Groundwater Monitoring Strategy
Final Report

Lower Minnesota River Watershed District

Cover Picture of Trout Stream and/or Fen

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1
Introduction

The objective of this project is to provide guidance to the Lower Minnesota River Watershed District (LMRWD) in developing a groundwater monitoring strategy that will be helpful in protecting the numerous groundwater-dependent resources that lie within the District's borders. Historically, the District has been involved to a relatively minor degree in groundwater management and monitoring, as the numerous fens and trout streams within the District are state-protected resources and the state has been fairly active in monitoring the higher profile resources. However, there are also lower profile resources about which relatively little is known. In addition, budget cuts at the state level have forced a reduction in the level of monitoring activity, and state staff are stretched thin in their capacity to track the health of, and offer the necessary level of protection to, some of these resources. The LMRWD feels it is in a position to step in and fill those gaps. This project is intended to help systematically identify how the District can be efficient at filling those gaps and thereby contribute to enhancing the effectiveness of management efforts for these important resources.

The general approach taken for this project was as follows:

- Identify and locate groundwater dependent resources such as trout streams and fens.
- With the help of other knowledgeable resource management professionals, evaluate the resources in terms of their current condition and restoration potential.
- Identify what, if any, groundwater monitoring efforts have been or are currently being carried out for these resources and summarize the results of those efforts.
- Identify opportunities for involvement in effective and useful groundwater monitoring efforts, including partnering opportunities.
- Prepare a report that summarizes those findings and estimates the cost of the recommended effort.

The priority groundwater dependent resources on which this project is focused are listed below in Table 1.1 and the general location of those resources within the LMRWD is shown in Figure 1.1.

Table 1.1 Groundwater-Dependent Surface Waters of the LMRWD

Calcareous Fens	Trout Streams
Quarry Island Fen	Kennaley's Creek
Fort Snelling Fen	Harnack Creek (Un-named Stream #1)
Nicols Fen	Un-named Stream #4
Black Dog Lake North Fen	Un-named Stream #7
Black Dog Fen	Eagle Creek
Savage Fen	Assumption Creek
Seminary Fen	

Section 2 General Hydrogeology of the LMRWD

Fens and trout streams are dependent on the steady input of groundwater that occurs in the unique hydrogeologic setting of the Lower Minnesota River Valley. The fens and trout streams are part of a complex of fens and other wetlands that extended along the length of the river terraces prior to urban development (Almendinger and Leete, 1998). The conditions necessary for the development of these unique groundwater dependent resources result from the topography and geology of the Minnesota River Valley.

2.1 Calcareous Fens

A calcareous fen is a peat-accumulating wetland dominated by distinct groundwater inflows having specific chemical characteristics. The water is characterized as circumneutral to alkaline, with high concentrations of calcium and low dissolved oxygen content. The chemistry provides an environment for specific and often rare hydrophytic plants (Minnesota Rule 8420.1020). More generally, a fen is usually described as a peat land that receives a significant contribution of groundwater resulting in a pH above a certain threshold.

The calcareous and other associated fens within the LMRWD all occur in a similar setting in the landscape. These fens occur at a break in land slope at the base of bluffs along the Minnesota River Valley where there is a steep water-table gradient (or slope). Shallow groundwater flow in the glacially derived sand and gravel aquifers and deeper regional groundwater flow in the upper bedrock aquifers is generally toward the Minnesota River. The break in the land surface and resulting steep water-table gradient result in a strong upward gradient in groundwater pressure at the base of the bluffs (Figures 2.1 and 2.2). The Minnesota River Valley is also a discharge area for deeper regional groundwater flow in the upper bedrock aquifers.

The upward gradient in groundwater pressure and abundant supply of water in the aquifers results in steady discharge of cool calcium rich groundwater from the sand and gravel aquifers underlying the fens. The calcareous fens develop as a sloping apron of peat extending from the base or near the base of the bluff. The peat contains deposits of calcium and magnesium carbonate precipitated from the inflowing groundwater. The slope of the peat surface has the same general profile as the water table, and the water table occurs at or near the surface (Almendinger and Leete, 1998).

The constant influx of cool, low oxygen groundwater allows thick peat accumulations to occur that would normally only develop in cooler boreal climates. The calcareous fens occur at particular locations where focused groundwater discharge has resulted in an accumulation of peat, the properties of which may tend to control the elevation of the water table and allow continued peat accumulation (Almendinger and Leete, 1998).

Information about the sources of the groundwater supplying the fens and the travel time from the recharge areas to the discharge areas at the fens lead to a better understanding of the scale of the groundwater flow paths. Almendinger and Leete (1998) collected shallow groundwater samples from Fort Snelling, Nicols Meadow, and Savage Fens and had them tested for tritium content, an indicator of the amount of time since groundwater was last in contact with the atmosphere.

Groundwater discharging to Fort Snelling Fen was determined to be greater than 40 years old, indicating that there is a relatively long travel time from the recharge area to the discharge area at the fen. Tritium levels at Nicols Meadow Fen were intermediate, indicating that a mixture of younger and older water may converge to discharge at the fen. Tritium levels were relatively high at Savage Fen, indicating a dominant travel time from the recharge area(s) to the fen of less than 40 years but probably greater than a decade. Stable isotope ratios of hydrogen and oxygen at Savage Fen indicate that a portion of the water discharging to the fen probably was recharged from ponds within approximately 1 mile of the bluffs above the fen (Komar, 1994).

The calcium and magnesium deposited in the fens most likely originates in the calcareous glacial deposits in the recharge area above the bluffs. Groundwater dissolves minerals in the sediments as it moves from the recharge areas to the fens. Groundwater flow from the upper bedrock aquifer may not discharge directly to the fens, but the regional bedrock flow system can have significant influence on shallow groundwater flow at the fens. For example, significant lowering of groundwater pressure in the upper bedrock artesian aquifer(s) beneath (St. Peter aquifer or Prairie du Chien-Jordan aquifer system) would almost certainly have some impact on any of the fens and trout streams on the south side of the Minnesota River within the LMRWD.

On the other hand, the bedrock aquifer (upper Franconia aquifer) directly beneath Seminary fen is probably not hydraulically well connected with the surficial sand and gravel aquifer because the bedrock in this area has been eroded to a depth greater than 200 ft. Also one or more layers of low permeability clay occur between the shallow aquifer and bedrock. Nevertheless, the shallow sand and gravel aquifer in this area is laterally connected with the regional groundwater flow system and the shallower bedrock aquifer that occurs beneath the other fens.

2.2 Trout Streams

The trout streams in the LMRWD receive groundwater from the same sand and gravel aquifers that feed the fens. In fact, Assumption Creek and Kennealy Creek receive water directly from Seminary Fen and Nicols Fen, respectively. The trout streams in the LMRWD and those found along the St. Croix River such as Brown's Creek and Valley Creek, occur in similar hydrogeologic settings. These Metro area trout streams occur within the major river valleys, which are regional groundwater discharge zones for the shallower sand & gravel and deeper bedrock aquifers.

Trout in these streams depend on the steady influx of cool, low nutrient groundwater which allows for the high dissolved oxygen content trout need to survive. In southern Minnesota, steady discharge of groundwater with very limited input of warm surface runoff is the only mechanism for providing the conditions trout need to survive.

Section 3

Priority Resource Assessment

This section provides a more detailed description of the priority groundwater-dependent resources on which this report focuses. The discussions below are broken out by type of resource, with trout streams covered in the first sub-section and fens in the next. For each resource, the narratives provide the following information:

- A brief description of the resource
- A summary of existing/historical monitoring efforts
- An overview of the existing health of the resource
- Current monitoring efforts
- Future planned monitoring efforts by other
- Overall priority for monitoring by the LMRWD

3.1 Trout Streams

The following sub-section describes the trout streams in the District. More detailed maps showing the locations of these trout streams are provided in Appendix A, as indicated below.

3.1.1 Kennaley's Creek

Description: This trout stream is located in the City of Eagan just south of the Seneca regional wastewater treatment plant and flows from the base of the river terrace west of the Silver Bell industrial park to the Minnesota River through Fort Snelling State Park. It is approximately 0.8 miles long and currently has an estimated mean annual discharge of 0.1-0.2 cfs near the railroad track crossing.

Figure A-1 in Appendix A at the back of this report contains ground photos of Keneally Creek just above and just below the railroad track crossing and Figure A-2 is an air photo of the Creek.

Existing Studies/Monitoring: In the late 1990, wells were installed adjacent to the stream in the vicinity of the Seneca wastewater treatment plant as part of an effort to monitor the impact of de-watering of the shallow aquifer to allow construction and operation of the plant. Collection of monitoring data from these wells continued between 1990 and 2002. The wells are still in place, though no monitoring data has been collected from them since 2002. Also, MnDNR conducts periodic fisheries surveys on this stream approximately every 3-5 years. The last survey for the resource was carried out in August 2003. No trout have been sampled in the stream since the 1983 survey.

Health of the Resource: As mentioned previously, no trout have been sampled in the stream since the 1983 MnDNR survey. Several activities have severely compromised the viability of this resource. The most serious of these appears to have been associated with de-watering of the headwaters of the Creek during the construction of the Seneca wastewater treatment plant, which may have partially collapsed the peat aquifer feeding the stream.

There is also a large (42") stormwater pipe that discharges stormwater from the City of Eagan at the base of the bluff above the Creek, but past field efforts have shown that for small and moderate storms, the stormwater appears to infiltrate into the peat before reaching the stream itself.

Current Monitoring Efforts: None at the present time.

Future Monitoring Efforts: The Gun Club Lake WMO has received $19,000 LCMR grant to increase monitoring efforts in this area, and they will be developing a detailed work plan that specifies what they intend to do in early 2006. The next DNR stream survey is planned for about 2008.

Priority for Monitoring: LOW. MnDNR acknowledges that this resource is heavily impacted by past activities (specifically de-watering associated with construction and operation of the Seneca wastewater treatment plant) that are not likely to be changed significantly and that investment of efforts may be more appropriate elsewhere.

3.1.2 Harnack Creek

Description: This trout stream is located in the City of Eagan between Nicols Road and Trunk Highway 77 and flows from the base of the river terrace just east of TH 77 to the Minnesota River through Fort Snelling Park. It is approximately 1.0 miles long and had a measured discharge of 1 cfs at its mouth in July 2000. Figure A-3 in Appendix A at the back of this report contains ground photos of Harnack Creek just above and just below the railroad track crossing and Figure A-4 is an air photo of the Creek.

Existing Studies/Monitoring: The latest MnDNR survey for this resource was carried out during the summer of 2000. Other than the stream surveys conducted by MnDNR, we are not aware of any existing or historical monitoring efforts or studies of this resource.

Health of the Resource: No trout have been sampled in this stream since 1981 when three young brook trout were found, presumably from a 1980 stocking effort. The watershed is small and has been compromised by the construction of Cedar Avenue along its west side.

Moderate to large precipitation events generate sheet runoff from this roadway that reaches the stream, scouring the stream and raising water temperatures. MnDNR fisheries staff feels the stream is moderately to heavily impacted by this runoff. There are no storm sewers discharging directly to the Creek. Due to low base flows, high flood loss potential for trout, and beaver activity, MnDNR feels the stream has limited potential to support trout.

Re-development of small industrial/commercial zoned areas in the headwaters represents a potential threat to this stream, though the City of Eagan has a shoreland protection zone to protect part of this area and has developed a policy to encourage infiltration in this area as part of the Cedar Grove AUAR if the parcel does re-develop.

Current Monitoring Efforts: None at the present time.

Future Monitoring Efforts: The Gun Club Lake WMO has received $19K LCMR grant to increase monitoring efforts in this area, and they will be developing a detailed work plan that specifies what they intend to do in 2006.

MnDNR fisheries staff conducted a fisheries survey during the summer 2005, but survey results are not yet available.

Priority for Monitoring: LOW/MODERATE. Due to access problems and the perceived limited potential of the resources to support a permanent trout population, MnDNR feels it merits protection primarily as part of the natural area and wetland/fen complex which lies adjacent to it.

3.1.3 Un-named Stream #4

Description: This trout stream is located in the City of Burnsville south of Trunk Highway 77 between Highway 13 and Black Dog Lake. It is approximately 0.45 miles long and had a measured discharge of 2 cfs at the railroad bridge in June 2000. Figure A-5 in Appendix A at the back of this report contains ground photos of Un-named Stream #4 above and just below the railroad track crossing and Figure A-6 an air photo of the Creek. Figure A-6 shows the location of several storm sewers that currently discharge to the Creek based on information provided by the City of Burnsville.

Existing Studies/Monitoring: The latest MnDNR fisheries survey was carried out in August of 2000. In 2003, the City of Burnsville conducted thermal monitoring of the stream between 5/30/03 and 10/30/03 at the locations shown in Figure A-6. The City of Burnsville provided the data and graphs of the monitoring results but there is no formal report showing the monitoring results. A cursory review of the data show temperature peaks during July and August in the lower reaches of the stream in the mid to upper 70^{o} F range. This is well above the optimum temperature range for brook trout as well as the macroinvertebrates on which they would feed and may be a consequence of urban runoff inputs and/or beaver dam activity.

Health of the Resource: No trout have been sampled in this stream since 1982 when one adult brook trout was found, presumably from a 1980 stocking effort. Most recent stream survey was conducted by MnDNR in August 2000. Due to low base flows, storm sewer discharges that eventually reach the stream, high flood loss potential for trout, and high beaver activity (especially in the vicinity of the railroad crossing), MnDNR feels the stream has limited potential to support trout.

Current Monitoring Efforts: None going on that we know of at the present time. MnDNR fisheries staff will be conducting a fisheries survey during the summer of 2005.

Future Monitoring Efforts: None planned, other than 5-year stream surveys.

Priority for Monitoring: LOW. A concerted effort would have to be made at beaver control and stormwater management to restore this stream to a viable trout fishery. Small size may mean it has limited recreational potential.

3.1.4 Un-named Stream #7

Description: This trout stream is located in the City of Burnsville about 1.5 miles southwest of Un-named stream #4 between Highway 13 and Black Dog Lake. It is approximately 0.2 miles long and there is no recent measured discharge information available for the stream. Estimated baseflow discharge based on a field visit to the stream in August 2005 was less than 1 cfs. Figure A-7 in Appendix A at the back of this report contains ground photos of Un-named Stream #7 just above the railroad track crossing. Figure A-8 is an air photo of the Creek. (Note: The cited location of Un-named Stream #7 by MnDNR differs from that identified by the City of Burnsville. The City identified the stream as located in Section 27, whereas MnDNR identifies the location of the stream in Section 26. The following narrative is based on the un-named stream in Section 26).

Existing Studies/Monitoring: The latest MnDNR fisheries survey was completed back in 1980. No other studies have been done on this resource that we are aware of. (Note: The City of Burnsville did conduct thermal monitoring of the un-named stream in Section 27 in 2003. The stream appears heavily impacted by storm sewer discharges, with water temperatures in the stream peaking in the low 90^{o} F range in early July of 2003).

Health of the Resource: Virtually no recent data or studies have been conducted for this resource. Based on a field visit to the area in July 2005, the stream is very small (less than 3 feet wide at the railroad crossing) and almost completely hidden by riparian grasses. The discharge observed was clear, cold water typical of a groundwater fed stream but flow was well under 1 cfs. The banks in this vicinity were well-vegetated and stable, with none of the signs of instability typical of water that receives large amounts of urban stormwater runoff. The area on top of the bluff above the stream is fully developed for commercial and industrial, but surface water runoff must be routed somewhere other than this drainage. The stream is of very limited value as a potential trout fishery because of its small size.

Current Monitoring Efforts: None going on that we know of, and MnDNR has no plans to conduct more fisheries surveys in the foreseeable future.

Future Monitoring Efforts: None planned by other parties.

Priority for Monitoring: LOW/MODERATE. Resource appears largely intact and un-affected by adjacent development, but it is small and has low potential as a recreational resource.

3.1.5 Eagle Creek

Description: This trout stream is located in the City of Savage and crosses Trunk Highway 13 just west of the intersection of Highways 13 and 101. It is approximately 2.3 miles long and had a baseflow at the mouth of 11.2 cfs in August 2002. Figure A-9 in Appendix A at the back of this report contains ground photos of Eagle Creek just above its crossing under Trunk Highway 101. Figure A-10 is an air photo of the Creek.

Existing Studies/Monitoring: This stream was extensively studied in the late 1990's as part of an effort to determine an acceptable mitigation strategy for a proposed residential development in the City of Savage within the Eagle Creek watershed. The most recent fish population survey completed by MnDNR was in August 2002. A total of 16 brown trout were sampled.

Health of the Resource: Eagle Creek is by far the largest known trout stream in the LMRWD and is the only trout stream tributary to the Minnesota River with a naturally reproducing population of brown trout. The population is relatively small and confined to a portion of the mainstem of the stream near the Highway 101 crossing. The Creek was the subject of a concerted effort to protect it from the effects of a 300-unit housing development in the City of Savage. A plan was executed to create a 200-foot wide buffer along each side of the Creek through the development as well as divert all runoff from the new development away from the stream. MnDNR staff indicate that the Creek is in good to excellent shape, with the "boiling springs" that provide significant groundwater to the Creek still active.

Current Monitoring Efforts: Since 1998, there has been a Watershed Outlet Monitoring Program (WOMP) station operated by the Metropolitan Council that measures flow, temp, etc. and collects water quality data above TH 101 where the mainstem of the stream crosses under 125th Street in Savage. The Shakopee Mdewakanton Sioux community has three sets of wells to monitor groundwater around the boiling springs. Finally, there is a set of wells located above the WOMP station that is intended to provide information on groundwater interactions with Eagle Creek.

Future Monitoring Efforts: Other parties (the Mdewakanton Sioux community and the Metropolitan Council) expect to continue current efforts indefinitely. Additional monitoring may be helpful to establish thermal regime of Creek immediately above and below CR 101 crossing, since this is an area of good habitat for trout and may receive urban stormwater inputs in the form of sheet drainage from the adjacent Highway 101 right-of-way.

Priority for Monitoring: HIGH. The fishery is high value, and monitoring to help test the effectiveness of protection measures and help track other potential impacts is important. However, the general consensus of management agencies is that the stream is adequately monitored at this time.

3.1.6 Assumption Creek

Description: This trout stream lies mostly in the City of Chanhassen, with a portion of the watershed of the western fork of the stream in the City of Chaska. The stream is approximately 1.5 miles in length. Estimated baseflow discharge is just less than 5 cfs based on discharge measurements taken near the mouth of the Creek in the early 1980's. Figure A-11 in Appendix 1 at the back of this report contains ground photos of Assumption Creek above and below its crossing under Highway 212. Figure A-12 is an air photo of the Creek.

Existing Studies/Monitoring: Assumption Creek is a small (5-8 feet wide) mostly shaded stream that has continued to maintain a small self-reproducing brook trout population. The last fish population survey was conducted by MnDNR in August 2002 and two brook trout were sampled. Currently, MnDOT is undertaking an extensive study of this area as part of the TH 41 re-routing project, although much of the focus at his time appears to be on Seminary Fen and not Assumption Creek. The scope of this study is explained in more detail in the narrative on Seminary Fen in the next section.

Health of the Resource: MnDNR staff indicates that they believe the stream is heavily impacted above the fen and is dry in some places, but is in good to excellent condition between the fen and the Minnesota River. Development of the watershed represents a potential danger to the Creek because of increased urban runoff. Also, MnDOT is looking at this vicinity as a potential re-routing alternative for TH 41, but most of their work to date has centered on the impact of that project on Seminary Fen and not the Creek.

Current Monitoring Efforts: MnDNR fisheries conduct surveys approximately once every five years. Instantaneous flow measurements collected occasionally by Dan Reess (Chaska High School) on Chaska branch of Creek, otherwise no consistent flow data collected. Wells have been installed to assess fen.

Future Monitoring Efforts: None planned at this time although Phase 2 of TH 41 impact study is supposed to concentrate more on Creek.

It may be helpful to establish more concentrated flow monitoring at TH 212 on mainstem as well as upstream on Chaska branch of Creek. Monitoring to define thermal regime in Creek would also be helpful to help establish suitability for trout.

Priority for Monitoring: HIGH. Some potential risk for impacts to occur to Creek from development, TH 41 project, and other activities. The Creek and the fen in this area are a significant and unique resource that merit protection. It is possible that additional monitoring could be carried out as part of the TH 41 study currently being undertaken by MnDOT.

3.2 Calcareous Fens

The following sub-section describes the known Calcareous Fens in the District. More detailed maps showing the locations of these fens are provided in Appendix B.

3.2.1 Quarry Island Fen

Description: The Quarry Island Fen lies within the City of Mendota Heights in the area immediately north of Interstate 494 and west of Highway 13. See Figure B-1 in Appendix B for location of fen. The fen is approximately 32 acres in size, with the main portion of the fen located in the northwest corner of the intersection of Interstate 494 and Highway 13. A long portion of the fen, however, runs parallel to railroad tracks on the west side of Highway 13, extending approximately 0.75 miles north of the main fen area. This long extension is an expression of the topography change near the railroad tracks. This fen is part of a larger fen complex that includes the Fort Snelling Fen. The fens became separated over the years due to the construction of Interstate 494 and development within the area.

Existing Studies/Monitoring: This fen has been studied by both MnDNR and Fort Snelling Park staff. Studies to date have concentrated on identifying the extent of the fen and studying the health of the fen and the plant species included at this location.

Health of the Resource: Quarry Island Fen is considered to be in relatively good condition by both MnDNR and Fort Snelling Park staff. Native fen species are present and no significant impacts from nearby development have been observed, other than the likely separation of this fen from the Fort Snelling fen during road construction and development activities. Is it thought that development in the recharge area east of the fen may have had some impacts to overall fen health, but there has been no historic monitoring that could quantify these impacts. Development to the recharge area to the east is thought to be complete at this time.

Current Monitoring Efforts: There have been no groundwater monitoring efforts that have taken place at this fen, nor are there any efforts currently taking place. The reason for the lack of monitoring is due to the area being largely developed, with very little future development expected to occur in the immediate area. Current efforts in the area are aimed at maintaining the health of the fen from surface impacts. Four MPCA maintained monitoring wells were identified in the area immediately east of Highway 13, but their value would be somewhat limited, since they would not tell the water table elevation at the fen itself. Their value would be limited only telling water table elevations upgradient of the northern limb of the fen.

Future Monitoring Efforts: According to MnDNR and Fort Snelling Park staff, there are no planned efforts to monitor the groundwater at the Quarry Island Fen. MnDNR staff stated that the best potential location for monitoring would be in the western side of the main fen area, just east of the access road. For this location, a single piezometer nest would likely be the extent of what is required to monitor water levels in this main portion of the fen. The nest would monitor water levels in the peat layer and in the deeper layer immediately below the peat. A well in the recharge area would have limited potential, since the area is already developed and there is no record of water levels in this area prior to development.

Priority for Monitoring: MODERATE/HIGH. The relatively good quality of the fen indicates some need for monitoring. However, since the area is largely fully developed, monitoring might not be able to do anything more than to indicate what, if any, current problems are affecting the fen. A single piezometer nest in the main fen area would likely serve the needs of the immediate future to monitor the ongoing health of the fen.

3.2.2 Fort Snelling Fen

Description: The Fort Snelling Fen lies within the City of Eagan in the area south of Interstate 494 and west of Highway 13. See Figure B-1 in Appendix B for location of fen. The fen is approximately 10 acres in size. This fen is part of a larger complex that likely included Quarry Island Fen to the north, but has since been isolated during roadway construction and development in the area. In some literature, Fort Snelling Fen has also been referred to as the "Sibley Fen".

Existing Studies/Monitoring: This fen has been studied and surveyed by both MnDNR and Fort Snelling State Park staff. This fen was also part of a study by Almendinger and Leete (1998) conducted for the US Geological Survey. Three nesting groups of monitoring wells were installed in the area to measure water levels in and around the fen. These nests are referred to as "N," "S," and "W" (North, South, and West, respectively). Each contains a deep and shallow well to monitoring water level in and below the fen. No wells were completed in the bluff area west of the fen, however. Data was collected from these monitoring wells was terminated in 2002 due to lack of funding and lack of MnDNR staff time.

Health of the Resource: Of the fens in the general area of the Fort Snelling State Park, the Fort Snelling fen is thought to be in the best overall condition. Native fen plant species are prevalent in the area. It is thought that development east of this area may have impacted the fen recharge area, but no monitoring was in place to measure these impacts. Portions of the area around the fen have also accumulated construction debris over the years, with the thickness of this debris ranging from 2 feet to 18 feet. This debris is impacting the areas of the fen that lie directly underneath. Condition and restorability of the underlying fen is unknown.

Current Monitoring Efforts: Currently, no monitoring is taking place at the fen, other than occasional visits by Fort Snelling Park and MnDNR staff to visually survey plant species that are present and to watch for encroachment of invasive species. The monitoring wells for this fen are still in place, although exact locations of the "S" wells are currently unknown.

Future Monitoring Efforts: Staff from MnDNR expressed a desire to locate the "S" wells for this fen and obtain accurate GPS coordinates for all of the wells. At present, neither MnDNR nor Fort Snelling Park staff has plans to resume monitoring of these wells, despite a desire to do so. Lack of funding and staff time are the main obstacles preventing monitoring from taking place.

Priority for Monitoring: HIGH. The overall good condition of this fen makes this an excellent candidate for continued monitoring. The presence of existing monitoring wells within this fen would make continued monitoring relatively easy to implement. Newly collected data from this site could be compared against existing data to measure any impacts that have occurred from development in recent years.

3.2.3 Nicols Fen

Description: The Nicols Meadow Fen lies within the City of Eagan and is located northeast of the intersection of Cedar Avenue (Highway 77) and Highway 13. See Figure B-2 in Appendix B for location of fen. This fen is approximately 35 acres in size and is located immediately south of Kennaley's Creek. Nicols fen is the third fen in the complex covered by the Fort Snelling State Park.

Existing Studies/Monitoring: This fen has been studied and surveyed by both MnDNR and Fort Snelling Park staff. This fen was also part of a study by Almendinger and Leete (1998) conducted for the US Geological Survey. Monitoring wells that exist at this fen include two deeper wells and an unknown number of shallow water table wells. Data was collected from these wells from 1990 to 2002 and was compiled by the MnDNR for study.

Health of the Resource: Of the three fens in the Fort Snelling State Park, Nicols Fen is the most heavily impacted fen. Anecdotal evidence states that this fen was in excellent condition in the mid 1970s, with a very prominent peat dome and plant species similar to what is currently seen at Seminary Fen. Construction of Cedar Avenue circa 1977 was thought to have heavily impacted this fen, with subsequent stormwater runoff heavily impacting the peat layer in the fen. Additionally, dewatering from the nearby Seneca wastewater treatment plant is thought to have heavily impacted water levels in and around the fen, possibly resulting in a partial collapse of the peat aquifer supplying fen species.

The number of native plant species in the fen has been severely limited, according to staff from the US Army Corps of Engineers. Encroachment of invasive plant species is prevalent, as water levels in the fen have been reduced. Finally, staff at Fort Snelling State Park believe that a number of drainage tiles exist within the fen, further reducing water levels and impacting the overall health of the fen.

Current Monitoring Efforts: At present, data collection from the monitoring wells within the fen has ceased due to lack of funding and staff time, with no measurements taking place since 2002. The nearby Seneca plant operates a number of dewatering wells and takes measurements of groundwater levels in the vicinity of the plant, but there is no way to presently correlate these measurements with water levels in the fen.

Future Monitoring Efforts: This resource is within the study area covered by the grant awarded to the Gun Club Lake WMO by the LCMR. Additional monitoring might be undertaken as part of that study, but a work plan detailing the WMO proposed actions will not be available until 2006. No future monitoring efforts for Nicols Fen are presently planned by other entities, other than occasional visual surveys of fen health and plant species in the area. Fort Snelling State Park staff indicated a desire to survey the fen in an attempt to locate and remove drainage tiles in the area to promote restoration of the fen. Any restoration efforts, however, would only be visible over a long time period (several years to decades). Having active monitoring wells to measure these restoration efforts would be a useful indicator to gauge the success of drainage tile removal.

Priority for Monitoring: MODERATE/HIGH. The existing monitoring well network provides an excellent opportunity to resume data collection at this heavily impacted fen. While damage to the fen is thought to be extensive, monitoring would provide an ideal gauge to measure efforts to mitigate damage and begin restoration of the fen. Since restoration would be a long-term effort, monitoring should also be considered for the long-term as well. Capital costs to re-establish monitoring may need to include deepening the shallow fen wells to reach current water table elevations.

3.2.4 Black Dog Lake North Fen

Description: Black Dog Lake North Fen lies in the City of Eagan in the area northwest of the intersection of Cedar Avenue (Highway 77) and Highway 13. See Figure B-2 in Appendix B for location of fen. The size of the fen is not currently known. It is likely this fen once formed part of a larger complex of fens that included Nicols Fen. Construction of Cedar Avenue and other nearby development likely isolated this section of fen from the Nicols Fen.

Existing Studies/Monitoring: There have been no known concentrated efforts to survey or study this fen. No known monitoring of the fen has been identified.

Health of the Resource: Since this fen has never been formally studied or surveyed, the health (and size) of the fen remains largely unknown. It is unlikely that this fen has any significant peat domes or features that would stand out as being high quality features, or else more efforts would have been concentrated on this fen. The impacted health of nearby Un-named Stream #4 indicates the general water table in the area has been somewhat impacted.

Current Monitoring Efforts: No monitoring efforts are currently taking place at this fen.

Future Monitoring Efforts: There are no future monitoring efforts planned for this fen at this time. Lack of MnDNR funding and staff time has prevented this fen from being properly surveyed and studied.

Priority for Monitoring: LOW. Until a proper survey of this fen can take place, the need for monitoring is unknown at this time. If funding for a survey of the fen can be found, and if the fen is thought to be of good enough condition for continued monitoring and/or restoration, then the value of monitoring can be re-evaluated at that time.

3.2.5 Black Dog Fen

Description: Black Dog Fen lies within the City of Eagan and is located east of Interstate 35W and south of Black Dog Lake. See Figure B-2 in Appendix B for location of fen. The size of the fen is not currently known. Portions of this fen are thought to lie on both the north side and south side of the railroad tracks in the area.

Existing Studies/Monitoring: This fen has been the subject of some field surveys by the MnDNR and the US Army Corps of Engineers. Surveys have been mostly aimed towards identifying native fen species, if any exist, and to evaluate the overall health of the fen. Exact size and extent of this fen is difficult to determine because it has been so heavily impacted.

Health of the Resource: Opinions from agency staff vary on the overall health of the fen. While all agree this is the most heavily impacted fen in the area, some have concluded this fen as being extinct (US Army Corps of Engineers and Fort Snelling Park staff) while others (MnDNR staff) believe some areas of fen remain with the potential of preservation. In particular, MnDNR staff have noted that areas of the fen south of the railroad tracks might still be in relatively good condition. Areas of Black Dog Fen north of the railroad tracks are thought to be essentially extinct. While there is some thought that the nearby dewatering of the Kraemer Quarry may have impacted the Black Dog Fen, almost all agency staff believe that stormwater runoff has done the most damage to this area. Reduction of infiltration upgradient of the fen is also thought to have reduced groundwater flow in the area.

Current Monitoring Efforts: There are no current groundwater monitoring efforts taking place at this fen. Monitoring efforts in the past have been directed to fens that were thought to be in better condition and thus, more restorable.

Future Monitoring Efforts: There are no future planned monitoring efforts for Black Dog Fen. The general consensus that this fen is largely extinct likely has limited any plans to monitor the area. The lack of funding to monitor fens in much better condition is indicative of the area-wide lack of resources for fen monitoring and management.

Priority for Monitoring: LOW/MODERATE. While there is very little anticipated value in monitoring the portion of the fen north of the railroad tracks, there may be some value to install a monitoring well nest in the portion south of the railroad tracks if future surveys indicate this area of fen is of sufficient condition to be restorable. Monitoring may also be of some value when the nearby Kraemer Quarry ceases its dewatering activities. Monitoring of this event would provide a fuller idea of the overall impact the Kraemer Quarry had on the nearby groundwater-fed natural resources.

3.2.6 Savage Fen

Description: Savage Fen lies within the City of Savage and is located south and east of Highway 13. See Figure B-3 in Appendix B for location of this fen. The size of the fen is approximately 87 acres, split into numerous segments below the bluff line.

Existing Studies/Monitoring: Numerous studies of Savage Fen have taken place over the years, with most of those having been spearheaded by MnDNR staff. The fen has been actively monitored since the early 1990s and there are numerous groundwater monitoring wells in the area being used to study water table elevations within the peat layer, within the aquifer below the fen, and in the recharge area to the south of the fen.

Health of the Resource: Savage Fen is considered to be in overall very good to excellent condition. Native fen plant species abound in the fen, although recent surveys have indicated that invasive plant species are starting to encroach somewhat at the perimeter of the fen. The lack of any recent fires is likely the reason for this encroachment of invasive species. Studies in the early 1990s concluded that the fen was being impacted by the pumping of nearby City of Savage municipal wells that were completed in the Prairie du Chien and Jordan aquifers.

As a result, the City abandoned their wells closest to the fen and drilled deeper wells to obtain water from the Franconia-Ironton-Galesville (FIG) and Mt. Simon aquifers. The FIG and Mt. Simon aquifer are thought to not be connected hydraulically to the aquifers that feed the Savage Fen. The City still maintains three wells in the shallower aquifers, but those wells area located behind the bluff line and their usage is typically limited only to peak demand periods.

Since the City of Savage reduced its pumping from the shallower aquifers, it is thought that Savage Fen showed an improvement, with the nearby monitoring wells indicating a return of water table levels to what is thought to be more "natural" conditions.

Current Monitoring Efforts: Savage Fen is currently monitored with two deep wells and seven shallow wells. MnDNR staff, with the assistance of District staff, collects data from these wells at regular intervals.

Future Monitoring Efforts: Since Savage Fen is still being actively monitored, there are no future plans to add wells to this site. One of the existing monitoring wells ("SF2") has been damaged from being shot at and will either need to be repaired or abandoned. MnDNR staff feels the current monitoring program does a good job of characterizing the water table in the north-south direction. MnDNR staff would ideally like to see a better characterization of groundwater flow in the east-west direction, but limited funding and resources will likely prevent this from occurring in the foreseeable future.

Priority for Monitoring: LOW. While the excellent condition of Savage Fen necessitates the need for monitoring of its health, the existing monitoring well network and data collection program appears to sufficiently characterize groundwater levels in the area. If the funding or resources to monitor these wells were to disappear, then the priority to re-establish these monitoring efforts should be classified as "HIGH".

3.2.7 Seminary Fen

Description: Seminary Fen lies mostly within the City of Chanhassen with portions of the western edge of the fen complex overlapping into the City of Chaska. The fen is located along Highway 212, west of Highway 101 and east of the City of Chaska. The main portions of the fen that have been more extensively surveyed lie north of Highway 212. More recent surveys have indicated good areas of fen remain in the area south of Highway 212.

See Figure B-4 in Appendix B for location of fen. The size of the fen is approximately 69 acres, but that estimate may change as areas south of Highway 212 are more fully surveyed and studied. Seminary Fen is the only fen identified in this study that lies on the north side of the Minnesota River. Seminary Fen is closely associated with Assumption Creek, with the creek thought to obtain most of its flow from groundwater being discharged by the fen.

Existing Studies/Monitoring: Previous efforts from the MnDNR and the US Army Corps of Engineers have surveyed the fen area to the north of Highway 212. More recently, studies have been commissioned by MnDOT to further survey the fen and to assess any impact that may take place with two currently planned highway projects. These projects include the re-alignment of Highway 212 and the construction of a new Minnesota River bridge to replace the existing bridge. The exact placement of the new bridge is unknown, therefore the study was needed to determine present conditions of the fen and provide a network of monitoring wells to measure the impact of these highway projects as they proceed.

Health of the Resource: Of the fens located within the District, Seminary Fen is thought to have some of the finest features, including a very prominent peat dome and an excellent community of native fen plant species. Portions of the fen have been impacted earlier in the 20th century when drainage tiles were installed and areas of the peat layer were mined. What remains of the fen complex, however, is still thought to be in excellent condition. The discovery of areas of fen south of Highway 212 increases the value of this resource, since portions of this area are likely undisturbed. The health of Seminary Fen is closely tied in with the health of Assumption Creek, as Seminary Fen is thought to supply Assumption Creek with most of its water.

The fact that Assumption Creek is heavily impacted upstream of the fen, but remains in good to excellent condition downstream of the fen attests to amount of water the fen supplies to the creek. Like Savage Fen, the encroachment of invasive plant species is starting to be noticed at Seminary Fen, due to the lack of any recent fires in the area.

Current Monitoring Efforts: As part of the MnDOT study, twelve shallow piezometers were installed in the fen to monitor water table elevations within the fen. Data taken from these piezometers will be used to establish baseline water levels prior to the beginning of the highway construction projects. Previous to the installation of these piezometers, no ongoing groundwater monitoring is known to have taken place.

Future Monitoring Efforts: Two well nests containing a total of five wells are to be installed to monitor the water level in the water table aquifer and the deeper buried aquifer. These monitoring wells will be useful in indicating whether regional aquifer water levels are being impacted. That data can then be tied in to measure the impacts to the shallow piezometers currently in place. Well installation is expected to be completed in late 2005.

Priority for Monitoring: HIGH. The lack of previous monitoring efforts for this high quality fen combined with the upcoming highway construction projects makes Seminary Fen the highest priority area to establish a full groundwater monitoring network. The current plans for well installation accomplish this. Priority should be placed on not only establishing the network but planning on maintaining data collection for the foreseeable future.

Section 4 Other Issues

4.1 Kraemer Quarry Pumping Impacts

The proximity of the Kraemer Quarry to the groundwater fed natural resources in the District brings up the question as to whether the dewatering at the quarry has a significant impact on the nearby fens and trout streams. In an effort to study potential impacts of the Kraemer Quarry dewatering, the MnDNR established a monitoring program at the quarry, collecting three years worth of water level data at wells near the quarry.

This monitoring program ceased in June 2005 with no report made on the findings of the study. Discussions with DNR staff revealed that very little could be determined from the data, since the groundwater levels near the quarry have essentially stabilized after years of continued dewatering.

When asked if the quarry had any affects on the closest trout streams and fens, MnDNR staff could not say with any certainty what the affect might have been. They acknowledge that the dewatering activities have been taking place longer than the MnDNR has been collecting regular groundwater level data in the area, so no solid picture of pre-dewatering water levels exists. While there is some acknowledgement that dewatering may have impacted the nearby Black Dog Fen, opinion appears to point towards other causes being the more likely demise of this fen, such as stormwater impacts and decreased infiltration in the recharge area above the bluff line. It is thought that the dewatering may mostly be capturing water that would otherwise be lost to discharge to the Minnesota River.

The effects on features that are to the sides of the quarry may be limited, as side gradient impacts are expected to be much less than down-gradient impacts. Since very little land rests down-gradient of the quarry (i.e. the area between the quarry and the Minnesota River), very little land may actually be impacted by the dewatering.

The Kraemer Quarry expects to continue dewatering for its mining operations until approximately 2018. At that time, dewatering will cease and the pit will be allowed to return to pre-pumping water levels, essentially creating a new lake in the area. There is a plan under consideration to utilize water from the quarry to supply water to a regional water treatment plant for local municipalities (such as Burnsville and Savage). This plan is designed to mitigate the need to drill more wells to obtain the water from other areas that could possibly worsen the impact on natural resources in other locations and/or apply unnecessary stress to aquifers already overworked in these communities. If this plan were enacted, the quarry would still be allowed to fill up and water would be pumped from the lake that formed.

When dewatering activities at the quarry cease, it will be valuable to have established monitoring well networks at nearby groundwater-fed natural resources to determine what impact, if any, the quarry had on these natural resources.

Section 5

Recommended Monitoring Program

This section presents a listing of monitoring opportunities that are recommended based on the findings of this study. Recommendations are listed in order of priority, with the highest priority items placed first. A summary of recommendations and their estimated costs is provided in Table 5.1.

5.1 Seminary Fen Monitoring

Recommendation: Install two well nests at locations immediately north of identified fen areas to supplement piezometers already installed for the MnDOT study. The high quality of the Seminary Fen and the lack of previous monitoring efforts make this a high priority fen for establishing a monitoring program. The upcoming highway and bridge construction projects also bring concerns about adverse impacts to the fen. Having a baseline of data before construction begins will allow the LMRWD to determine if impacts from construction are adversely affecting the fen (and nearby Assumption Creek) and possibly allow time to remedy problems before they become too severe.

Implementation: The installation of two upgradient well nests will allow for data collection from the water table aquifer and the deeper buried aquifer. A total of five wells will be installed among the two nests. Installation of automatic measuring equipment will provide a continuous stream of data that will allow for high quality data to pinpoint exactly when impacts reach the underlying aquifer. During periods of construction, data should be downloaded on a monthly basis to not only observe impacts shortly after they occur but to ensure effective operation of the instruments during critical periods. Post construction data collection can be reduced to allow for greater time between data downloads. One visit every 2 months, at a minimum, should be maintained to ensure consistent ongoing data collection and to routinely replace batteries and check instrument calibration.

Estimated Cost: Capital costs: $17,500 for the installation of two monitoring well nests. $5,000 for automatic data recorders to be installed in these wells. $1000 per year in maintenance and repair costs to wells and instruments.

Staff hours: 90 hours for first year for installation of equipment, monthly site visits, data interpretation, and analysis. 70 hours annually for subsequent years.

Potential Co-operators: MnDOT staff and their consultants would be the primary co-operators during the highway and bridge construction projects. MnDNR would be a co-operator with the collection and/or analysis of data.

5.2 Assumption Creek Monitoring

Recommendation: Install water level recorders and temperature recorders at two locations in Assumption Creek (probably on mainstem near Highway 212 and on west fork). For reasons cited in the previous write-up on Seminary Fen, this is an important coldwater resource for which relatively little monitoring data has been collected.

Implementation: It is anticipated that a number of instantaneous discharge measurements would need to be taken to develop a reliable rating curve at the two flow monitoring sites. During and after this is done, data loggers to record stream water surface levels would be installed to provide a continuous record for the monitoring period (assumed to be 8 months between April 1 and November 30). Along with the stream water surface recorders, temperature recorders would also be installed and operated during the same time period.

Estimated Costs: Capital costs: $3,400 for 2 data loggers and 2 temperature probes and optic shuttles as well as associated mounting hardware.

Staff hours: Year 1: 94 hours for both sites (24 hours for development of rating curves, 40 hours for monthly site visits and downloading of data, 30 hours for data analysis and preparation of summary report. Assumes 8 month monitoring period).

Year 2+: 80 hours total for re-installation of equipment, checking of rating curve, monthly visits and downloading of data, and data analysis and preparation of brief summary report.

Potential Co-operators: MnDOT staff and their consultants would be the primary co-operators during the TH 41 studies of area. MnDNR would be a co-operator with the collection and/or analysis of data.

5.3 Fort Snelling Fen Monitoring

Recommendation: Data collection should resume at the existing monitoring well network to ensure that degradation of this resource is not occurring. The good quality of this fen establishes the need to provide continued monitoring and protection.

Implementation: With the infrastructure already in place to continue monitoring, implementation can simply be either the collection of manually-recorded groundwater levels in each of the monitoring wells or the installation of automatic data recorders in the wells. Manual measurements would likely take place at the same frequency as measurements recorded in other fen monitoring wells (i.e. Savage Fen wells). This is typically once a month. Automatic data recorders provide higher quality and more continuous data, but they still require routine visits to ensure instrument functionality and calibration. For the Fort Snelling Fen, where much of the surrounding area is already developed, longer term trends will be more important to monitor than short term trends. As such, monthly manual measurements would likely suffice.

Estimated Cost: Capital costs: Approximately $1,500 should be invested in locating (and surveying) all of the fen wells and conducting any necessary repairs to the wells before utilizing them for monitoring. Approximately $500 per year (average) will be required for maintenance and repairs to monitoring wells, noting that some years may not need repairs and others may need significant repairs beyond $500.

Staff hours: 60 hours per year of staff time will be required for monthly site visits for data collection, data analysis, and reporting. Actual hours may be reduced if coupled with other nearby fen monitoring.

Potential Co-operators: MnDNR and Fort Snelling State Park would be potential co-operators, either with data collections efforts or with data analysis efforts.

5.4 Quarry Island Fen Monitoring

Recommendation: A 2-3 piezometer nest should be installed in the west edge of the main fen area, near the access road. The quality of this fen necessitates that monitoring of this resource be established to measure what impacts, if any, reach this fen from nearby activities. Additionally, correlation of water levels between the Quarry Island Fen and the Fort Snelling Fen would be useful in determining whether there is a strong hydraulic relationship between these two fens.

Implementation: Installation of a nest of 2-3 piezometers should take place near the access road. Like the Fort Snelling Fen, monitoring of these wells is likely best accomplished through manually recorded measurements taken once a month. Automatic data collection instruments are an option, but the need for continuous measurements at this already-developed area may be low.

Estimated Cost: Capital costs: Installation and surveying of 3 piezometers will be approximately $1,500 (including labor). Approximately $200 per year (average) will be required for maintenance and repairs to piezometers, noting that some years may not need repairs and others may need significant repairs beyond $200.

Staff hours: 50 hours per year of staff time will be required for monthly site visits for data collection, data analysis, and reporting. Actual hours may be reduced if coupled with other nearby fen monitoring.

Potential Co-operators: MnDNR staff should be consulted on exact placement of monitoring wells. MnDNR and Fort Snelling State Park staff may be co-operators with data collection and/or data analysis.

5.5 Nicols Fen Monitoring

Recommendation: Re-establish monitoring at the wells already installed in Nicols Fen. While this fen is heavily impacted, there is still a value for monitoring the fen and groundwater levels. If restoration efforts (i.e. removal of drainage tiles) take place, having a working monitoring well network will be essential to gauge the success of any restoration program.

The monitoring well network would also be useful in determining whether the impacts on Nicols Fen have stabilized or whether drawdown of the water table is continuing. Correlation of data from the fen wells with the nearby Seneca plant wells can establish how much impact the dewatering at the plant is impacting the fen.

Implementation: Deepen any of the shallow piezometers, if necessary. Resume data measurement at the monitoring well network, taking monthly manual measurements.

Estimated Cost: Capital costs: Approximately $1,500 should be invested in locating, surveying, and conducting any necessary repairs to the piezometers (i.e. deepening them) before utilizing them for monitoring. Approximately $500 per year (average) will be required for maintenance and repairs to monitoring wells, noting that some years may not need repairs and other may need significant repairs beyond $500.

Staff hours: 60 hours per year of staff time will be required for monthly site visits for data collection, data analysis, and reporting. Actual hours may be reduced if coupled with other nearby fen monitoring.

Potential Co-operators: MnDNR can be co-operators with finding wells and advising on any well re-construction, if necessary. MnDNR and Fort Snelling State Park staff may be co-operators with data collection and/or analysis. The Gun Club WMO has also expressed a willingness to be a cooperator, and it is possible that some of the cost of re-establishing the monitoring network could be paid for by the LCMR grant they received.

5.6 Black Dog Fen Monitoring

Recommendation: Establish monitoring well nest in an area of fen, if found, that is identified as still containing native fen plant species. The assumption that all of the Black Dog Fen is "dead" may not be wholly accurate, according to MnDNR staff. If parts of Black Dog Fen are found to be in good or restorable condition, establishing monitoring of local groundwater elevations will be key in fen restoration and/or maintenance.

Implementation: Work closely with MnDNR staff to identify areas of fen with native species. Install monitoring well nest in shallow water table and in aquifer below peat layer. Conduct monthly manual groundwater measurements to determine stability of water levels in area.

Estimated Cost: Capital costs: Approximately $1,500 should be budgeted for initial investigation of the fen to locate possible areas of monitoring. Another $1,500 is estimated for the installation of a 3 piezometer nest for water level measurements (including labor). An average of $200 per year should be budgeted for well maintenance and repairs, with actual costs expected to vary each year depending on the amount of repairs or maintenance required.

Staff hours: 50 hours per year of staff time will be required for monthly site visits for data collection, data analysis, and reporting. Actual hours may be reduced if coupled with other nearby fen monitoring.

Potential Co-operators: MnDNR staff should cooperate to offer advice on areas of fen that would be ideal for monitoring wells. MnDNR staff may cooperate with data collection and/or analysis.

5.7 Un-named Stream #7 Monitoring

Recommendation: Install a temperature recorder in Un-named Stream #7 near the railroad crossing. While the stream is small and access is very limited, it appears to be largely intact. This monitoring effort could help establish baseline conditions for future protection of this unique area at minimal cost and could be of value in characterizing the un-impacted condition of similar resources elsewhere in the District.

Implementation: A temperature recorder would be installed and operated to generate a continuous record of temperature during at least the critical summer period (May 30 – September 30) when thermal impacts from urban discharges are most likely to occur. It is anticipated that the monitoring effort would need to be carried out over a single year. At the same time, several instantaneous discharge measurements could be taken during trips to generate temperature data at virtually no additional cost.

Estimated Costs: Capital costs: $500 for 1 temperature probe and optic shuttle as well as associated mounting hardware.

Staff hours: Year 1: 44 hours (8 hours for ordering and installing equipment, 20 hours for monthly site visits and downloading of data, 16 hours for data analysis and preparation of summary report. Assumes a four month monitoring period).

Potential Co-operators: City of Burnsville. MnDNR could also be a co-operator with the collection and/or analysis of data.

5.8 Eagle Creek Monitoring

Recommendation: Install a temperature recorder in Eagle Creek near the Highway 101 crossing. While the stream is well-monitored, information from MnDNR indicates that the some of the best habitat and trout populations lie near the Highway 101 crossing, well below the WOMP station. This monitoring effort could inexpensively help establish habitat conditions in this reach of the stream and provide data that indicate whether urban runoff from Highway 101 is having an impact on the stream.

Implementation: Two temperature recorders would be installed and operated to generate a continuous record of temperature during at least the critical summer period (May 30 – September 30) when thermal impacts from urban and highway discharges are most likely to occur. It is anticipated that the monitoring effort would need to be carried out over a single year initially, then re-evaluated for continuation. The temperature recorders would be installed above and below the Highway 101 crossing.

Estimated Costs: Capital costs: $1,000 for 2 temperature probe and an optic shuttle as well as associated mounting hardware.

Staff hours: Year 1: 54 hours (10 hours for ordering and installing equipment, 24 hours for monthly site visits and downloading of data, 24 hours for data analysis and preparation of summary report. Assumes a four month monitoring period).

Potential Co-operators: Met Council and/or MnDNR could be a co-operator with the collection and/or analysis of data.

5.9 Monitoring Recommendation Summary

Table 5.1 below summarizes the monitoring recommendations presented above in order of priority.

Table 5.1 Recommended Monitoring Efforts and Associated Costs

Monitoring Effort	Capital Costs	Staff Hours
Seminary Fen Monitoring	$17,500 for nested well installation. $5,000 for data loggers. $1,000 annually for maintenance.	Year 1: 90 hours Year 2+: 70 hours per year
Assumption Creek Monitoring	$3,400 for two data loggers and two temperature probes, along with associated hardware.	Year 1: 94 hours Year 2+: 80 hours per year
Fort Snelling Fen Monitoring	$1,500 for well survey and repairs. $500 annually for maintenance.	60 hours per year*
Quarry Island Fen Monitoring	$1,500 for piezometer installation. $200 annually for maintenance.	50 hours per year*
Nichols Fen Monitoring	$1,500 for well survey and repairs. $500 annually for maintenance.	60 hours per year*
Black Dog Fen Monitoring	$1,500 for initial well location study. $1,500 for piezometer installation. $200 annually for maintenance.	50 hours per year*
Un-named Stream #7	$500 for equipment	44 hours per year
Eagle Creek	$1,000 for equipment	54 hours per year

*combining four fen monitoring efforts would reduce staff hours by approximately 60 hours per year

Section 6

Other Possible Recommended Actions

The above recommendations are geared towards groundwater monitoring efforts, which is what this study concentrated on. In the course of our study, however, we identified possible recommended activities that could be conducted to help restoration efforts of specific natural resources. The scope of these recommendations can vary greatly, depending on the level of effort the District may wish to undertake. As such, accurate cost estimates are not available at this time. To enact any of these recommendations would involve close co-operation with MnDNR staff and any other local agencies with jurisdiction in these areas. In some cases, such as the restoration of the Nicols Fens, Fort Snelling staff have expressed a desire to begin restoration efforts, but haven't yet done so due to lack of funding and staff time.

6.1 Reclaim Eroded Stormwater Conveyance Channel Adjacent to Nicols Fen

Past stormwater discharges from a storm sewer near the intersection of Nicols Road with the railroad have created an eroded channel that appears to skirt the southwestern edge of the Nicols fen. MnDNR staff have expressed concern that the eroded channel appears to be bleeding some water from the fen. The storm sewer was removed and relocated by the City of Eagan in 2003 and the plunge pool immediately off the end of the pipe was filled in. However, the channel along the flank of the fen remains. Backfilling and stabilization/re-vegetation of the existing channel should be undertaken in cooperation with the MnDNR and Fort Snelling Park, and possibly with the Gun Club Lake MWO.

6.2 Assist with Control of Invasive Species

One identified concern among staff from MnDNR, US Army Corps of Engineers, and Fort Snelling State Park, was the encroachment of invasive plant species at the perimeters of established fens, including Savage Fen and Seminary Fen. In natural settings, these invasive species are usually controlled from occasional grass and brush fires. The proximity of these fens to developed areas reduces the likelihood that natural fires can establish themselves and be allowed to burn sufficiently to remove invasive species.

Agency staff have expressed a desire to control invasive species, either through direct removal efforts or controlled burning. Direct removal efforts would require a trained botanist to identify which species are native to fens (and thus should be left in place) and what species should be removed. As such, if the district were to assist in removal of invasive species, it would likely be through the funding of a trained individual or team to conduct the removal.

6.3 Assist with Nicols Fen Restoration Efforts

Staff at Fort Snelling State Park have reason to believe that a number of buried drain tiles exist within the Nicols Fen complex. One possible means of fen restoration would be to locate and remove these drain tiles (if found to still be discharging water) in the hopes that water levels would return to pre-tiled conditions. Removal of tile would be a delicate operation, needing to avoid disturbance of nearby fen species and habitat in order to avoid further damage to the fen. Again, the District's role would likely be assistance in funding the removal of these tiles. Supplementing the tile removal would be efforts to monitor any responses at the nearby Nicols Fen monitoring wells.

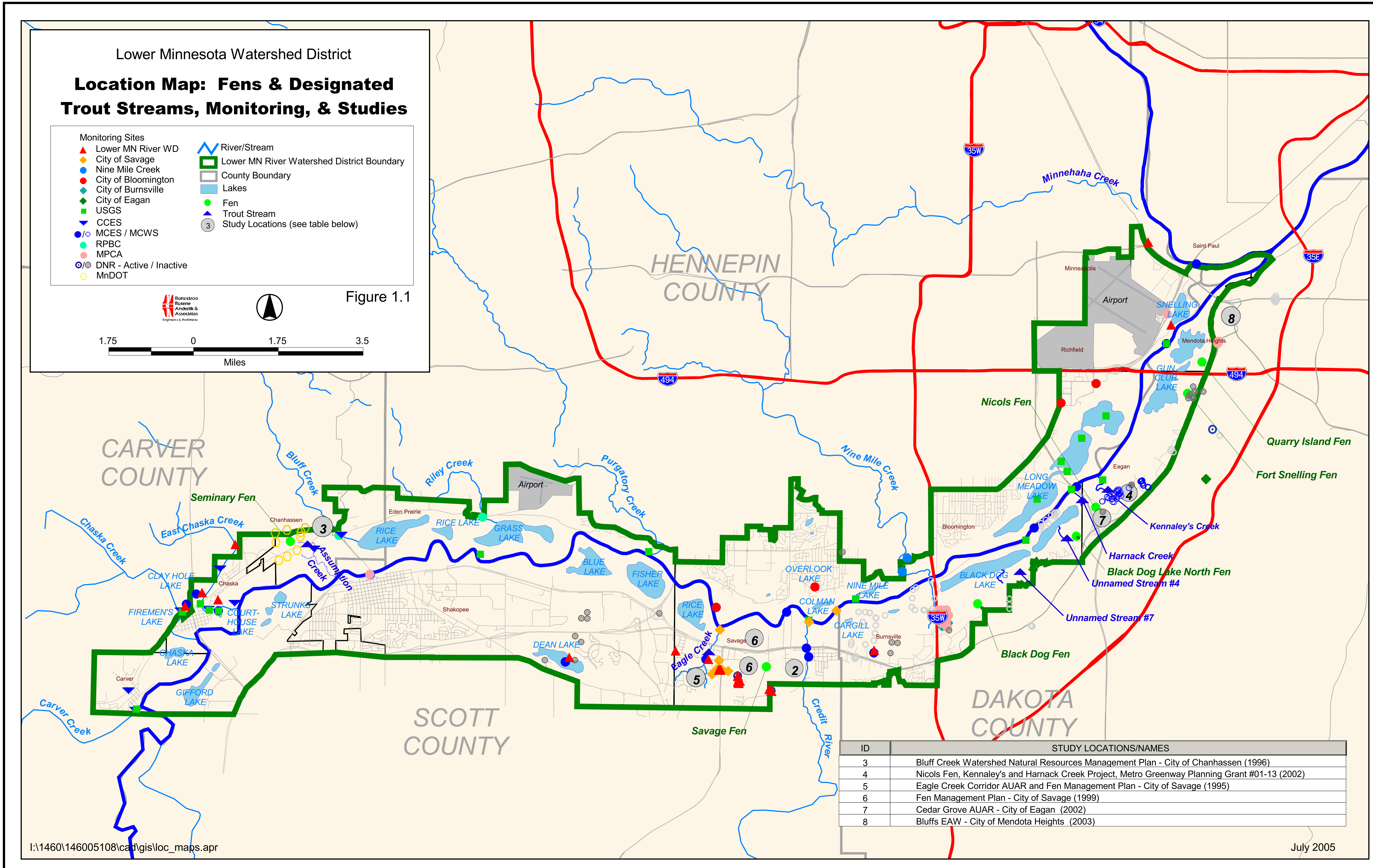
6.4 Removal of Construction Debris at Fort Snelling Fen

The present deposits of construction debris over parts of Fort Snelling Fen range from 2 feet to 18 feet in depth, according to Fort Snelling State Park staff. Removal of this debris may aid in restoring additional areas of this fen. To conduct this removal, a study would first have to be conducted to determine if intact peat layers remain underneath the debris and are thought to be in sufficient condition as to be habitable for native fen species once the debris is removed. Actual removal of the debris would need to be conducted so as to not compact or disturb the underlying soils, with great attention being taken to not impact areas of the fen currently in good condition.

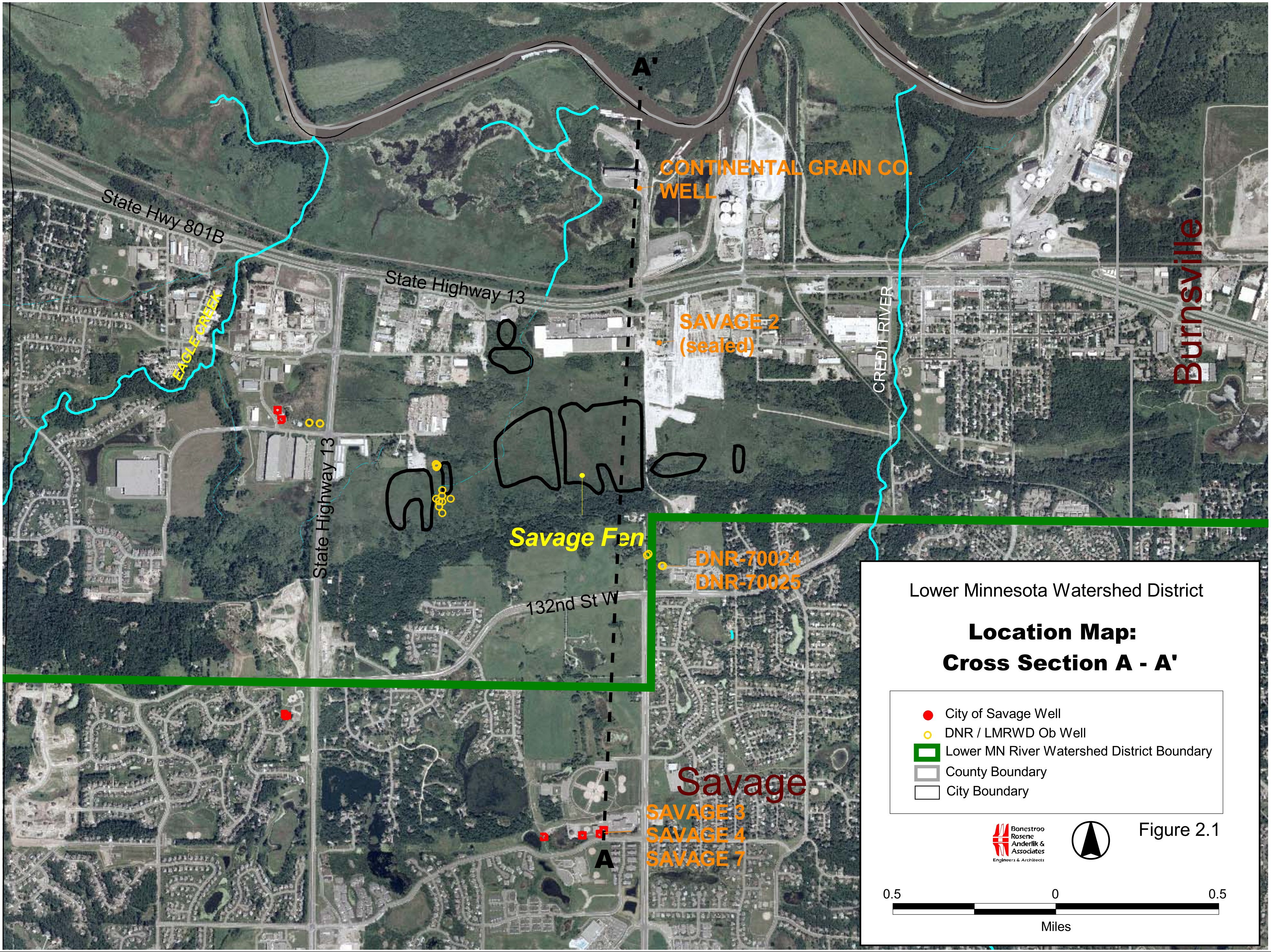
Section
7 References

Almendinger, James E. and Jeanette H. Leete. June 1998. *Regional and Local Hydrogeology of Calcareous Fens in the Minnesota River Basin, USA*. Wetlands 18:184-202.

Komar, S. C. 1994. *Geochemistry and Hydrology of a Calcareous Fen within the Savage Fen Wetlands Complex, Minnesota, USA.* Geochimica et Cosmochimica Acta 58:3353-3367.



ID	STUDY LOCATIONS/NAMES
3	Bluff Creek Watershed Natural Resources Management Plan - City of Chanhassen (1996)
4	Nicols Fen, Kennaley's and Harnack Creek Project, Metro Greenway Planning Grant #01-13 (2002)
5	Eagle Creek Corridor AUAR and Fen Management Plan - City of Savage (1995)
6	Fen Management Plan - City of Savage (1999)
7	Cedar Grove AUAR - City of Eagan (2002)
8	Bluffs EAW - City of Mendota Heights (2003)


A'
CONTINENTAL GRAIN CO. WELL
State Hwy 801B
State Highway 13
SAVAGE 2 (sealed)
CREDIT RIVER
Burnsville
EAGLE CREEK
State Highway 13
Savage Fen
DNR-70024
DNR-70025
132nd St W
Savage
SAVAGE 3
SAVAGE 4
SAVAGE 7
A
Lower Minnesota Watershed District
Location Map:
Cross Section A - A'
City of Savage Well
DNR / LMRWD Ob Well
Lower MN River Watershed District Boundary
County Boundary
City Boundary
Bonestroo Rosene Anderlik & Associates
Figure 2.1
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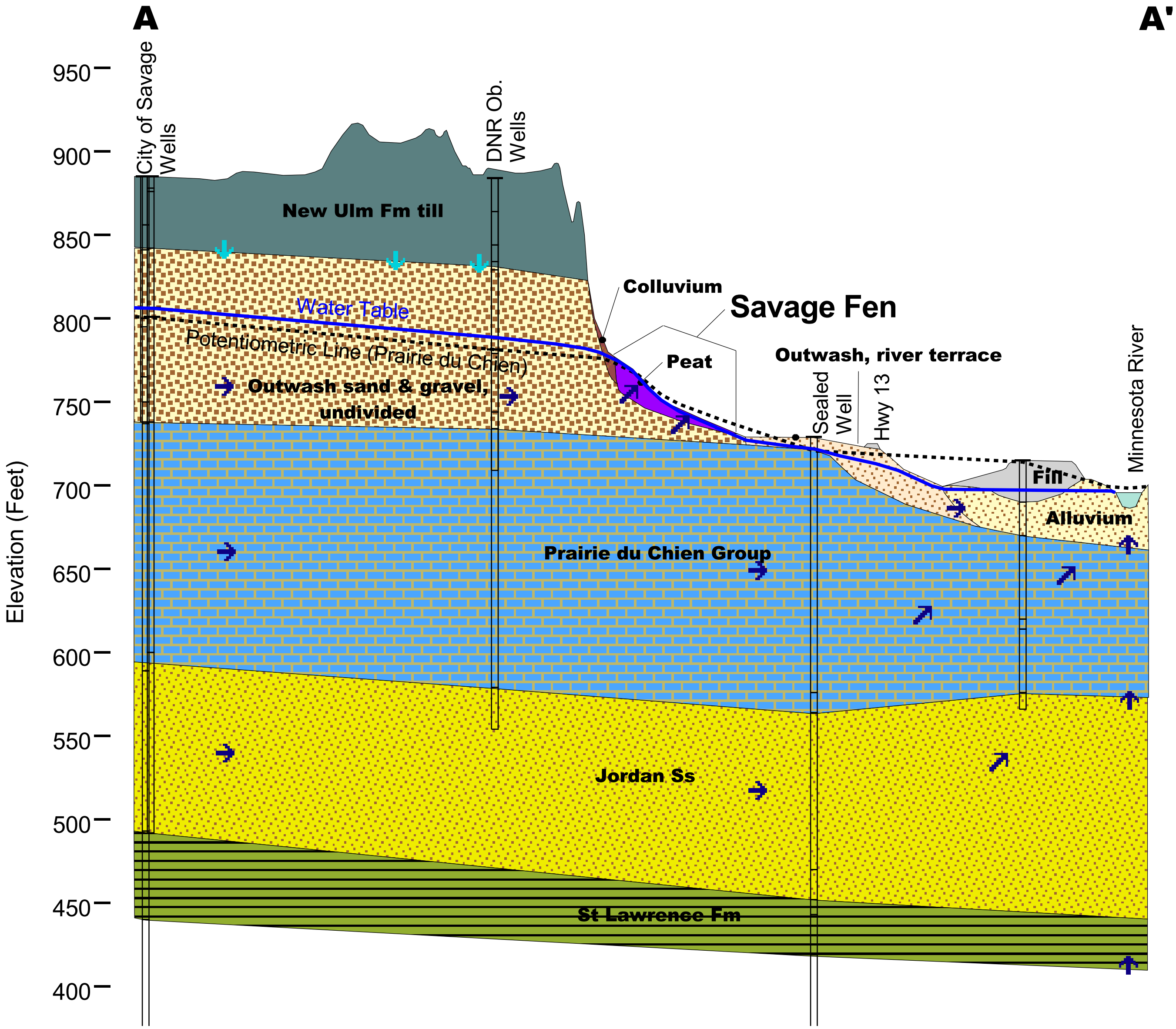

Geologic Cross Section A - A'

Lower Minnesota River Watershed District **Figure 2.2**

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miles

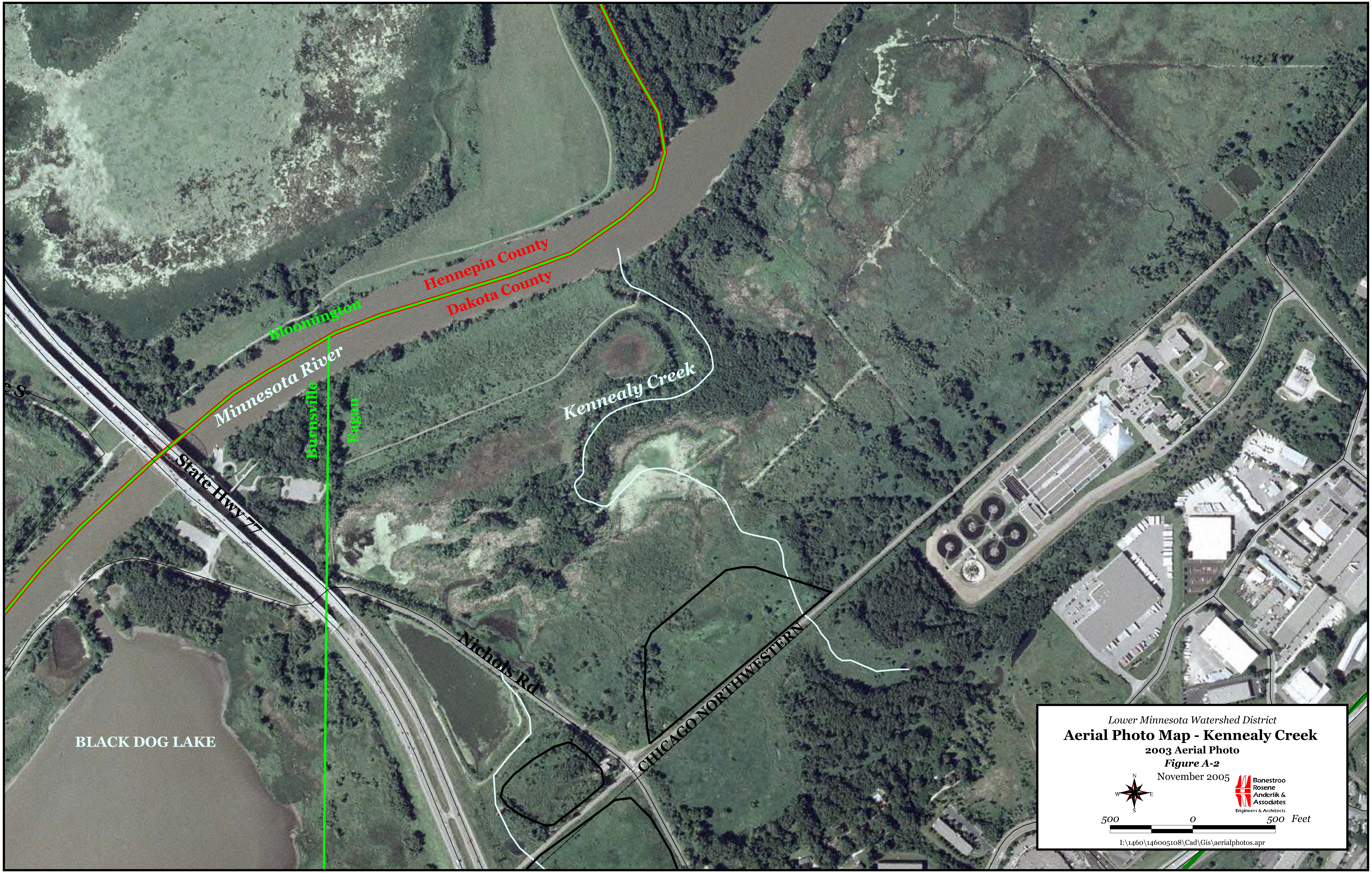
Bonestroo Rosene Anderlik & Associates
Engineers & Architects

June 2005

Figure A-1
Kennaley Creek (Photos taken October 2005)

Looking downstream from RR crossing

Looking upstream from RR crossing



Hennepin County
Dakota County
Bloomington
Minnesota River
Burnsville
Eagan
Kennealy Creek
State Hwy 77
Nichols Rd
CHICAGO NORTHWESTERN
BLACK DOG LAKE
Lower Minnesota Watershed District
Aerial Photo Map - Kennealy Creek
2003 Aerial Photo
Figure A-2
November 2005
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Bonestroo Rosene Anderlik & Associates
Engineers & Architects
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Figure A-3
Harnack Creek (Un-named Steam #1) (Photos taken October 2005)


Looking downstream from RR crossing, TH 77 in background


Looking upstream from RR crossing

State Hwy 77
Minnesota River Rd
BLACK DOG LAKE
Nichols Rd
CHICAGO NORTHWESTERN
Harnack Creek
Silver Bell Rd
State Hwy 13
Cedarvale Blvd
CHICAGO NORTHWESTERN
Lower Minnesota Watershed District
Aerial Photo Map - Harnack Creek
2003 Aerial Photo
Figure A-4
November 2005
Bonestroo Rosene Anderlik & Associates
Engineers & Architects
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Figure A-5
Un-named Stream #4 (photos taken August 2005)

Looking downstream from RR crossing, note beaver dam

Channel upstream of RR crossing showing scour from storm sewer discharges

Bloomington
Hennepin County
Minnesota River
Dakota County
BLACK DOG LAKE
Unnamed Stream #4
CHICAGO NORTHWESTERN
Burnsville
Eagan
Hayes Dr
Cedarbridge Ave
State Hwy 13
Lower Minnesota Watershed District
Aerial Photo Map - Unnamed Stream #4
2000 Aerial Photo
Figure A-6
November 2005
Storm Sewer
Bonestroo Rosene Anderlik & Associates
500 0 500 Feet
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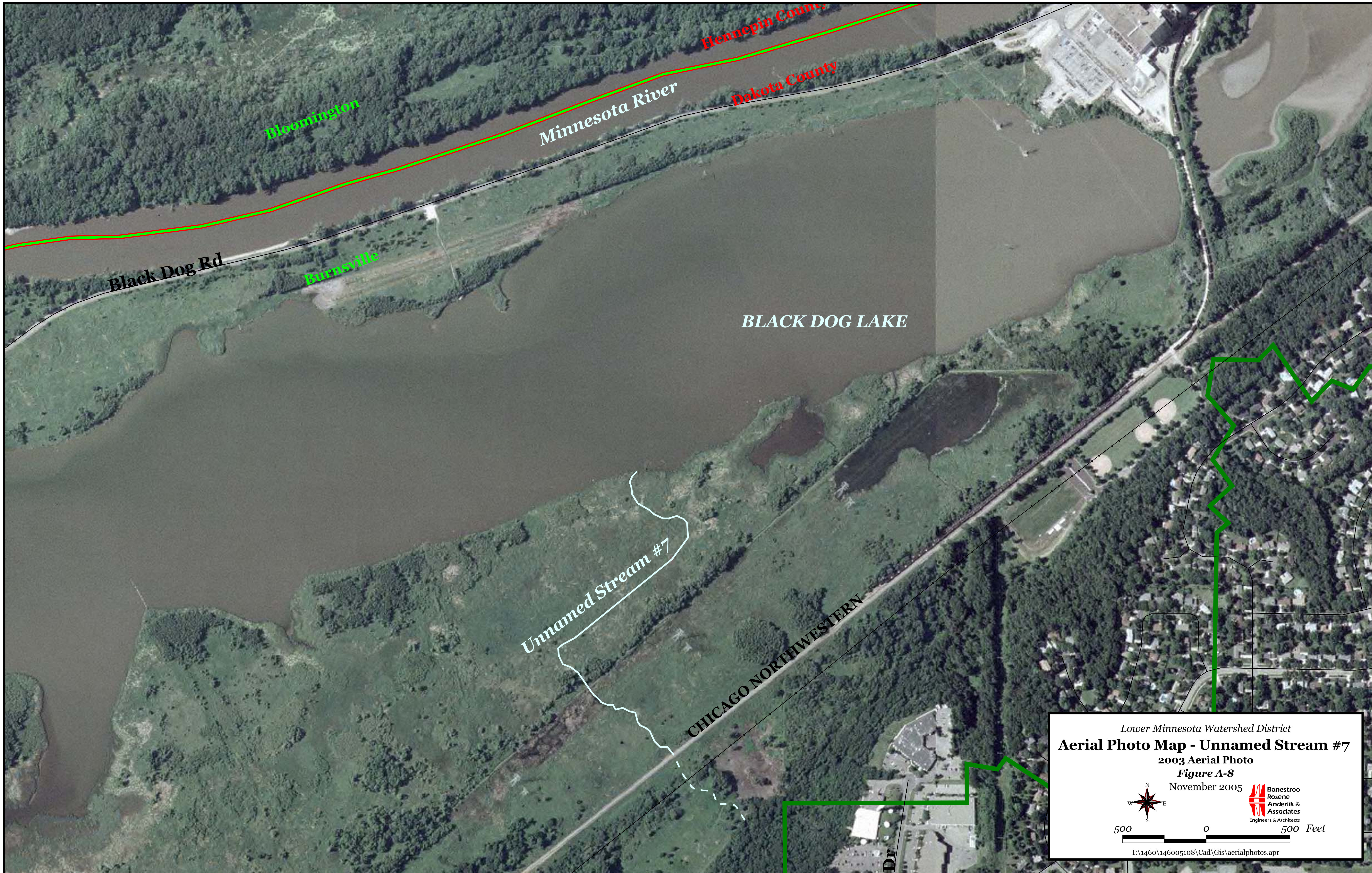
Figure A-7
Un-named Stream #7 (photos taken August 2005)

Looking upstream from RR crossing

Channel just upstream of RR crossing with water cress



Hennepin Count
Bloomington
Minnesota River
Dakota County
Black Dog Rd
Burnsville
BLACK DOG LAKE
Unnamed Stream #7
CHICAGO NORTHWESTERN
Dr
Lower Minnesota Watershed District
Aerial Photo Map - Unnamed Stream #7
2003 Aerial Photo
Figure A-8
November 2005
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Bonestroo Rosene Anderlik & Associates
Engineers & Architects
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Figure A-9
Eagle Creek (photos taken October 2005)

Looking downstream from wooden bridge just above Highway 101

Looking upstream from wooden bridge just above Highway 101


RICE LAKE
Scott County
Hennepin County
Bloomington
Savage
Minnesota River
Eagle Creek
CHICAGO NORTHWESTERN
State Hwy 101B
State Hwy 13
Boone Ave
Zinran Ave
125th St
Rhode Island Ave S
Pennsylvania Ave
Shakopee
Creek Way
128th St
State Hwy 13
Boiling Springs Ln
Creekside Dr
Lower Minnesota Watershed District
Aerial Photo Map - Eagle Creek
2003 Aerial Photo
Figure A-10
November 2005
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Bonestroo Rosene Anderlik & Associates
Engineers & Architects
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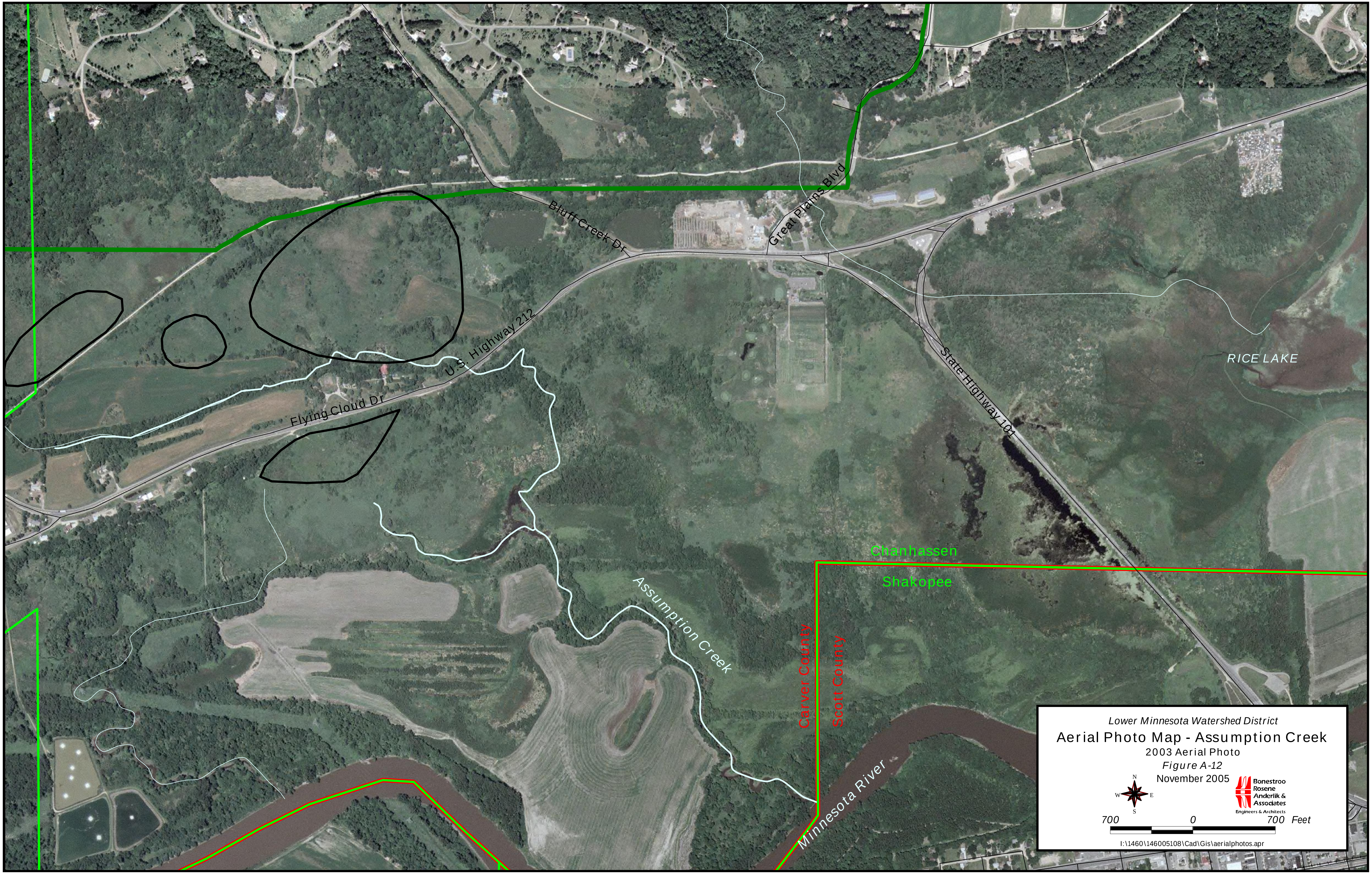
Figure A-11
Assumption Creek (photos taken October 2005)

Creek just downstream of Highway 212 crossing

Creek just above Highway 212 crossing



Bluff Creek Dr
Great Plains Blvd
U.S. Highway 212
Flying Cloud Dr
State Highway 101
RICE LAKE
Assumption Creek
Chanhassen
Shakopee
Carver County
Scott County
Minnesota River
Lower Minnesota Watershed District
Aerial Photo Map - Assumption Creek
2003 Aerial Photo
Figure A-12
November 2005
Bonestroo Rosene Anderlik & Associates
Engineers & Architects
700 0 700 Feet
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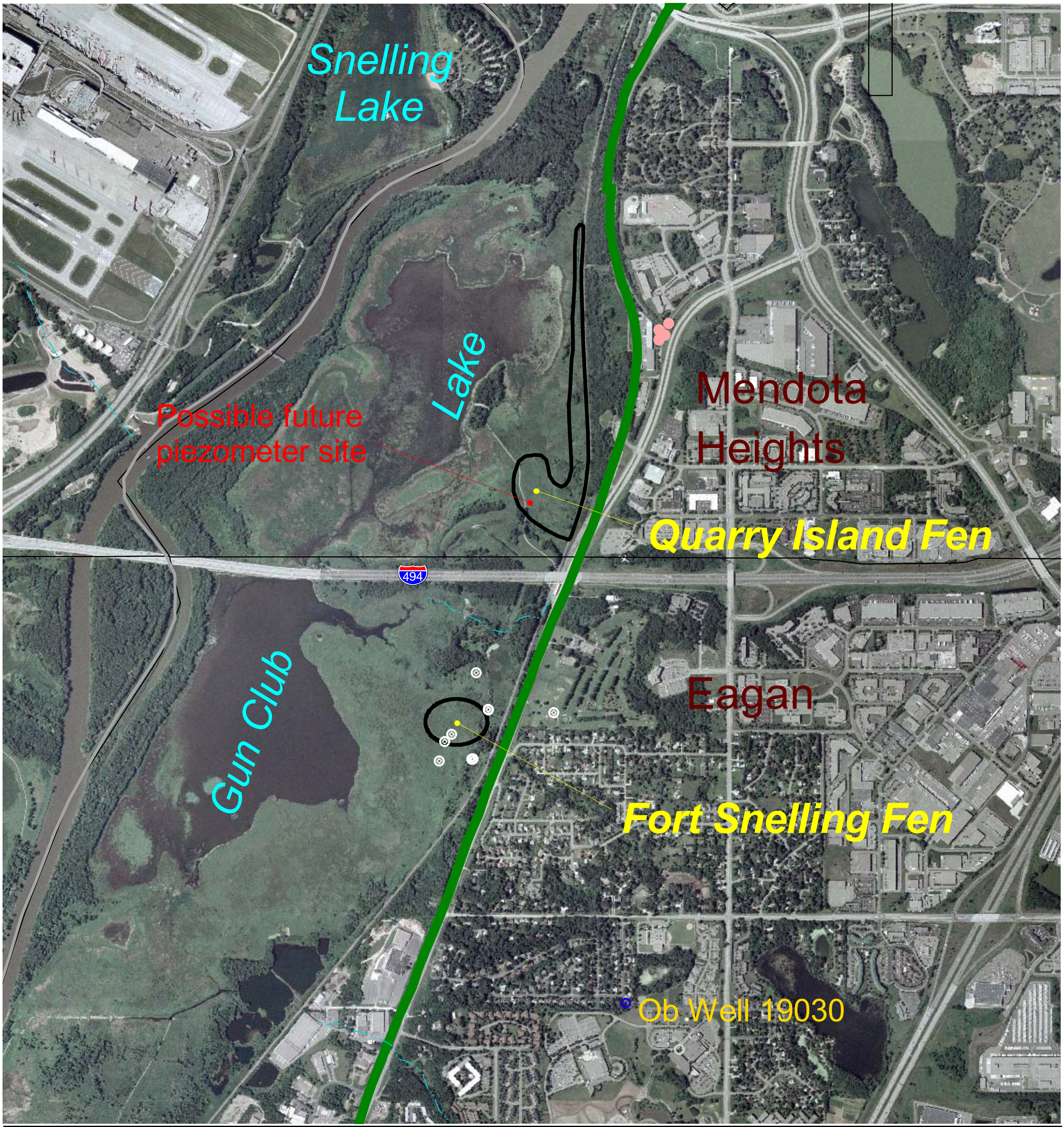

Figure B-1

Monitoring Sites
- DNR Ob Well
- DNR (Inactive)
- MPCA

- Lower MN River Watershed District Boundary
- Watershed Boundary
- County Boundary
- City Boundary

Lower Minnesota Watershed District

Location Map: Gun Club Lake Area Resources & Monitoring

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

0.5 0 0.5 1
Miles

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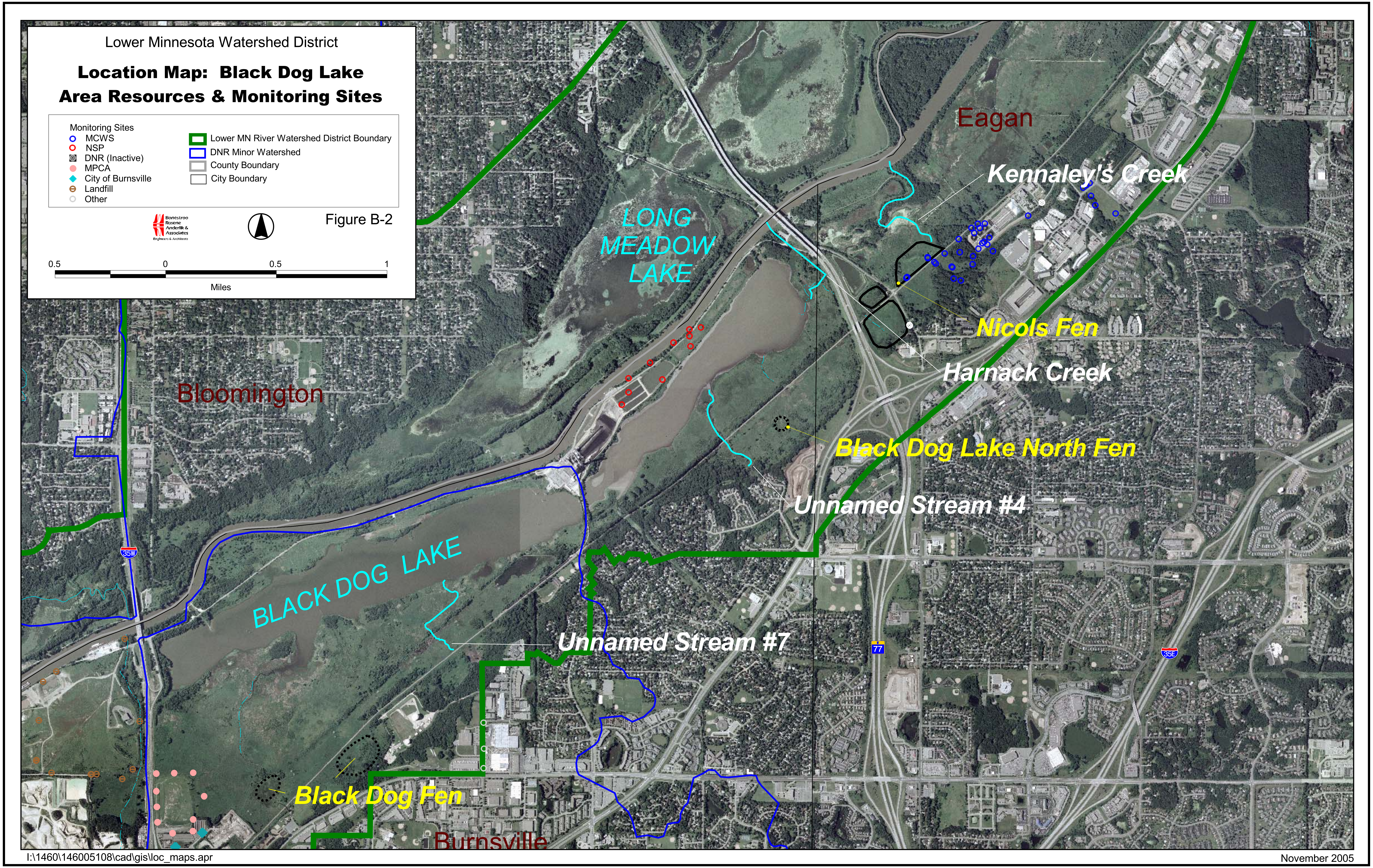
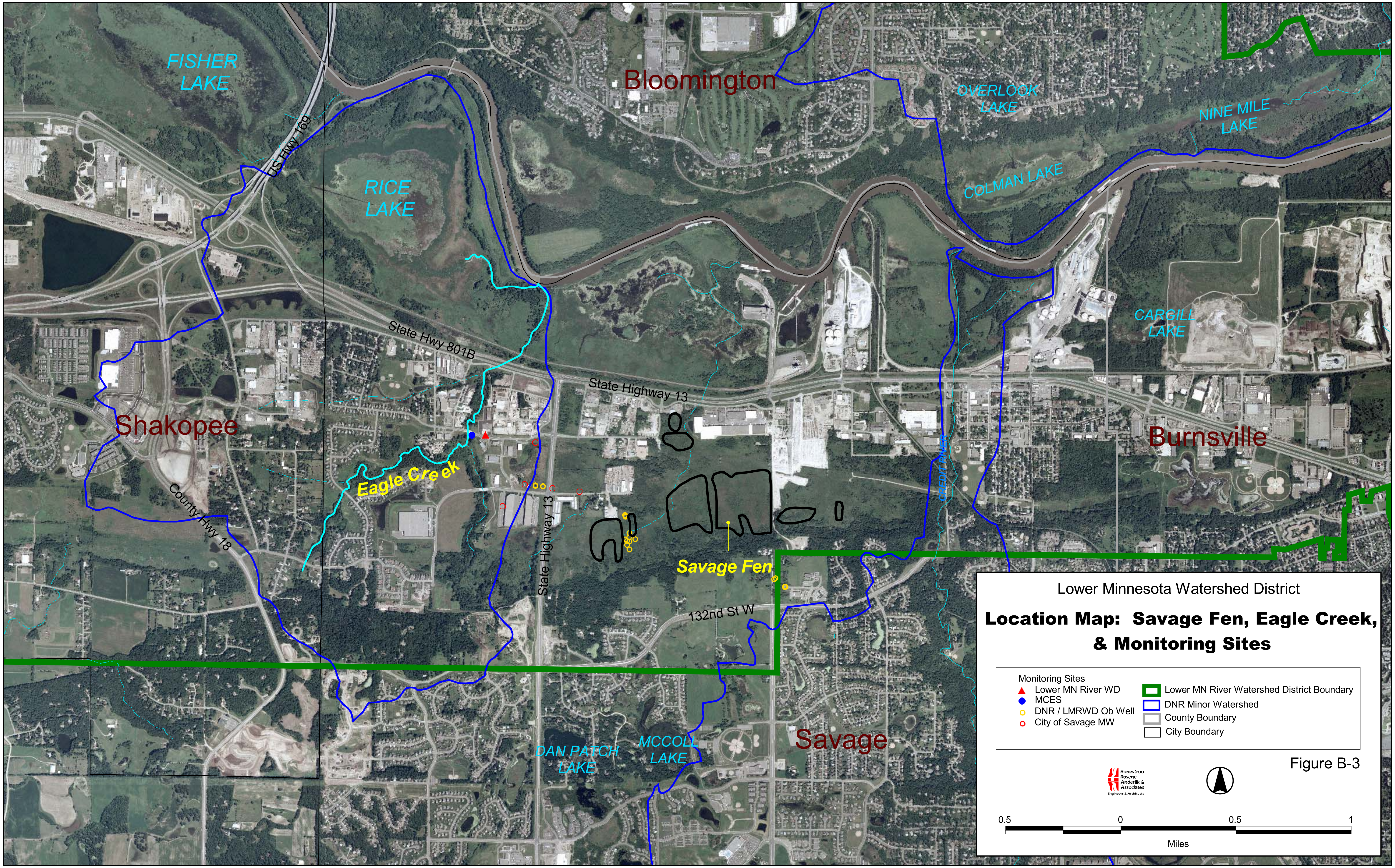
July 2005


Lower Minnesota Watershed District
Location Map: Black Dog Lake
Area Resources & Monitoring Sites
Monitoring Sites
MCWS
NSP
DNR (Inactive)
MPCA
City of Burnsville
Landfill
Other
Lower MN River Watershed District Boundary
DNR Minor Watershed
County Boundary
City Boundary
Figure B-2
0.5
0
0.5
1
Miles
Eagan
Kennaley's Creek
LONG MEADOW LAKE
Nicols Fen
Harnack Creek
Bloomington
Black Dog Lake North Fen
Unnamed Stream #4
BLACK DOG LAKE
Unnamed Stream #7
Black Dog Fen
Burnsville
35W
77
35E
I:\1460\146005108\cad\gis\loc_maps.apr
November 2005



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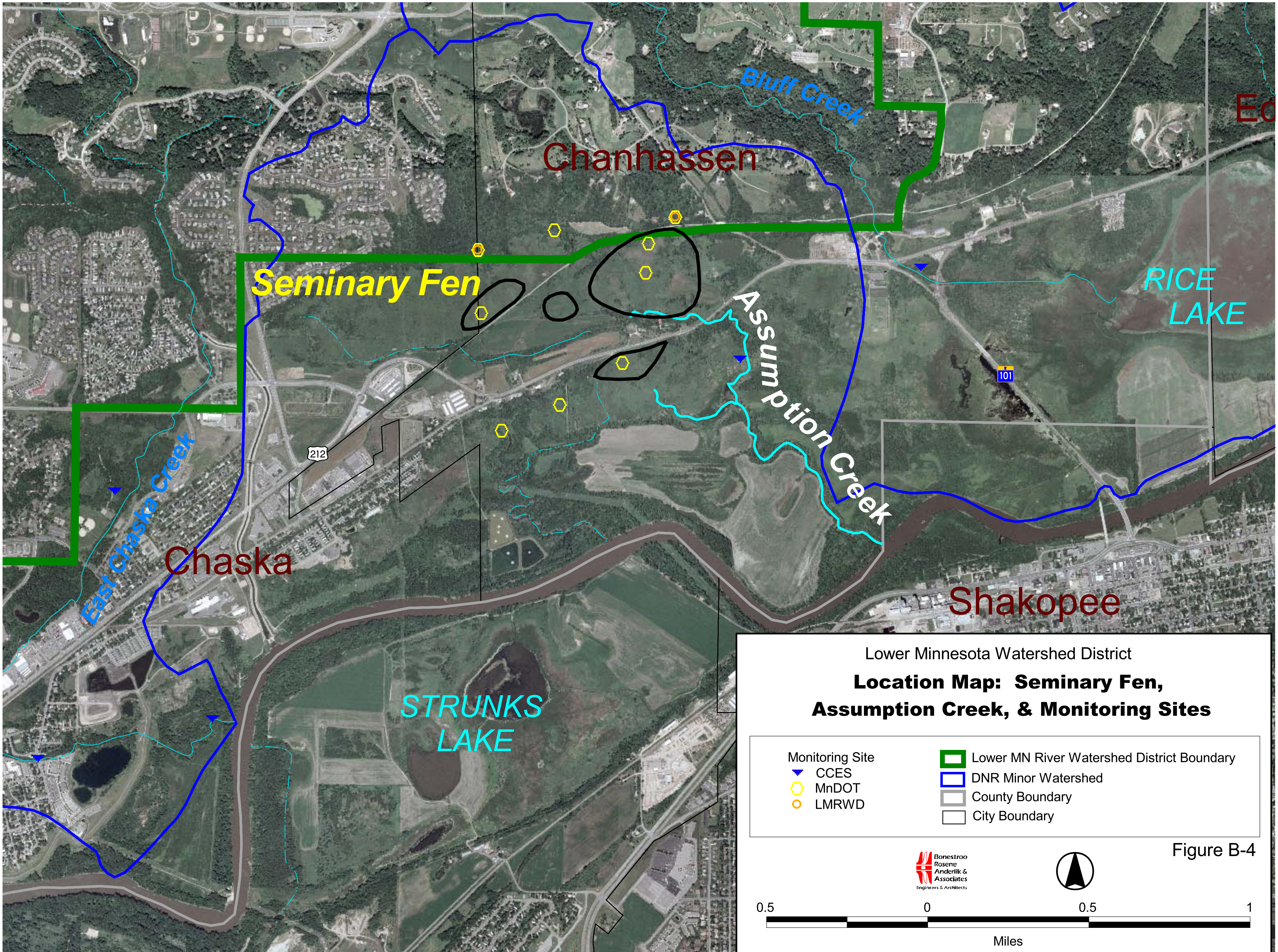
July 2005



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November 2005

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