APPENDIX B - GROUNDWATER WELLS AND RECOMMENDATIONS FOR THE LOWER MINNESOTA RIVER WATERSHED DISTRICT

Young Environmental Consulting Group, LLC

Technical Memorandum

To: Linda Loomis, Administrator
Lower Minnesota River Watershed District

From: Lan Tornes, Natural Resources Scientist
Katy Thompson, PE, CFM
Della Schall Young, CPESC, PMP

Date: April 30, 2020

Re: Monitoring Well Summary and Recommendations for Calcareous Fens in the Lower Minnesota River Watershed District

Introduction

Calcareous fens (fens) in the valley of the lower Minnesota River watershed are increasingly valued as rare ecosystems and continue to be the focus of interest and study. The Lower Minnesota River Watershed District (LMRWD) is supporting efforts to better understand and protect fens and enhance their viability. To help understand the complex hydrology and chemistry of the environment in which they are situated, monitoring wells have been installed in and nearby the fens to monitor groundwater levels within the fen and the underlying aquifers.

As part of the development of the 2020 LMRWD Fens Sustainability Gaps Assessment, the existing monitoring well network and additional nearby wells have been reviewed and evaluated to determine whether the as-is network is suitable to continue monitoring the health of the fens, whether any data gaps exist, and whether there are improvements to be made to the network to better monitor the status of the fens. This memorandum serves as documentation of the data reviewed and proposed recommendations.

The LMRWD is advocating a uniform approach to monitoring the hydrology and quality of the fens. A narrative supplementing each table provides a brief description of the existing fen groundwater monitoring network based on information collected from readily available sources. Recommendations, developed collaboratively with the Minnesota

Department of Natural Resources (MNDNR), are provided to enhance the existing monitoring network, to improve the information provided, and to reduce redundancies.

Well Information Sources

Sources of well information data are these: the Minnesota Geological Survey (MGS) and Minnesota Department of Health (MDH) County Well Index (CWI); the MNDNR DNR obwell database and WISKI database; the Metropolitan Council of Environmental Services (MCES); and the County Soil and Water Conservation Districts (SWCDs) for Carver, Dakota, and Scott Counties. National databases, such as the U.S. Geological Survey National Water Information System and the U.S. Environmental Protection Agency Storage and Retrieval System, now identified as the Water Quality Portal, also provide well information. A review of national databases identified nothing that could supplant the information already found from local sources.

The primary data source used in this study is the CWI. CWI is a database that was created and maintained by the MGS, a department of the University of Minnesota, with assistance from the MDH. Records from the CWI are accessible through the MDH Minnesota Well Index (MWI) mapping application (http://www.health.state.mn.us/divs/eh/cwi/).

The DNR obwell is a construction database for MNDNR observation wells and WISKI is the time series water database for the state (e.g. water level, temperature, water quality, climate data, precipitation, etc). The data is accessible through the Cooperative Groundwater Monitoring Network (CGM) and Cooperative Stream Gaging (CSG) web applications.

It should be noted that while all state agencies are in the middle of an effort to standardize data structures, currently each agency maintains its own data networks and associated databases for its own purposes, and a common data structure has not been adopted. This is especially noticeable when it comes to well identification names and numbers because different organizations may have different names for the same well. The MDH maintains unique numbers for each well and those identifiers generally were given preference in this document, and aliases may be indicated if known.

Data Collected

The well databases reviewed for this compilation often provide a wealth of information regarding the details and characteristics for each of the wells. The following provides a brief description of the data collected for each well at this time.

Unique Number: The Minnesota Unique Well Number is the unique identifier in the County Well Index database used to identify wells and borings across the state. This

number serves as the unique identifier for all Minnesota state databases related to data gathered at a well, including chemistry data (EQUIS database), time-series water level data (WISKI database), and hydro-geologic data (CWI database). The MDH has assigned this identifier to all wells drilled in the state since 1972 and to a substantial number of pre-1972 wells. Unique numbers in the 277XXX series were recently assigned numbers as part of a 2016 data management effort, led by the MNDNR, specifically for the Twin Cities Metropolitan fens.

Well Name: This is the common name currently assigned to the well and may be different depending on the person or organization assigning the name. Aliases sometimes are included with the primary well name, and well names may be changed.

Drill Date: This is the year construction and installation of the well were completed. A value of “n/a” indicates that the information could not be located at this time.

Period of Record: This represents the years for which field data measurements or monitoring records exist for a particular well. A value of “n/a” indicates that the information could not be located at this time.

Well Elevation (feet): This typically is the elevation of the point on the well casing from which the water level is measured and is provided by the organization monitoring the well, often called the measure point. It generally is referenced to mean sea level, using the North American Vertical Datum of 1988; however, because the wells are installed in the fens, they must be periodically resurveyed to determine whether the well elevation has changed and to reestablish the reference elevation. The elevation data provided in this document came from several sources, with values provided in the DNR obwell database given priority over the elevations in the CWI database because the DNR obwell provided a more complete data summary, including survey date and vertical datum used.

Well Depth (feet): This is the depth, in feet below land surface, to the bottom of the well. It often provides an indication of the aquifer the well water represents. This value is important in fens because they typically have feet of peat overlying a shallow sand and gravel aquifer that may be situated above bedrock, a confining layer, or other geologic features. As with the well elevation data, values from the DNR obwell database were given priority over depths provided in the CWI database.

Preliminary Recommendations: The MNDNR has provided a preliminary assessment of the fen wells, providing three categories: recommendation to keep a specific well, recommendation to abandon a specific well, and no current recommendation because additional information is needed.

List of Well Information by Fen

Gun Club Lake North (Quarry Island) Fen

Gun Club Lake North Fen has two wells at different depths in the same location, shown on **Figure 1** and provided in **Table 1**, suggesting they are intended to provide complementary information on groundwater hydrology at that location. One well is labeled ***D*** and the other labeled ***S***, presumably meaning “Deep” and “Shallow,” respectively. Water levels in these wells have been monitored at least since 2007 by the Dakota County SWCD, and their location and elevation are provided in the CWI. There is no information for these wells in the DNR obwell database. The total depth of the wells was provided by the MNDNR along with its preliminary recommendations.

Table 1. Gun Club Lake North Fen Wells Summary

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
277776	OP1-S (P1-S)	2007	n/a	7.1	708.6	1 – Keep
277777	OP1-D (P1-D)	2007	n/a	11.1	708.7	1 – Keep

The two Gun Club Lake North Fen wells are located within the 100-year floodplain of the Minnesota River and in a portion of the fen that is severely degraded. An old ditch cut through the fen has drained the peat substrate near the wells. The MNDNR suggests keeping these wells because of their monitoring history; however, it has proposed three locations to consider for future installation of a shallow well and a deep well in the northwest corner of the fen adjacent to the Union Pacific Railroad railbed (**Figure 1**). The locations proposed are outside the influence of the Minnesota River’s 100-year floodplain, away from the ditch scar, and within a potentially healthier part of the fen complex.

Gun Club Lake South (Fort Snelling) Fen

Gun Club Lake South Fen appears to have an adequate density and distribution of wells, shown in **Figure 2** and provided in **Table 2,** to define and monitor the hydrology of the system. Water levels in these wells have been monitored at least since 2007 by the Dakota County SWCD, and their location and elevation are provided in the CWI. Two of the wells (identified by unique numbers 484653 and 482157) also are monitored by the MNDNR, and those readings are stored in the DNR obwell database. The water level readings by the MNDNR and Dakota County SWCD were not made concurrently, so the results are not identical.

Table 2. Gun Club Lake South Fen Wells Summary

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
277778	S3-USGS	1992	n/a	23	714.2	2 – Consider Sealing
277779	S1-USGS	1992	n/a	24	723.8	2 – Consider Sealing
277780	S2-USGS	1992	n/a	28	722.8	2 – Consider Sealing
482154	MW-3	1992	2008–2019	50	723.3	1 – Keep
482155	MW-4	1992	2008–2019	22	726.7	2 – Consider Sealing
482156	MW-2	1992	2008–2019	75	727.6	2 – Consider Sealing
482157	MW-1	1992	2008–2019	80	731.6	1 – Keep
484653	MW-5	1992	2008–2019	46	726.6	2 – Consider Sealing
591977	DNR-N1	1992	n/a	5	714.0	3 – Seal
591978	DNR-N2	1992	n/a	5	719.0	3 – Seal
591979	DNR-W3	1992	2008–2019	22	730.3	1 – Keep
591980	DNR-W4	1992	2008–2019	12	731.7	1 – Keep
591981	DNR-S1	1992	n/a	5	722.0	2 – Consider Sealing
591982	DNR-S2	1992	n/a	5	718.0	2 – Consider Sealing
591983	DNR-S3	1992	n/a	5	708.0	2 – Consider Sealing

Gun Club Lake South Fen has one well nest that penetrates four different levels in the subsurface to a depth of more than 80 feet. Another well nest penetrates three different levels in the subsurface to a depth of nearly 80 feet. A well nest is more than one well, constructed adjacent to each other, but driven to different depths, and it can be used to determine the vertical direction of groundwater flow. These well nests provide detailed information about the hydrology of the aquifer supplying water to the fen.

Other wells in the fen align to form lateral and longitudinal transects that help define hydraulic head gradients or subsurface flow paths. No additional monitoring wells are suggested, but it is possible that some of these wells could be sealed due to low variability or redundant hydrographs.

In addition, many of these wells flow (e.g. the water level rises above the top of casing and flows out of the well) and should be retrofitted to prevent flowing either by attaching a riser or using a mechanical packer valve. The deeper wells flow more frequently than the shallow wells and should be prioritized.

Nicols Meadow Fen

Nicols Meadow Fen appears to have an adequate coverage of monitoring wells, as shown in **Figure 3** and provided in **Table 3**, including monitoring wells outside of the fen. A network of wells is maintained and monitored by the MCES as part of its permitting obligations associated with the Seneca Wastewater Treatment Plant operations and that plant's proximity to the fen. Many of these wells could provide data that will support efforts to understand the subsurface hydrology surrounding the Nicols Meadow Fen and are shown in **Figure 3** with white labels.

Some of the wells nearest the fen are also monitored by the MNDNR and the Dakota County SWCD, and both readings are stored in the DNR obwell database. The water level readings by the different organizations are not made concurrently, so the results are not identical.

Table 3. Nicols Meadow Fen Wells

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
227989	MWCC PROP./USGS	1988	n/a	8.73	721.52	n/a
277770	OWT-5 (540952E)	1989	2008–2019	10.5	718.26	1 – Keep
277771	OWT-3 (540952C)	1989	2008–2019	7	713.63	3 – Seal
277772	OWT-4 (540952D)	1989	2008–2019	n/a	719.92	2 – Consider Sealing
277773	OWT-2 (540952B)	1989	2008–2019	n/a	718.13	3 – Seal
277774	WN1-USGS	n/a	n/a	8	722.0	1 – Keep
277775	WNS5-USGS	n/a	n/a	9	721.5	1 – Keep
447006	MW-1	n/a	n/a	11	718.3	n/a
447008	MW-3	2008	n/a	7	713.6	n/a
447009	MW-4	1988	n/a	9	719.6	n/a
452922	MW-FEN-1	1989	n/a	n/a	719.9	2 – Consider Sealing
452923	MW-FEN-2B	1989	1993–2019	n/a	718.1	2 – Consider Sealing
452924	MW-FEN-3	1989	1993–2019	22	713.6	1 – Keep
452925	MW-FEN-4	1989	1993–2019	49	732.0	1 – Keep
462718	*OBS-11A*	*1990*	*n/a*	58	737.7	*SEALED*
462719	*OBS-11B*	*1990*	*n/a*	72	714.1	*SEALED*
483659	FC-1	1992	n/a	17	714.8	n/a
483661	FC-3	1992	n/a	74	720.9	n/a
483663	FC-5	1992	n/a	22	720.7	n/a
483664	FC-6	1992	n/a	*32*	*716.0*	n/a
501466	OBS-6	1992	n/a	*12*	*716.0*	n/a
501488	OBS-5	1989	n/a	30	722.0	n/a
506857	OBS-4	1989	n/a	30	723.0	n/a
506858	OBS-4A	1989	n/a	30	723.0	n/a
506859	OBS-10	1989	n/a	30	723.0	n/a
506861	MW-7A	1989	n/a	37	717.0	n/a
506862	MW-8A	1989	n/a	63	718.0	n/a
506863	MW-9A	1989	n/a	62	722.0	n/a
522299	MW-1LS	1993	2008–2019	21	722.0	1 – Keep
526701	PZ-1 LN	1993	2008–2019	42	719.0	1 – Keep
526702	*PZ-1RN*	*1993*	*n/a*	27	729.6	*SEALED*
526703	*PZ-1 RS*	*1993*	*n/a*	41	745.4	*SEALED*
526704	*PZ 2 LN*	*1993*	*n/a*	43	746.3	*SEALED*
526705	*PZ 2 LS*	*1993*	*n/a*	11	751.8	*SEALED*
526706	*PZ 2 RN*	*1993*	*n/a*	32	751.9	*SEALED*
526707	*PZ-2 RS*	*1993*	*n/a*	*36*	*753.1*	*SEALED*

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
526708	*PZ-3 LN*	*1993*	*n/a*	*11*	*753.1*	*SEALED*
526709	*PZ-3 LS*	*1993*	*n/a*	*36*	*739.0*	*SEALED*
526710	*PZ-2 RN*	*1993*	*n/a*	*6*	*739.0*	*SEALED*
526711	*PZ-2 RS*	*1993*	*n/a*	*37*	*738.8*	*SEALED*
526712	*PZ-4 LN*	*1993*	*n/a*	*8*	*738.8*	*SEALED*
526713	*PZ-4 LS*	*1993*	*n/a*	*40*	*727.7*	*SEALED*
526714	*PZ-4 RN*	*1993*	*n/a*	*6*	*727.7*	*SEALED*
526715	*PZ-4 RS*	*1993*	*n/a*	*40*	*726.4*	*SEALED*
540952	MW-1 OF 5	1989	1993–2019	*7*	*726.4*	1 – Keep

The MNDNR has recommended maintaining a number of the existing active wells and outfitting more with data loggers, particularly near a down-cutting spring-fed swale that has the potential for a future restoration project. The MNDNR also recommends that the MNDNR, Dakota County, and MCES discuss monitoring wells and data collection at Nicols Meadow Fen to reduce redundancies in data collection efforts.

Black Dog Lake Fen

Black Dog Lake Fen does not have any identified monitoring wells. In 2005, the LMRWD developed a Groundwater Monitoring Strategy Report that discussed the state of Black Dog Lake Fen. Agency staff agree that this fen has been the most heavily affected of those in the area, with some believing the fen may be extinct. MNDNR staff have noted that areas south of the Union Pacific Railroad railbed may still be in good condition and may benefit from the installation of a monitoring well nest in this area. The same report also recommends monitoring groundwater levels when Kraemer Quarry ceases dewatering activities to provide a fuller idea of the overall impact the Kraemer Quarry had on the nearby groundwater-fed natural resources.

Because the fen is severely degraded, the MNDNR asked for the construction of these wells to be put on hold until the fen was assessed. The MNDNR recommended reviewing available well permit data from the Cities of Burnsville and Eagan that could be valuable in determining whether the calcareous fen groundwater hydrology is still intact. In 2020–2021 the MNDNR plans to assess if the native calcareous fen vegetative community still exists within Black Dog Lake Fen. The outcome of this assessment will dictate whether wells are placed in the fen or not.

Savage Fen Complex

The Savage Fen Complex has several monitoring wells with long records describing fen hydrology. The majority of the fen monitoring wells are positioned at the western edge of the fen complex, shown on **Figure 4,** and provided in **Table 4**. The Scientific Natural Area (SNA) for Savage Fen is divided primarily into eastern and western parts by the

proposed but not completed alignment of Dakota Avenue (County Road 27). Fen monitoring wells were not found in the eastern part of the SNA.

Table 4. Savage Fen Complex Wells

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
180410	BOHN, KARL	1981	n/a	185	891.0	Private
211809	BAY + BAY TRANSFER CO.	1972	n/a	280	745.0	Private
211812	RUBBER SPECIALITIES	1969	n/a	135	725.0	Private
244111	MN DNR SCIENTIFIC AREA	1992	1992–2019	10	744.4	3 – Seal
244112	MN DNR SCIENTIFIC AREA	1992	1992–2019	20	744.9	1 – Keep
244113	MN DNR SCIENTIFIC AREA	1992	1992–2019	37	745.0	1 – Keep
277781	n/a	n/a	2008–2019	16	747.5	3 – Seal
277782	n/a	n/a	n/a	n/a	n/a	3 – Seal
277783	n/a	n/a	2008–2019	24	758.9	3 – Seal
277784	n/a	n/a	2008–2019	20	749.3	3 – Seal
277785	n/a	n/a	2008–2019	11	745.4	1 – Keep
404816	CHASE, RON	1985	n/a	280	972.0	Private
431194	MW-1 MN DNR	1991	1987–2019	5	748.9	1 – Keep
431195	MW-2 MN DNR	1991	1987–2019	4	755.1	3 – Seal
431199	MW-3 MN DNR	1991	1987–2019	5	749.5	3 – Seal
491702	MW-4 MN DNR	1991	1987–2019	5	748.3	1 – Keep
517639	*BLUFF WELL SHALLOW*	*1992*	*1994–2019*	*115*	*880.7*	*SEALED*
517640	*BLUFF WELL DEEP*	*1992*	*1994–2019*	*152*	*881.0*	*SEALED*
568788	EAGLE CREEK MW-6	1997	2006–2019	43	742.1	2 – Consider Sealing
568789	EAGLE CREEK MW-4	1997	2005–2018	43	739.5	2 – Consider Sealing
568790	EAGLE CREEK MW-5	1997	2005–2019	28	739.4	2 – Consider Sealing
568791	EAGLE CREEK MW-3	1997	2005–2019	28	739.7	2 – Consider Sealing

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
578964	DNR OB 70024 (DNR-1)	1998	1998–2020	175	883.2	n/a
578965	DNR OB 70025 (DNR-2)	1998	1998–2019	330	883.4	n/a
578966	DNR OB 70026 (DNR-1)	1998	1998–2015	70	746.8	1 – Keep
578967	DNR OB 70027 (DNR-2)	1998	1998–2015	208	747.6	1 – Keep
594776	*PZ-1*	*2014*	*n/a*	*20*	*897.7*	*SEALED*
594777	*PZ-2*	*2014*	*n/a*	*20*	*900.7*	*SEALED*
594778	*PZ-3*	*2014*	*n/a*	*20*	*892.3*	*SEALED*
684021	DUST COATING	2003	n/a	200	737.0	Private

Figure 4 and **Table 4** include a number of wells that are outside the LMRWD's boundary, but after discussion with the MNDNR these wells were determined to be valuable to monitoring the health of the Savage Fen, even if they are outside the watershed. Thus the MNDNR recommends maintaining these wells and has also suggested that some of the wells may be redundant (244111), may benefit from additional instrumentation (244112, 244113, 578966), or need further coordination with the well owners (568788, 568789, 568790, 568791).

Although the existing wells are clustered to the west, these wells provide the information needed to evaluate the health of the fens, and no new wells to the east are warranted at this time. However, the MNDNR does recommend reviewing the fen in five years to determine whether new wells would be warranted.

Seminary Fen Complex

Seminary Fen appears to have a good distribution of wells for groundwater level monitoring, as shown in **Figure 5** and provided in **Table 5**, including the area adjacent to the railroad alignment west of the existing SNA boundary of the fen.

Table 5. Seminary Fen Complex Wells

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
109899	MONNENS, JOSEPH	1989	n/a	80	752.0	Private
142778	THOLEN, AL	1978	n/a	117	763.0	Private
277864	SFPZ12	2015	n/a	6	734.2	2 – Consider Sealing
277865	SFPZ13	2015	n/a	11	734.2	2 – Consider Sealing

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
277866	SFPZ14	2015	n/a	7	734.0	2 – Consider Sealing
277867	SFPZ15	2015	n/a	12	734.0	2 – Consider Sealing
277868	SFPZ16	2015	n/a	6	741.2	2 – Consider Sealing
277869	SFPZ17	2015	n/a	13	741.2	2 – Consider Sealing
400776	POPPITZ, TROY	1983	n/a	135	753.0	Private
400777	DAHLKE, WILFRRED	1983	n/a	75	747.0	Private
424044	DUNGY, GARY	1986	n/a	97	769.0	Private
433424	PROGRESS VALLEY STORAGE	1987	n/a	75	766.0	Private
433442	GABOURY, JAMES	1987	n/a	75	764.0	Private
570176	NYSTROM, DENNIS	1997	n/a	100	755.0	Private
665376	1PZB1 at SemFen	2005	2009–2019	17	746.9	1 – Keep
665377	1WTB1 at SemFen	2005	2009–2019	4	745.2	1 – Keep
665378	1PZA1 at SemFen	2005	2009–2019	19	760.6	1 – Keep
665379	1WTA1 at SemFen	2005	2009–2019	6	755.5	1 – Keep
665380	NEST 4 (3PZA1)	2005	n/a	12	719.7	1 – Keep
665381	3WTA1 at SemFen	2005	2009–2019	4	721.1	1 – Keep
665382	2PZA1 (Nest #3) at SemFen	2005	2009–2019	13	749.2	1 – Keep
665383	2WTA1 (Nest #3) at SemFen	2005	2009–2019	4	747.3	1 – Keep
665384	2PZB1 at SemFen	2005	2009–2019	17	758.2	1 – Keep
665385	2WTB1 at SemFen	2005	2009–2019	4	756.3	1 – Keep
727737	MW-7WT near SemFen	2005	2008–2019	15	789.3	1 – Keep
727738	MW-7A near SemFen	2005	2009–2019	30	788.7	1 – Keep
727740	MW-9A near SemFen (Riehl)	2005	2009–2019	40	795.6	3 – Seal
727741	MW-9B near SemFen (Riehl)	2005	2009–2018	65	795.7	3 – Seal

Unique Number	Well Name	Drill Date	Period of Record	Depth (ft)	Elevation (MSL, ft)	Preliminary Recommendations
817603	DNR OB 10007	2016	2016–2020	420	892.4	1 – Keep
817604	DNR OB 10008	2016	2016–2020	152	892.4	1 – Keep
817605	DNR OB 10009	2016	2016–2020	228	892.6	1 – Keep
817606	DNR OB 10010	2015	2016–2020	300	745.2	1 – Keep
817607	DNR OB 10011	2016	2016–2020	79	745.6	1 – Keep

Figure 5 and **Table 5** include a number of wells that are outside the LMRWD boundary. After discussion with the MNDNR, these wells were determined to contribute to the overall understanding of the Seminary Fen hydrology, and thus they should be maintained.

Several wells (277864–277686) are to be kept until a future restoration project related to the erosion of a nearby spring-fed ditch is completed. The MNDNR hopes to collect at least two consecutive years of monitoring data to aid in the development of restoration designs.

Summary and Recommendations

The calcareous fens of the Lower Minnesota River Valley have numerous established monitoring well networks; however, these wells often are unevenly distributed across the fens, are poorly placed, or may need additional wells to better monitor the health and status of groundwater in some fens, such as Gun Club Lake North Fen, Black Dog Lake Fen, and the eastern portion of Savage Fen. Conversely, some fens may be over-monitored with a redundancy of well networks by different agencies. Nicols Meadow Fen and Seminary Fen have a wealth of monitoring data; however, some of these efforts are being duplicated by several agencies. Further discussion among these agencies is warranted to reduce the duplication of efforts and increase monitoring efforts across the fens.

The following provides recommendations generated in whole or in part in consultation with the MNDNR for maintaining and enhancing the existing monitoring networks across the Lower Minnesota River Valley fens.

- At Gun Club Lake North Fen, maintain the existing wells and continue hand monitoring activities. Recommend installation of a new shallow and new deep well with instrumentation near the Union Pacific railbed, further removed from the influence of the Minnesota River and within healthy fen habitat.
- Analyze well records at Gun Club Lake South Fen for wells 482155, 482156, and

484653 to determine whether these wells should be maintained with the others shown on **Figure 2**.

- Retrofit the flowing wells at Gun Club Lake South Fen by either attaching a riser or using a mechanical packer valve. The deeper wells flow more frequently than the shallow wells and should be prioritized.
- At Nicols Meadow Fen, maintain existing wells shown on **Figure 3** and consider outfitting these wells with instrumentation.
- Wells at Gun Club Lake South Fen, Nicols Meadow Fen, and Seminary Fen are being monitored by the MNDNR and Dakota and Carver County SWCDs. These wells should be monitored either by the MNDNR or SWCD, not both.
- At Black Dog Lake Fen, due to the degradation of the fen habitat, the MNDNR has recommended assessing the fen health before any wells are installed. The MNDNR has recommended reviewing available well permit data from the Cities of Burnsville and Eagan that could be valuable in determining whether the calcareous fen groundwater hydrology is still intact.
- Although the existing wells at Savage Fen are clustered to the west, these wells provide the information needed to evaluate the health of the fens, and no new wells to the east are warranted at this time. However, the MNDNR does recommend reviewing the fen in five years to determine whether new wells would be warranted, particularly if the Dakota Avenue extension project is pursued.

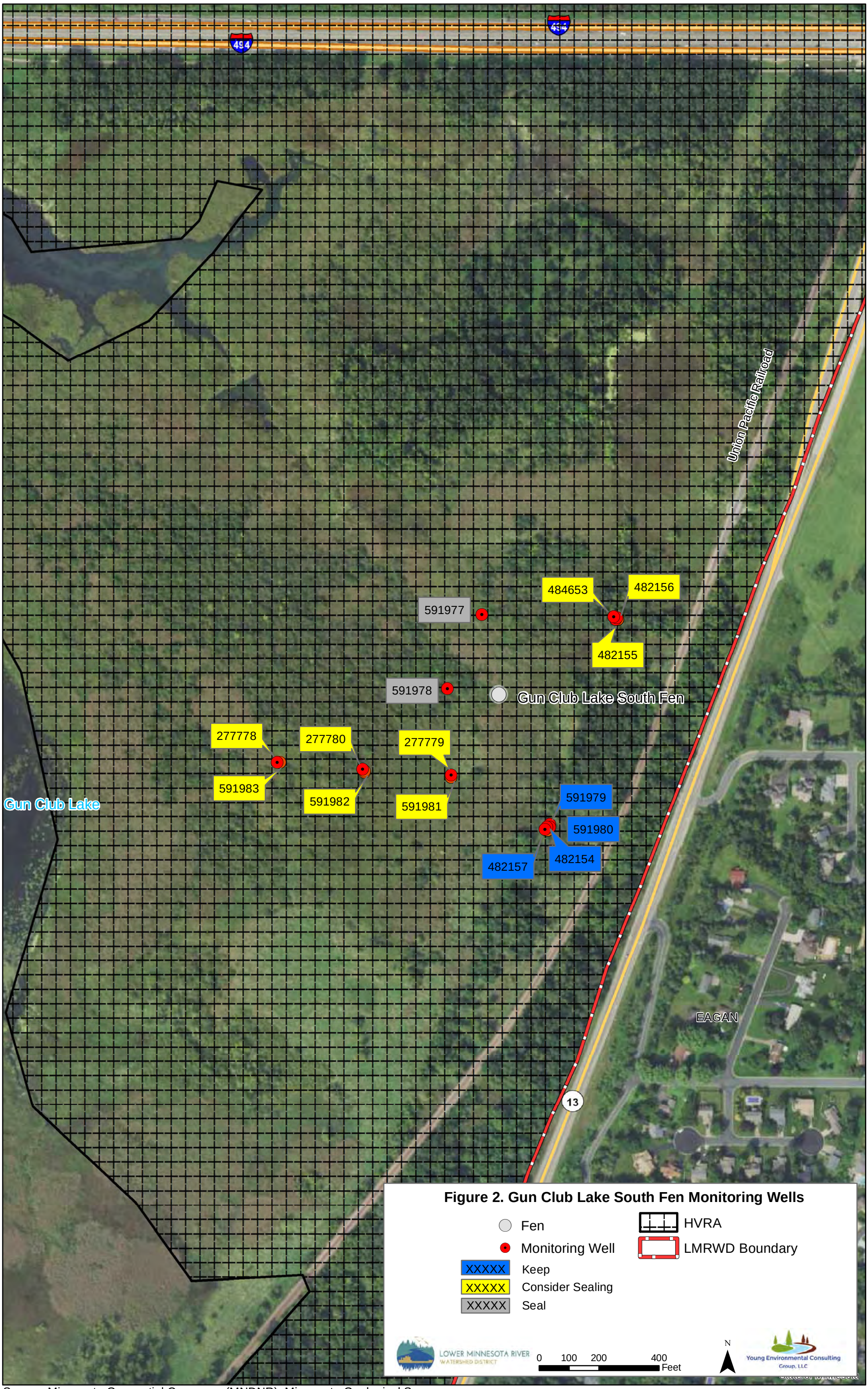
Figure 1. Gun Club Lake North Fen Monitoring Wells

Fen
Monitoring Well
Suggested Well Locations
XXXXX Keep
XXXXX Consider Sealing
XXXXX Seal
HVRA
LMRWD Boundary
City Boundary

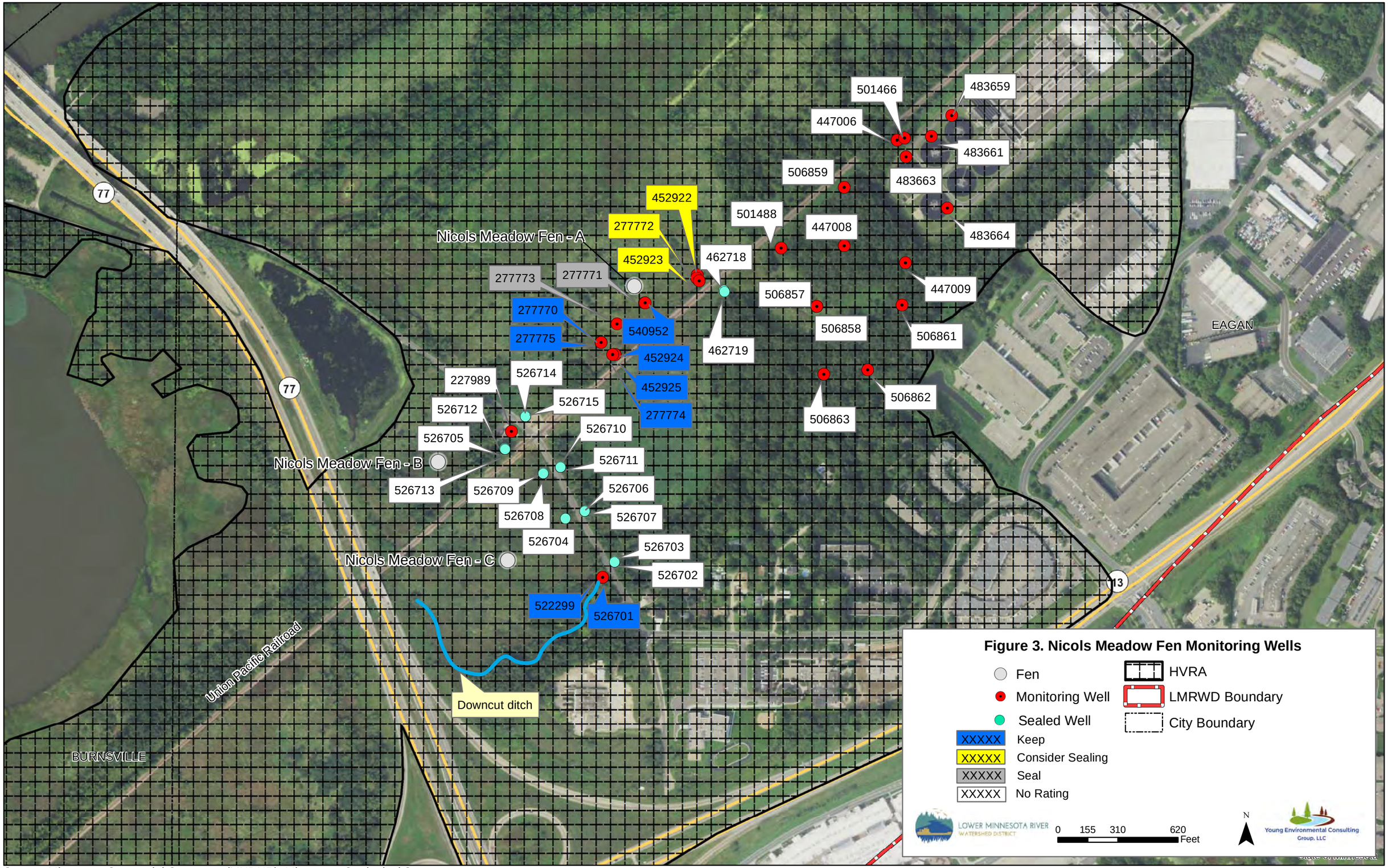
LOWER MINNESOTA RIVER WATERSHED DISTRICT
0 110 220 440 Feet
N
Young Environmental Consulting Group, LLC

Gun Club Lake
Gun Club Lake North Fen
Fen scar
277777
277776
Union Pacific Railroad
MENDOTA HEIGHTS
EAGAN
494
State of Minnesota

Source: Minnesota Geospatial Commons (MNDNR), Minnesota Geological Survey



Source: Minnesota Geospatial Commons (MNDNR), Minnesota Geological Survey



Source: Minnesota Geospatial Commons (MNDNR), Minnesota Geological Survey

211812
568791
684021
568788
568790
568789
Savage Fen
Dakota Ave
244112
578966
244113
578967
277785
211809
244111
277781
431194
491702
431199
277784
277782
431195
277783
517640
517639
578965
578964
180410
594776
404816
594778
594777
SAVAGE
43

Figure 4. Savage Fen Monitoring Wells

Fen
Monitoring Well
Sealed Well
Private Well
XXXXX Keep
XXXXX Consider Sealing
XXXXX Seal
XXXXX No Rating
HVRA
LMRWD Boundary
Scientific and Natural Area

LOWER MINNESOTA RIVER WATERSHED DISTRICT
0 220 440 880 Feet
N
Young Environmental Consulting Group, LLC

Source: Minnesota Geospatial Commons (MNDNR), Minnesota Geological Survey

817603
817605
817604
CHASKA
CHANHASSEN
727740
727741
665379
665378
727737
727738
Seminary Fen
277868
277869
665376
665377
665384
665385
Minnesota Bluffs LRT Regional Trail
277867
277865
277866
277864
665382
665383
817606
817607
665380
665381
570176
400776
142778
400777
433424
109899
433442
424044
101

Figure 5. Seminary Fen Monitoring Wells

Fen
Monitoring Well
Private Well
XXXXX Keep
XXXXX Seal
XXXXX No Rating
HVRA
LMRWD Boundary
City Boundary
Scientific and Natural Area

LOWER MINNESOTA RIVER WATERSHED DISTRICT
0 195 390 780 Feet
N
Young Environmental Consulting Group, LLC

Source: Minnesota Geospatial Commons (MNDNR), Minnesota Geological Survey