high capacity wells, parcel access, local setting, and the SPUC utility network. Any future well site may consider these recommendations but must still perform all required local, State, and Federal guidelines as well as field surveys to make sure the site meets all setback criteria.

6.1 Prairie Due Chien / Jordan Aquifer Formation Review

Overall, geologic references and source material support that there is both a sufficient geologic formation thickness and water column thickness for the Prairie Du Chien-Jordan Aquifers to site additional wells for most areas within Shakopee City limits. The Prairie Du Chien-Jordan Aquifer is completely eroded away within Bedrock Valley in some locations within the City and south of the City as depicted on **Figure 4**. Future well sites should avoid areas where the Jordan has been eroded away. In general, the Jordan Aquifer next to a bedrock valley that has been filled with course grained material such as sand, has the potential to create much higher yields and recharge to the aquifer; however, the forming of the bedrock valley through erosion and deposition of finer grained material may also decrease yields. The MGS Hydrogeology of Scott County publication (2007) noted that secondary porosity and permeability of the aquifer increases adjacent to bedrock valleys. This would suggest that SPUC should expect higher yields near bedrock valleys. For a more predictable yield, SPUC should avoid areas adjacent to bedrock valleys.

Literature, as noted in the original 2005 aquifer sustainability study, suggests that well yields may be less nearer to the Minnesota River where a bedrock valley exists. Well No. 23 was completed approximately 8,000 feet to the southeast of the Minnesota River bedrock and is able to sustain 800 gpm. This yield may be representative of the lower yielding region closer to the Minnesota River, or possibly be a result of well construction or development. This yield is reasonable for the Jordan aquifer and can still help to support a public water supply system. With proper well construction and development these yields at a minimum would likely be achievable anywhere open hole to the Jordan.

6.2 Location Feasibility

Future well feasibility for SPUC is likely to be driven by parcel availability and design constraints. **Figure 29** depicts parcels currently owned by SPUC per Scott County parcel records. At present, SPUC does not own or maintain excess land for future well sites or fields. SPUC currently owns land around proposed future Wells No. 18, 19, 22, and 23. Future well development beyond the discussed areas may revolve around the ability to purchase or place a well on available property and should be considered if it arises. A majority of the northern portion within Shakopee City limits is not assessed for future well feasibility due to being downgradient of existing wellfields and a higher number of potential contaminant sources.

The following four general well feasibility locations were chosen as a balance between practicality and more desirable model results with a focus on Potential Well Siting Area’s A and B.

6.2.1 Potential Well Siting Area A

Potential Well Siting Area A is the current location of Well 23 and is depicted on **Figure 29**. SPUC already owns land adjacent to Well 23 and a future Well 24 is already planned in the near vicinity. **Figure 26** depicts expected drawdown around Well 23 and future wells should attempt to be placed at a minimum of 300 feet from the well and parallel to groundwater contours.

The MGS Scott County Geologic Atlas maps the top elevation of the Prairie du Chien formation between 785 to 845 feet amsl with an aquifer thickness between 50 and 95 feet. The Jordan formation top is expected at elevations between 680 to 710 feet amsl with an aquifer thickness between 70 and 90 feet.

In general, the MGS Scott County Geologic Atlas predicts that this area's pollution sensitivity is very slow and surface contaminants are less likely to impact water quality. **Figure 27** depicts proximity to a downgradient superfund site that has the potential for contamination but with current information on the site it is unlikely to travel upgradient and reach the planned wellfield. If SPUC plans to further develop the wellfield it could consider installing observation wells to monitor groundwater gradients between the Superfund site and the wellfield and even collect regular water quality samples to ensure no contamination from the site is migrating to the wellfield. No other major contamination sources are noted in the area. No notable MnDNR appropriation permit users are within the near vicinity while many private residences to the southeast have wells within the Jordan Aquifer.

6.2.2 Potential Well Siting Area B

Potential Well Siting Area B is the current location of Wells No. 9, 11, 15, 16, and 17 (**Figure 29)**. SPUC already owns land within the area for future Wells No. 18, 19, and 22. The site is centrally located within the distribution system.

The MGS Scott County Geologic Atlas maps the top elevation of the Prairie du Chien formation between 745 to 775 feet amsl with an aquifer thickness between 75 and 91 feet. The Jordan formation top is expected at elevations between 620 to 640 feet amsl with an aquifer thickness between 70 and 75 feet.

Groundwater models showed that this area is within with pronounced drawdown in existing and future modeling scenarios. It is likely the downgradient Wells No. 12 and 13 and side gradient Wells No. 9, 11, 15, 16, and 17 will likely create some form of well interference in this area. However, the newly proposed wells were shown to decrease the total amount of drawdown by approximately 10 feet in the area with the addition of these wells when comparing Scenario #2 and #3. The future wells are upgradient of Wells No. 6, 7, and 10 and will likely create well drawdown induced well interference for these wells. Well No. 22 is in an ideal location because of its distance from all other public water supply wells and the lack of direct upgradient wells. There is a nearby mining operation, Shakopee Gravel Inc, in the central portion of this zone. The MnDNR Appropriation Permits lists the site with one high capacity well that uses water from the Jordan Aquifer. In addition to water use from the site, any mining activity can reduce protective geologic material and increase surface contaminants from reaching the bedrock aquifers. The MGS Scott County Atlas predicts that this area's pollution sensitivity is very fast and surface contaminants may reach the bedrock within hours to months. Besides the mining activity there are very few documented environmental sites of concern in the near vicinity. Water quality is likely to be comparable to other SPUC wells in the area.

6.2.3 Potential Well Siting Area C

Potential Well Siting Area D presently has very little SPUC infrastructure. The site is located where MGS Scott County Geologic Atlas predicts that this area's pollution sensitivity is very slow and surface contaminants are less likely to impact water quality. Very little listed contamination sites are within the area. Many of the private residences in the area are on private wells open to the Jordan.

This area utilizes groundwater contours that travel towards potential Well Siting Area A but would still likely create some well interference for existing well to the north. Water is primarily recharged from the South/southeast outside of City limits. The Area is more susceptible to pumping interference from other communities such as Mdewakanton Sioux Community and Prior Lake as the potential capture zone of water is outside of Shakopee City limits. O'Dowd Lake is within the central portion of this area and will likely have additionally regulatory criteria if a well is pursued near the lake. SPUC should work with the DNR prior to assessing this locations for future well sites.

The MGS Scott County Geologic Atlas maps a bedrock valley a bedrock valley to the south and east of this area where the Prairie due Chien and Jordan Aquifer are completed eroded away. It is possible that the very southern portion of potential well siting area D that the Prairie du Chien-Jordan Aquifer has been eroded away. The top elevation of the Prairie du Chien formation between 820 to 850 feet amsl with an aquifer thickness between 85 and 100 feet. The Jordan formation top is expected at elevations between 651 to 740 feet amsl with an aquifer thickness between 65 and 93 feet.

6.2.4 Potential Well Siting Area D

The MGS Scott County Geologic Atlas maps a bedrock valley cross cutting the central portion of this area and is noted on **Figure 29**. As mentioned previously, the bedrock valley may increase susceptibility of surface contamination reaching the well and either decrease or increase water yields. This area utilizes groundwater contours that travel straight to the north and would likely create less well interference for other existing well fields. The Area is more susceptible to pumping interference from other communities such as savage as the potential capture zone of water is outside of Shakopee City limits. To the north of this area are many potential contaminant sources including documented PFAS in groundwater from the Pollution Control Inc. Superfund site. A conservative approach would be to keep a well south of Deans Lake. Additionally, the Savage Fen is to the east where water use restrictions will likely apply. SPUC should work with the DNR prior to assessing this locations for future well sites.

In places where the bedrock valley exist the Prairie due Chien and Jordan Aquifer are completed eroded away. The top elevation of the Prairie du Chien formation between 0 to 780 feet amsl with an aquifer thickness between 0 and 100 feet. The Jordan formation top is expected at elevations between 0 to 630 feet amsl with an aquifer thickness between 0 and 80 feet. Within the regions shaded on the **Figure 29**, aquifer thickness has been mapped at the higher end of the range provided.

7 Findings and Opinion

This study was performed to evaluate and assess the sustainability of the Prairie du Chien-Jordan Aquifer in the Shakopee, Minnesota area under future pumping conditions and forecasted groundwater withdrawals. Although the Prairie du Chien-Jordan is a laterally-extensive and heavily relied-upon source of groundwater regionally, portions of this aquifer is truncated, encompassed, and isolated by buried bedrock valleys in the Shakopee area. Therefore, the amount of groundwater from this aquifer, available to the SPUC and others for development, is locally dependent upon the amount of groundwater in storage and the amount and capability of recharge and discharge to and from the aquifer, respectively. At present it appears that recharge contributes more inflows to the aquifer than outflows from wells. Precipitation models as noted above suggest that Minnesota should increase; however, ongoing research is being conducted by entities such as Met Council and Scott County to assess the increased precipitation to recharge the aquifer due to land use and climate changes. Met Council as part of their master water supply plan have been advocating for water efficiency not only including water system upgrades but also things such as planting vegetation that allows for more recharge to the aquifer.

The following findings and opinions have been derived from this study, and are offered to the SPUC:

- The Prairie du Chien-Jordan Aquifer in the study area is approximately 30,709 acres (1.34 billion square feet) and is typically 200-300 feet thick.
- Recharge to the aquifer is estimated to range from 7.6 to 12.2 billion gallons per year (SEH, 2005). Modeling from the Metro Model 3 during this study indicate recharge over city limits is closer to 12 billion gallons per year. Additionally, the aquifer is recharged over a much larger regional area, even outside of the Twin Cities area.
- Studies suggest that recharge to the aquifer is complicated and may increase or decrease depending on land use changes, climate, and timing/frequency of precipitation (Scott County, 2009 and Met Council, 2022). Droughts in Minnesota are expected to decrease with current climatic models (Blumenfeld, 2021).
- Based on information from the SPUC Comprehensive Water Plan and data from the Met Council Master Water Supply (2015) the following ultimate groundwater demand projections are forecasted for the Prairie du Chien-Jordan Aquifer in the study area:
    - City of Shakopee 6.1 million gallons per day (MGD) to 9 MGD in 2040
    - City of Prior Lake: 2.9 MGD to 4.32 MGD in 2040
    - City of Savage: 2.52 MGD to 3.12 MGD in 2040
    - Mdewakanton Sioux Community: 0.5 MGD to 1 MGD in 2040 (estimated)
    - Non-municipal use: 4.09 MGD to 6 MDG (estimated)
    - **Total**: ~23 MGD.
- Groundwater flow modeling was performed to simulate various future aquifer pumping scenarios. Four scenarios of current and future water use were modeled to assess water recharge and drawdown within the Prairie du Chien-Jordan Aquifer within the study area.
- The groundwater flow modeling appears to suggest that the Prairie du Chien-Jordan Aquifer will remain in a fully-saturated condition (groundwater heads at or above the Jordan Sandstone), even under reduced recharge and aquifer capacity conditions. Outflows from wells within the model domain currently make of 6% to 14% of water inflows. Because outflows were increased by wells it is a likely presumption that the increase in pumping is balanced by a decrease in aquifer outflows to surface water features.
- Well drawdown refers to the decline in water level within a well due to pumping, the ability of the aquifer to recharge once pumping stops is crucial for maintaining sustainable groundwater resources. Balancing drawdown with recharge is essential to prevent overexploitation and depletion of aquifers.
- Four potential future well feasibility sites were discussed in this report. Potential well sites within the northern portion of the City were not assessed due to potential lower yields and an increase number of potential contaminant sites. Potential Well Sitting Area A and B are currently planned for future wells due to existing infrastructure and should be the priority for well development. This study cannot definitely provide a

justification for or against the SPUC developing these sites; however, modeling efforts and available public data support that they could be viable sites. Modeling for potential well sitting Area A indicate the least amount of well interference between SPUC wells due to different upgradient flow paths and spacing away from existing well fields. This wellsite is upgradient from a known superfund site and as a conservative approach additional monitoring would be preferable at this well field. Potential Well Siting Area C and D are also discussed as potential future options for SPUC but regulatory hurtles for the Savage Fen and around O'Dowd Lake may have additional restrictions in the future. SPUC should work with the DNR prior to assessing these locations for future well sites.

8 Recommendations

Based on the results of this study, the following recommendations are offered to the SPUC:

- Over the next several years and decades, groundwater levels in the SPUC municipal wells should be monitored frequently and on a regular schedule during both static and pumping conditions to determine whether the Prairie du Chien-Jordan Aquifer elevations are decreasing over time. This data can be used to identify long-term trends in the aquifer's condition.
- SPUC should continue to work with Met Council and their partners on water planning efforts. Recharge to the aquifer is vital for long term potable water supply. Met Council continues to evaluate and implement strategies to address these concerns and SPUC should remain open to their efforts in this regard. SPUC could work with City of Shakopee to promote and implement their education material, findings, and solutions.
- As additional publications are made available from the Met Council on recharge, precipitation rate, and leakage rates to the aquifer the groundwater flow model could be updated to re-assess the overall mass balance of the Prairie du Chien-Jordan Aquifer.
- SPUC should remain aware that the Minnesota Department of Natural Resources drawdown thresholds are described in MN Rule 6115.0630 Definitions Subps.15 and 16. Two thresholds are in place and regulate that wells must not drawdown DNR assigned static water levels to within 50% and 25% to the top of aquifer. These threshold values are set by a DNR observation well and would typically be enforced if long term issues are observed. At present, no DNR threshold values were identified for the area. If excessive drawdown and well interference is observed by SPUC, SPUC may want to reach out to the DNR to set up threshold values for the aquifer.
- As additional municipal wells are constructed, the SPUC should continue to collect hydrogeologic data through comprehensive aquifer pumping tests. This data can supplement existing data and could be useful in refining the groundwater flow model. A 72-hour pump test should be conducted for new municipal wells including at least one observation well.
- As a conservative approach, SPUC should consider additional groundwater monitoring be conducted around Well 23 for the potential of the Louisville Landfill Superfund site contamination to reach the site. Additionally, SPUC could contact the Minnesota Pollution Control Agency (MPCA) site manager to discuss the likelihood of contamination reaching the site in the case that flow modeling of the site has already been completed.
- As additional wells or wellfields are pursued, it is recommended that before a well site is selected to request recent environmental documentation from the relevant agencies (MPCA, MDA, EPA) to assess for known groundwater contamination.
- The SPUC should continue to cooperate and collaborate with the Southwest Metro Ground Water Group to identify strategies and best management practices to minimize the groundwater use and pumping development pressure on the aquifer.
- The SPUC may want to consider reaching out and opening dialogue with the DNR on their local monitoring stations for sensitive natural resources (e.g. springs, trout streams, and calcareous fens). The DNR routinely sets up monitoring networks and

may already have monitoring locations close to City limits. These features have the potential to be impacted by increasing water demand increases in the region. Working collaboratively with the DNR before problems arise could help alleviate any potential future appropriation permit issues.

9 Standard of Care

The interpretations presented in this report are based on local and regional data collected during this study and previous studies, such as historical aquifer pumping tests and regional hydrogeologic studies completed by governmental agencies. Data collected and analyzed by other parties and used in this report may not be precise or accurate. This report does not account for any variations that may occur between points of exploration; geologic and hydrogeologic conditions likely differ across the study area. Also, it must be noted that seasonal and cyclical fluctuations in the hydrogeologic characteristics and properties of the aquifer(s) will occur.

The scope of this study and report, and the groundwater flow modeling used herein, are limited to the purposes of this study for Shakopee Public Utilities. Use of the groundwater flow model or the data and conclusions in this report by others or for purposes other than those stated in this document, must be done with caution and a full understanding of the inherent assumptions and limitations utilized and discussed in this document.

This report represents our understanding of the significant aspects of the local geologic and hydrogeologic conditions; the conclusions are based on our hydrogeologic and engineering judgment, and represent our professional opinions. These opinions were arrived at in accordance with the currently accepted standard of care for geologic and engineering practices at this time and location. No warranty is implied or intended.

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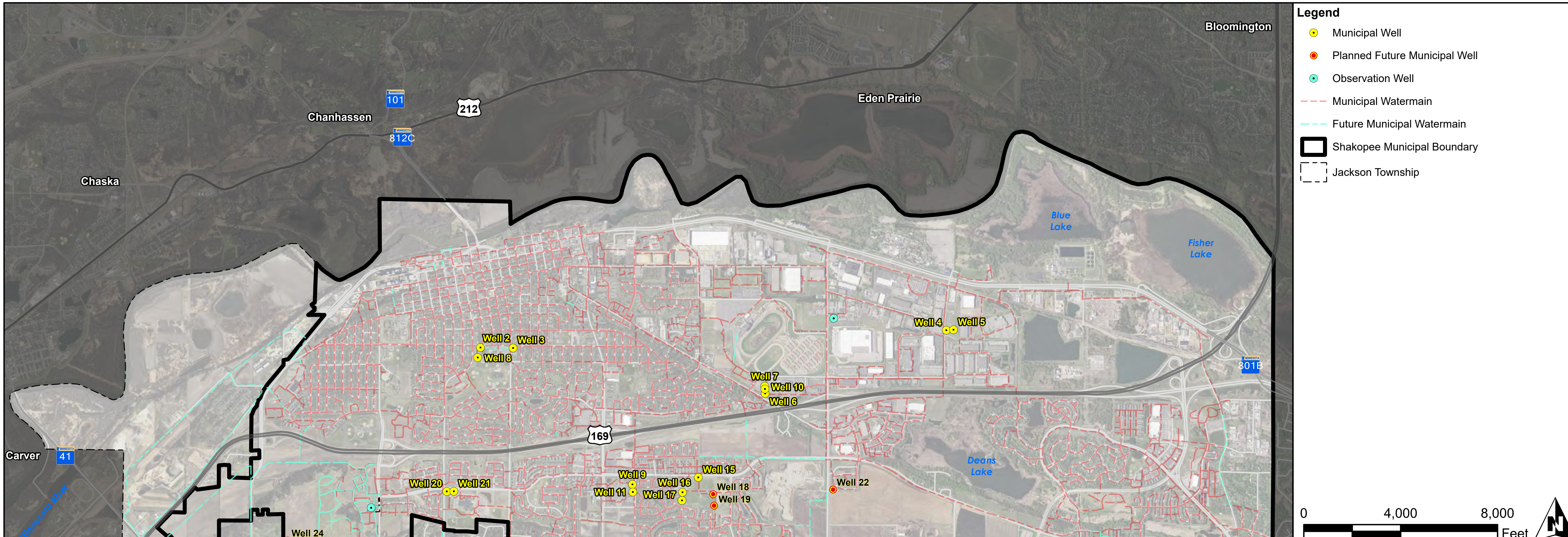
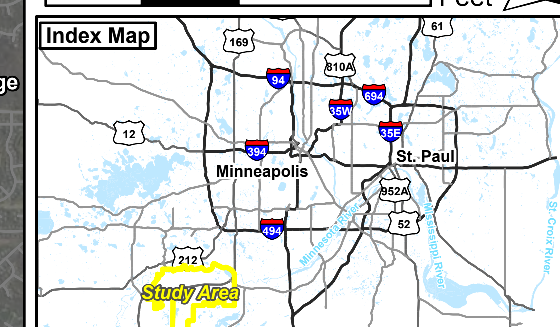
Figures





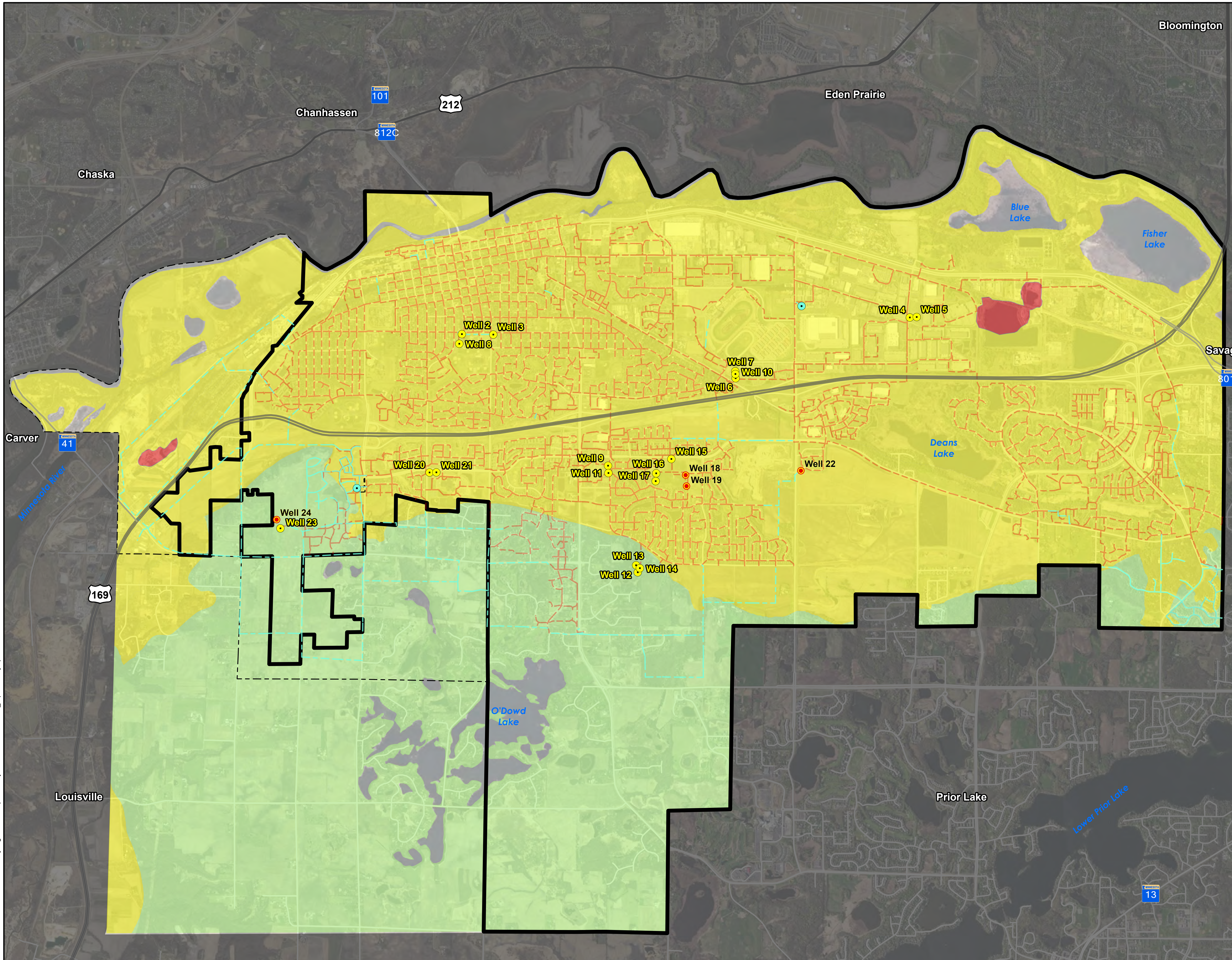
Distribution System

Aquifer Sustainability
Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure
1



Legend

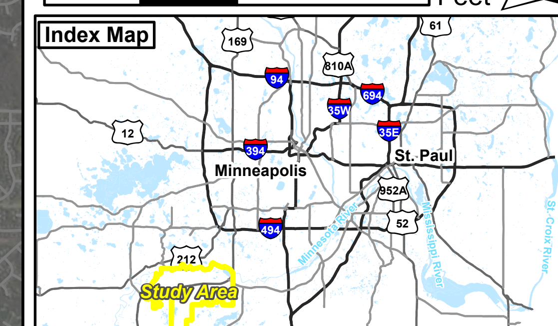
- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Minnesota Geologic Survey (Plate 4, Scott County)

Quaternary Stratigraphy

- Sand and/or gravel
- Till (Confining Unit)
- Bedrock at Surface

0 4,000 8,000 Feet



Surficial Geology

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 2

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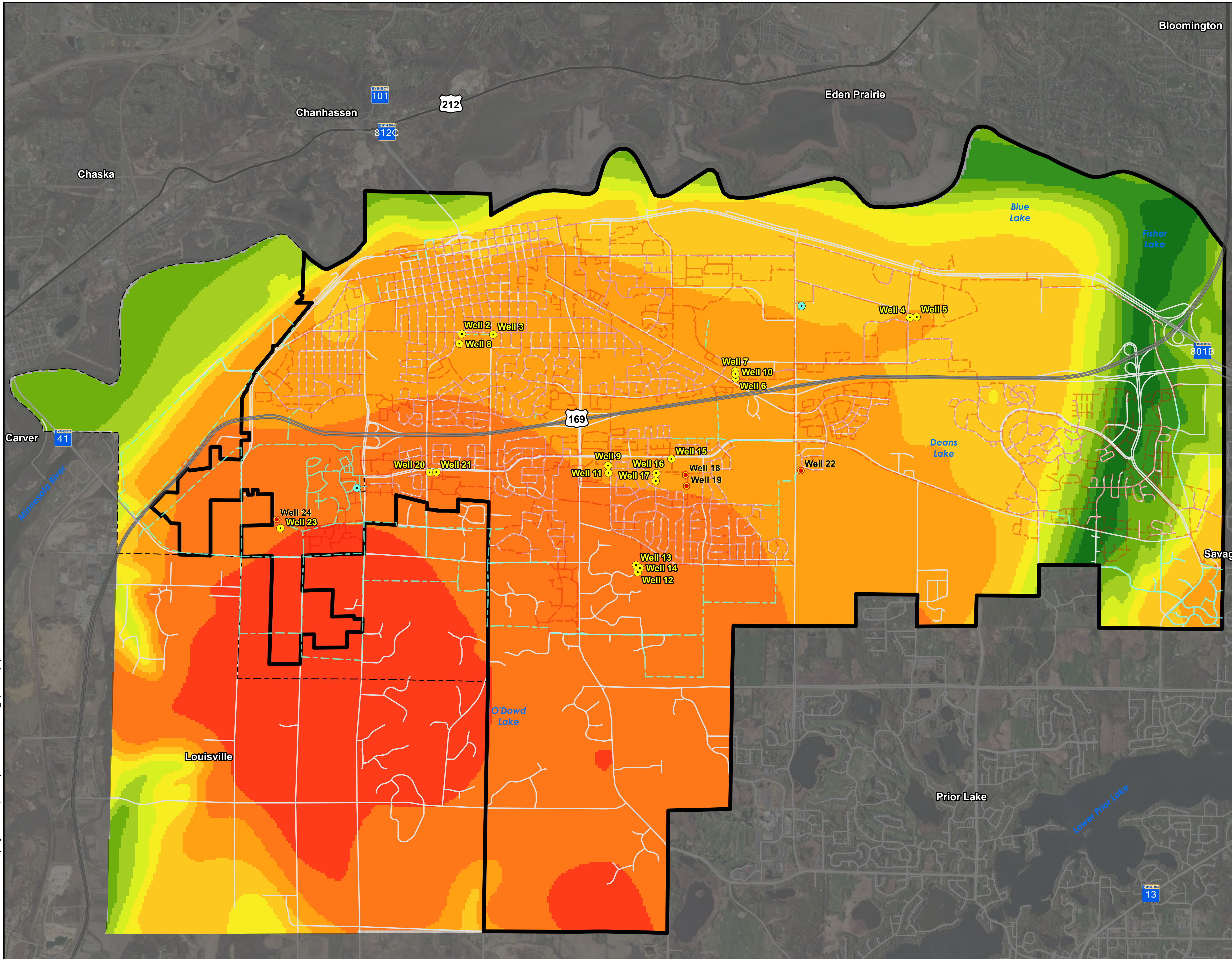


Legend

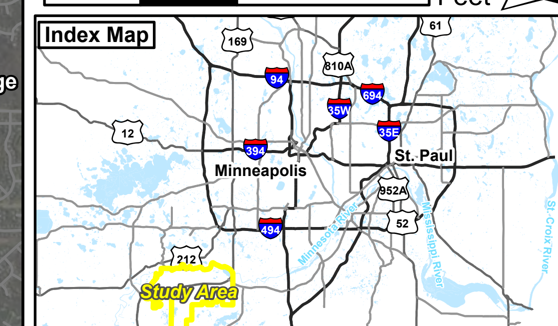
- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surficial Thickness / Depth to Bedrock (MGS, 2008)

Feet Below Ground Surface

- 392 - 433
- 434 - 485
- 486 - 532
- 533 - 579
- 580 - 633
- 634 - 682
- 683 - 725
- 726 - 774
- 775 - 818
- 819 - 852

0 4,000 8,000 Feet



Depth to Bedrock

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 3

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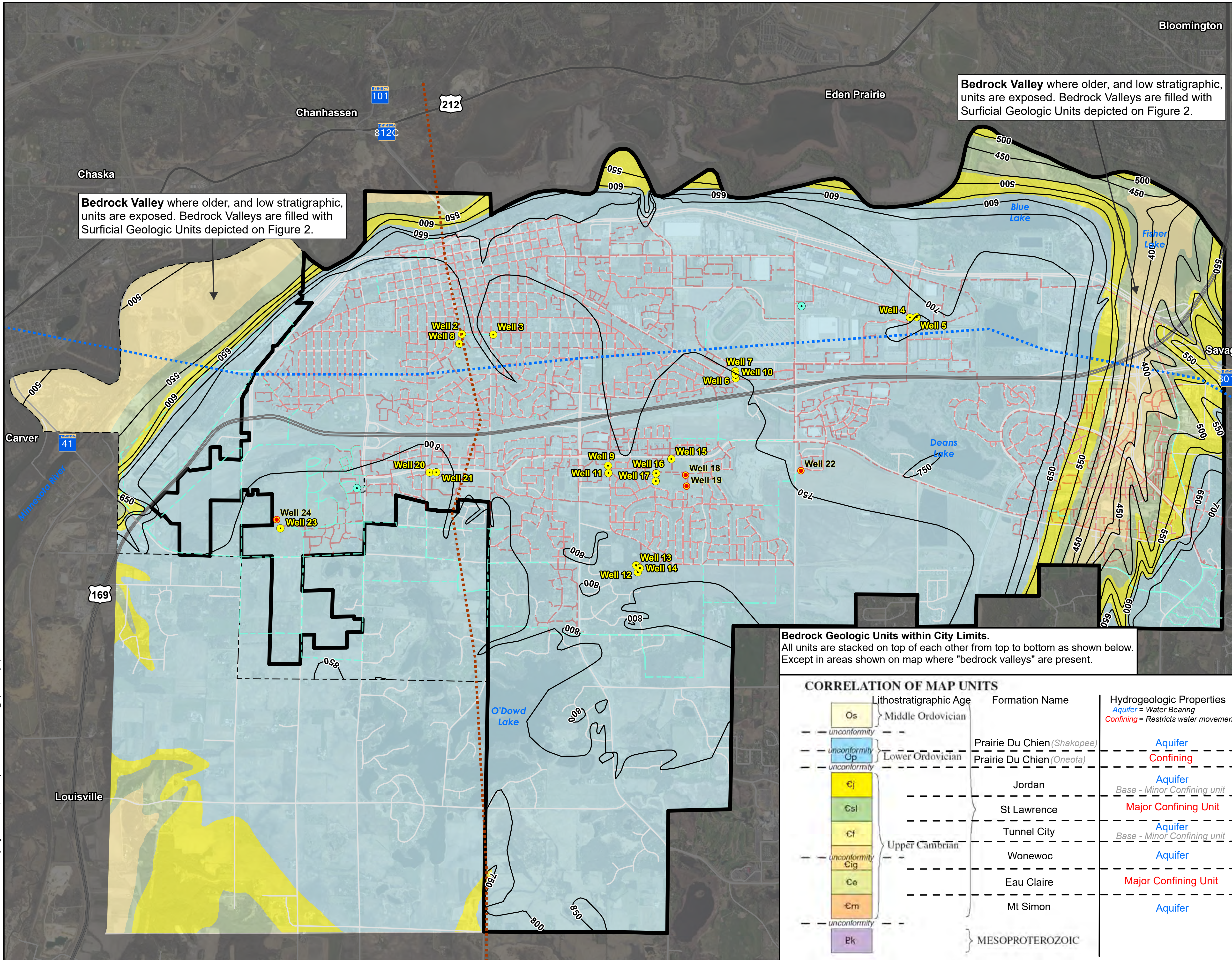


CORRELATION OF MAP UNITS

Map Unit	Lithostratigraphic Age	Formation Name	Hydrogeologic Properties (*Aquifer* = Water Bearing; *Confining* = Restricts water movement)
Os	Middle Ordovician		
unconformity			
unconformity / Op	Lower Ordovician	Prairie Du Chien (*Shakopee*)	Aquifer
		Prairie Du Chien (*Oneota*)	Confining
unconformity			
Ꞓj	Upper Cambrian	Jordan	Aquifer (Base - Minor Confining unit)
Ꞓsl		St Lawrence	Major Confining Unit
Ꞓf		Tunnel City	Aquifer (Base - Minor Confining unit)
unconformity / Ꞓig		Wonewoc	Aquifer
Ꞓe		Eau Claire	Major Confining Unit
Ꞓm		Mt Simon	Aquifer
unconformity			
Ꞓk	MESOPROTEROZOIC		

Legend

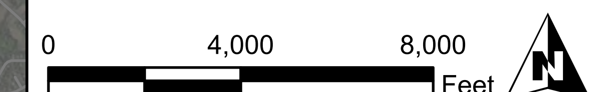
- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township
- Cross Section A to A' (Figure 5)
- Cross Section B to B' (Figure 6)

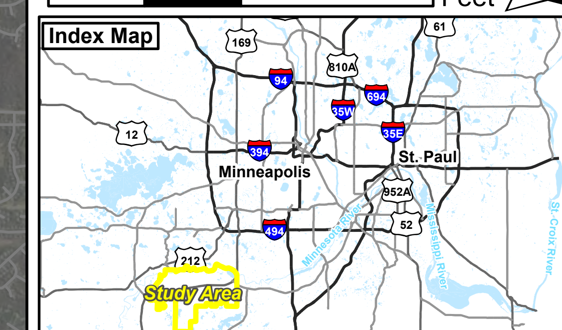
Scott County Minnesota Geologic Survey (Plate 2)

Bedrock Formation Name

- Prairie du Chien Group (Aquifer/confining)
- Jordan Sandstone (Aquifer)
- St Lawrence Formation (Confining Unit)
- Tunnel City Group (Aquifer)

Tunnel City Group was formerly referred to as the Franconia Formation





Bedrock Geology

Aquifer Sustainability Study Update
Shakopee, Minnesota

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Projection: UTM Zone 15N
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Figure 4

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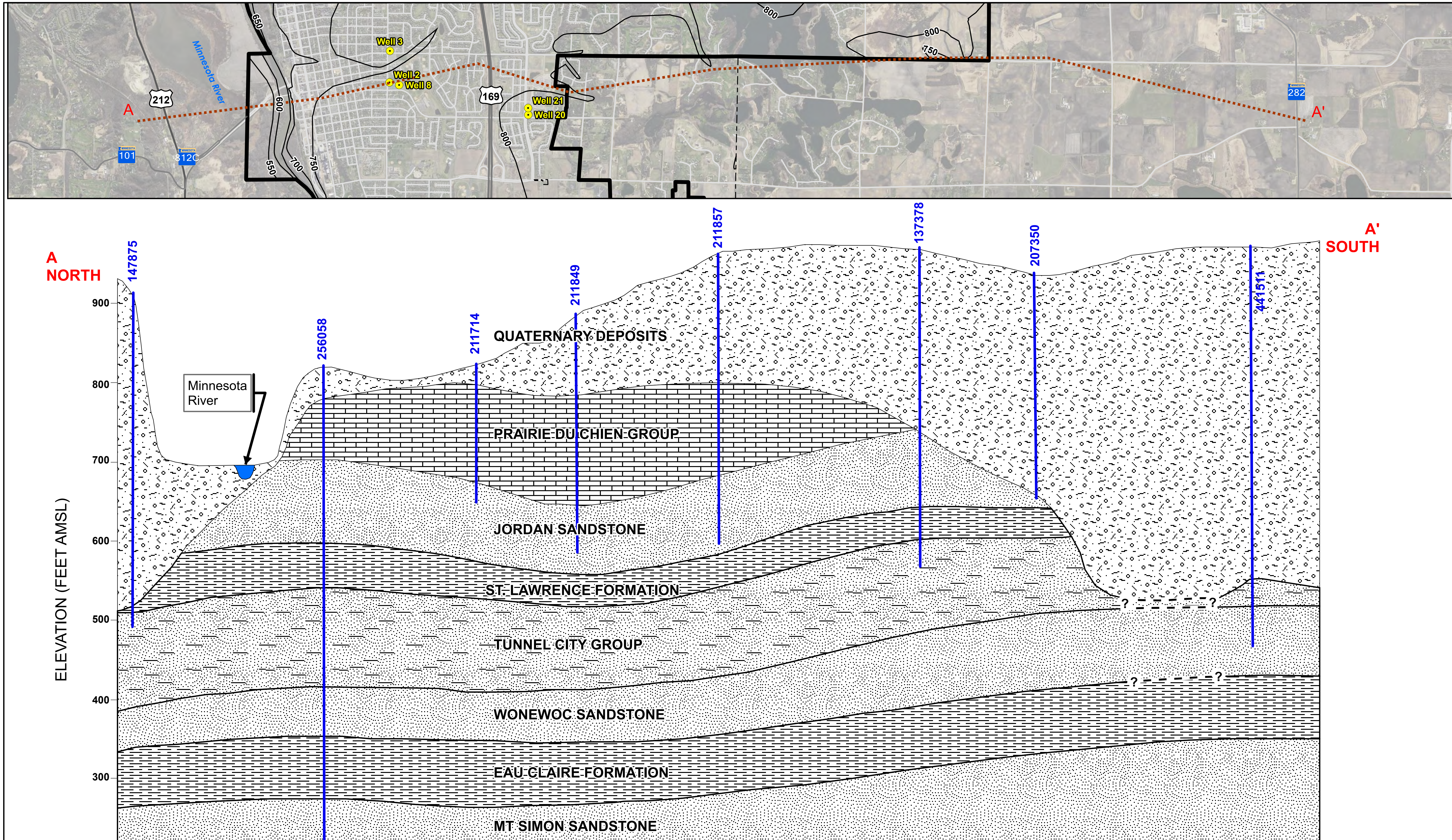

AQUIFER SUSTAINABILITY STUDY

Aquifer Sustainability Study Update

Shakopee, Minnesota

Typical Geologic Cross-section A - A'

Figure 5

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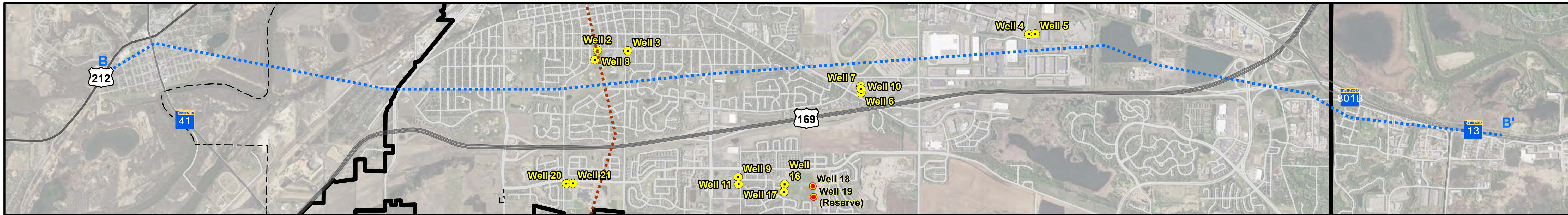

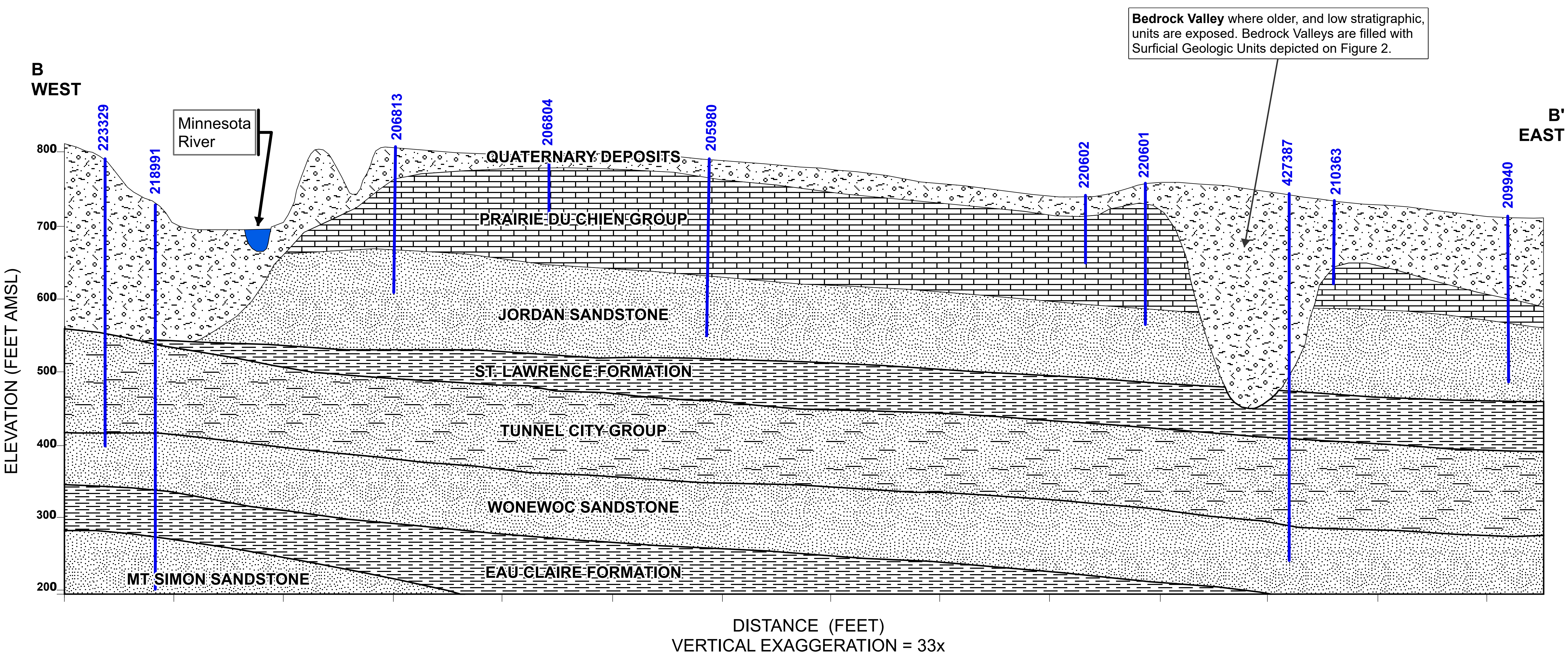

AQUIFER SUSTAINABILITY STUDY

Aquifer Sustainability Study Update
Shakopee, Minnesota

Typical Geologic Cross-section B - B'

Figure 6

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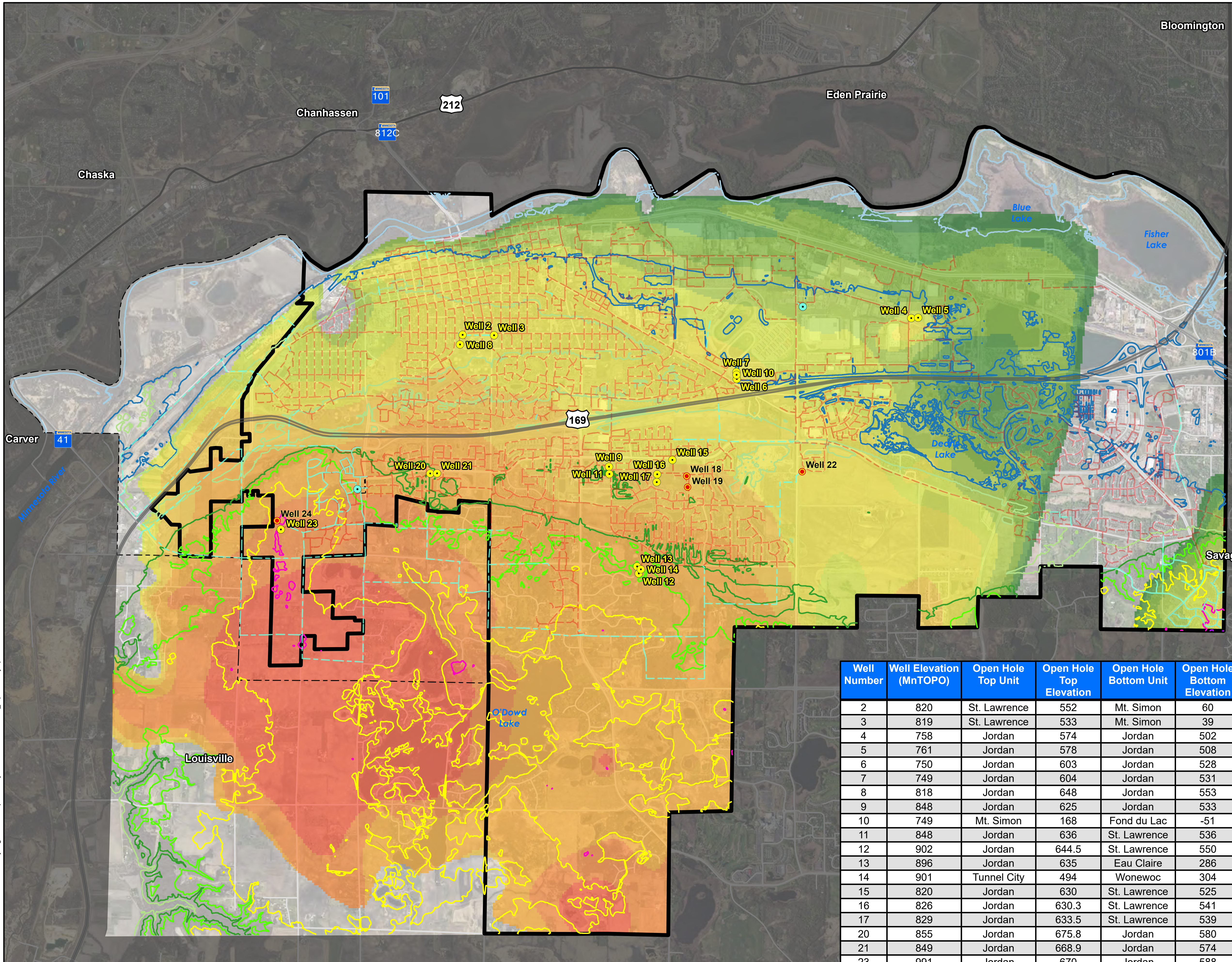


Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
2	820	St. Lawrence	552	Mt. Simon	60
3	819	St. Lawrence	533	Mt. Simon	39
4	758	Jordan	574	Jordan	502
5	761	Jordan	578	Jordan	508
6	750	Jordan	603	Jordan	528
7	749	Jordan	604	Jordan	531
8	818	Jordan	648	Jordan	553
9	848	Jordan	625	Jordan	533
10	749	Mt. Simon	168	Fond du Lac	-51
11	848	Jordan	636	St. Lawrence	536
12	902	Jordan	644.5	St. Lawrence	550
13	896	Jordan	635	Eau Claire	286
14	901	Tunnel City	494	Wonewoc	304
15	820	Jordan	630	St. Lawrence	525
16	826	Jordan	630.3	St. Lawrence	541
17	829	Jordan	633.5	St. Lawrence	539
20	855	Jordan	675.8	Jordan	580
21	849	Jordan	668.9	Jordan	574
23	991	Jordan	670	Jordan	588

Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)
Feet Above Mean Sea Level

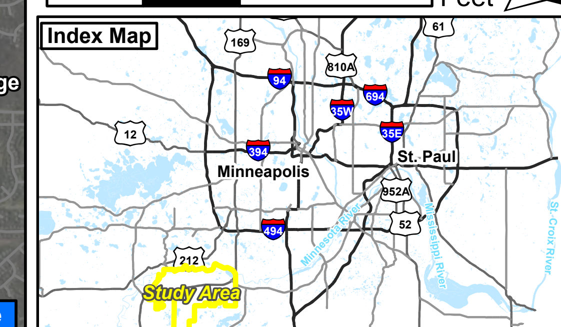
- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

Prairie Du Chien (Shakopee) Aquifer top elevation (MnDNR Part B Atlas for Scott County)
Feet Above Mean Sea Level

- 634 - 671
- 672 - 692
- 693 - 709
- 710 - 727
- 728 - 743
- 744 - 762
- 763 - 786
- 787 - 808
- 809 - 828
- 829 - 851

0 4,000 8,000 Feet

Index Map



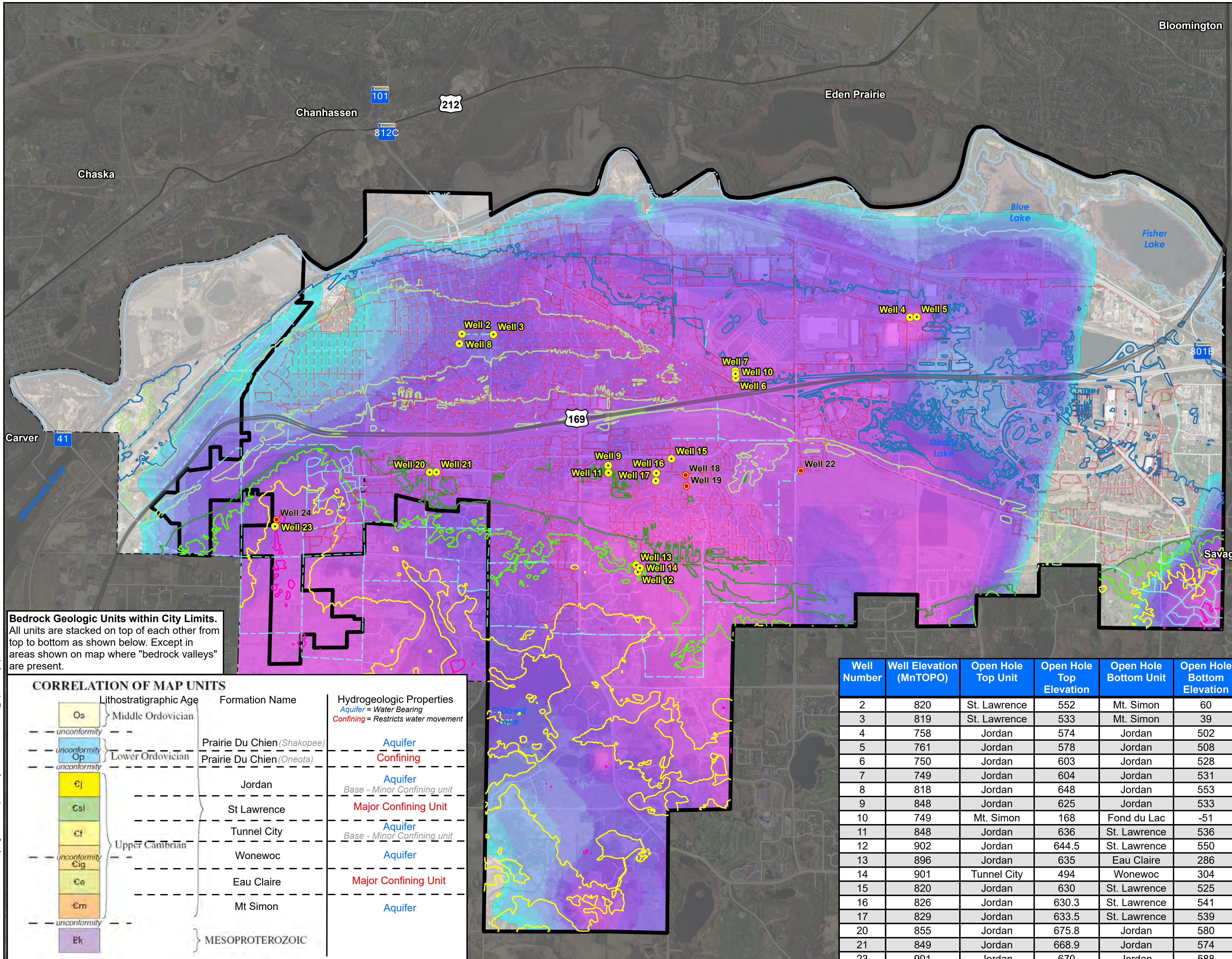
Prairie Du Chien (Shakopee) Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 7



Legend

- Municipal Well
- Planned Future Municipal Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

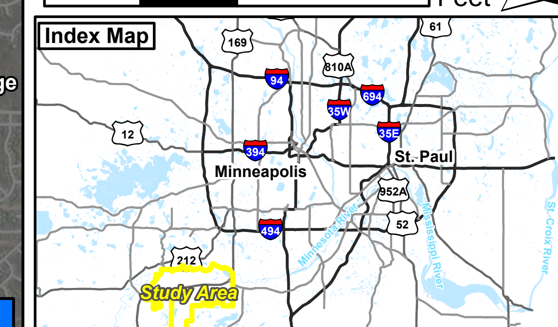
- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

Prairie Du Chien (Shakopee) Aquifer Thickness

Aquifer Thickness in Feet

- 1 - 13
- 14 - 25
- 26 - 37
- 38 - 47
- 48 - 57
- 58 - 66
- 67 - 75
- 76 - 84
- 85 - 95
- 96 - 110

Index Map



Bedrock Geologic Units within City Limits.
All units are stacked on top of each other from top to bottom as shown below. Except in areas shown on map where "bedrock valleys" are present.

CORRELATION OF MAP UNITS

Aquifer = Water Bearing
Confining = Restricts water movement

Unit	Lithostratigraphic Age	Formation Name	Hydrogeologic Properties
Os	Middle Ordovician		
unconformity			
unconformity Op	Lower Ordovician	Prairie Du Chien *(Shakopee)*	Aquifer
		Prairie Du Chien *(Oneota)*	Confining
unconformity			
Ꞓj	Upper Cambrian	Jordan	Aquifer *Base - Minor Confining unit*
Ꞓsl		St Lawrence	Major Confining Unit
Ꞓf		Tunnel City	Aquifer *Base - Minor Confining unit*
unconformity Ꞓig		Wonewoc	Aquifer
Ꞓe		Eau Claire	Major Confining Unit
Ꞓm		Mt Simon	Aquifer
unconformity			
Ꞓk	MESOPROTEROZOIC		

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Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
2	820	St. Lawrence	552	Mt. Simon	60
3	819	St. Lawrence	533	Mt. Simon	39
4	758	Jordan	574	Jordan	502
5	761	Jordan	578	Jordan	508
6	750	Jordan	603	Jordan	528
7	749	Jordan	604	Jordan	531
8	818	Jordan	648	Jordan	553
9	848	Jordan	625	Jordan	533
10	749	Mt. Simon	168	Fond du Lac	-51
11	848	Jordan	636	St. Lawrence	536
12	902	Jordan	644.5	St. Lawrence	550
13	896	Jordan	635	Eau Claire	286
14	901	Tunnel City	494	Wonewoc	304
15	820	Jordan	630	St. Lawrence	525
16	826	Jordan	630.3	St. Lawrence	541
17	829	Jordan	633.5	St. Lawrence	539
20	855	Jordan	675.8	Jordan	580
21	849	Jordan	668.9	Jordan	574
23	991	Jordan	670	Jordan	588

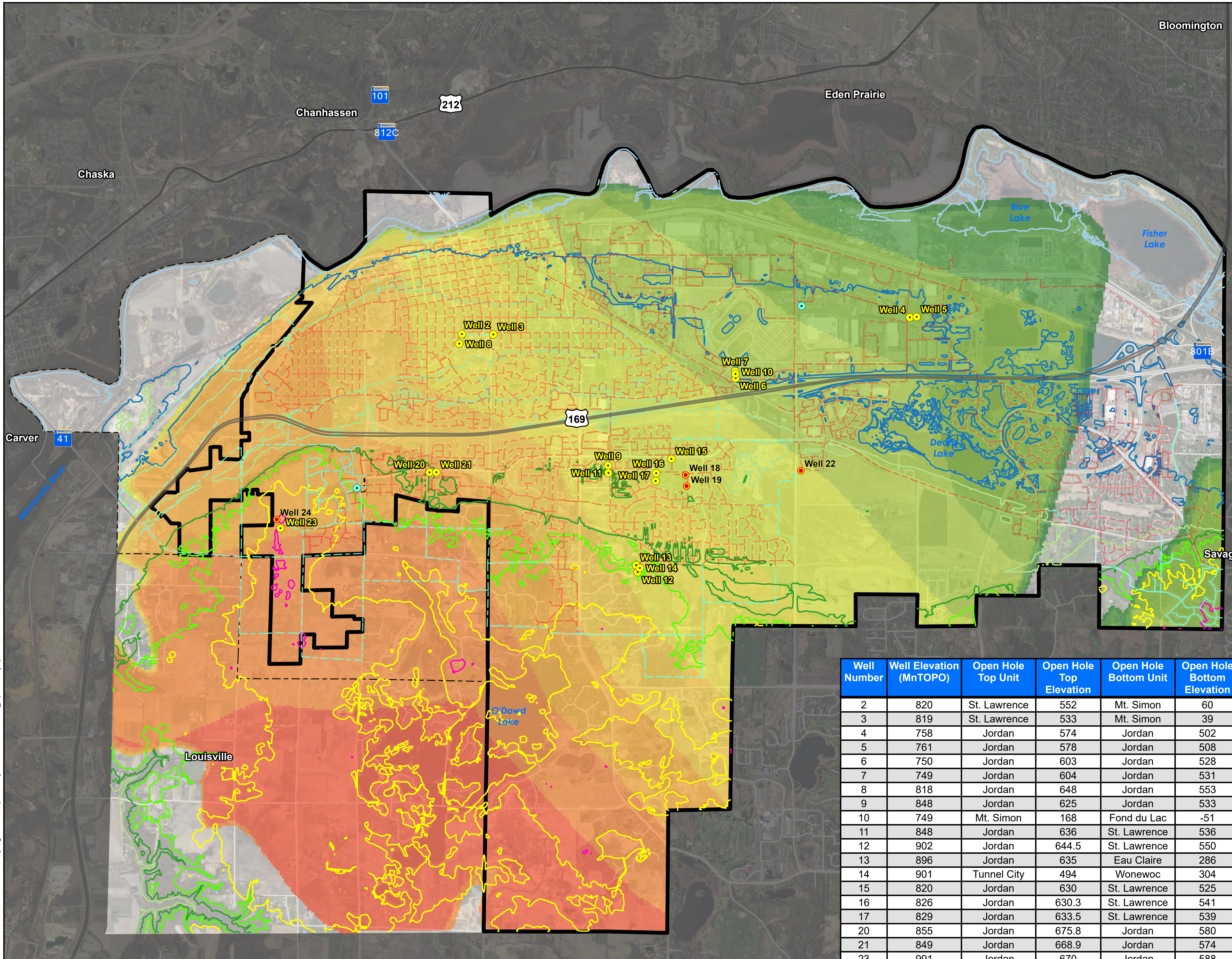
Prairie Du Chien (Shakopee) Thickness

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 4/2/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 8



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Legend

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- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

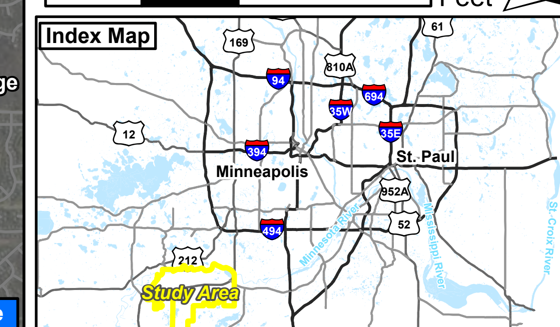
- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

Prairie Du Chien (Oneota) Confining Unit top elevation (MnDNR Part B Atlas for Scott County)

Feet Above Mean Sea Level

- 584 - 622
- 623 - 643
- 644 - 655
- 656 - 671
- 672 - 688
- 689 - 706
- 707 - 724
- 725 - 741
- 742 - 761
- 762 - 790

0 4,000 8,000 Feet



Prairie Du Chien (Oneota) Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

SEH

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 9

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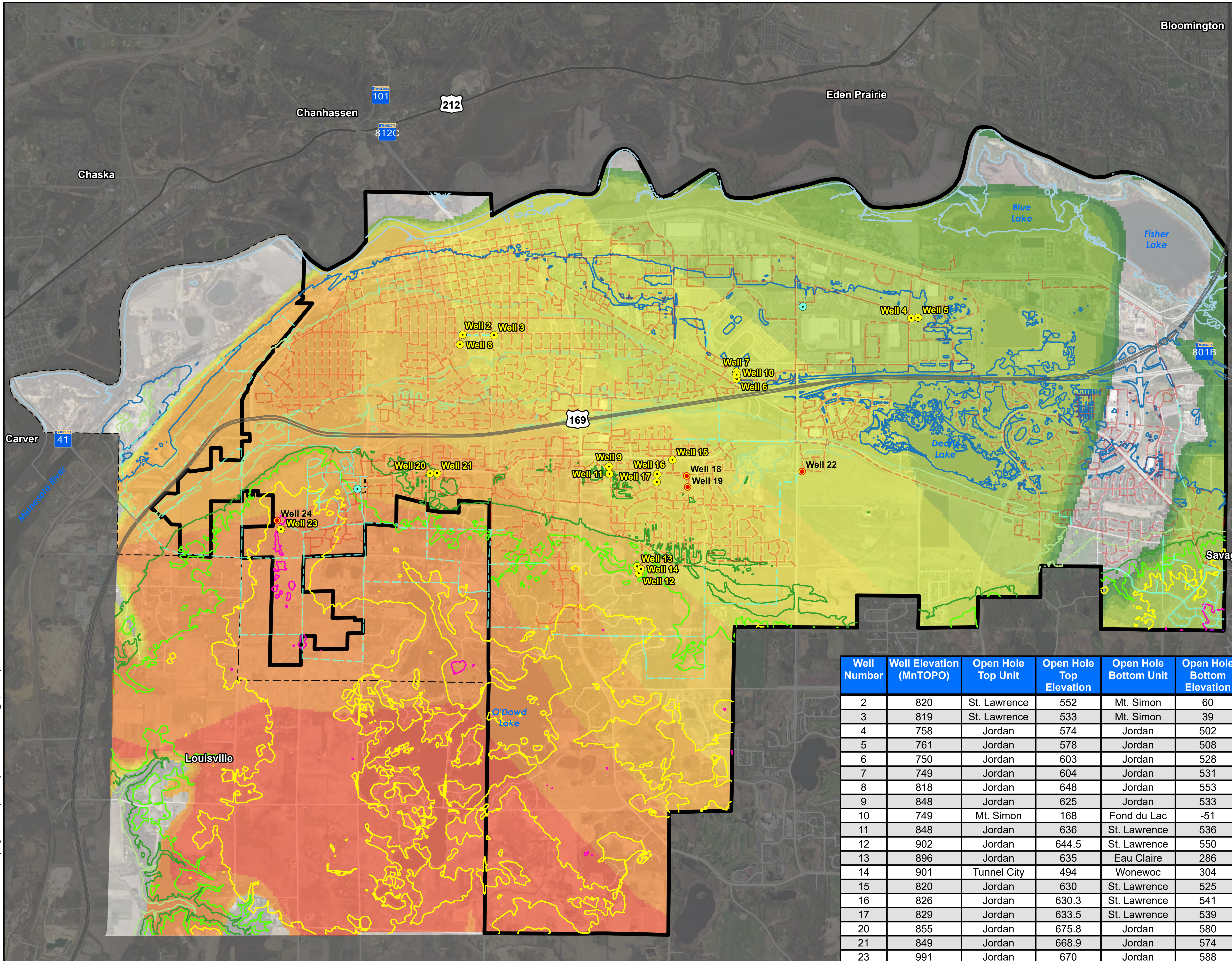

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Legend

- Municipal Well
- Planned Future Municipal Well
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- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

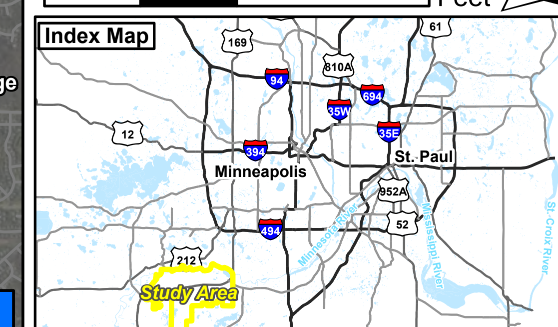
Jordan Aquifer top elevation (MnDNR Part B Atlas for Scott County)

Feet Above Mean Sea Level

- 500 - 539
- 540 - 571
- 572 - 594
- 595 - 610
- 611 - 628
- 629 - 648
- 649 - 668
- 669 - 688
- 689 - 710
- 711 - 744

0 4,000 8,000 Feet

N



Jordan Aquifer Top Elevation

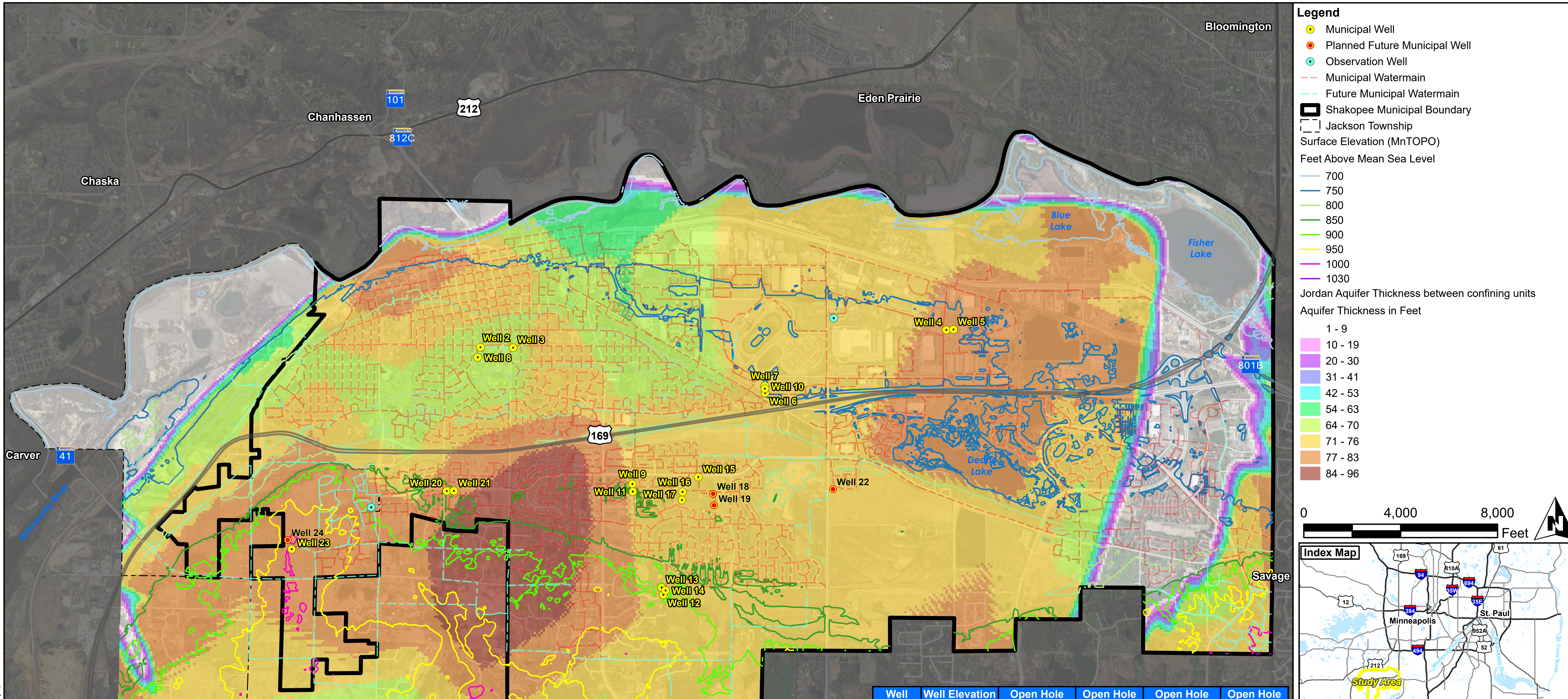
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 10

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
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21	849	Jordan	668.9	Jordan	574
23	991	Jordan	670	Jordan	588

Jordan Aquifer Thickness

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 11

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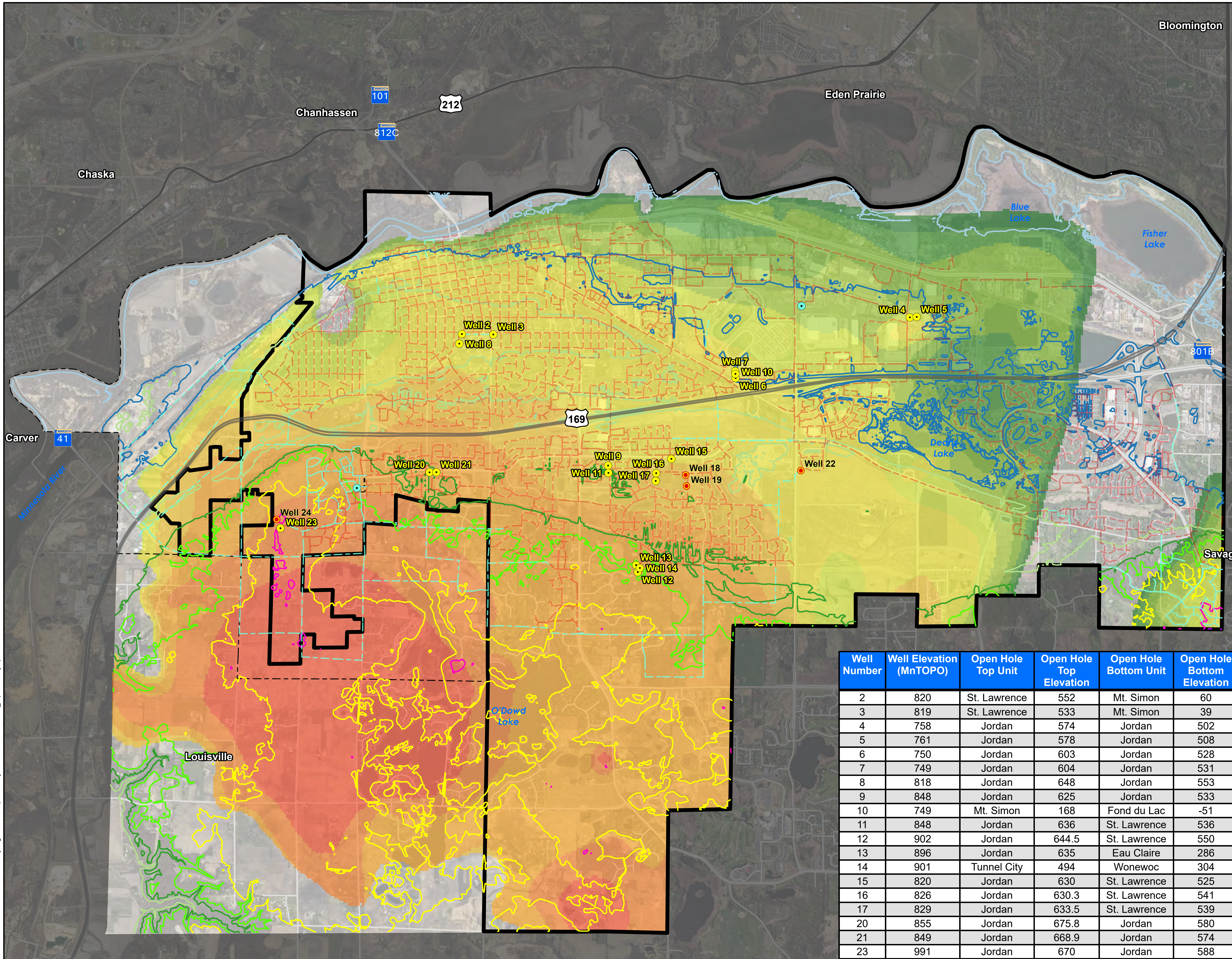

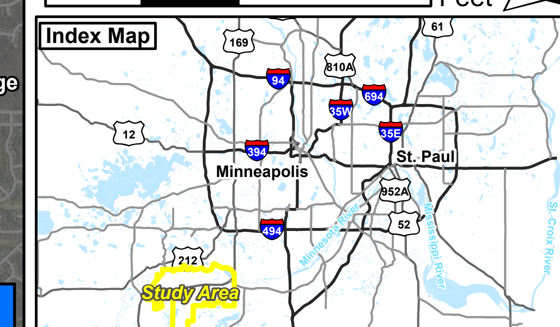

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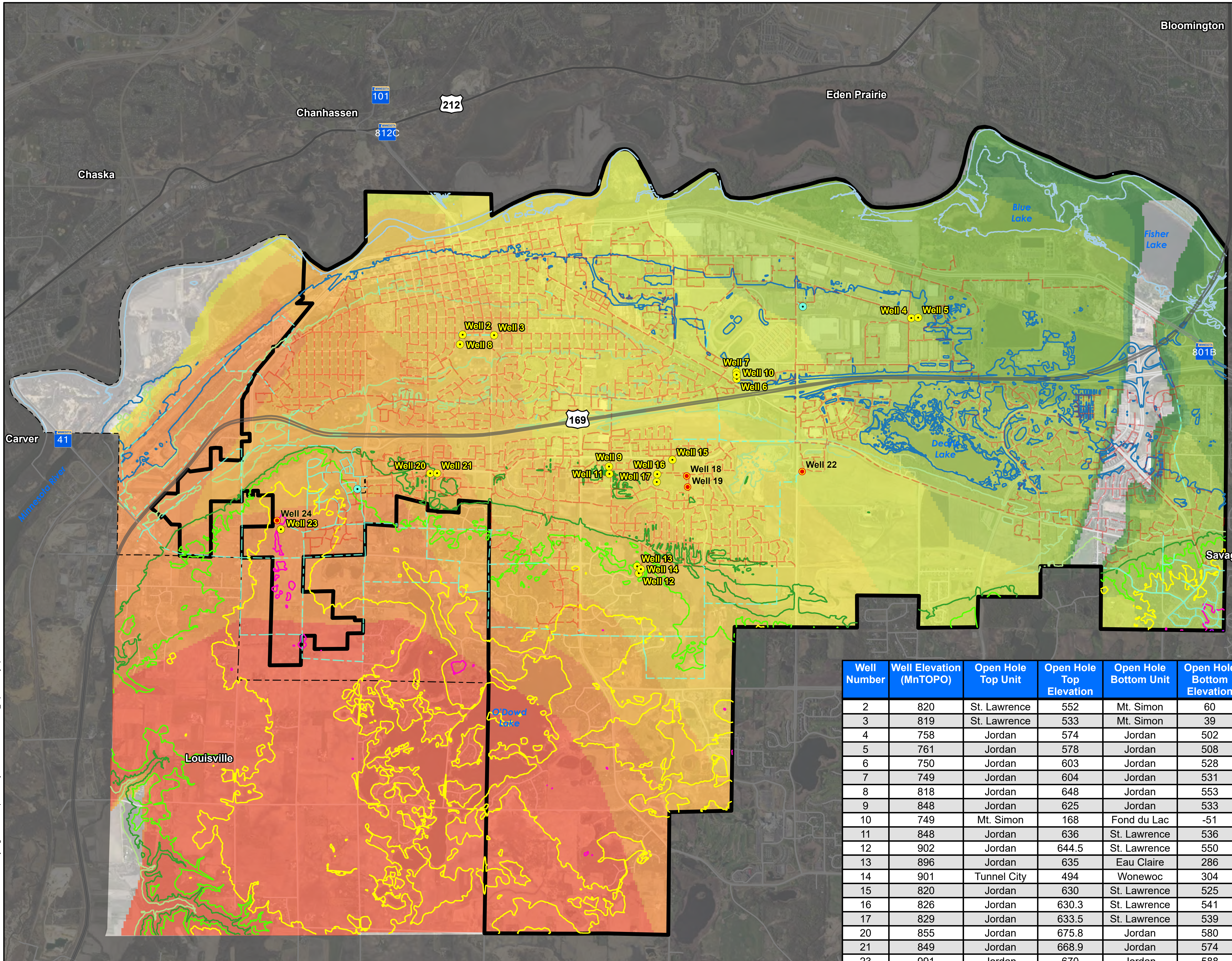
Jordan Confining Unit Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 12



Legend

- Municipal Well
- Planned Future Municipal Well
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- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

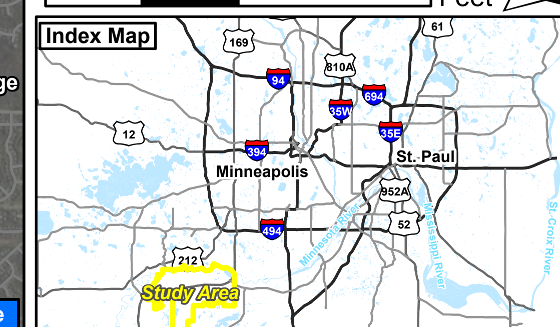
St. Lawrence Conging Unit top elevation (MnDNR Part B Atlas for Scott County)

Feet Above Mean Sea Level

- 429 - 466
- 467 - 487
- 488 - 500
- 501 - 514
- 515 - 531
- 532 - 550
- 551 - 569
- 570 - 587
- 588 - 605
- 606 - 635

0 4,000 8,000 Feet

N



Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
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23	991	Jordan	670	Jordan	588

St. Lawrence Confining Unit Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 13

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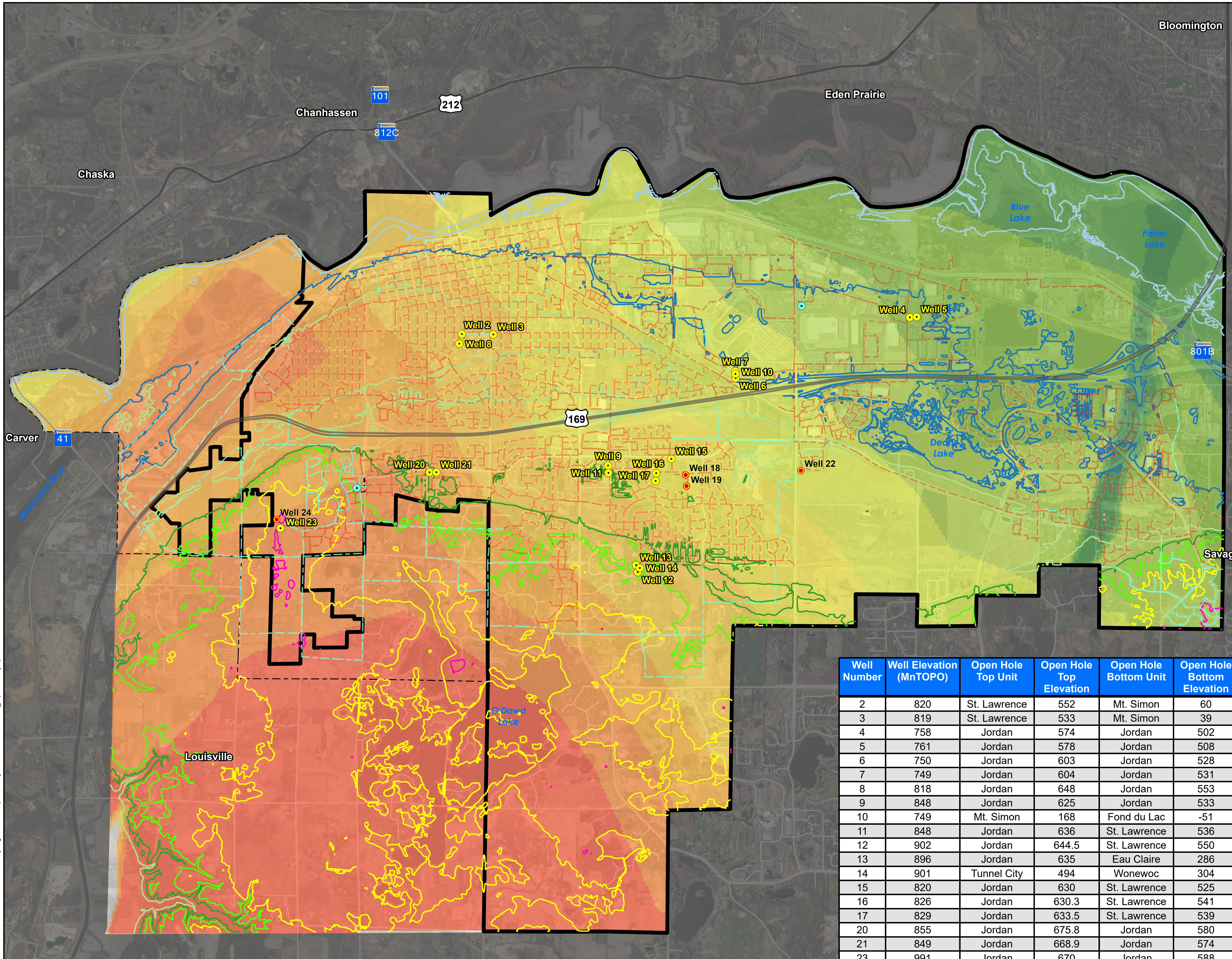

Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
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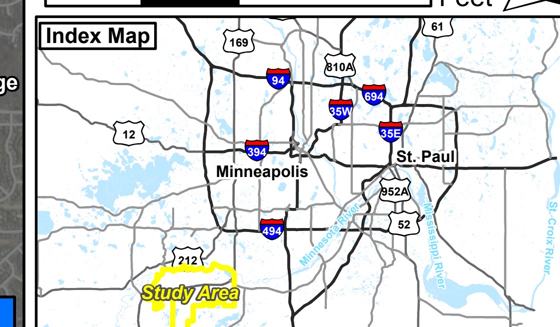

Tunnel City Aquifer Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

SEH

Print Date: 6/14/2024
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 14

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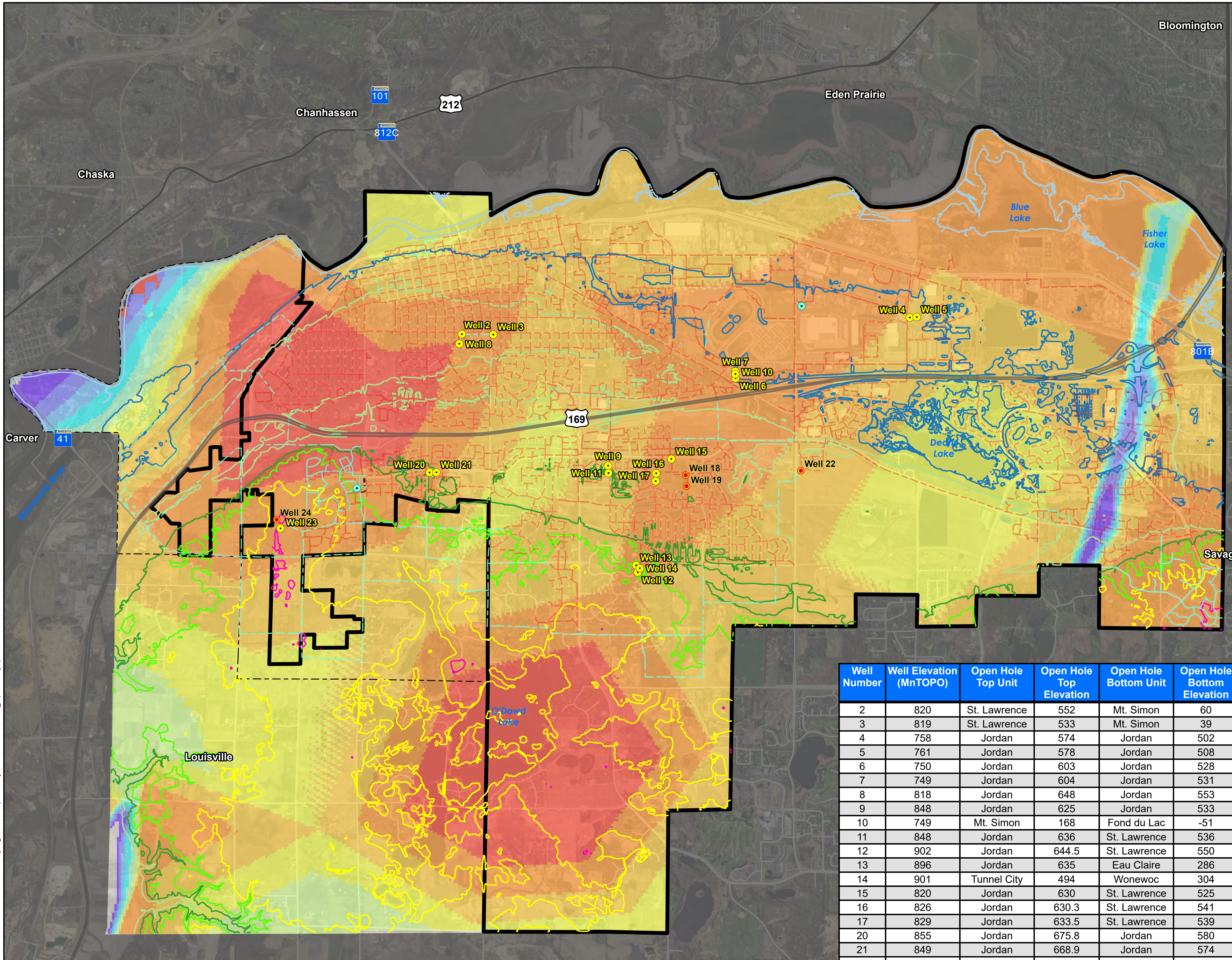

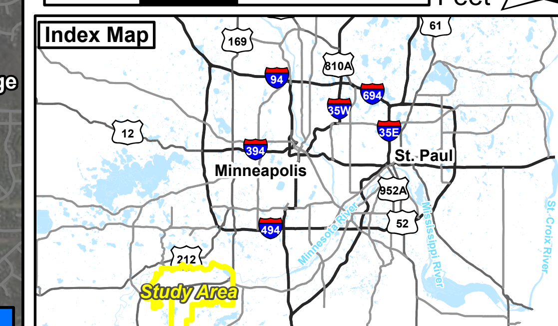

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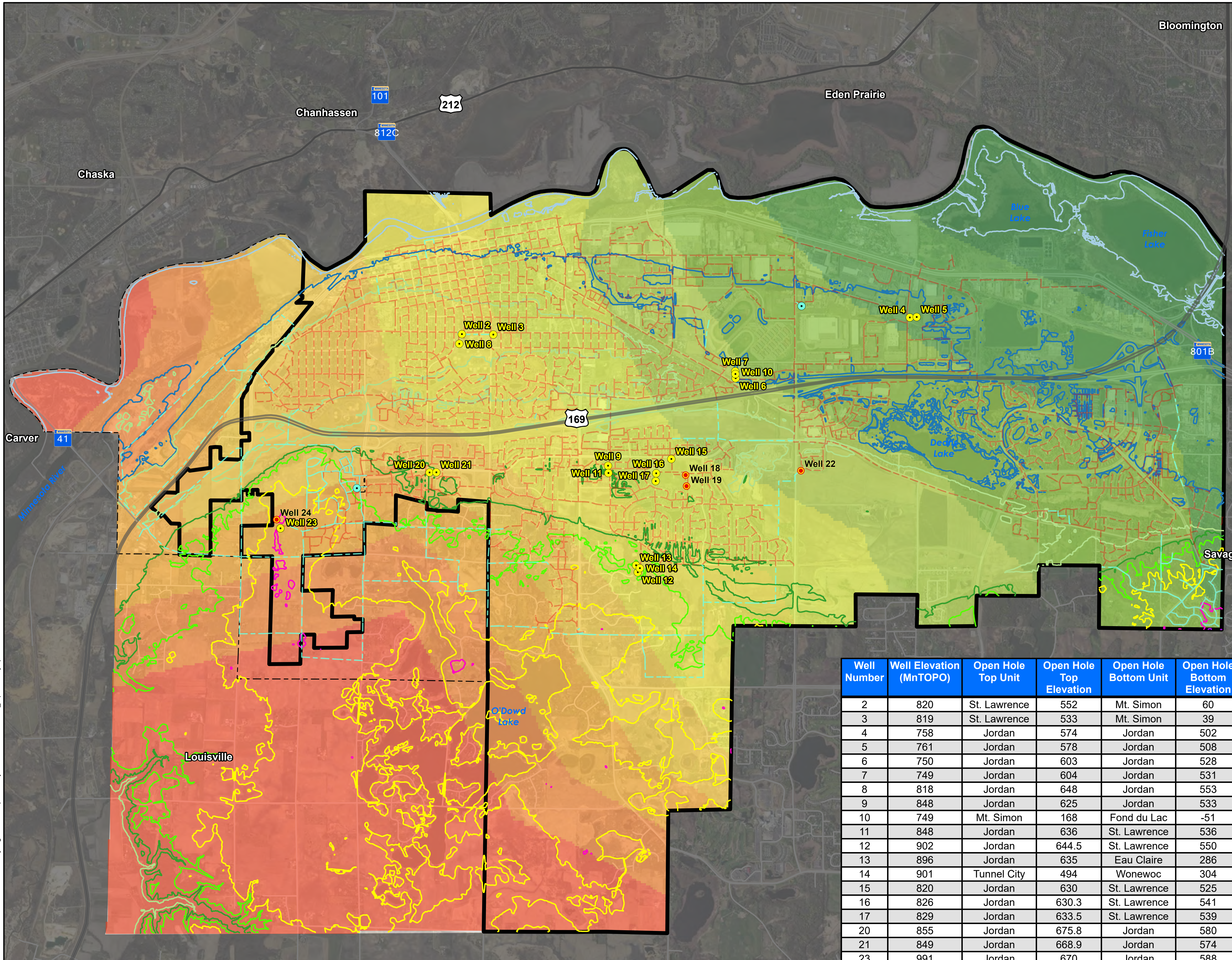
Tunnel City Aquifer Thickness

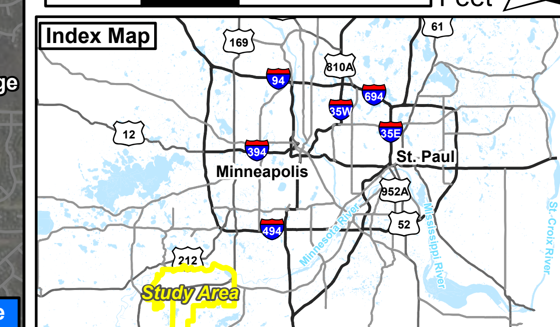
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 15





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23	991	Jordan	670	Jordan	588

Tunnel City Confining Unit Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 16

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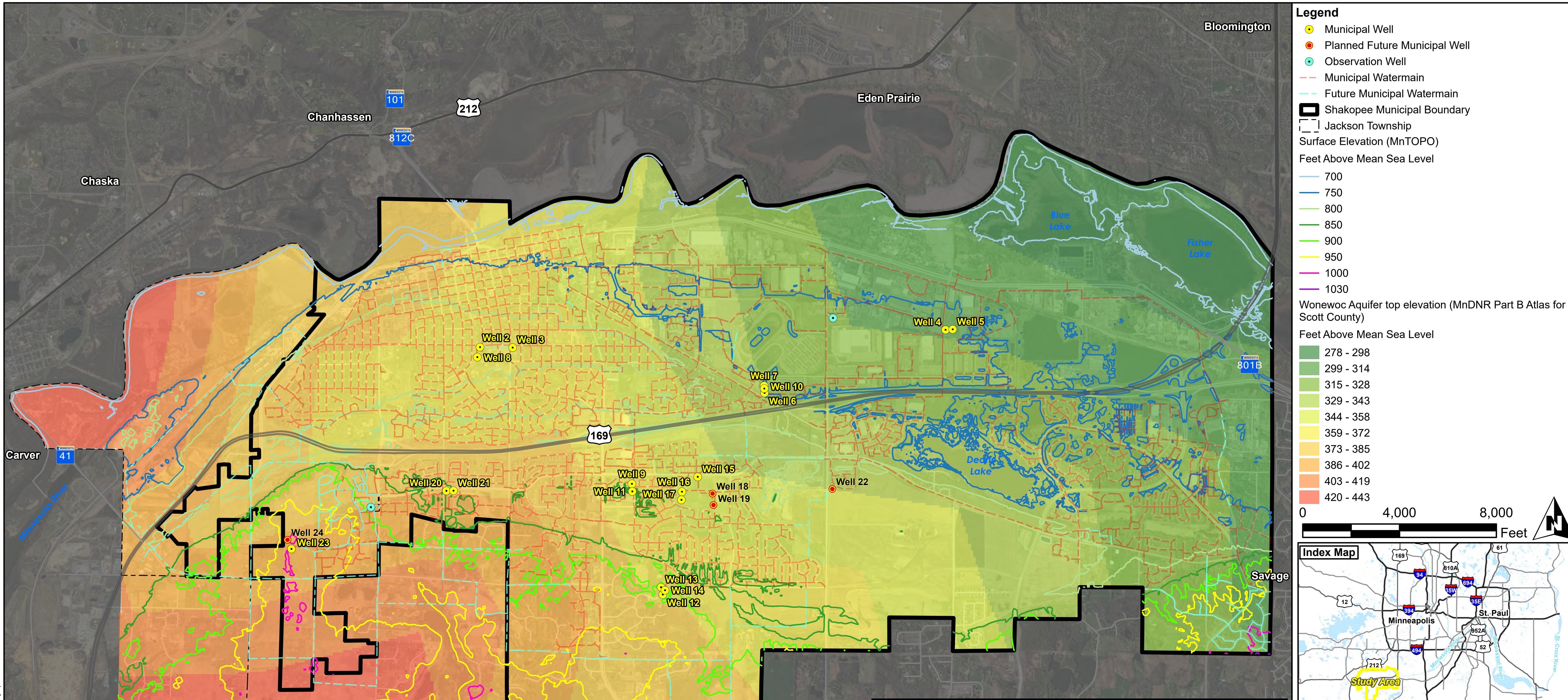

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20	855	Jordan	675.8	Jordan	580
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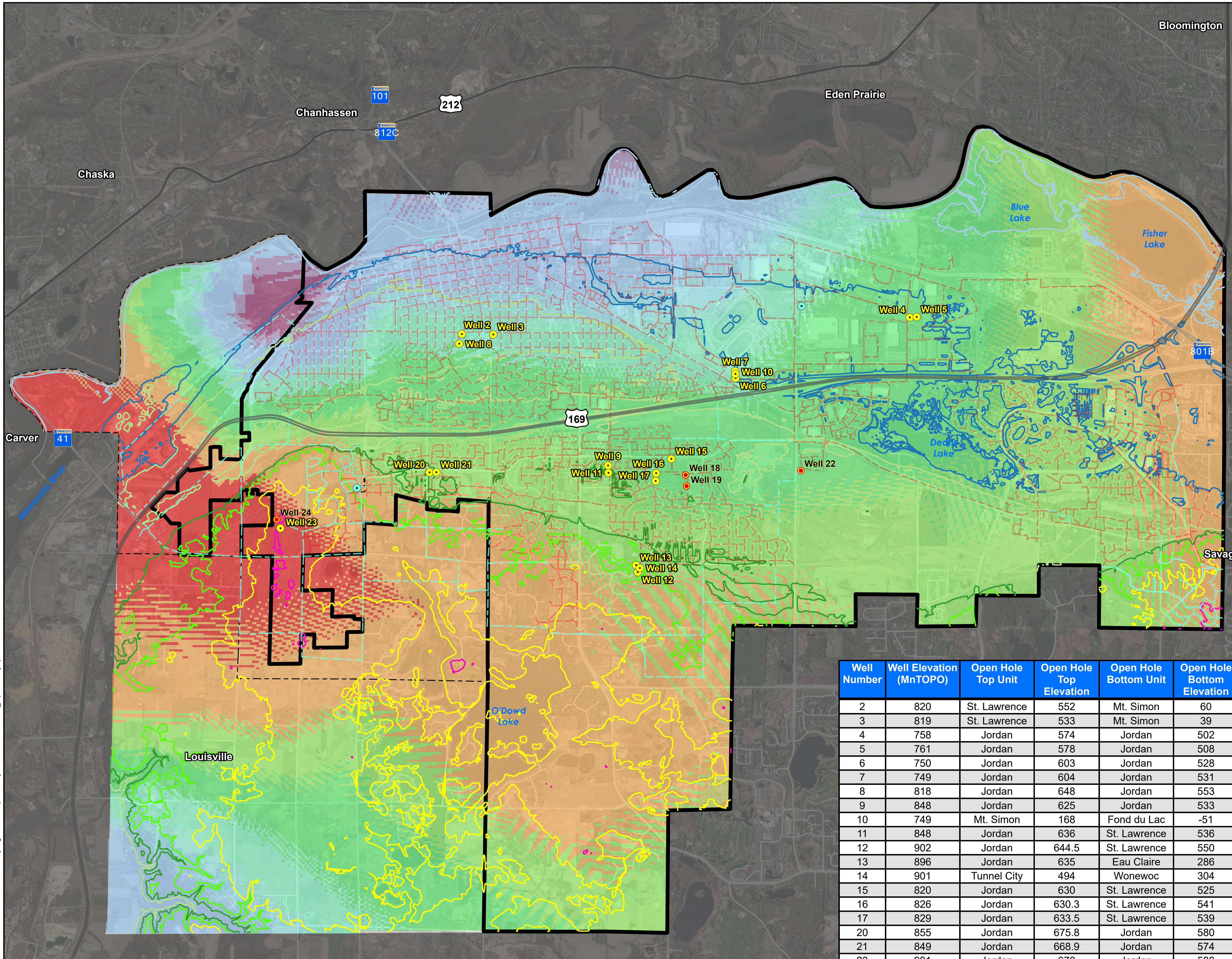
Wonewoc Aquifer Top Elevation

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 17



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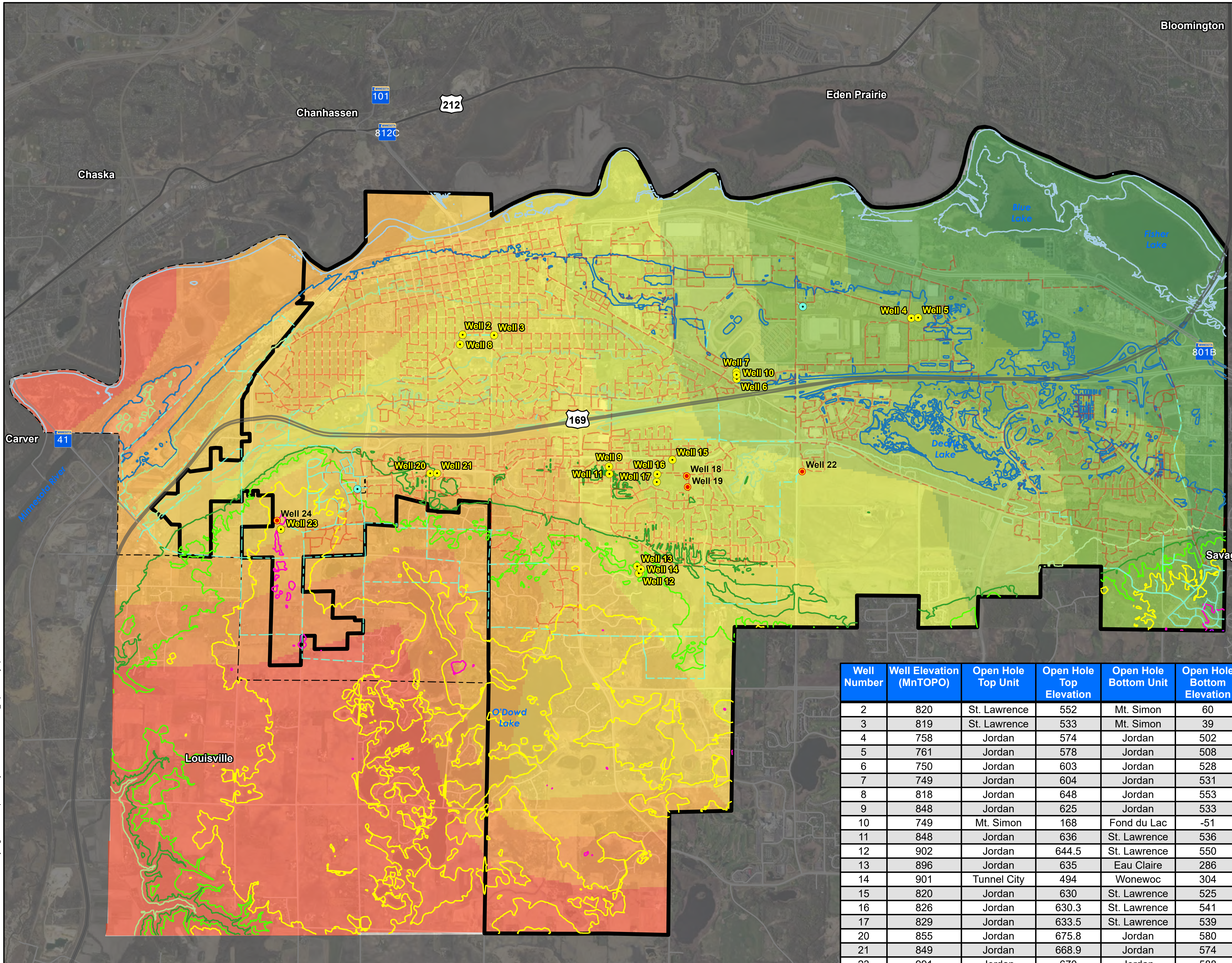
Wonewoc Aquifer Thickness

Aquifer Sustainability Study Update
Shakopee, Minnesota

SEH

Print Date: 6/14/2024
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 18



Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx

Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

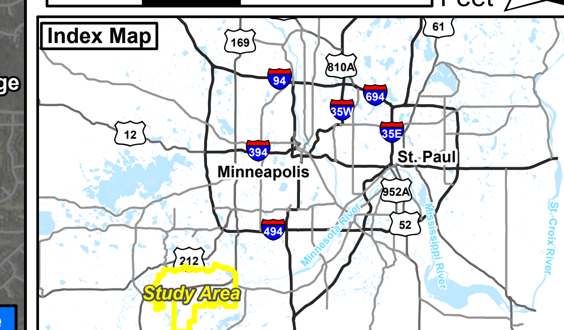
Eau Claire confining unit top elevation (MnDNR Part B Atlas for Scott County)

Feet Above Mean Sea Level

- 212 - 232
- 233 - 249
- 250 - 263
- 264 - 278
- 279 - 295
- 296 - 310
- 311 - 323
- 324 - 337
- 338 - 354
- 355 - 380

0 4,000 8,000 Feet

N



Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
2	820	St. Lawrence	552	Mt. Simon	60
3	819	St. Lawrence	533	Mt. Simon	39
4	758	Jordan	574	Jordan	502
5	761	Jordan	578	Jordan	508
6	750	Jordan	603	Jordan	528
7	749	Jordan	604	Jordan	531
8	818	Jordan	648	Jordan	553
9	848	Jordan	625	Jordan	533
10	749	Mt. Simon	168	Fond du Lac	-51
11	848	Jordan	636	St. Lawrence	536
12	902	Jordan	644.5	St. Lawrence	550
13	896	Jordan	635	Eau Claire	286
14	901	Tunnel City	494	Wonewoc	304
15	820	Jordan	630	St. Lawrence	525
16	826	Jordan	630.3	St. Lawrence	541
17	829	Jordan	633.5	St. Lawrence	539
20	855	Jordan	675.8	Jordan	580
21	849	Jordan	668.9	Jordan	574
23	991	Jordan	670	Jordan	588

Eau Claire Confining Unit Top Elevation

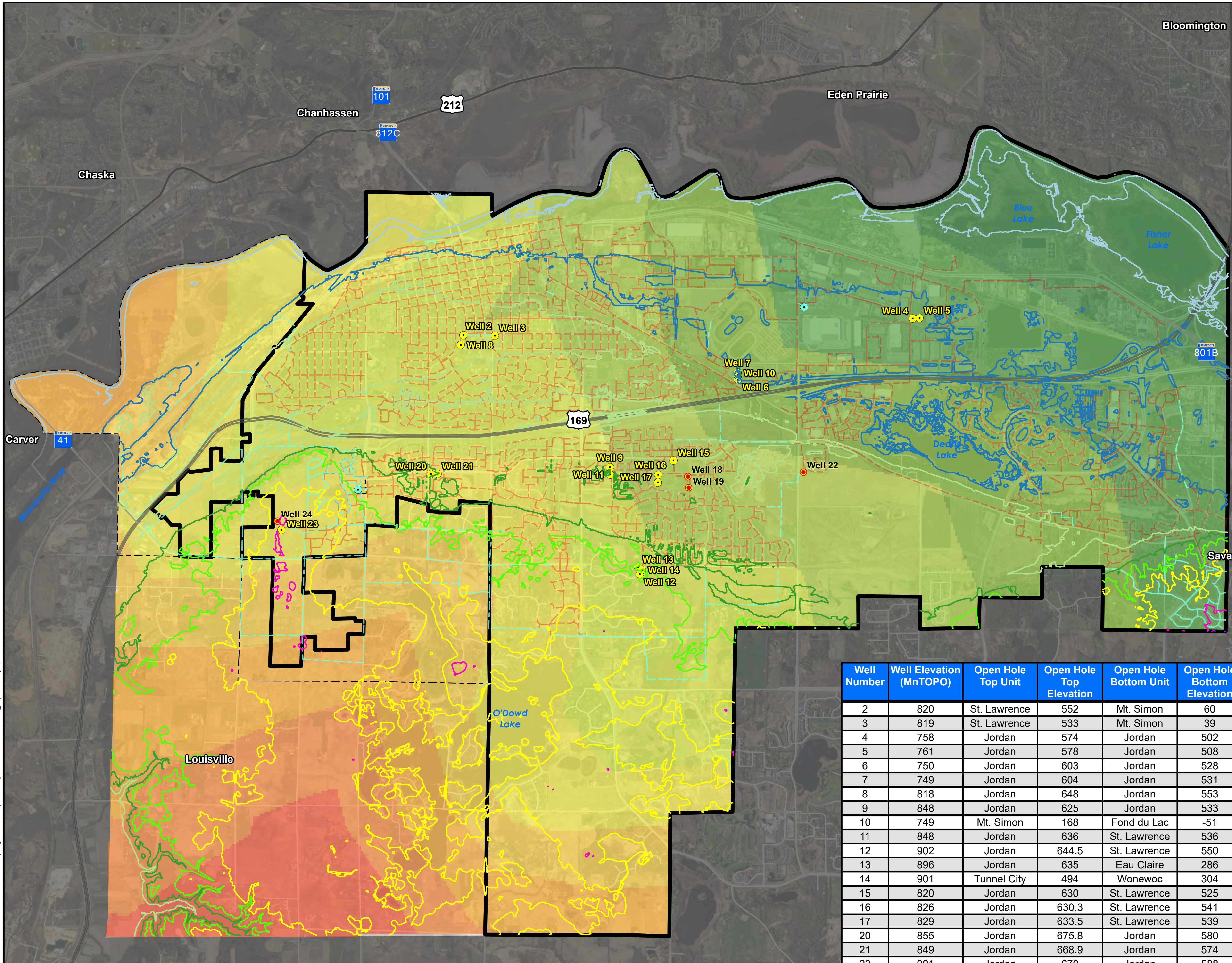
Aquifer Sustainability Study Update
Shakopee, Minnesota

SEH

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 19



Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Surface Elevation (MnTOPO)

Feet Above Mean Sea Level

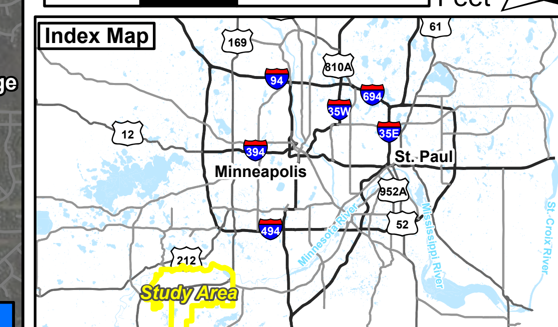
- 700
- 750
- 800
- 850
- 900
- 950
- 1000
- 1030

Mt Simon Aquifer top elevation (MnDNR Part B Atlas for Scott County)

Feet Above Mean Sea Level

- 134 - 159
- 160 - 181
- 182 - 201
- 202 - 224
- 225 - 243
- 244 - 261
- 262 - 280
- 281 - 302
- 303 - 327
- 328 - 364

0 4,000 8,000 Feet



Well Number	Well Elevation (MnTOPO)	Open Hole Top Unit	Open Hole Top Elevation	Open Hole Bottom Unit	Open Hole Bottom Elevation
2	820	St. Lawrence	552	Mt. Simon	60
3	819	St. Lawrence	533	Mt. Simon	39
4	758	Jordan	574	Jordan	502
5	761	Jordan	578	Jordan	508
6	750	Jordan	603	Jordan	528
7	749	Jordan	604	Jordan	531
8	818	Jordan	648	Jordan	553
9	848	Jordan	625	Jordan	533
10	749	Mt. Simon	168	Fond du Lac	-51
11	848	Jordan	636	St. Lawrence	536
12	902	Jordan	644.5	St. Lawrence	550
13	896	Jordan	635	Eau Claire	286
14	901	Tunnel City	494	Wonewoc	304
15	820	Jordan	630	St. Lawrence	525
16	826	Jordan	630.3	St. Lawrence	541
17	829	Jordan	633.5	St. Lawrence	539
20	855	Jordan	675.8	Jordan	580
21	849	Jordan	668.9	Jordan	574
23	991	Jordan	670	Jordan	588

Mt. Simon Aquifer Top Elevation

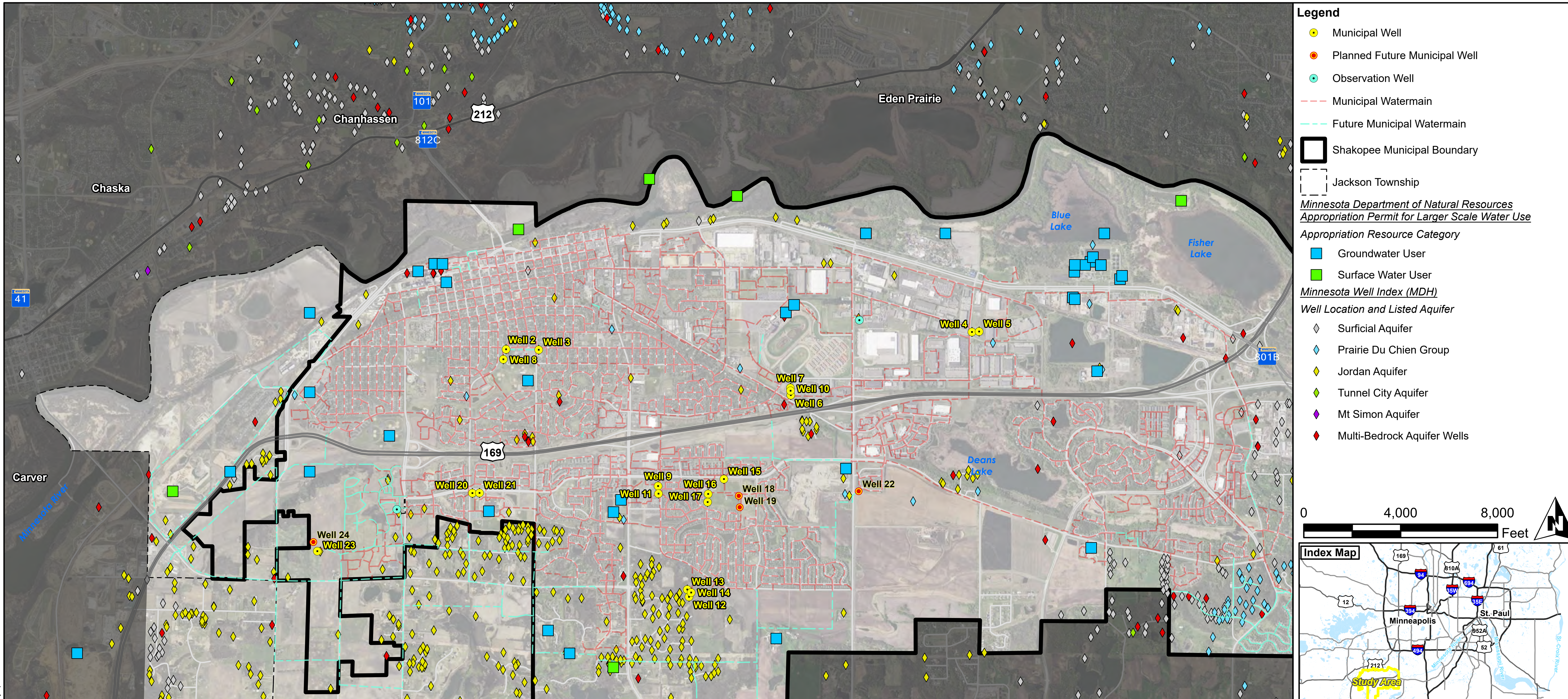
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 20

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Other Water Users

Aquifer Sustainability Study Update
Shakopee, Minnesota

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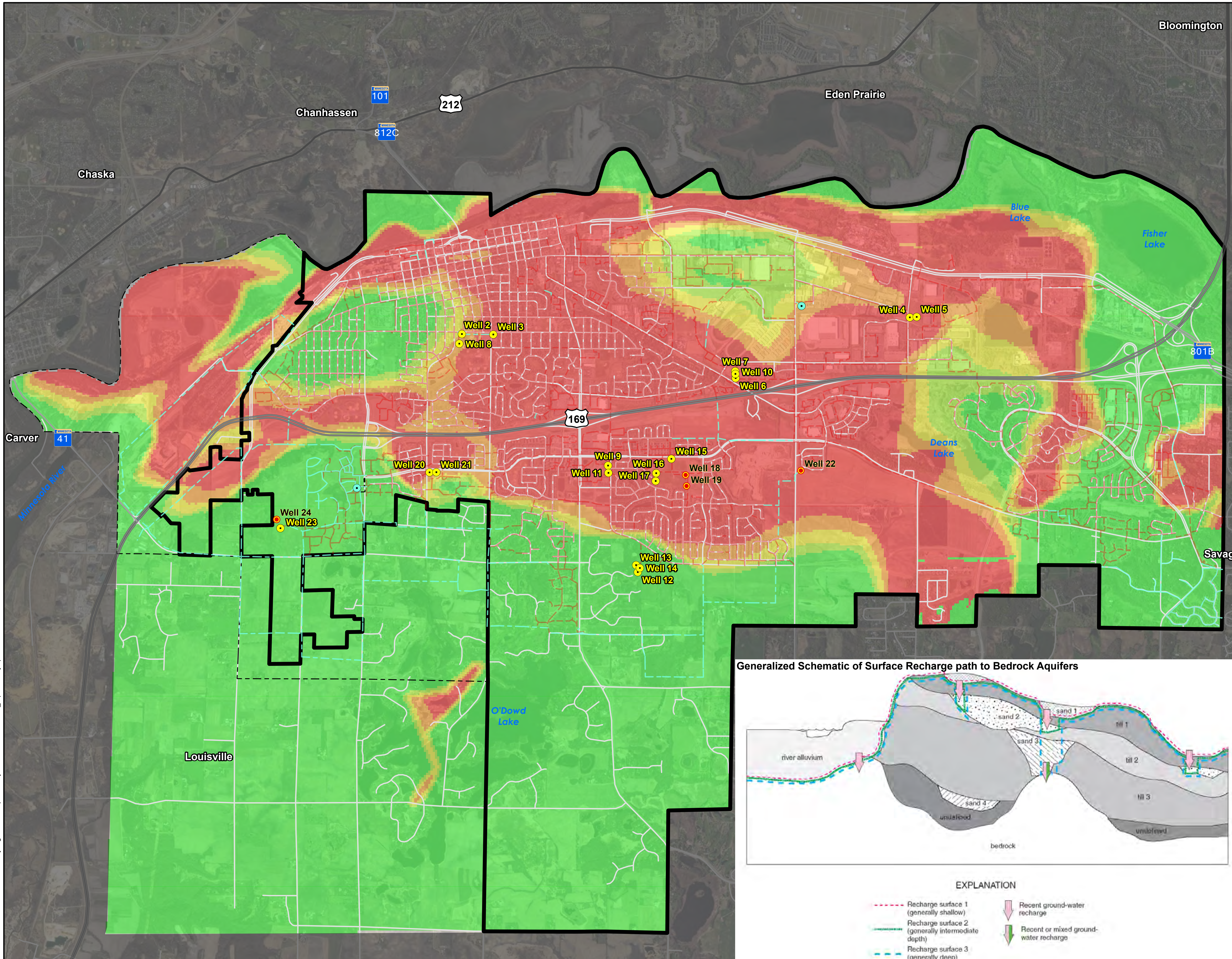
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 21

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township

Pollution Sensitivity (Plate 6, Scott County Geologic Atlas)

Speed of Surface Recahrge to Bedrock Aquifer

- Very Fast (Hours to Months)
- Fast (Weeks to Years)
- Moderate (Years to Decades)
- Slow (Decades to a Century or more)
- Very Slow (Century or more)

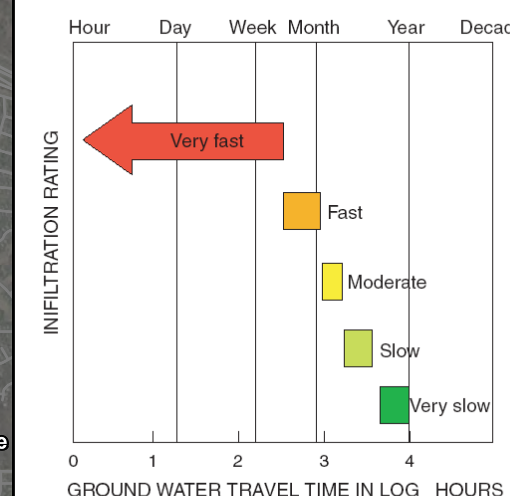


Figure 8. Infiltration ratings as defined by vertical travel time. Ratings are calculated from minimum estimated transmission rates for soil hydrologic groups (Natural Resources Conservation Service, 2006b) applied over a distance of 10 feet (3 meters).

Pollution Sensitivity

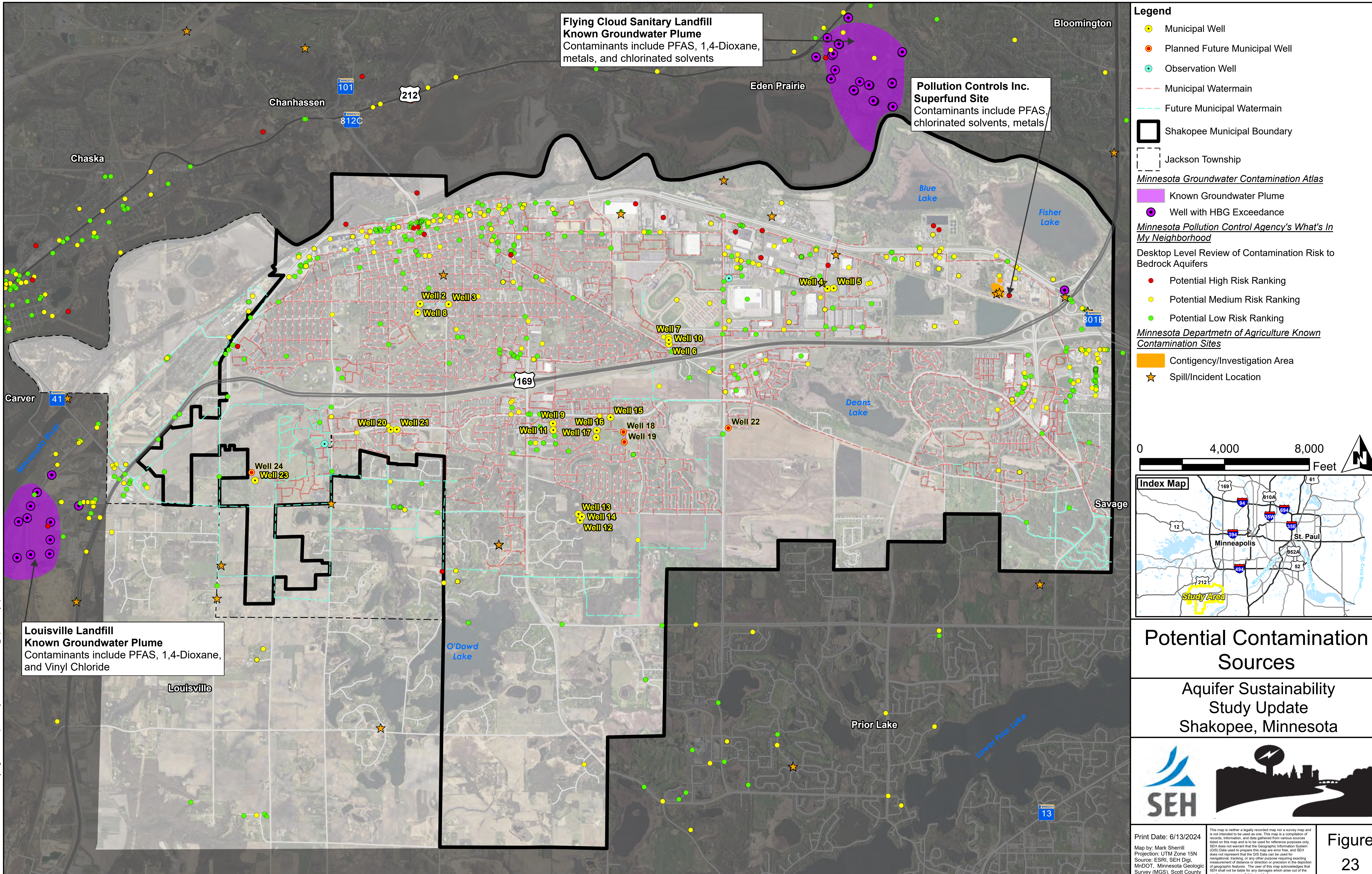
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/13/2024

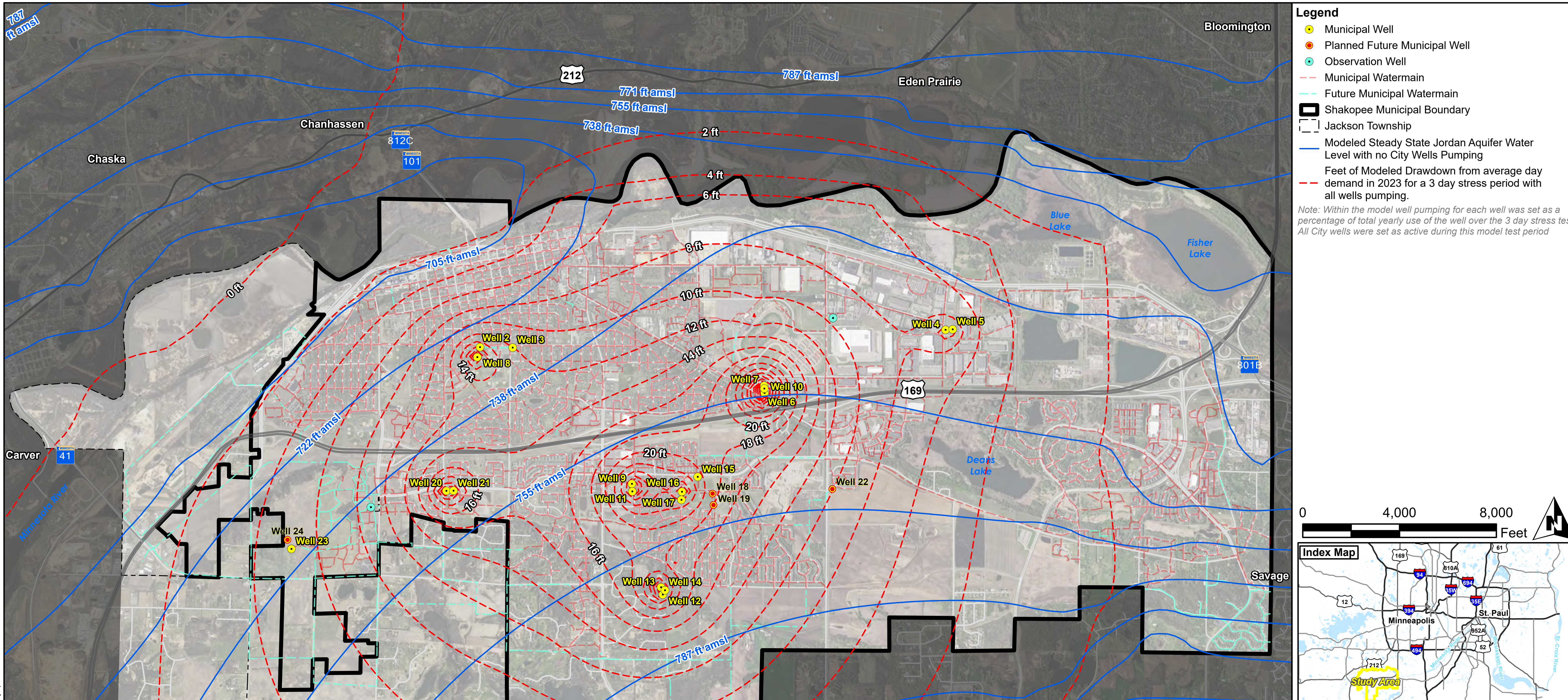
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 22

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Flying Cloud Sanitary Landfill Known Groundwater Plume
Contaminants include PFAS, 1,4-Dioxane, metals, and chlorinated solvents
Pollution Controls Inc. Superfund Site
Contaminants include PFAS, chlorinated solvents, metals
Louisville Landfill Known Groundwater Plume
Contaminants include PFAS, 1,4-Dioxane, and Vinyl Chloride
Bloomington
Eden Prairie
Chanhassen
Chaska
Carver
Louisville
Prior Lake
Savage
Blue Lake
Fisher Lake
Deans Lake
O'Dowd Lake
Lower Prior Lake
Minnesota River
Well 2
Well 3
Well 8
Well 4
Well 5
Well 7
Well 10
Well 6
Well 9
Well 11
Well 15
Well 16
Well 17
Well 18
Well 19
Well 20
Well 21
Well 22
Well 24
Well 23
Well 13
Well 14
Well 12
Legend
Municipal Well
Planned Future Municipal Well
Observation Well
Municipal Watermain
Future Municipal Watermain
Shakopee Municipal Boundary
Jackson Township
Minnesota Groundwater Contamination Atlas
Known Groundwater Plume
Well with HBG Exceedance
Minnesota Pollution Control Agency's What's In My Neighborhood
Desktop Level Review of Contamination Risk to Bedrock Aquifers
Potential High Risk Ranking
Potential Medium Risk Ranking
Potential Low Risk Ranking
Minnesota Departmetn of Agriculture Known Contamination Sites
Contigency/Investigation Area
Spill/Incident Location
0
4,000
8,000
Feet
Index Map
Minneapolis
St. Paul
Study Area
Potential Contamination Sources
Aquifer Sustainability Study Update
Shakopee, Minnesota
SEH
Print Date: 6/13/2024
Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County
Figure 23



Modeled 2023 Drawdown within Jordan Aquifer

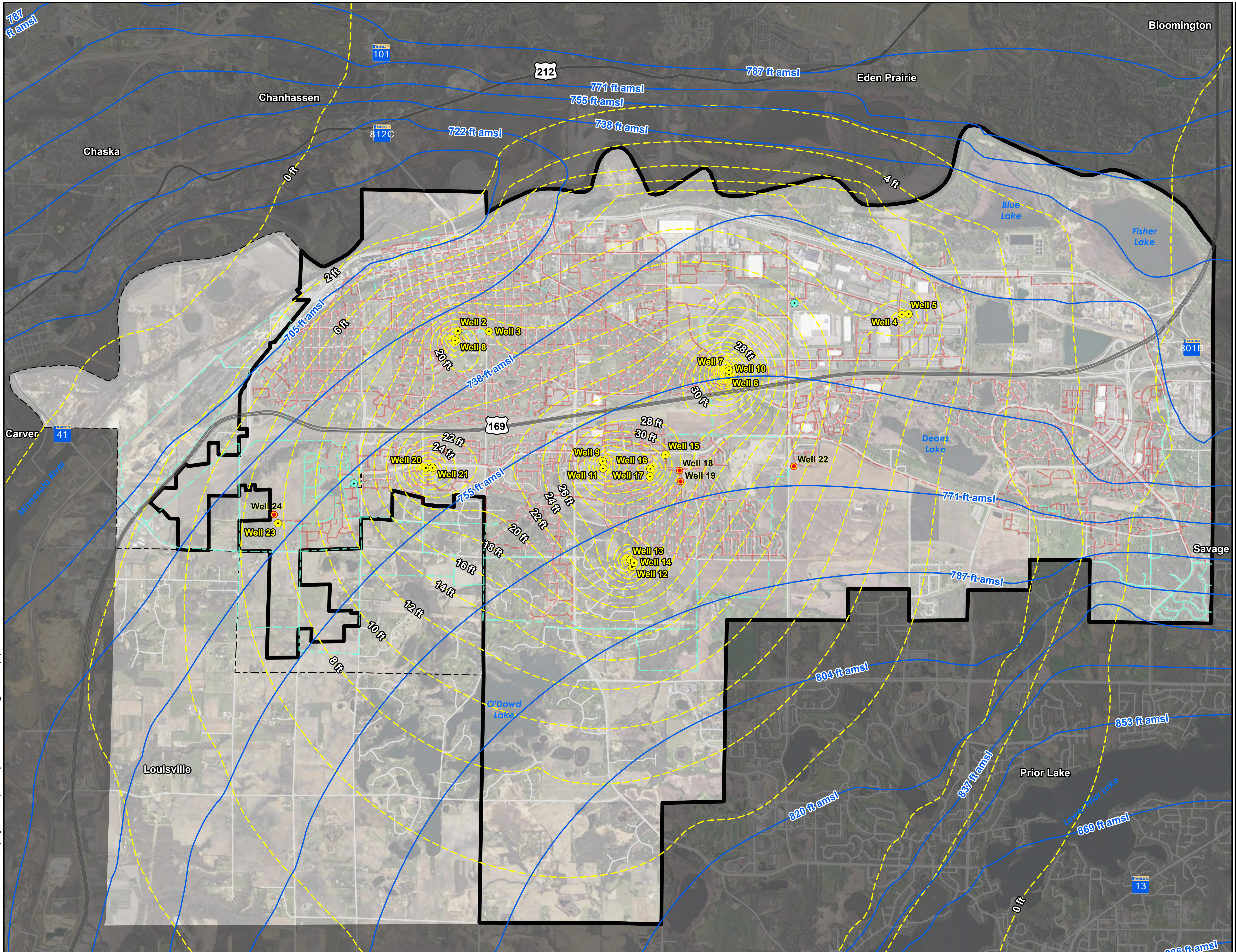
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 24

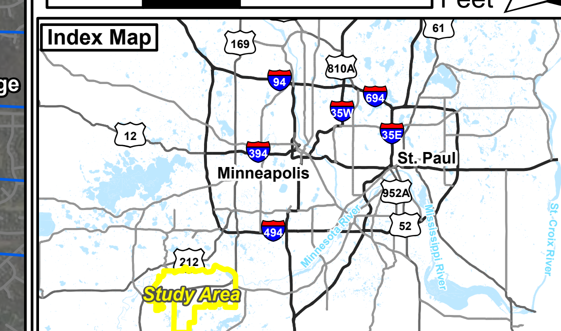
Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township
- Modeled Steady State Jordan Aquifer Water Level with no City Wells Pumping
- Feet of Modeled Drawdown from 2040 projected demand for a 3 day stress test period with only existing wells pumped.

Note: Within the model well pumping for each well was set as a percentage of total yearly use of the well over the 3 day stress test. All City wells were set as active during this model test period



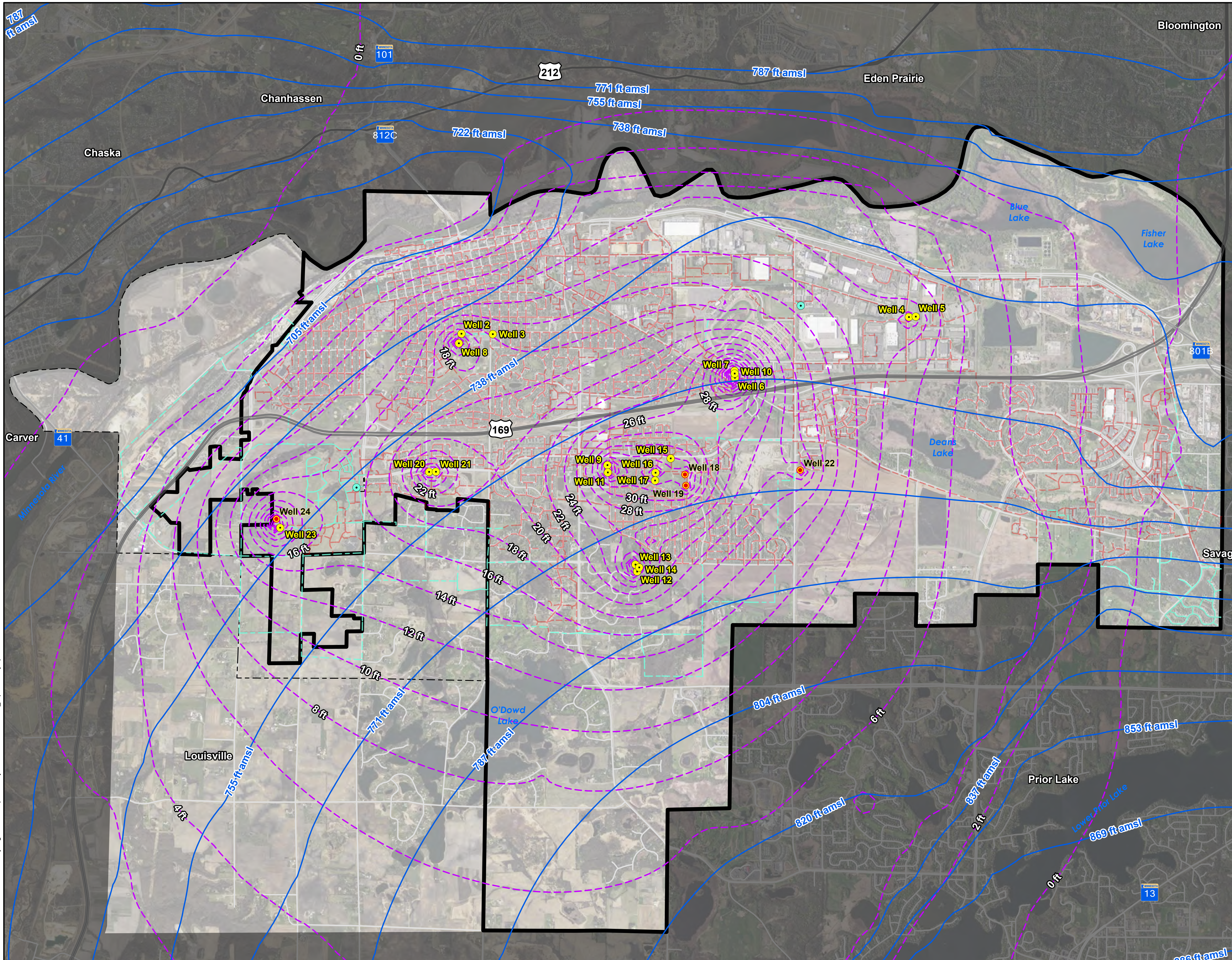
Modeled 2040 Drawdown within Jordan Aquifer for Existing Wells

Aquifer Sustainability Study Update Shakopee, Minnesota

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 25



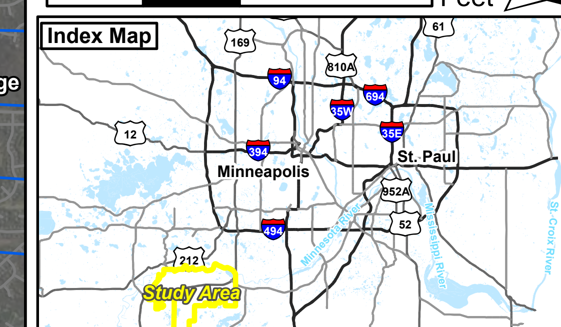
Legend

- Municipal Well
- Planned Future Municipal Well
- Observation Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township
- Modeled Steady State Jordan Aquifer Water Level with no City Wells Pumping
- Feet of Modeled Drawdown from 2040 projected demand for a 3 day stress test period with new and existing wells pumped.

Note: Within the model well pumping for each well was set as a percentage of total yearly use of the well over the 3 day stress test. All City wells were set as active during this model test period. New Wells were assigned average pumping rates of 250 - 500 gpm over the 3 day period.

0 4,000 8,000 Feet

N



Modeled 2040 Drawdown within Jordan Aquifer w/ Proposed Wells

Aquifer Sustainability Study Update
Shakopee, Minnesota

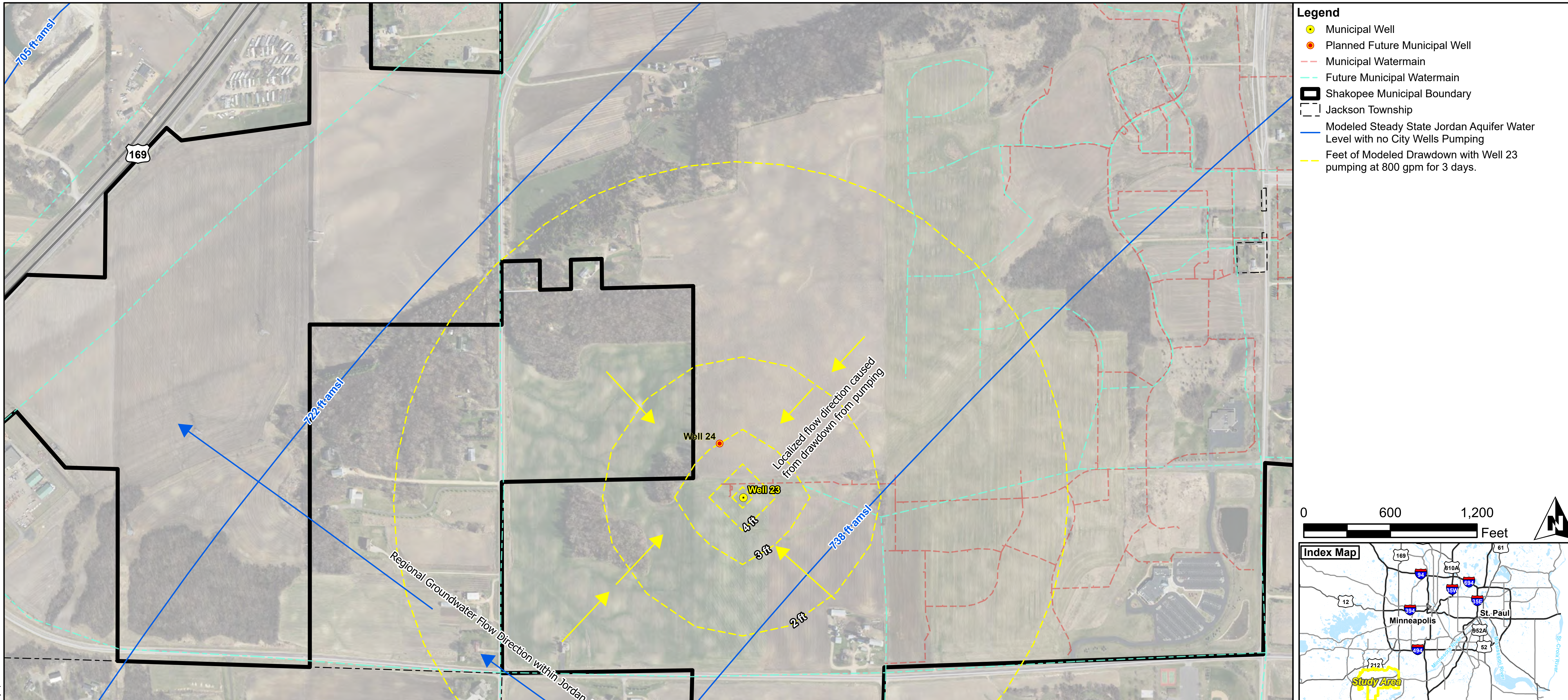
SEH

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 26

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx



Drawdown in Well 23 Pumping at 800 gpm

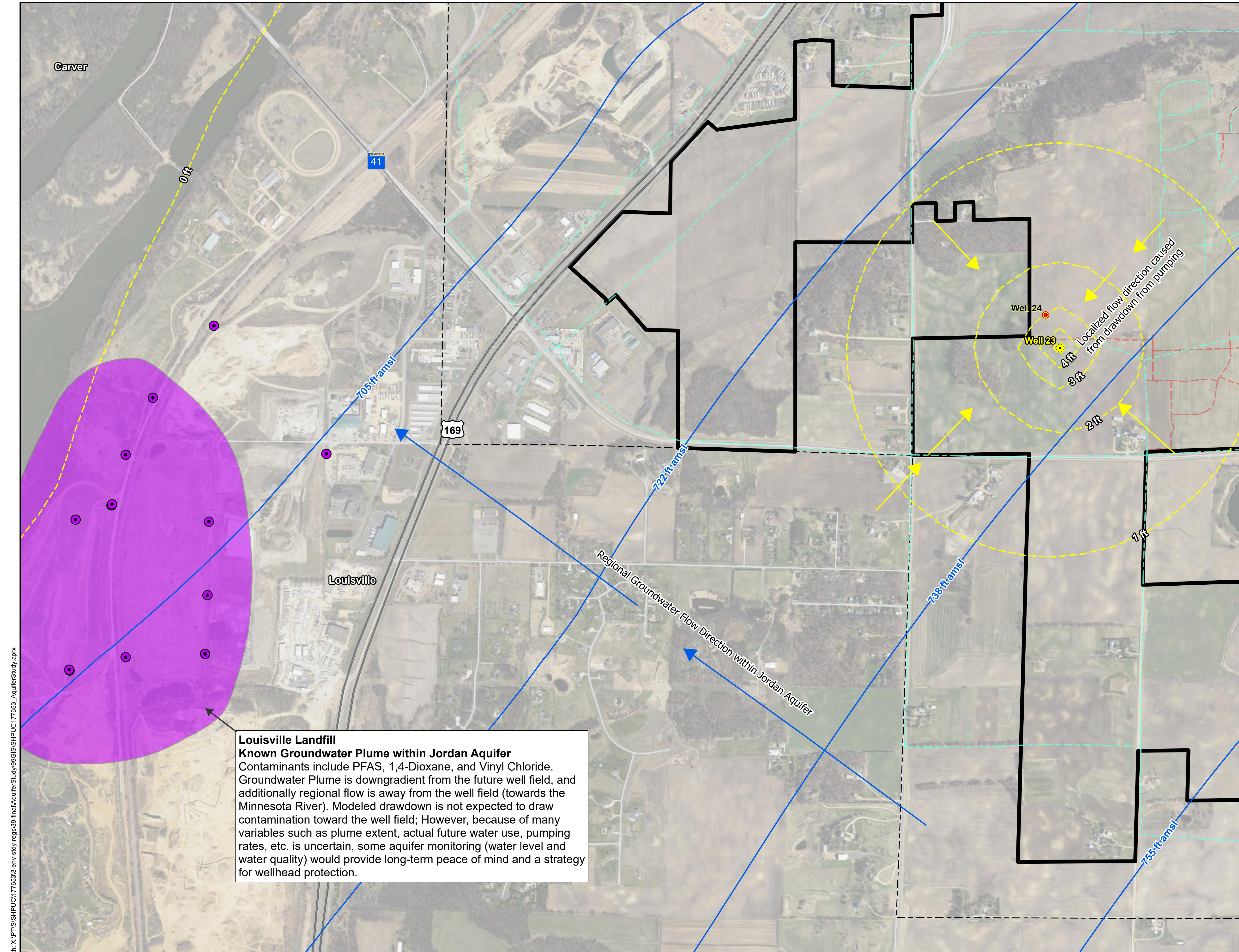
Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 27

Path: X:\PT\S\SHPUC\177653\3-env-stdy-regs\39-final\AquiferStudy\99GIS\SHPUC177653_AquiferStudy.aprx

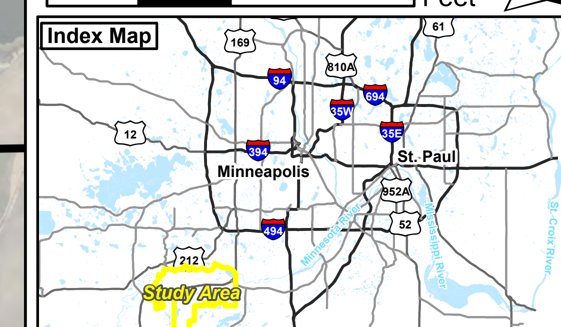


Legend

- Municipal Well
- Planned Future Municipal Well
- Municipal Watermain
- Future Municipal Watermain
- Shakopee Municipal Boundary
- Jackson Township
- Modeled Steady State Jordan Aquifer Water Level with no City Wells Pumping
- Feet of Modeled Drawdown with Well 23 pumping at 800 gpm for 3 days.

Minnesota Groundwater Contamination Atlas

- Known Groundwater Plume
- Well with HBG Exceedance



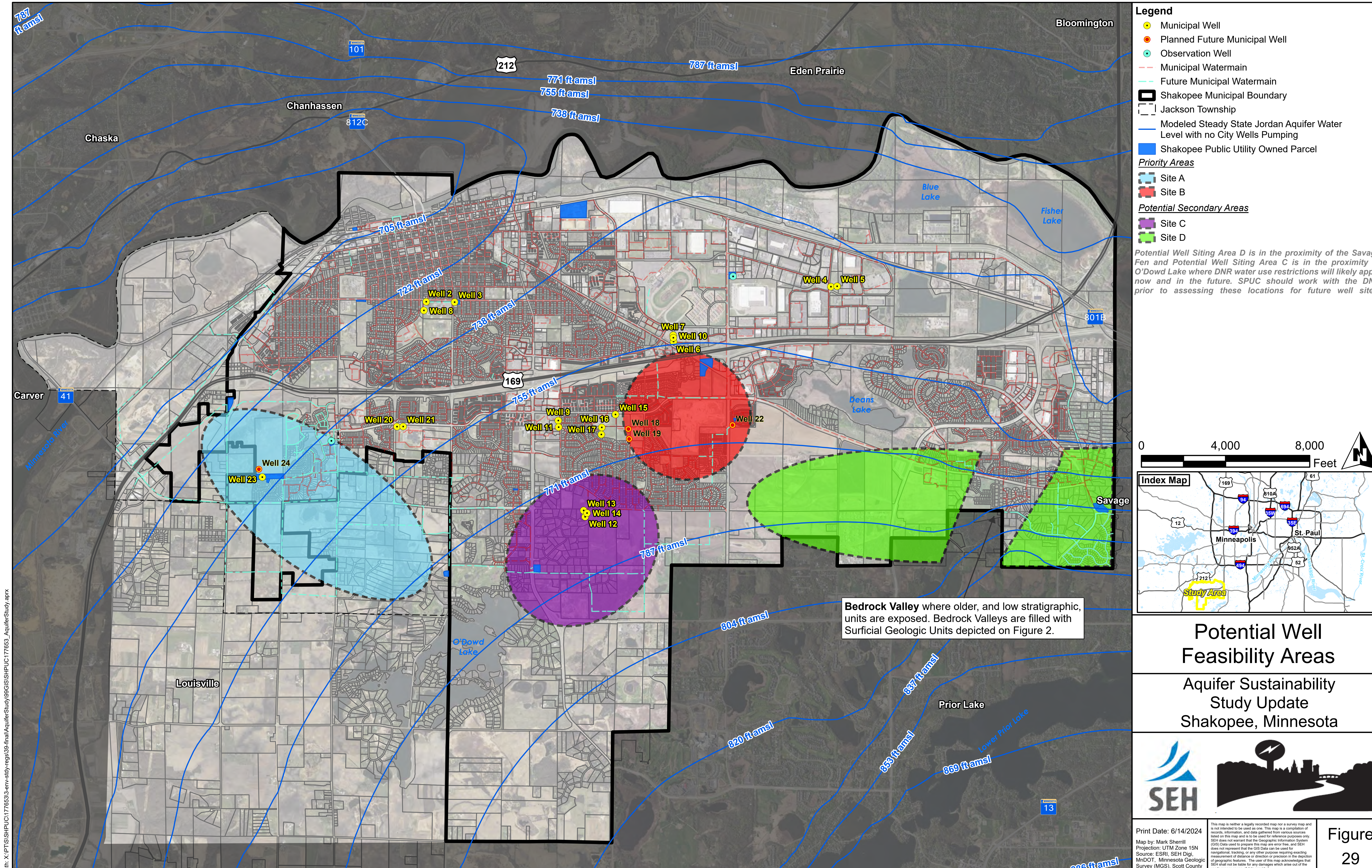
Well 23 Wellfield and Louisville Landfill

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/13/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 28



Potential Well Feasibility Areas

Aquifer Sustainability Study Update
Shakopee, Minnesota

Print Date: 6/14/2024

Map by: Mark Sherrill
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 29

Appendix A

United States Geologic Survey Age Dating

Program USGS-CFC2008xls -- **Major revision --Change from the SIO 1998 to the SIO 2005 Scale**
Please send comments or suggestions to: USGS Chlorofluorocarbon Laboratory --cfc@usgs.gov

Air data SIO 2005 Scale

NOAA 2002 air-SIO 2005 scale (F-12=548.39; F-11=260.84; F-113=79.98
Enrichment factor of 1.00 = Niwot Ridge, CO air (CMDL, NOAA).
Factors other than 1.00 can be used to model local variations of CFCs in air
CAUTION: Use a factors of 1.00 if no enrichment data is available
Factors other than 1.00 will change the air curves and results obtained with this worksheet!
Yellow background cells are INPUT locations through out this worksheet

	INPUT	
CFC-11 enrichment	1.00	Local CFC-11 enrichment factor
CFC-12 enrichment	1.00	Local CFC-11 enrichment factor
CFC-113 enrichment	1.00	Local CFC-113 enrichment factor
Meters =0; feet =1	1	Select units of elevation
pMol/kg =0; pg/kg =1	0	Select units of concentration

You can calculate the sensitivity of of recharge ages to temperature and to temperature and elevation uncertainties.

Temperature add or subtract uncertainty in tempt. (C) =
Elevation add or subtract uncertainty in elevation =
MAKE ABSOLUTELY SURE TO SET THE CELL BACK TO 0.0
+++++++++++++ CAUTION ! ++++++++++++++++
"0.0" is required in cells "X15 & X16" for the correct calculation of the correct recharge ages.
Use below feature to evaluate the sensitivity of all well together.
Use "Sensitivity sheet" to evaluate individual wells.
MAKE ABSOLUTELY SURE TO SET THE CELL BACK TO 0.0

INPUT	
0.0	degrees C
0.0	feet

	INPUT	INPUT	INPUT	INPUT				INPUT	INPUT	INPUT	INPUT	INPUT	INPUT	INPUT		
Sample Number (Do not alter cells A22 through A252)	**Sample Name**	No.	**(Format Column) Sampling Date (m/d/y)**	Time	**Corrected concentrations IN SOLUTION CFC-12 pmol/kg**	**CFC-11 pmol/kg**	**CFC-113 pmol/kg**	**Percent error in concentrations IN SOLUTION CFC-12 %**	**CFC-11 %**	**CFC-113 %**	**Excess Air cc/kg**	**Recharge Temp C**	**Recharge Elevation feet**	**Salinity o\oo**	Recommended Age Based on	Comments
1	Well #11	2	07/26/22	1245	2.677	3.012	13.127	0.667	0.697	0.514	3.0	6.1	750	0.000	SF6	Early 2000s
2	Well #11	4	07/26/22	1245	2.676	3.019	12.921	0.702	0.724	0.534	3.0	6.1	750	0.000	CFCs	
3	Well #9	2	07/26/22	1335	3.243	4.216	19.007	0.629	0.624	0.467	2.5	6.6	750	0.000	SF6	Early 2000s
4	Well #9	4	07/26/22	1335	3.240	4.379	17.738	0.677	0.647	0.487	2.5	6.6	750	0.000	CFCs	
5	Well #2	3	07/27/22	815	5.249	10.835	0.173	0.547	0.471	1.307	4.1	4.1	750	0.000	SF6	Around 1990
6	Well #2	4	07/27/22	815	5.230	10.524	0.168	0.585	0.496	1.334	4.1	4.1	750	0.000		
7	Well #8	2	07/27/22	855	7.629	11.331	0.357	0.649	0.526	0.879	2.4	8.0	750	0.000	SF6	Around 2010
8	Well #8	4	07/27/22	855	7.713	11.463	0.366	0.687	0.553	0.887	2.4	8.0	750	0.000		
9	Well #16	1	07/27/22	1010	2.308	3.729	66.367	0.724	0.736	0.535	3.1	7.6	750	0.000	SF6	Early 2000s
10	Well #16	4	07/27/22	1010	2.336	3.558	61.486	0.750	0.766	0.556	3.1	7.6	750	0.000	CFCs	
11	Well #17	3	07/27/22	1040	2.240	4.422	7.290	0.776	0.781	0.607	3.0	7.5	750	0.000	SF6	Early 2000s
12	Well #17	4	07/27/22	1040	2.267	4.302	6.881	0.817	0.809	0.629	3.0	7.5	750	0.000	CFCs	
13	Berkeley Spr.	18	12/16/21	1200	0.351	0.283	0.020	1.993	0.864	11.211	2.0	12.0	800	0.000	Berkeley Spr.	
14	Lewis Spr	16	11/18/21	1400	2.555	3.915	0.378	0.215	0.104	0.651	0.0	9.0	3000	0.000	Lewis Spr	

Changing the recharge temperatures, elevations or excess air will change the model ages. You can alter temperature and elevation in cells AN15 and AN16 and the spreadsheet will calculate new ages. The recharge temperatures, elevations and excess air values in the above report were derived from dissolved gas data when available or from the estimated mean annual temperatures.

Since small changes in the above variables can significantly change the model ages, it is important to input the best available data. In the comments column, the indicated ages were determined assuming piston flow, unless noted, and do not account for mixing scenarios that can occur in wells with large open intervals or multiple producing fractures. For this reason the reported ages are referred to as "apparent ages" or "model ages". The mixing information provided may or may not be valid for a particular sample.

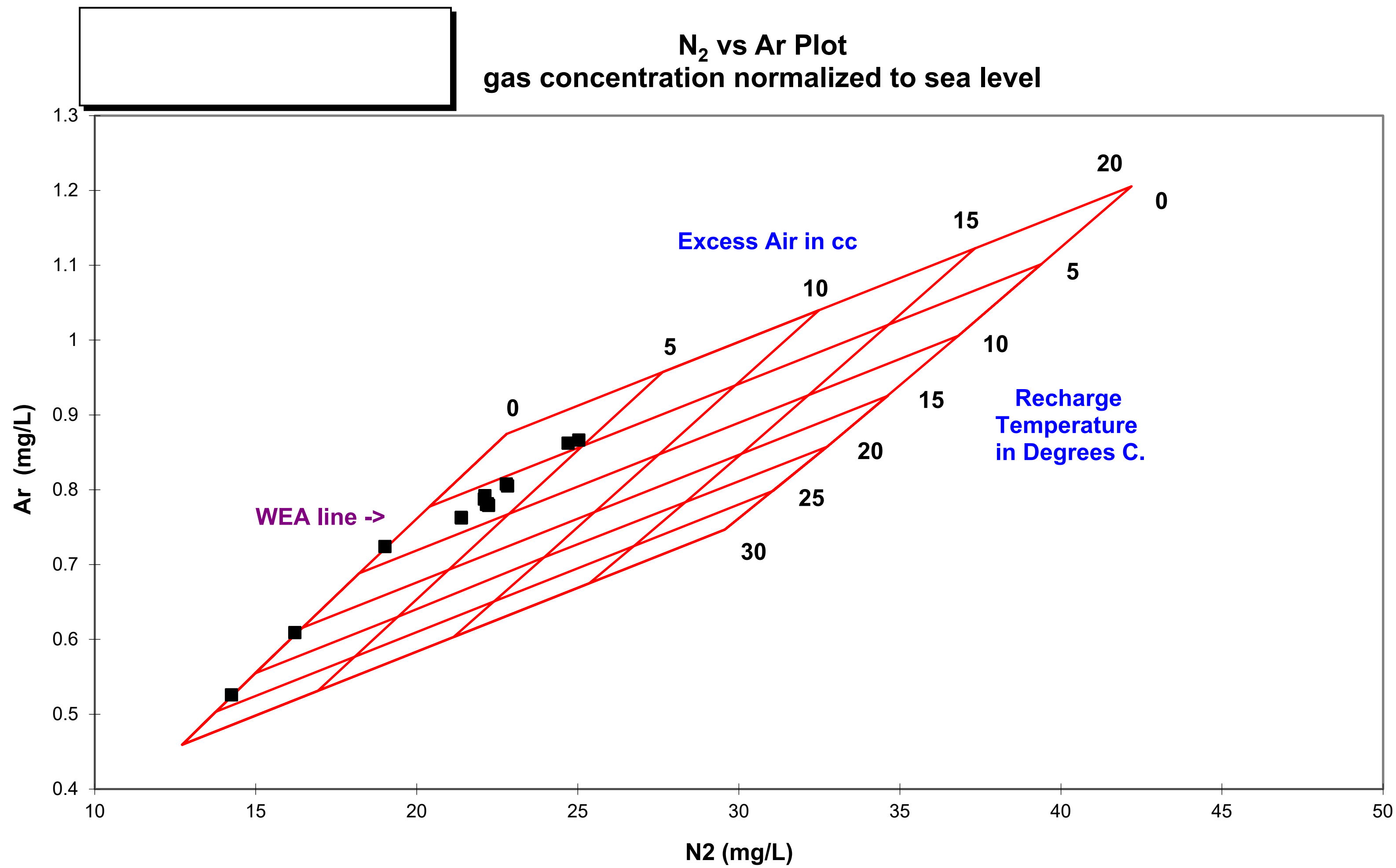
In anoxic environments, CFC-11 degrades first, followed by CFC-113 and CFC-12. Under these conditions some or all of the model ages will appear older than they actually are. In the interpretation of CFC ages, the ages are considered reliable when all CFC tracers give similar model ages. If the model ages differ, CFC-12 has proved to be the most reliable tracer followed by CFC-113 and CFC-11.

The analytical equipment calibration is not reliable past these concentrations 1200pg/kg for CFC-11, 2500pg/kg for CFC-12 and 900pg/kg for CFC-113. Any concentrations above these values are estimates.
If you have any questions please call

Samples submitted by:	T. Meyers	**Revised 2/1/2011**	**Program written by E. Busenberg, USGS, (8-30-1994), Revised (4/19/2006), Revised (6/16/2009), Revised (01/19/2011), Revised (2/1/2012)**
Project:		Version: 7.0	This program calculates the dissolved gas composition of waters, and the volume percent composition in a gas sample (revised 2/2/2012).
Geographic location:	MN		{N2, Ar} R. F. Weiss, 1970, Deep-Sea Res., vol. 17, 721-735. R.F. {CO2} Weiss, 1974, Marine Chem. 2, 203-215.[Bunsen Coef.]
Date received:	8/3/2022		{O2} B. B Beson and D. Krause,1980, Limnol. Oceanogr. 25(4) 662-671; 1984, Limnol. Oceanogr. 29(3), 620-632.
Dated analyzed:	9/7/2022		{CH4} D.A. Wiesenburg and N.L. Guinasso, 1979, J. Chem. Eng. Data Vol. 24, 356-360.
Analyzed by:	JC		
Comments:		Land surface elevation used for estimated recharge elevation	

***** SAMPLES ***** Well Name	Site Number	Date Collected	Time Collected	Field Temp	Salinity	Recharge Elevation	Lab ID #	Bottle #	Concentration in mg/L CH4	CO2	N2	O2	Ar
Well #11		7/26/2022	1311	10.56		750		22Y4008	0.0000	41.6339	22.1959	4.3223	0.7832
Well #11		7/26/2022	1311	10.56		750		22Y4022	0.0000	40.7370	22.1572	4.4506	0.7858
Well #9		7/26/2022	1343	10.56		750		22Y4003	0.0000	39.3302	21.4951	4.2796	0.7663
Well #9		7/26/2022	1343	10.56		750		22Y4010	0.0000	39.6315	21.5122	4.6415	0.7707
Well #2		7/27/2022	846	11.66		750		22Y4013	0.0047	26.3770	24.3487	0.9080	0.8430
Well #2		7/27/2022	846	11.66		750		22Y4018	0.0047	28.2090	24.0270	1.1447	0.8389
Well #8		7/27/2022	915	12.22		750		22Y4017	0.0000	24.1379	20.8009	4.9620	0.7417
Well #8		7/27/2022	915	12.22		750		22Y4023	0.0000	22.9069	20.7996	5.5123	0.7425
Well 16		7/27/2022	1035	11.11		750		22Y4002	0.0000	31.0983	21.5910	3.6639	0.7603
Well 16		7/27/2022	1035	11.11		750		22Y4011	0.0000	31.8860	21.6231	3.7254	0.7580
Well #17		7/27/2022	1100	10.56		750		22Y4009	0.0005	28.9808	21.5588	3.5432	0.7594
Well #17		7/27/2022	1100	10.56		750		22Y4019	0.0000	28.8443	21.5766	3.7980	0.7599
21Q1118		8/17/2022		23.06				21Q1118	0.0000	0.0852	14.0771	8.3336	0.5198
21Q1101		7/26/2022		8.52				21Q1101	0.0000	0.4667	18.7709	10.7692	0.7151
21Q1088		7/6/2022		16.10				21Q1088	0.0000	0.1005	15.9524	9.5202	0.5993

Well Name	Concentration in mmol/L CH4	CO2	N2	O2	Ar	Partial pressures at Field Temperatures in atm. CH4	CO2	N2 (0.7808)	O2 (0.2094)	Ar (0.00934)	Measured Pressure	Tot Press Corrected	Elevation	Barometric pressure
Well #11	0.0000	0.9460	0.7923	0.1351	0.0196	0.000000	0.017968	0.9552	0.0803	0.01063	1.06407	1.09378	750	0.972834
Well #11	0.0000	0.9256	0.7910	0.1391	0.0197	0.000000	0.017581	0.9536	0.0826	0.01067	1.06443	1.09416	750	0.972834
Well #9	0.0000	0.8937	0.7673	0.1337	0.0192	0.000000	0.016974	0.9251	0.0795	0.01041	1.03190	1.06071	750	0.972834
Well #9	0.0000	0.9005	0.7679	0.1451	0.0193	0.000000	0.017104	0.9258	0.0862	0.01046	1.03954	1.06857	750	0.972834
Well #2	0.0003	0.5993	0.8692	0.0284	0.0211	0.000157	0.011812	1.0717	0.0173	0.01173	1.11263	1.14370	750	0.972834
Well #2	0.0003	0.6410	0.8577	0.0358	0.0210	0.000156	0.012632	1.0575	0.0218	0.01167	1.10374	1.13456	750	0.972834
Well #8	0.0000	0.5485	0.7425	0.1551	0.0186	0.000000	0.011012	0.9258	0.0956	0.01044	1.04287	1.07199	750	0.972834
Well #8	0.0000	0.5205	0.7425	0.1723	0.0186	0.000000	0.010450	0.9258	0.1062	0.01046	1.05286	1.08226	750	0.972834
Well 16	0.0000	0.7066	0.7707	0.1145	0.0190	0.000000	0.013673	0.9397	0.0689	0.01045	1.03273	1.06157	750	0.972834
Well 16	0.0000	0.7245	0.7719	0.1164	0.0190	0.000000	0.014019	0.9411	0.0700	0.01042	1.03560	1.06452	750	0.972834
Well #17	0.0000	0.6585	0.7696	0.1107	0.0190	0.000018	0.012507	0.9278	0.0658	0.01031	1.01642	1.04480	750	0.972834
Well #17	0.0000	0.6554	0.7702	0.1187	0.0190	0.000000	0.012449	0.9286	0.0705	0.01032	1.02185	1.05038	750	0.972834
21Q1118	0.0000	0.0019	0.5025	0.2604	0.0130	0.000000	0.000054	0.7587	0.1981	0.00903	0.96582	0.96582		1
21Q1101	0.0000	0.0106	0.6701	0.3365	0.0179	0.000000	0.000188	0.7738	0.1908	0.00927	0.97400	0.97400		1
21Q1088	0.0000	0.0023	0.5695	0.2975	0.0150	0.000000	0.000052	0.7646	0.1988	0.00915	0.97262	0.97262		1


N2 vs Ar Plot
gas concentration normalized to sea level
Ar (mg/L)
N2 (mg/L)
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
15
20
25
30
35
40
45
50
Excess Air in cc
0
5
10
15
20
Recharge
Temperature
in Degrees C.
0
5
10
15
20
25
30
WEA line ->

K(Henry) from Bullister et al., 2002, Deep-Sea Reseach, v. 49, 175-187.
In older version K(Henry) was from Wilhelm et al., 1977, Chemical Reviews, v. 77, 219-262.
Bullister et al., 2002, salting out effect was added.
Units of concentration fMol/L fMol = 10E-15 Moles.
Revised 02/26/14

Worksheet Name: MN Meyers

Standard used for calibration. Lab Temperature in °C 21.0

Scott tank SF6 in N2 104 pptv K_{Henry} 0.0002649 Headspace Correction

CMDL/NOAA tank Air 5.12 ppt Lab Pressure in mm mercury 750.0

INPUT Salinity 0.0

	INPUT	
Enrichment	1.00	Local SF6 enrichment factor (1.00= Northern Hemisphere)
Meters =0; feet =1	1	Select units of elevation
fMol/L=0; pg/kg =1	0	Select units of concentration

You can change:
1) Excess air in cc at STP
2) Temperature in C
3) Elevation
4) Salinity in o/oo

Corrected Age Date Results

Samples should be collected without headspace (HS). If a HS forms, the HS volume (column "H") is measured and a correction is applied. Since the total pressure of the HS bubble cannot be measured, the HS SF_6 concentration cannot be exactly calculated. The MAXIMUM PERCENT UNCERTAINTY in the water concentration that may be introduced by the HS bubble is given in column "AO". The uncertainty is significantly smaller in most cases.

USGS ID No.	Sample No. (INPUT)	Sample Name (INPUT)	Sampling Date (Mo/day/year) (INPUT)	Time (INPUT)	Bottle Headspace in cc (INPUT)	Excess Air (mL) (INPUT)	Recharge Temperature (C) (INPUT)	Recharge Elevation feet (INPUT)	Salinity in (o/oo) parts per thousand (INPUT)	SF6 Concentration in water: SF6 FemtoMol/kg With HS corr.	Excess air cc/kg at STP	SF6 in pptv corrected for Excess air: Calculated SF6 (pptv) partial pressure	SF6 Corrected for Excess air: Piston flow model SF6 recharge year	SF6 Corrected for Excess air: Piston flow model SF6 recharge age, years	Sample Name	(see abovecomment) Maximum % headspace uncertainty	Comments
	1	Well #11	07/26/22	1300	2.80	**3.0**	**6.1**	**750**		3.25	3	**5.55**	**2004.0**	**18.6**	Well #11	3.06	
	2	Well #11	07/26/22	1300	1.10	**3.0**	**6.1**	**750**		3.30	3	**5.64**	**2004.5**	**18.1**	Well #11	1.20	
	1	Well #9	07/26/22	1325	2.00	**2.5**	**6.6**	**750**		2.90	2.5	**5.24**	**2002.5**	**20.1**	Well #9	2.19	
	2	Well #9	07/26/22	1325	0.30	**2.5**	**6.6**	**750**		3.29	2.5	**5.95**	**2006.0**	**16.6**	Well #9	0.33	
	1	Well #2	07/27/22	830	2.00	**4.1**	**4.1**	**750**		1.82	4.1	**2.69**	**1991.5**	**31.1**	Well #2	2.19	
	2	Well #2	07/27/22	830	0.90	**4.1**	**4.1**	**750**		1.84	4.1	**2.72**	**1991.5**	**31.1**	Well #2	0.98	
	1	Well #8	07/27/22	900	1.60	**2.4**	**8.0**	**750**		3.85	2.4	**7.36**	**2010.5**	**12.1**	Well #8	1.75	
	2	Well #8	07/27/22	900	1.10	**2.4**	**8.0**	**750**		3.95	2.4	**7.56**	**2011.5**	**11.1**	Well #8	1.20	
	1	Well #16	07/27/22	1025	2.00	**3.1**	**7.6**	**750**		2.55	3.1	**4.55**	**1999.5**	**23.1**	Well #16	2.19	
	2	Well #16	07/27/22	1025	1.30	**3.1**	**7.6**	**750**		2.70	3.1	**4.81**	**2001.0**	**21.6**	Well #16	1.42	
	1	Well #17	07/27/22	1050	2.00	**3.0**	**7.5**	**750**		2.61	3	**4.68**	**2000.5**	**22.1**	Well #17	2.19	
	2	Well #17	07/27/22	1050	1.60	**3.0**	**7.5**	**750**		2.73	3	**4.89**	**2001.0**	**21.6**	Well #17	1.75	
		Aerated Water 21.9 degrees C	09/14/22	1040	0.00	**0.0**	**21.9**	**450**		2.47	0	**10.03**	**2019.0**	**3.7**	Aerated Water 21.9 degrees C	0.00	Lab Air 11.38 ppt

Building a Better World for All of Us®

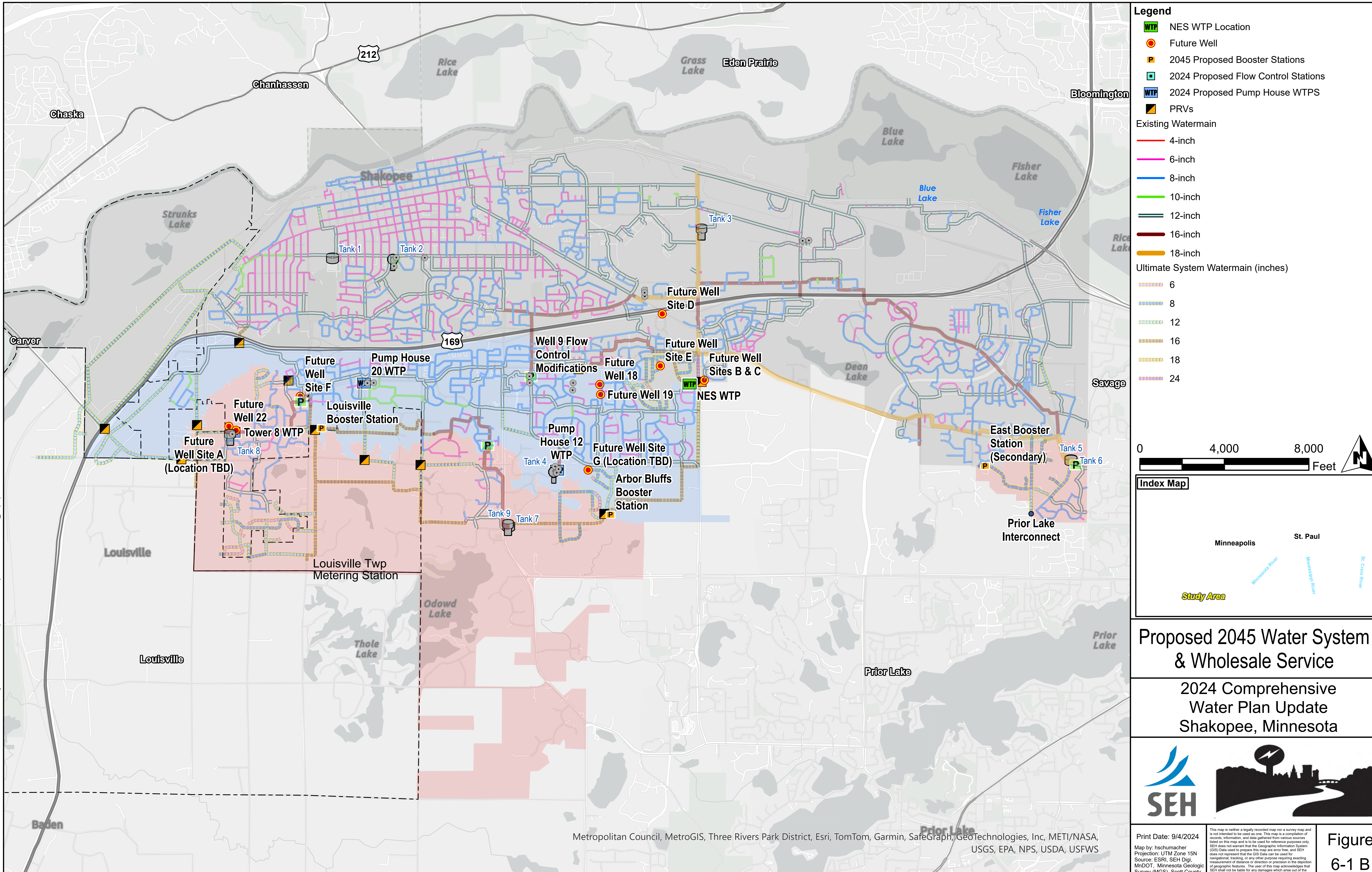
Sustainable buildings, sound infrastructure, safe transportation systems, clean water, renewable energy, and a balanced environment. Building a Better World for All of Us communicates a company-wide commitment to act in the best interests of our clients and the world around us.

We're confident in our ability to balance these requirements.

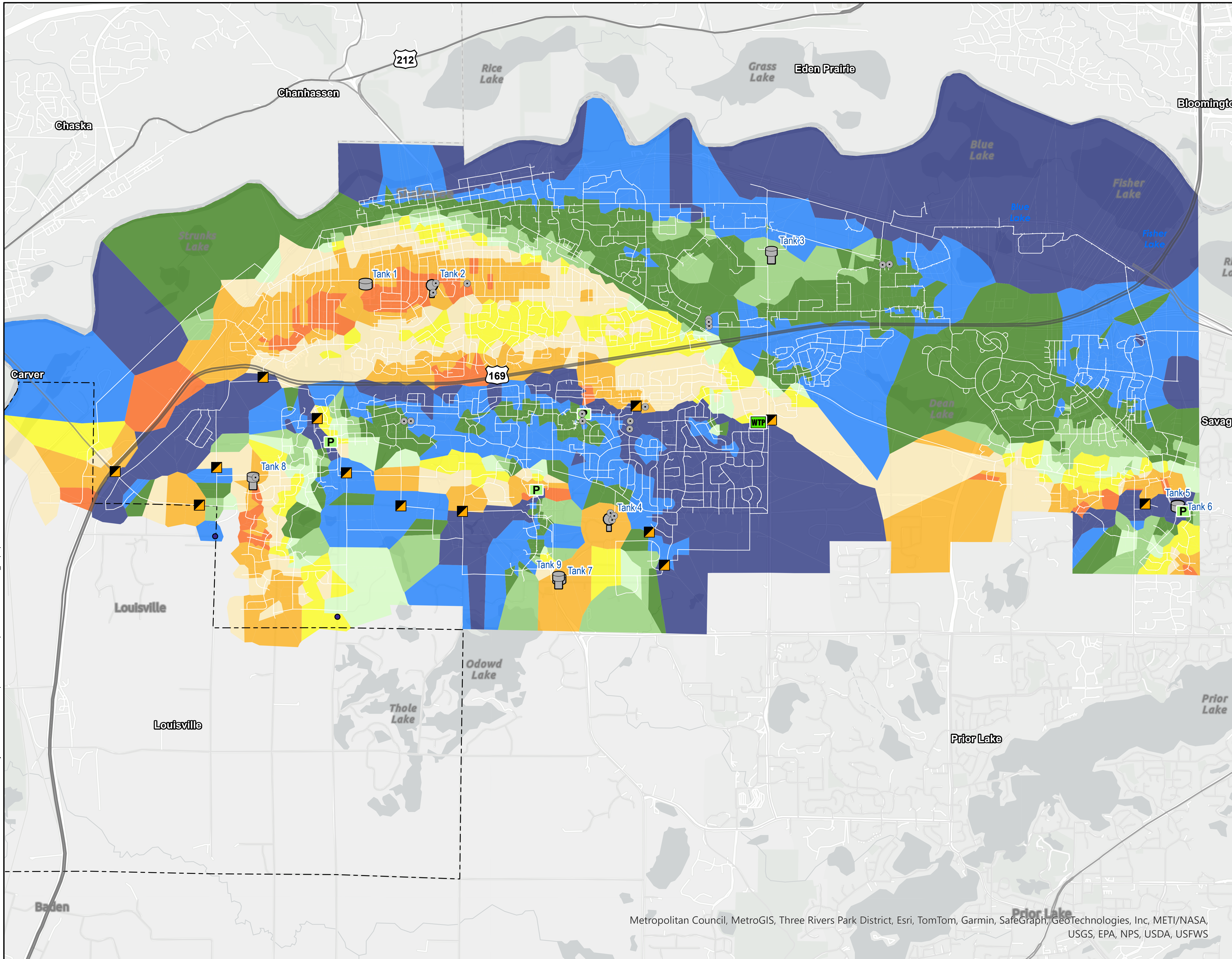
JOIN OUR SOCIAL COMMUNITIES

Appendix B

Wholesale Water Service to Louisville Township



Legend
NES WTP Location
Future Well
2045 Proposed Booster Stations
2024 Proposed Flow Control Stations
2024 Proposed Pump House WTPS
PRVs
Existing Watermain
4-inch
6-inch
8-inch
10-inch
12-inch
16-inch
18-inch
Ultimate System Watermain (inches)
6
8
12
16
18
24
0
4,000
8,000
Feet
Index Map
Minneapolis
St. Paul
Study Area
Chaska
Chanhassen
Eden Prairie
Bloomington
Carver
Shakopee
Savage
Louisville
Prior Lake
Baden
Rice Lake
Grass Lake
Blue Lake
Fisher Lake
Strunks Lake
Dean Lake
Odowd Lake
Thole Lake
212
169
Tank 1
Tank 2
Tank 3
Tank 4
Tank 5
Tank 6
Tank 7
Tank 8
Tank 9
Future Well Site D
Future Well Site E
Future Well Sites B & C
NES WTP
Well 9 Flow Control Modifications
Future Well 18
Future Well 19
Pump House 20 WTP
Future Well Site F
Louisville Booster Station
Future Well 22
Tower 8 WTP
Future Well Site A (Location TBD)
Pump House 12 WTP
Future Well Site G (Location TBD)
Arbor Bluffs Booster Station
East Booster Station (Secondary)
Prior Lake Interconnect
Louisville Twp Metering Station
Metropolitan Council, MetroGIS, Three Rivers Park District, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
Proposed 2045 Water System & Wholesale Service
2024 Comprehensive Water Plan Update
Shakopee, Minnesota
SEH
Print Date: 9/4/2024
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County
Figure 6-1 B



Legend

- Junctions_Ult_AD
- NES WTP Location
- Future Well
- 2045 Proposed Booster Stations
- 2024 Proposed Flow Control Stations
- 2024 Proposed Pump House WTPS
- PRVs
- Wholesale Service Locations

Existing Watermain

- 4-inch
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 16-inch
- 18-inch

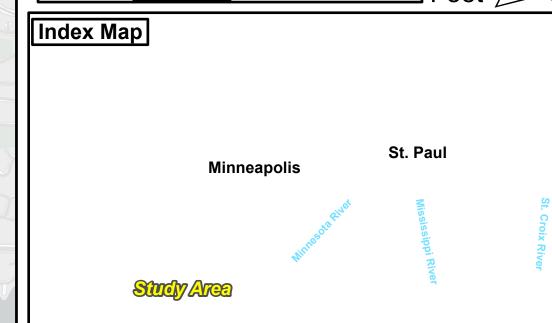
Ultimate System Watermain (inches)

- 6
- 8
- 12
- 16
- 18
- 24

0 4,000 8,000 Feet

N

Index Map



2045 Water System AD Ultimate System & Louisville Static Pressure

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 9/4/2024

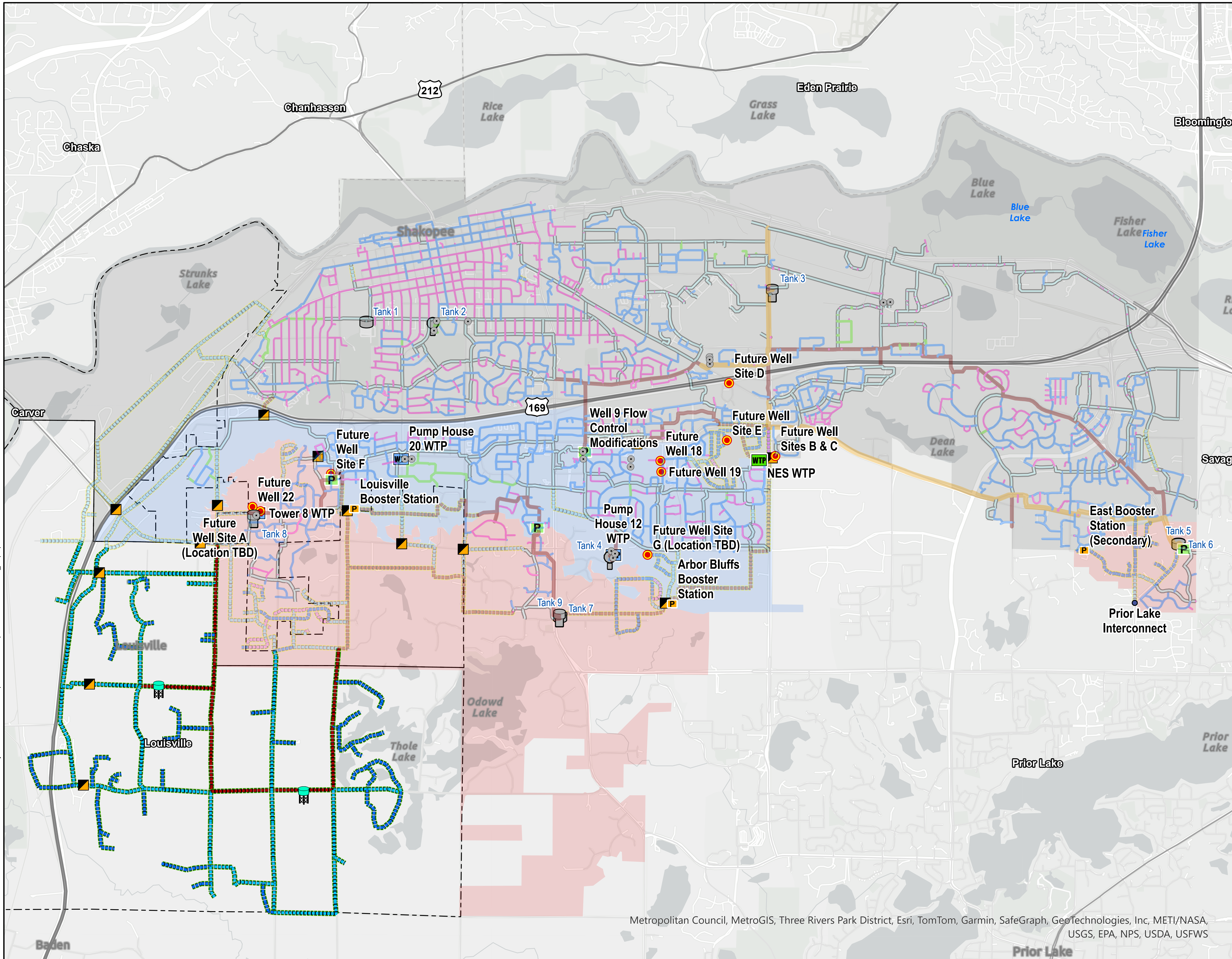
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-6

Path: C:\Users\hschumacher\OneDrive - Short Elliott Hendrickson Inc\Project Folders\WMs\Shakopee\GIS\Final Maps\SPU\WaterDistribution_Map.aprx

Appendix C

SPU Water Service Provided to Louisville Township



Proposed Louisville System Improvements

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 9/4/2024
Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-1 C

Table B1
Projected Water Consumption By Land Use - Louisville Township

Land Use[1]	Full Buildout Units/Parc	Full Buildout Units or Acres[1]	Estimated AD Water Use (gpd/acre or Unit)	Projected Full Buildout AD Water Use (MGD)	MD/AD Ratio	Projected Full Buildout MD Water Use (gpd)
Future Service to Existing Development						
Commercial	441	1,405	675	0.76	2.0	1.52
Industrial	6	152	500	0.06	1.3	0.08
Residential	441	1,405	245	0.11	2.5	0.27
Subtotal	**447**	**1,557**	**--**	**0.9**		**1.9**
Future Service to Developing Areas						
Commercial	25	116	675	0.06	2.0	0.13
Industrial	73	1,648	675	0.89	1.3	1.11
Public Lands	51	2,425	0	0.00	0.0	0.00
Rural Business Reserve	4	129	675	0.07	2.0	0.14
Transition Area (Low Density Res.)	55	1,437	245	0.28	2.5	0.70
Urban Expansion (Res.)	373	1,013	490	0.40	2.5	0.99
Subtotal	**581**	**6,769**	**--**	**1.7**		**3.1**
All Land Use	**1,028**	**8,326**		**2.63**		**4.9**
*Estimates based on typical historical usage						

1. 20 percent of future areas assumed to be streets and open areas. Calculated by [(Future - Existing) x 0.8] + Existing.

2. 20 percent of Township areas assumed to be streets and open areas and 80 percent as 1/2 acre single-family lots; water not included; (2.9 persons per household x 2 households per acre x 84 gpcd = 490 gpd/acre).

Table B - C-9
Supply & Storage Analysis for 2nd High West Zone + Louisville

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Combined Maximum Day Demand (mgd)[1]	1.14	4.10	8.9
Combined Average Day Demand (mgd)	0.41	1.64	3.7
Existing Firm Supply Capacity (mgd)[2]	2.59	3.74	4.32
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**1.45**	**-0.35**	**-4.59**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	170,000	610,000	1,340,000
Reserve Storage (1/2 AD)	205,000	818,000	1,844,000
Fire Protection Volume (gallons)[5]	300,000	300,000	300,000
Recommended Total Volume (gallons)	*495,000*	*1,526,000*	*3,321,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[6]	180,000	202,000	163,000
No Storage			
Total Existing Volume Available (gallons)	*750,000*	*750,000*	*750,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**255,000**	**-776,000**	**-2,571,000**

1. See Table 4-6
2. Assumes addition of booster stations and supply wells
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 2,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

X:\PT\S\SHPUC\177653\4-prelim-dsgn-rpts\[2024 Supply & Storage_Add Louisville.xlsx]C-9 2ndHWStg

Table B-10.2
Supply & Storage Analysis for 2nd High West + Central Zones +Louisville

	Design Demand Year		
<u>Pumping Capacity Analysis</u>	**<u>2025</u>**	**<u>2035</u>**	**<u>2045</u>**
Combined Maximum Day Demand (mgd)[1]	1.41	4.50	9.42
Combined Average Day Demand (mgd)	0.51	1.78	3.87
Existing Firm Supply Capacity (mgd)[2]	5.47	5.47	5.47
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**4.06**	**0.98**	**-3.95**
<u>Recommended Storage Volume</u>			
Maximum Day Equalization Volume (gallons)[4]	210,000	670,000	1,410,000
Reserve Storage (1/2 AD)	255,000	890,000	1,935,000
Fire Protection Volume (gallons)[5]	300,000	240,000	240,000
Recommended Total Volume (gallons)	*255,000*	*1,678,000*	*3,585,000*
<u>Existing Storage & Pumping Volume</u>			
Surplus Firm Pump Volume (gallons)[6]	510,000	122,000	(493,000)
No Storage			
Total Existing Volume Available (gallons)	*1,250,000*	*1,250,000*	*1,250,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**995,000**	**-428,000**	**-2,335,000**

1. See Table 4-6
2. Assumes addition of booster stations and supply wells
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 2,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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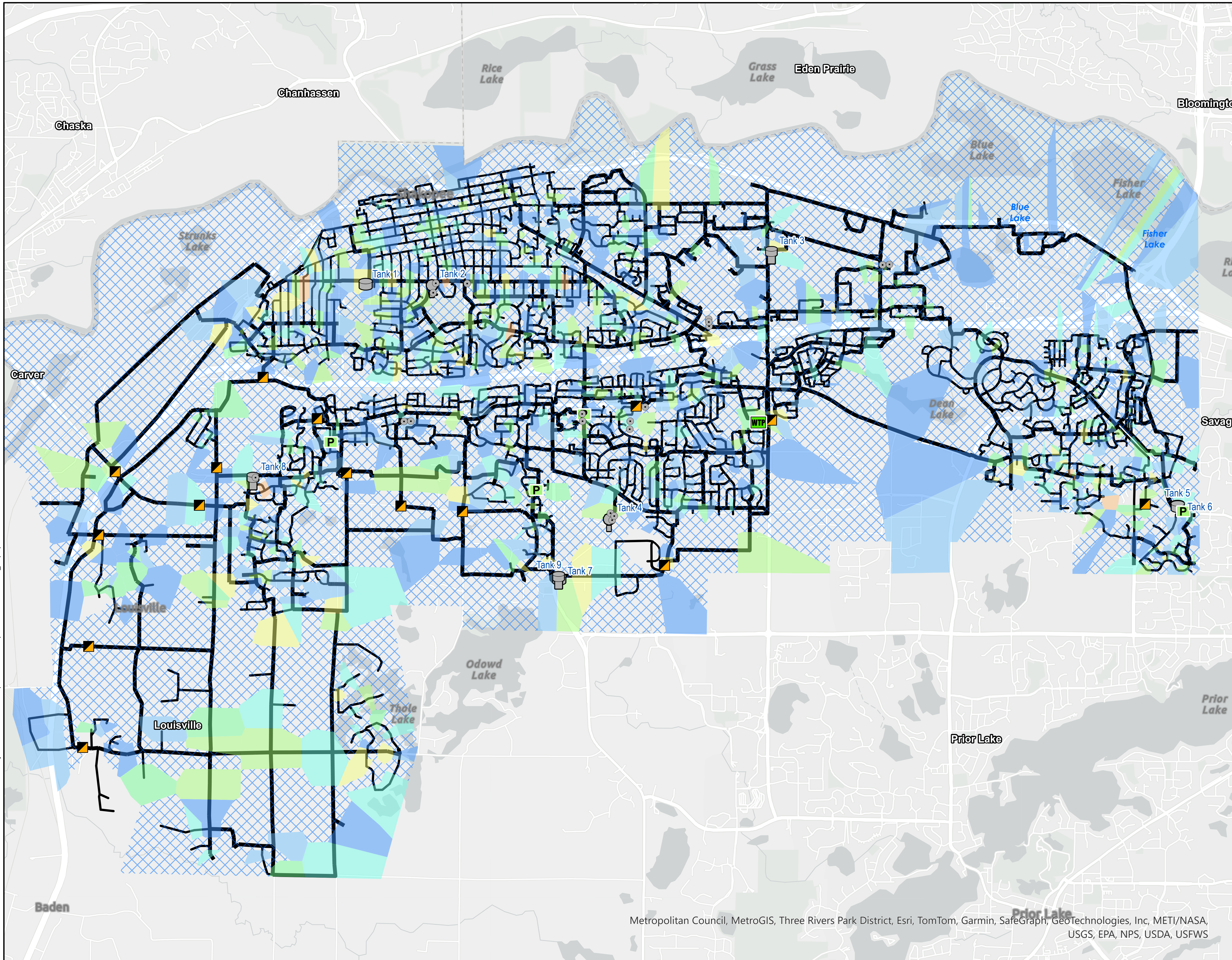
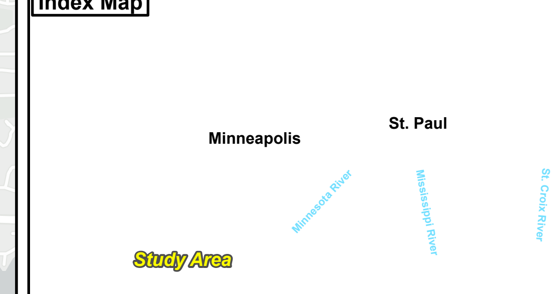


Legend

- PRVs
- Diameter (inches)
  - 4
  - 5 - 6
  - 7 - 8
  - 9 - 10
  - 11 - 12
  - 13 - 18
  - 19 - 24
- Fire Flow (gpm)
  - 0 - 500
  - 501 - 1000
  - 1001 - 1500
  - 1501 - 2000
  - 2001 - 2500
  - 2501 - 3000
  - 3001 - 4000
  - 4001 - 5000
  - 5001+

Index Map



2045 System Fire Flows Ultimate System & Louisville Fire Flow

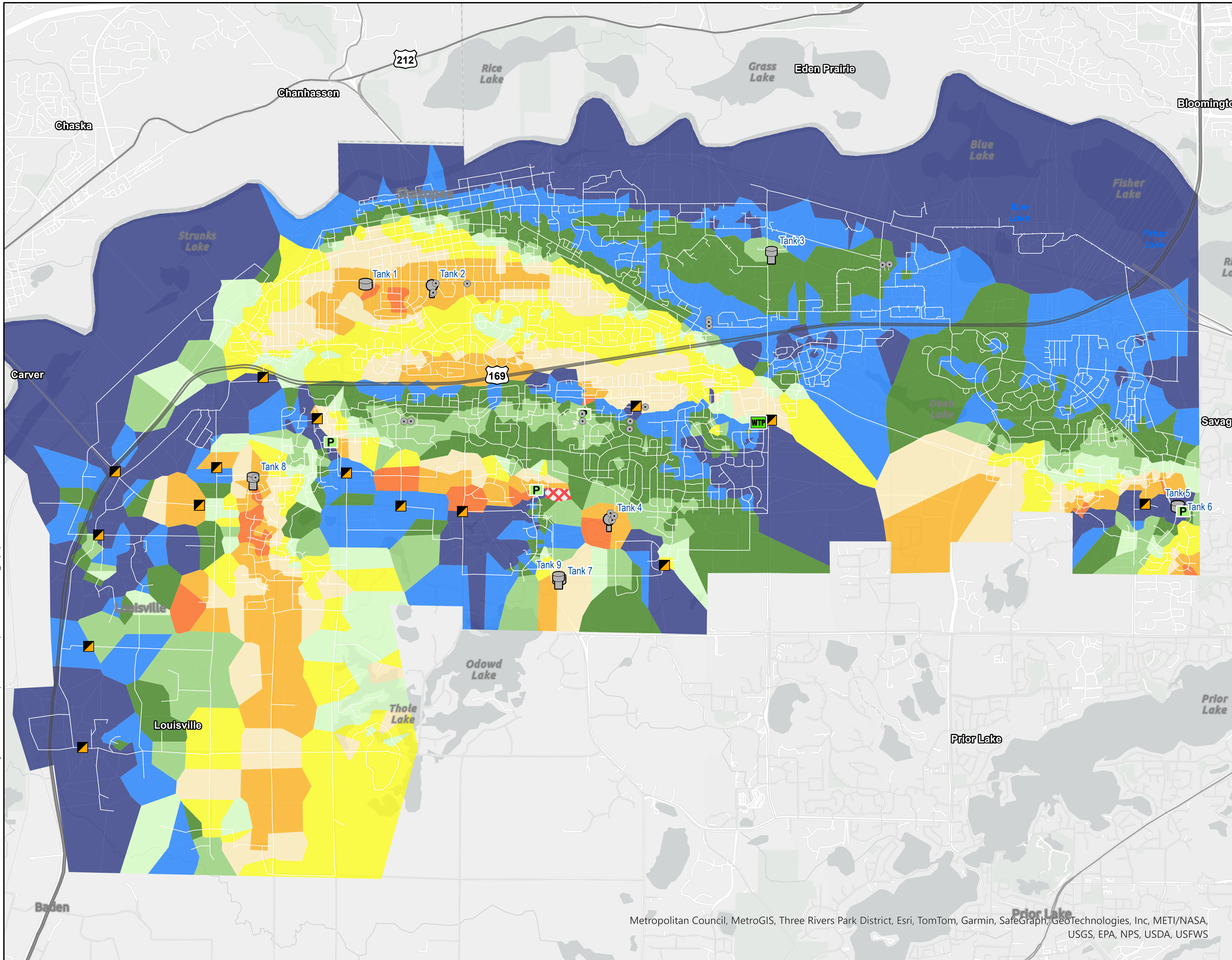
2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 9/4/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-4

Path: C:\Users\hschumacher\OneDrive - Short Elliott Hendrickson Inc\Project Folders\WMs\Shakopee\GIS\Final Maps\SPUWaterDistribution_Map.aprx

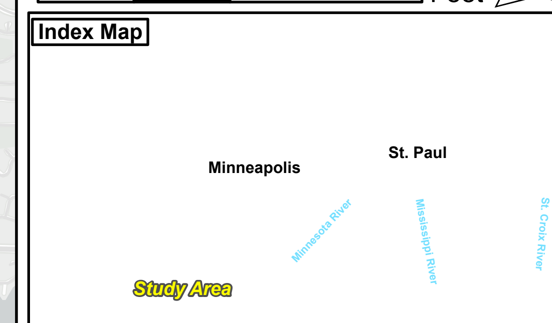


Legend

- NES WTP Location
- PRVs
- Existing Water Towers
  - Ground Stg Res.
  - Hydropillar
  - Hydrosphere
- Pressure (psi)
  - <40
  - 40 - 45
  - 46 - 50
  - 51 - 55
  - 56 - 60
  - 61 - 65
  - 66 - 70
  - 71 - 75
  - 76 - 80
  - 80+

0 4,000 8,000 Feet

Index Map



2045 Water System AD Ultimate System & Louisville Static Pressure

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

SEH

Print Date: 9/4/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

Figure 6-6

Path: C:\Users\hschumacher\OneDrive - Short Elliott Hendrickson Inc\Project Folders\WMs\Shakopee\GIS\Final Map\SPUWaterDistribution_Map.aprx

Appendix D

Capital Improvement Planning

Cost Per Foot Water Main

Diameter

Item	6	8	10	12	16	20	24	30	36
Water Main		0.9	0.95	1.05	1.07	1.1	1.15	1.2	1.25
Water Main - Cement-Lined Class 52 DIP w/ Push-On Locking Gasket Joints + Bonding Straps	$ 32	$ 38	$ 46	$ 57	$ 82	$ 113	$ 156	$ 233	$ 350
Fittings - Full Body Gray Cast Iron w/ MegaLug Gasket Joints + Thrust Blocks - Every 150 feet	$ 5	$ 6	$ 8	$ 10	$ 14	$ 19	$ 26	$ 39	$ 58
Polyethythene Encasement - 8 mil thickness	$ 1	$ 1	$ 1	$ 2	$ 3	$ 4	$ 5	$ 7	$ 11
Gate Valves w/ Megalug Gasket Joints + Thrust Block - Every 300 feet	$ 4	$ 5	$ 6	$ 7	$ 10	$ 14	$ 19	$ 29	$ 44
Hydrant w/ Megalug Gasket Joints + 30' 6" Lead + Thrust Block - Every 300 feet	$ 20	$ 21	$ 22	$ 23	$ 25	$ 26	$ 28	$ 31	$ 34
Curb Stop, Box, copper service - Every 50 feet	$ 31	$ 31	$ 31	$ 31	$ 31	$ 31	$ 31	$ 31	$ 31
Pipe Trench									
Pipe Bedding - 6" thick	$ 4	$ 4	$ 4	$ 4	$ 4	$ 5	$ 5	$ 5	$ 6
Trench Excavation - 8 foot bury depth	$ 32	$ 33	$ 34	$ 35	$ 38	$ 40	$ 43	$ 47	$ 52
Pavement									
Saw Cut Asphalt Pavement - Full Depth	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4
Lower Layer Asphalt Pavement - 2-3/4" 58-28S	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33
Tack Coat	$ 9	$ 9	$ 9	$ 9	$ 9	$ 9	$ 9	$ 9	$ 9
Upper Layer Asphalt Pavement - 2-3/4" 58-28S	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33
12" 1-1/4" CABC	$ 30	$ 30	$ 30	$ 30	$ 30	$ 30	$ 30	$ 30	$ 30
Traffic Control	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10	$ 10
Base Total Price Per Foot	$ 336	$ 349	$ 365	$ 389	$ 439	$ 500	$ 583	$ 732	$ 950

Al Provided $24 per inch-foot for 12-inch

Price with Contingency + Engineering based on project size

Contingency Scale Factor Based on Project Size		6	8	10	12	16	20	24	30	36
100	1.75	$ 587	$ 611	$ 639	$ 681	$ 768	$ 875	$ 1,020	$ 1,281	$ 1,663
120	1.73	$ 581	$ 605	$ 633	$ 674	$ 761	$ 867	$ 1,010	$ 1,268	$ 1,647
144	1.72	$ 576	$ 599	$ 626	$ 668	$ 753	$ 858	$ 1,000	$ 1,255	$ 1,630
173	1.70	$ 570	$ 593	$ 620	$ 661	$ 746	$ 850	$ 990	$ 1,243	$ 1,614
207	1.68	$ 564	$ 587	$ 614	$ 655	$ 738	$ 841	$ 980	$ 1,231	$ 1,598
249	1.67	$ 559	$ 582	$ 608	$ 648	$ 731	$ 833	$ 971	$ 1,218	$ 1,582
299	1.65	$ 553	$ 576	$ 602	$ 642	$ 724	$ 825	$ 961	$ 1,206	$ 1,567
358	1.63	$ 548	$ 570	$ 596	$ 635	$ 717	$ 816	$ 952	$ 1,194	$ 1,551
430	1.62	$ 542	$ 565	$ 590	$ 629	$ 710	$ 808	$ 942	$ 1,183	$ 1,536
516	1.60	$ 537	$ 559	$ 584	$ 623	$ 703	$ 800	$ 933	$ 1,171	$ 1,521
619	1.58	$ 532	$ 553	$ 578	$ 617	$ 696	$ 792	$ 924	$ 1,159	$ 1,506
743	1.57	$ 526	$ 548	$ 573	$ 611	$ 689	$ 785	$ 915	$ 1,148	$ 1,491
892	1.55	$ 521	$ 542	$ 567	$ 604	$ 682	$ 777	$ 905	$ 1,136	$ 1,476
1,070	1.54	$ 516	$ 537	$ 561	$ 598	$ 675	$ 769	$ 896	$ 1,125	$ 1,461
1,284	1.52	$ 511	$ 532	$ 556	$ 593	$ 668	$ 761	$ 888	$ 1,114	$ 1,447
1,541	1.51	$ 506	$ 527	$ 550	$ 587	$ 662	$ 754	$ 879	$ 1,103	$ 1,433
1,849	1.49	$ 501	$ 521	$ 545	$ 581	$ 655	$ 746	$ 870	$ 1,092	$ 1,418
2,219	1.48	$ 496	$ 516	$ 539	$ 575	$ 649	$ 739	$ 862	$ 1,081	$ 1,404
2,662	1.46	$ 491	$ 511	$ 534	$ 569	$ 642	$ 732	$ 853	$ 1,071	$ 1,390
3,195	1.45	$ 486	$ 506	$ 529	$ 564	$ 636	$ 724	$ 845	$ 1,060	$ 1,377
3,834	1.43	$ 481	$ 501	$ 524	$ 558	$ 630	$ 717	$ 836	$ 1,050	$ 1,363
4,601	1.42	$ 476	$ 496	$ 518	$ 553	$ 623	$ 710	$ 828	$ 1,039	$ 1,350
5,521	1.41	$ 472	$ 491	$ 513	$ 547	$ 617	$ 703	$ 820	$ 1,029	$ 1,336
6,625	1.39	$ 467	$ 486	$ 508	$ 542	$ 611	$ 696	$ 812	$ 1,019	$ 1,323
7,950	1.38	$ 462	$ 481	$ 503	$ 536	$ 605	$ 689	$ 804	$ 1,009	$ 1,310
9,540	1.36	$ 458	$ 477	$ 498	$ 531	$ 599	$ 683	$ 796	$ 999	$ 1,297
11,448	1.20	$ 403	$ 419	$ 438	$ 467	$ 527	$ 600	$ 700	$ 878	$ 1,140
13,737	1.19	$ 399	$ 415	$ 434	$ 462	$ 522	$ 594	$ 693	$ 869	$ 1,129
16,484	1.18	$ 395	$ 411	$ 429	$ 458	$ 516	$ 588	$ 686	$ 861	$ 1,118
19,781	1.16	$ 391	$ 407	$ 425	$ 453	$ 511	$ 583	$ 679	$ 852	$ 1,107
23,738	1.15	$ 387	$ 403	$ 421	$ 449	$ 506	$ 577	$ 672	$ 844	$ 1,096
28,485	1.14	$ 383	$ 399	$ 417	$ 444	$ 501	$ 571	$ 666	$ 836	$ 1,085
34,182	1.13	$ 379	$ 395	$ 413	$ 440	$ 496	$ 565	$ 659	$ 827	$ 1,074
41,019	1.12	$ 376	$ 391	$ 409	$ 436	$ 491	$ 560	$ 653	$ 819	$ 1,064
49,222	1.11	$ 372	$ 387	$ 405	$ 431	$ 487	$ 554	$ 646	$ 811	$ 1,053

Appendix E

Water Quality Data

DEPARTMENT OF HEALTH

Shakopee PFAS Summary

Jessie Kolar | District Engineer

Todd Johnson | District Engineer Supervisor

January 18, 2022

Per- and Polyfluoroalkyl Substances (PFAS)

- Family of many synthetic chemicals
- Developed and used since the 1940s
  - resist heat, stains, water, oil, grease
  - “non-stick”
- Production increased rapidly in the 1970s
- Persist in the environment, found everywhere
- Not regulated under the SDWA

Source: open access images – bing.com

SAMPLING OF SHAKOPEE FOR PFAS

- Shakopee initially sampled for PFAS in 2014 & 2015
  - UCMR3
  - Not every well sampled
  - No PFAS compounds detected.
- Current sampling conducted as part of MDH's Statewide PFAS Sampling
  - MDH goal of sampling all PWSs for PFAS (started in 2021)
  - 'Voluntary', or not required.

Minnesota PFAS Guidance- How low can we go?

- MDH develops health-based guidance values (HBVs) at concentrations likely to pose little or no risk to human health
- Not enforceable
- Do not consider cost and treatability
- Health Risk Index (HRI): additive risk assessment of co-contaminants with similar health effects
  - HRI > 1 considered an exceedance

	PFOA	PFOS	PFBA	PFBS	PFHxS
2002	7	1			
2006	1	0.6	1		
2007	0.5	0.3	7		
2009	0.3	0.3	7	7	
2013	0.3	0.3	7	7	0.3
2016	0.07	0.07	7	7	0.07
2017	0.035	0.027	7	3/2	0.027
2019	0.035	0.015	7	3/2	0.047

Blue = HRL; Red = HBV; Green = Surrogate

units = µg/L

$$HRI = \frac{PFOA_{[conc]}}{0.035} + \frac{PFOS_{[conc]}}{0.015} + \frac{PFBA_{[conc]}}{7} + \frac{PFBS_{[conc]}}{2} + \frac{PFHxS_{[conc]}}{0.047}$$

Well	PFOA	PFOS	PFBA	PFBS	PFHxS	PFHxA	HRI
Well #2	0.0008	0.0016	0.011	0.0015	0	0.0019	0.14
Well #4	0.002	0.0012	0.03	0.0026	0.0009	0.02	0.26
Well #5	0.0027	0.0018	0.036	0.0031	0.001	0.021	0.33
(Wells 6, 7 & 10)	0.0017	0.0028	0.017	0.0017	0	0.0024	0.25
Well #8	0.0012	0.0027	0.017	0.0015	0.002	0.0029	0.27
Well #9	0	0	0.01	0.0009	0	0	0.00
Well #11	0	0	0.005	0	0	0	0.00
Well #12	0	0	0.002	0	0	0	0.00
Well #15	0	0	0.009	0.0012	0	0.0011	0.01
Well #16	0	0	0.011	0.0015	0	0	0.00
Well #17	0	0	0.011	0.0016	0	0	0.00
Well #20	0.0011	0	0.011	0.001	0	0.0014	0.04
Well #21	0.0017	0	0.014	0.0015	0	0.0043	0.07

WHAT'S NEXT?

- MDH has no plans for immediate follow up sampling at Shakopee.
- EPA preliminary draft MCLs for PFOS & PFOA scheduled for release in fall of this year. (Final MCLs in fall 2023).
- Shakopee will be sampled by MDH for PFAS in December 2024 and June 2025 (UCMR5).

COMMUNICATIONS

- PFAS results not required to be included in CCR.
- MDH recommends that you include them in your next CCR and can provide resources to help you give context about what these results mean.
- Results will be included in MDH's PFAS Dashboard.
- Perfluoroalkyl Substances (PFAS) - EH: Minnesota Department of Health (state.mn.us)

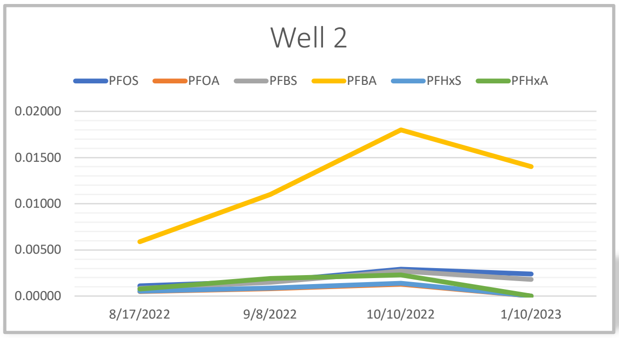
DEPARTMENT OF HEALTH

Thank you

jessie.kolar@state.mn.us

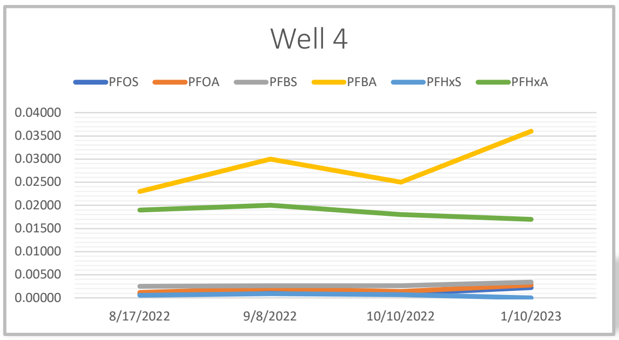
MDH - (651) 201-4562

Minnesota Department of Health
PFAS HRI Testing Results



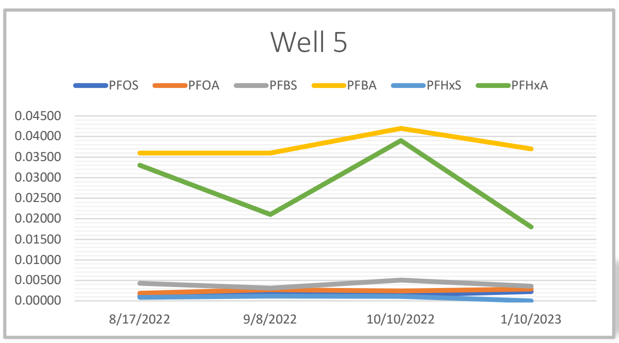
HRI Average
0.19

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00110	0.00049	0.00083	0.00590	0.00054	0.00075	0.11
9/8/2022	0.00160	0.00079	0.00150	0.01100	0.00088	0.00190	0.17
10/10/2022	0.00290	0.00130	0.00270	0.01800	0.00140	0.00230	0.30
1/10/2023	0.00240	0.00000	0.00180	0.01400	0.00000	0.00000	0.18



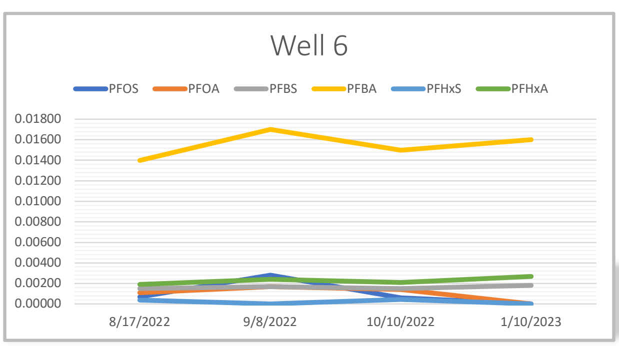
HRI Average
0.27

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00077	0.00120	0.00250	0.02300	0.00058	0.01900	0.22
9/8/2022	0.00120	0.00200	0.00260	0.03000	0.00090	0.02000	0.29
10/10/2022	0.00095	0.00140	0.00260	0.02500	0.00074	0.01800	0.24
1/10/2023	0.00220	0.00280	0.00340	0.03600	0.00000	0.01700	0.35



HRI Average
0.38

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00110	0.00190	0.00430	0.03600	0.00085	0.03300	0.36
9/8/2022	0.00180	0.00270	0.00310	0.03600	0.00120	0.02100	0.36
10/10/2022	0.00140	0.00240	0.00510	0.04200	0.00110	0.03900	0.44
1/10/2023	0.00230	0.00290	0.00360	0.03700	0.00000	0.01800	0.37



HRI Average
0.13

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00068	0.00110	0.00150	0.01400	0.00040	0.00190	0.11
9/8/2022	0.00280	0.00170	0.00170	0.01700	0.00000	0.00240	0.27
10/10/2022	0.00061	0.00140	0.00150	0.01500	0.00045	0.00210	0.12
1/10/2023	0.00000	0.00000	0.00180	0.01600	0.00000	0.00270	0.03

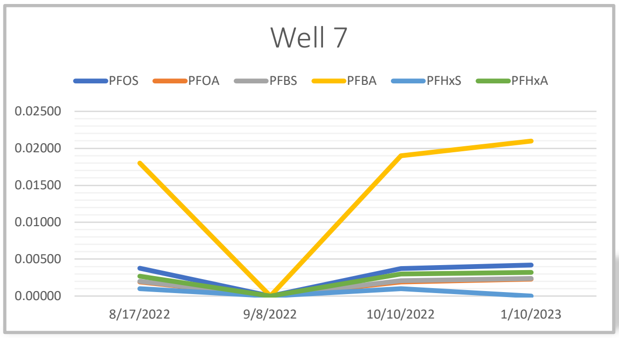
All values are in µg/L
A value of 0.00000 indicates that a compound is below detection.

PFAS Testing of Minnesota Community Water Systems

https://tinyurl.com/PFAS-MDH

MDH - (651) 201-4562

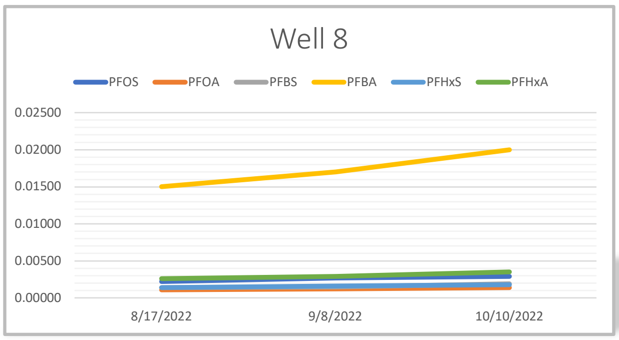
Minnesota Department of Health
PFAS HRI Testing Results



Sampled w/Well 6

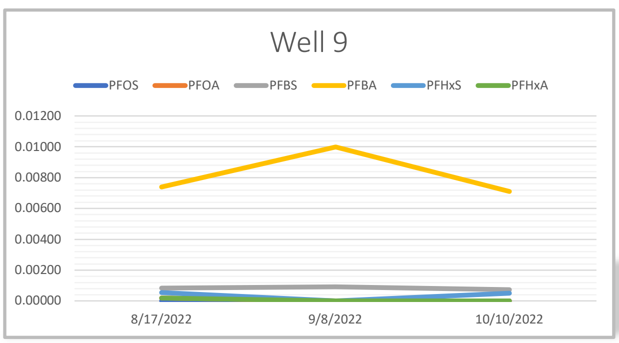
	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00380	0.00190	0.00200	0.01800	0.00100	0.00270	0.36
9/8/2022	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00
10/10/2022	0.00370	0.00190	0.00210	0.01900	0.00100	0.00300	0.36
1/10/2023	0.00420	0.00230	0.00240	0.02100	0.00000	0.00320	0.39

HRI Average
0.37



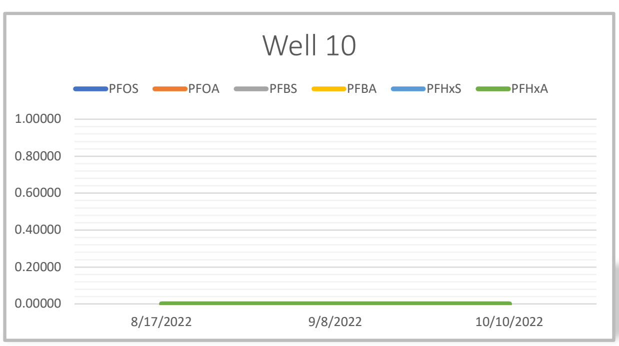
	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00220	0.00110	0.00140	0.01500	0.00140	0.00260	0.24
9/8/2022	0.00270	0.00120	0.00150	0.01700	0.00160	0.00290	0.28
10/10/2022	0.00290	0.00140	0.00190	0.02000	0.00180	0.00350	0.31

HRI Average
0.28



	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00020	0.00083	0.00740	0.00054	0.00019	0.03
9/8/2022	0.00000	0.00000	0.00092	0.01000	0.00000	0.00000	0.01
10/10/2022	0.00000	0.00000	0.00073	0.00710	0.00051	0.00000	0.02

HRI Average
0.02



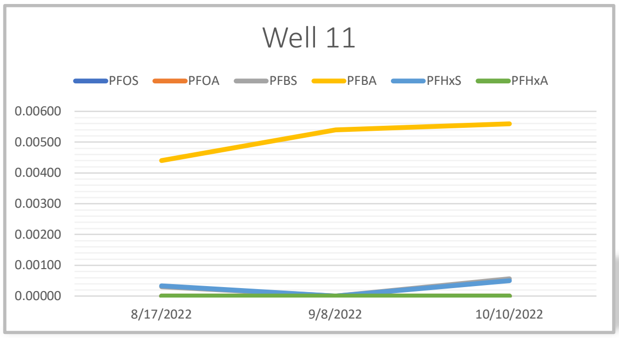
	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00
9/8/2022	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00
10/10/2022	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00

HRI Average
0.00

All values are in µg/L
A value of 0.00000 indicates that a compound is below detection.

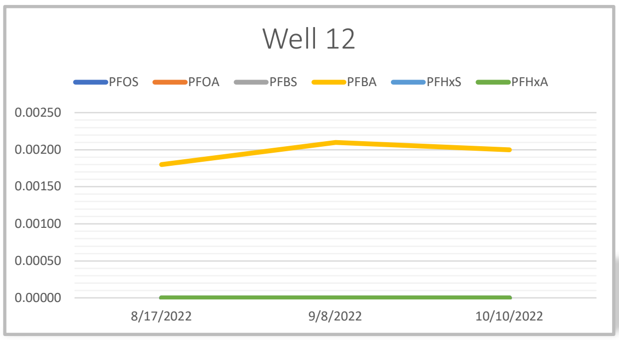
MDH - (651) 201-4562

Minnesota Department of Health
PFAS HRI Testing Results



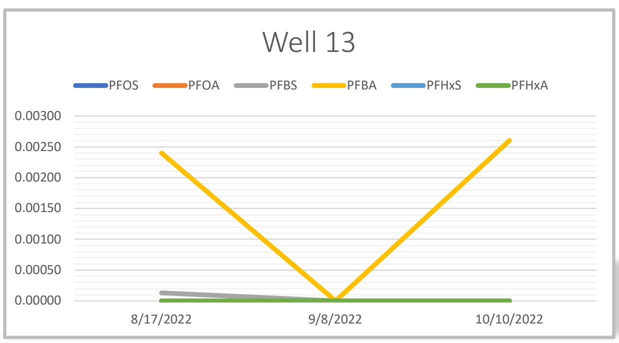
	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00000	0.00030	0.00440	0.00033	0.00000	0.01
9/8/2022	0.00000	0.00000	0.00000	0.00540	0.00000	0.00000	0.00
10/10/2022	0.00000	0.00000	0.00056	0.00560	0.00050	0.00000	0.02

HRI Average
0.01



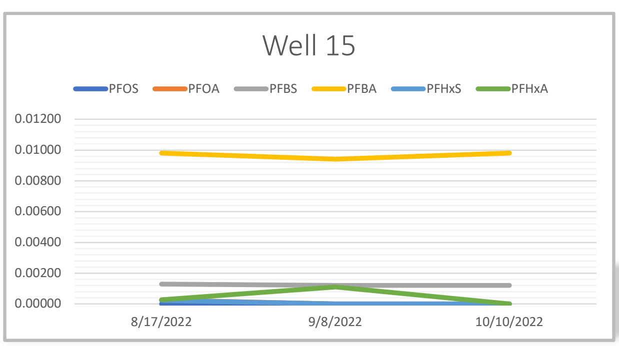
	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00000	0.00000	0.00180	0.00000	0.00000	0.00
9/8/2022	0.00000	0.00000	0.00000	0.00210	0.00000	0.00000	0.00
10/10/2022	0.00000	0.00000	0.00000	0.00200	0.00000	0.00000	0.00

HRI Average
0.00



	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00000	0.00013	0.00240	0.00000	0.00000	0.00
9/8/2022	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00
10/10/2022	0.00000	0.00000	0.00000	0.00260	0.00000	0.00000	0.00

HRI Average
0.00



	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00026	0.00130	0.00980	0.00023	0.00027	0.03
9/8/2022	0.00000	0.00000	0.00120	0.00940	0.00000	0.00110	0.02
10/10/2022	0.00000	0.00000	0.00120	0.00980	0.00000	0.00000	0.01

HRI Average
0.02

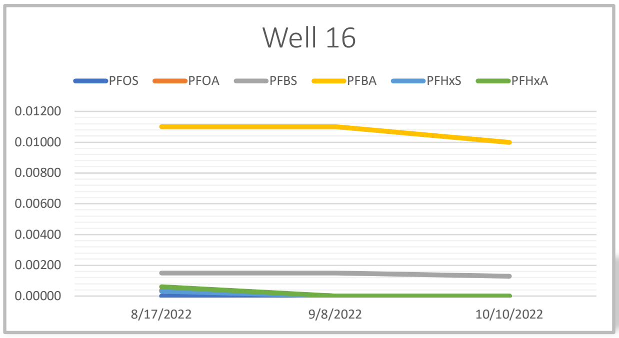
All values are in µg/L
A value of 0.00000 indicates that a compound is below detection.

PFAS Testing of Minnesota Community Water Systems

https://tinyurl.com/PFAS-MDH

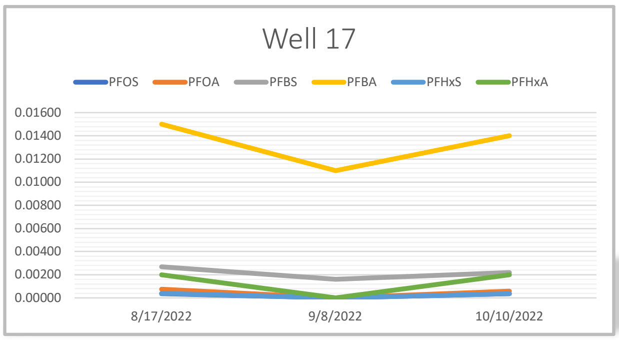
Minnesota Department of Health
PFAS HRI Testing Results

MDH - (651) 201-4562



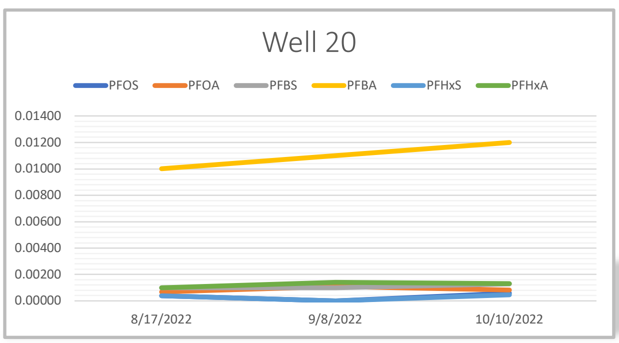
HRI Average
0.02

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00000	0.00037	0.00150	0.01100	0.00031	0.00061	0.04
9/8/2022	0.00000	0.00000	0.00150	0.01100	0.00000	0.00000	0.02
10/10/2022	0.00000	0.00000	0.00130	0.01000	0.00000	0.00000	0.01



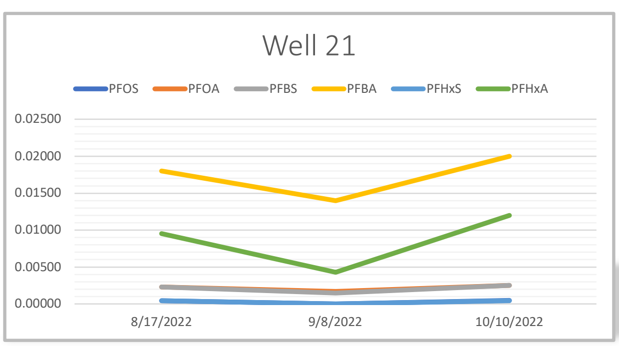
HRI Average
0.06

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00038	0.00076	0.00270	0.01500	0.00039	0.00200	0.09
9/8/2022	0.00000	0.00000	0.00160	0.01100	0.00000	0.00000	0.02
10/10/2022	0.00036	0.00059	0.00220	0.01400	0.00037	0.00200	0.08



HRI Average
0.07

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00039	0.00069	0.00100	0.01000	0.00039	0.00100	0.07
9/8/2022	0.00000	0.00110	0.00100	0.01100	0.00000	0.00140	0.05
10/10/2022	0.00058	0.00084	0.00130	0.01200	0.00046	0.00130	0.09



HRI Average
0.16

	PFOS	PFOA	PFBS	PFBA	PFHxS	PFHxA	HRI
8/17/2022	0.00043	0.00230	0.00230	0.01800	0.00041	0.00950	0.18
9/8/2022	0.00000	0.00170	0.00150	0.01400	0.00000	0.00430	0.09
10/10/2022	0.00050	0.00250	0.00250	0.02000	0.00043	0.01200	0.20

All values are in µg/L
A value of 0.00000 indicates that a compound is below detection.

PFAS Testing of Minnesota Community Water Systems

https://tinyurl.com/PFAS-MDH

Appendix F

Supply + Storage Needs Calculations

Building a Better World for All of Us®

HYDRAULIC DESIGN GUIDELINE

BACKGROUND

This memo has been developed to document criteria for evaluating the performance of existing facilities and for designing future facilities. This criteria is a combination of criteria established by Ten States Standards, Minnesota Department of Health (DOH), Minnesota Rules Chapter 4720, Minnesota Statues Chapter 144 and the Shakopee Public Utilities Commission Water Policy Manual. Planning and Design Criteria are the general guidelines and provide a framework in which to evaluate the performance of the existing system and evaluate recommended facilities to serve future growth or changes in the distribution system.

WELLS

Criteria established for the wells include well capacity and emergency power/pumping. They are summarized in Table 1.

Table 1

Well Planning and Design Criteria

Criteria	Guideline
Well Capacity	**For the Shakopee water system, the well capacity must meet all of the following:** • Average run time on wells less than 12 hours during the average day demand (ADD). • Firm capacity (two largest wells out of service) of wells at least 100% of MDD.
Emergency Operation	Emergency power generation (or engine powered pump capacity) to meet at least the ADD.
Footnote:	

PRESSURE

Pressure criteria are established for low, high and emergency operations. The low pressure criterion is established to provide customers with adequate pressures for normal operation of residential and commercial fixtures including irrigation systems. The high pressure criterion is established to protect fixtures and pipelines from undue stress. Customers with normal operating pressures over 80 psi may consider installing a pressure reducing valve (PRV) on their service to protect indoor fixtures. The emergency operating criterion is established to prevent negative system pressures during emergency and fire flow events. Table 2 summarizes the pressure criteria.

Table 2
Pressure Planning and Design Criteria

Criteria	Guideline
Pressure Requirements	
Non-Emergency Demand Conditions	> 35 psi
Emergency High Flow Conditions	> 20 psi
Preferred Operating Pressure	50 to 80 psi
Maximum Operating Pressure	< 115 psi

PRESSURE MANAGEMENT

Shakopee may implement limited pressure management strategies to reduce system leakage and encourage conservation during specific periods of low customer demand. However, Shakopee will always operate water supply pumps to meet the Ten States Standards minimum system pressure under all normal operating conditions (35 psi), and above 20 psi under emergency and fire flow conditions within the distribution system.

PIPELINES

Pipeline criteria are established for velocity, pipe roughness, minimum sizing, and pipe material. Velocity criteria are used to minimize system headlosses due to pipe size or roughness and to minimize the impact of transients in the distribution system. A roughness criterion is generally assumed or measured and is used for hydraulic model calibration and evaluation. Minimum sizing is used to ensure adequate capacity for fire protection. Table 3 summarizes planning and design criteria for pipelines.

Table 3
Pipeline Planning and Design Criteria

Criteria	Guideline
Maximum Velocity	
Maximum Hour During MDD	< 5 fps
Fire During MDD	< 10 fps
Hazen-Williams Roughness Coefficient (C-Factor)	
Existing Pipes	Varies up to 130
High Density Polyethylene (HDPE) (new)	150
Ductile Iron (new, cement lined)	130
Pipe Diameter(3)	
General Grid Considerations	12-inch minimum diameter on 3,000 foot grid (Larger diameter or closer spacing may be required based on use or zoning).
The minimum diameter for lateral water mains shall be as follows:	
Zoning: R-1A, R-1B, R-1C, R-2	6-inch minimum diameter
Zoning: R-3, B1, B-2, B-3, BP	8-inch minimum diameter, or as modeling results require for increased fire flow.
Zoning: I-1, I-2, E	12-inch minimum diameter, or as modeling results require for increased fire flow.

SUPPLY AND STORAGE

Supply and storage criteria are designed to ensure adequate capacity for maximum hour, fireflow, or emergency demands. Table 4 summarizes planning and design guidelines supply pumping and storage.

Table 4
Supply and Storage
Planning and Design Criteria

Criteria	Guideline
Supply	
Capacity	Firm Capacity (largest two pumps out of service) able to meet either: • MDD with equalization storage
Storage volume (sum of the following)	
Emergency Storage Volume	Volume of water held in reserve in case that supply is lost. • 12 hour supply at ADD[1]
Equalization Storage Volume	Volume required to deliver difference between peak hour demand (PHD) and MDD for each pressure zone (normally 15 – 30% of MDD)
Fire Storage Volume	Fire flow goal x fire duration (see Table 5 for fire flow and duration recommendations)

Footnotes:
[1] Provides a temporary emergency reserve source.

FIRE FIGHTING CRITERIA

Projected water demands are developed from existing water demands and the anticipated impact of growth and conservation on the demand. Table 5 summarizes the fire flow goals and durations.

Table 5
Fire Fighting Planning and Design Criteria[1]

Land Use	Fire Flow Goal (gpm)[1,2]	Fire Duration[2] (hours)
Zoning: R-1A, R-1B, R-1C, R-2	1,500	2
Zoning: R-3, B1, B-2, B-3, BP	2,000	2
Zoning: I-1, I-2, E	3,500	3

Footnotes:
(1) Fire flow in addition to MDD.
(2) *Distribution System Requirements for Fire Protection*, AWWA M31, 2008
(3) *2015 Minnesota State Plumbing Code*

SYSTEM PLANNING

Shakopee's Master Plan will be regularly reviewed and updated as necessary to efficiently and cost-effectively respond to the long-term needs of system and all Utility customers. In addition, Shakopee planning for future service area growth will incorporate the following:

- Shakopee's long range master planning will be consistent with the City's adopted current and future Land Use Planning documents.
- Considerations will be included for sizing future transmission mains for areas outside of the current adopted Land Use Plan.
- Acquire adequate land for future water supply, treatment or storage facilities based on Shakopee's master plan recommendations.
- Provide adequate space for Shakopee building additions or expansions to supply, treatment, and/or storage facilities. Consider providing building space in new designs for anticipated future facility expansion.
- Plan to support future population growth with a sustainable, quality water source, utilizing treatment when necessary.

SYSTEM REDUNDANCY AND RELIABILITY

For Shakopee to serve its customers and protect the public welfare, the Shakopee system facilities, equipment and distribution systems must be reliable under all operating conditions. Reliability of water utility service comprises a large part of Shakopee's investment in plant and equipment. Several basic conditions that Shakopee follows to enhance service reliability include the following:

- Provide backup power generation installed at critical supply wells to provide at least firm average day demand.
- Provide backup proper generation at large capacity wells.
- Provide adequate ground and elevated storage:
  - To meet peak hour demands in excess of supply pumping capacity
  - For fire protection needs
  - For other emergencies or facility and/or power outages
  - To take advantage of off-peak purchased power costs
- Require looping of water mains wherever possible to improve customer service reliability, fire protection and water quality.
- Provide latest technology supervisory control and data acquisition (SCADA) system to enhance control and monitoring of critical Shakopee functions and operations, and minimize emergency response times.
- Additional SCADA improvements may be pursued to streamline existing system reporting efforts.

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Table F-1
Pumping Capacity & Storage Analysis for Entire System

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	18.4	21.3	24.0
Average Day Demand	6.6	7.7	8.7
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	2,750,000	3,200,000	3,600,000
Fire Protection Volume (gallons)[5]	630,000	630,000	630,000
Reserve Volume (1/2 of Average Day)	3,316,000	3,854,000	4,333,000
Recommended Total Volume (gallons)	*6,696,000*	*7,684,000*	*8,563,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[7]	550,000	180,000	(150,000)
Tank 1	1,000,000	1,000,000	1,000,000
Tank 2	250,000	250,000	250,000
Tank 3	1,500,000	1,500,000	1,500,000
Tank 4	500,000	500,000	500,000
Tank 5	2,000,000	2,000,000	2,000,000
Tank 6	2,000,000	2,000,000	2,000,000
Tank 7	2,000,000	2,000,000	2,000,000
Total Existing Volume Available (gallons)	*9,250,000*	*9,250,000*	*9,250,000*
Water Storage Mass Balance	2,554,000	1,566,000	687,000
Additional Storage Recommended (gallons)	**None**	**None**	**None**

1. Additional firm pumping capacity may be recommended if the maximum day demand exceeds the existing firm pumping capacity.
2. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential dirunal curves were assumed with a peaking factor of 1.65.
3. Fire Protection storage was calcuated based on one fire of 3,500 gpm for 3 hours.
4. Reserve Volume is recommended to provide supply in event of a power outage
5. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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Table F-2
Supply Capacity into Normal Zone

Well Name	Pressure Zone	Unique Well Number	Depth (ft)	Rated Capacity (gpm)	Normal Operational Capacity (gpm)	Daily Capacity (MGD)
Well 2	Normal	206803	0.43228	300	300	0.43
Well 3	Normal	205978	1.29683	900	900	1.30
Well 4	Normal	206854	1.0317	716	716	1.03
Well 5	Normal	206855	1.22478	850	850	1.22
Well 6	Normal	180922	1.69308	1175	1175	1.69
Well 7	Normal	415975	1.58501	1100	1100	1.59
Well 8	Normal	500657	1.58501	1100	1100	1.59
Well 10	Normal	578948	1.62104	1125	1125	1.62
Well 15	Normal	694921	1.65706	1150	1150	1.66
Well 16	Normal	731139	2.08934	1450	1450	2.09
Well 17	Normal	731140	2.01729	1400	1400	2.02
				Total	**11,266**	**16.2**
					Highest Yielding Well (Well No. 16)	**2.1**
					Firm Capacity (Minus Well No. 16)	**14.1**

Table Notes:

Source: City Records

Table F-3
Supply & Storage Analysis for Main Zone Dependencies

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	12.77	13.93	14.97
Average Day Demand (mgd)	4.62	5.04	5.41
Existing Firm Supply Capacity (mgd)[2]	14.14	14.14	14.14
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**1.37**	**0.21**	**-0.82**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	1,920,000	2,090,000	2,250,000
Reserve Storage (1/2 AD)	2,308,000	2,518,000	2,704,000
Fire Protection Volume (gallons)[5]	630,000	630,000	630,000
Preliminary Recommended Total Volume (gallons)	*4,858,000*	*5,238,000*	*5,584,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[7]	170,000	30,000	(100,000)
Tank 1	1,000,000	1,000,000	1,000,000
Tank 2	250,000	250,000	250,000
Tank 3	1,500,000	1,500,000	1,500,000
Tank 5	2,000,000	2,000,000	2,000,000
Tank 6	2,000,000	2,000,000	2,000,000
Total Existing Volume Available (gallons)	*6,750,000*	*6,750,000*	*6,750,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**1,892,000**	**1,512,000**	**1,166,000**
Additional Storage Recommended (gallons)	**None**	**None**	**None**

1. Includes Normal Zone and East Zone
2. See Table 5-1
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 3,500 gpm for 3 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

Table F-4
Supply Capacity into First High Zone

Well/Supply Name	Unique Well Number	Normal Operational Capacity (gpm)	Allowed Pumping Time per Day (Hours)	Daily Capacity (MGD)
Well No.12	626775	810	24	1.17
Well No.13	674456	1,036	24	1.49
Well No.14	694904	381	24	0.55
Well No.20	722624	1,142	24	1.64
Well No.21	722625	1,175	24	1.69
VC Booster		1,000	24	1.69
W9 Booster		1,000	24	1.69
	Total	**6,544**	**--**	**9.93**
			Highest Yielding Well (Well No. 21)	**1.69**
			Firm Capacity (Minus Well No. 21)	**8.24**

Table Notes:

Source: City Records

Table F-5
Supply & Storage Analysis for 1st High Zone Dependencies

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	4.36	4.99	5.54
Average Day Demand (mgd)	1.58	1.80	2.00
Existing Firm Supply Capacity (mgd)[2]	8.24	8.24	8.24
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**3.87**	**3.25**	**2.69**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	650,000	750,000	830,000
Reserve Storage (1/2 AD)	788,000	901,000	1,002,000
Fire Protection Volume (gallons)[5]	630,000	630,000	630,000
Recommended Total Volume (gallons)	*1,588,000*	*1,871,000*	*2,122,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[6]	480,000	410,000	340,000
Tank 4	500,000	500,000	500,000
Tank 7	2,000,000	2,000,000	2,000,000
Total Existing Volume Available (gallons)	*2,500,000*	*2,500,000*	*2,500,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**912,000**	**629,000**	**378,000**

1. Includes First High and both Second High Zones.
2. See Table 5-1.
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 3,500 gpm for 3 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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Table F-6
Pumping Capacity into 2nd High Central Zone

Pump Name	Normal Operational Capacity (gpm)	Daily Capacity (MGD)
Valley Creek 1	1,000	1.44
Valley Creek 2	1,000	1.44
Total	**2,000**	**2.88**
Largest Pump		**1.44**
Firm Capacity (Largest Pump)		**1.44**
Table Notes: Shakopee does not have any water treatment.		

Source: City Records

Table F-7
Supply & Storage Analysis for 2nd High Central Zone

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	0.27	0.40	0.50
Average Day Demand (mgd)	0.10	0.14	0.18
Existing Firm Supply Capacity (mgd)[2]	1.44	1.44	1.44
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**1.17**	**1.04**	**0.94**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	40,000	60,000	80,000
Reserve Storage (1/2 AD)	50,000	72,000	91,000
Fire Protection Volume (gallons)[5]	300,000	300,000	300,000
Recommended Total Volume (gallons)	*240,000*	*302,000*	*351,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[6]	150,000	130,000	120,000
No Storage			
Total Existing Volume Available (gallons)	*500,000*	*500,000*	*500,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**260,000**	**198,000**	**149,000**

1. See Table 4-6
2. See Table 5-1.
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 2,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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Table F-8
Pumping Capacity into 2nd High West Zone

Pump Name	Normal Operational Capacity (gpm)	Daily Capacity (MGD)
Windermere 1	1,000	1.44
Windermere 2	1,000	1.44
Well No. 23	800	1.15
Total	**2,800**	**4.03**
	Largest Pump	**1.44**
	Firm Capacity (Largest Pump)	**2.59**

Table Notes:

Source: City Records

Table F-9
Supply & Storage Analysis for 2nd High West Zone

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	1.14	2.13	3.02
Average Day Demand (mgd)	0.41	0.77	1.09
Existing Firm Supply Capacity (mgd)[2]	2.59	3.74	4.32
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**1.45**	**1.61**	**1.31**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	170,000	320,000	450,000
Reserve Storage (1/2 AD)	205,000	385,000	544,000
Fire Protection Volume (gallons)[5]	300,000	300,000	300,000
Recommended Total Volume (gallons)	*495,000*	*803,000*	*1,131,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[6]	180,000	202,000	163,000
No Storage			
Total Existing Volume Available (gallons)	*750,000*	*750,000*	*750,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**255,000**	**-53,000**	**-381,000**

1. See Table 4-6
2. Assumes addition of booster stations and supply wells
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 2,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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Table F-10
Pumping Capacity into 2nd High West + Central Zone

Pump Name	Normal Operational Capacity (gpm)	Daily Capacity (MGD)
Windermere 1	1,000	1.44
Windermere 2	1,000	1.44
Well No. 23	800	1.15
Valley Creek 1	1000	1.44
Valley Creek 2	1000	1.44
Total	**4,800**	**6.91**
	Largest Pump	**1.44**
	Firm Capacity (Largest Pump)	**5.47**
Table Notes:		

Source: City Records

Table F11
Supply & Storage Analysis for 2nd High West + Central Zones

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	1.41	2.53	3.52
Average Day Demand (mgd)	0.51	0.91	1.27
Existing Firm Supply Capacity (mgd)[2]	5.47	5.47	5.47
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**4.06**	**2.94**	**1.95**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	210,000	380,000	530,000
Reserve Storage (1/2 AD)	255,000	456,000	635,000
Fire Protection Volume (gallons)[5]	300,000	240,000	240,000
Recommended Total Volume (gallons)	*255,000*	*708,000*	*1,161,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[6]	510,000	368,000	244,000
No Storage			
Total Existing Volume Available (gallons)	*1,250,000*	*1,250,000*	*1,250,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**995,000**	**542,000**	**89,000**

1. See Table 4-6
2. Assumes addition of booster stations and supply wells
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 2,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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Table F-12
Pumping Capacity into East Zone

Pump Name	Normal Operational Capacity (gpm)	Daily Capacity (MGD)
River View 1	1,000	1.44
River View 2	1,000	1.44
Total	**2,000**	**2.88**
	Largest Pump	**1.44**
	Firm Capacity (Largest Pump)	**1.44**

Table Notes:
Source: City Records

Table F-13
Supply & Storage Analysis for East Zone

	Design Demand Year		
Pumping Capacity Analysis	**2025**	**2035**	**2045**
Maximum Day Demand (mgd)[1]	0.23	0.30	0.37
Existing Firm Supply Capacity (mgd)[2]	1.44	1.44	1.44
Firm Supply and/or Interzone Transfer Capacity Mass Balance (mgd)[3]	**1.21**	**1.14**	**1.07**
Recommended Storage Volume			
Maximum Day Equalization Volume (gallons)[4]	30,000	50,000	60,000
Fire Protection Volume (gallons)[5]	180,000	180,000	180,000
Recommended Total Volume (gallons)	*60,000*	*90,000*	*110,000*
Existing Storage & Pumping Volume			
Surplus Firm Pump Volume (gallons)[7]	150,000	140,000	130,000
No Storage			
Total Existing Volume Available (gallons)	*150,000*	*140,000*	*130,000*
Storage or Pumping Volume Mass Balance (gallons)[3]	**90,000**	**50,000**	**20,000**

1. See Table 4-6
2. One pump offline
3. A positive value represents a surplus. A negative valve represents a deficiency.
4. Maximum Day Equalization Volume is the projected maximum volume depletion during the peak hours of the maximum day assuming the pumping rate into the service zone is equal to the maximum day demand rate. Typical residential diurnal curves were assumed with a peaking factor of 1.65.
5. Fire Protection storage was calculated based on one fire of 1,500 gpm for 2 hours.
6. Surplus Firm Pump Volume is the difference between maximum day demand and Firm Pumping Capacity which is available to supplement fire protection for 3 hours.

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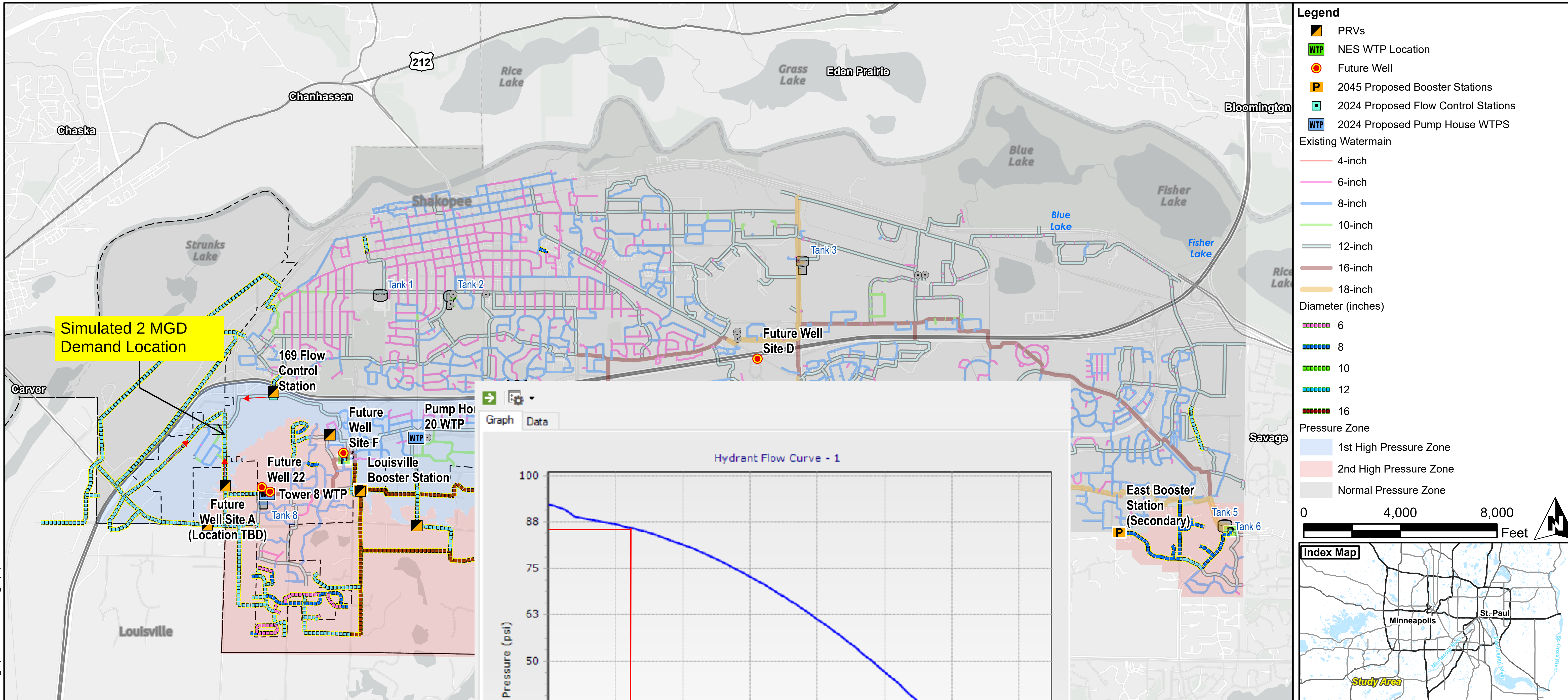
Appendix G

Large Water User Modeling and Planning



Large Format Water User Impacts

2024 Comprehensive Water Plan Update
Shakopee, Minnesota

Print Date: 7/31/2024

Map by: hschumacher
Projection: UTM Zone 15N
Source: ESRI, SEH Digi, MnDOT, Minnesota Geologic Survey (MGS), Scott County

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