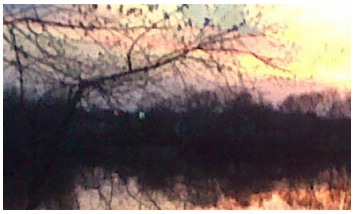
STRATEGIC RESOURCES EVALUATION OF THE LOWER MINNESOTA RIVER WATERSHED



LOWER **MINNESOTA RIVER**
WATERSHED DISTRICT

Managing and protecting the Minnesota River, lakes, streams, wetlands, and groundwater, and assisting and facilitating in providing river navigation

January 2014

Prepared for the

Lower Minnesota River Watershed Management District

By

HDR, Engineering Inc.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Executive Summary

A comprehensive survey and review of on-going resource management and monitoring efforts in the Lower Minnesota River Watershed Management District (District) was performed to assess critical resource areas and recommend management strategies. This effort was undertaken as an extension of the District's third Water Management Plan and associated implementation program, prepared for the District by HDR, Inc. in 2011.

The Strategic Resources Evaluation (SRE) reviewed nineteen lakes, sixteen streams (including six trout streams), nine wetlands and seven fens as critical resource areas within the District's boundaries. Using the data collected, each critical resource area was classified as either Category 1 or Category 2. Category 1 represents resource areas needing additional information to determine the best approach to improve, protect or preserve the resource. Category 2 characterizes resource areas with enough data for a feasibility study of management strategies. Using the District's prioritization process, an implementation matrix was developed for the District's reference in managing these critical resource areas over the next three to five years.

The results of the SRE categorized fifteen lakes, seven streams, all nine wetlands and two fens as Category 1 strategic resources requiring more data before a feasibility study of management needs and options can be made. The water bodies designated as Category 2 critical resource areas should proceed with a feasibility study of management strategies. Recommendations for both categories are presented in this report and also summarized in an implementation plan (Appendix F) to be amended into the District's Third Generation Watershed Plan.

Introduction

The Lower Minnesota River Watershed District (District) is located in the southwest portion of the Minneapolis-St. Paul metropolitan area and covers an area of approximately 80 square miles. The District's boundary generally follows the bluff line along both banks of the Minnesota River for approximately 32 river miles from the City of Carver and Louisville Township in the west, and to the Minnesota River's confluence with the Mississippi River in the east. The District's jurisdiction covers twelve cities, three townships, and five counties in the Twin Cities metro area (Figure 1 and Figure 2).

In 2004, the District adopted the *Guidance to Implementation* (LMRWD, 2004) in order to move the implementation agenda from their second Water Management Plan (WMP) (LMRWD, 1999) forward. As part of that report, a comprehensive survey and review of on-going water resource management and monitoring efforts in the District was performed to assess critical areas. This included a written survey and follow-up discussions with the cities, counties, agencies and other individual stakeholders working on resource management in the District. Implementation strategies in the second WMP were then reviewed in the context of the resource management assessment. Specific strategies were refined and prioritized, and additional actions were added based on discussions with the District's stakeholders. The result was a prioritized list of critical water resources, which allowed the District to move its implementation agenda forward in a proactive, systematic fashion (LMRWD, 2004). Recently, the District completed its Third Generation Watershed Plan (Plan). One implementation strategy identified in the Plan (and the subject of this report) is to conduct a strategic resource evaluation (SRE) building on the 2004 Guidance to Implementation (LMRWD, 2004). This document presents the process and results of the SRE.

Methods

The SRE assessed surface waters within the District (Table 1). Available data for each water body was collected from a variety of sources. The complete results of the data review are included in data summary sheets for lakes (Appendix A), streams (Appendix B), wetlands (Appendix C) and fens (Appendix D). Data collected for each resource included:

- *Designated use*
- *Location, watershed land use*
- *Percentage of watershed within the District*
- *Water quality and/or quantity monitoring data, State of Minnesota water quality standards, 303(d) listed impairments*
- *Recreational access point(s)*
- *Fisheries information*
- *Natural resources information*

Using the data collected, each critical surface water resource was reviewed and classified as either Category 1 or Category 2 resource. Category 1 represents water features needing additional information to determine the best approach to improve, protect or preserve them. Category 2 characterizes surface waters with enough data for a comprehensive assessment: an analysis of existing conditions to determine an appropriate management action (e.g., a feasibility study or explicit management action). Using the District's prioritization process, an implementation plan was developed and is included as Appendix F. The implementation plan prioritizes actions the District will take to manage its resources over the next three to five years.

Because each water body has unique hydrologic conditions, the final recommendations to move forward with more monitoring (Category 1 resource) or a feasibility study/management strategy (Category 2 resource) needed to be considered with distinct criteria. Each resource type's evaluation criteria and recommended District actions are described in the remainder of the report.

Lakes

The resource assessment process for lakes is based on the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (MPCA, 2012). Existing data for each lake was reviewed to determine if a sufficient assessment of water quality could be made. If the minimum data criterion discussed below was not met, the lake was classified as a Category 1 resource. The following information was used in making this determination.

Data Requirements for a Category 2 Lake Classification

- At least eight samples for each lake for total phosphorus, chlorophyll-*a*, and secchi transparency collected over two years during the June-September period (typically one sampling event per month);
- The lake must be located outside the Minnesota River floodplain; and

- The lake must be accessible to the public and have either:
  - Recreational access; or
  - Is bordered by private or public areas (making the lake highly accessible and/or visible to the public)

Lakes that did not have the necessary data required for assessment or did not meet the visibility conditions were assigned a Category 1 status. Category 1 lakes are presented in Table 2 and data summary sheets of each lake are presented in Appendix A.

Streams

The resource assessment process for streams is also based on the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (MPCA, 2012). The Minnesota River downstream of the City of Jordan is impaired for dissolved oxygen (DO) and turbidity. DO was only considered in the water quality assessment for trout streams, since DO levels from non-trout streams don't significantly contribute to the Minnesota River's DO impairment. Existing data for each stream was reviewed to determine if a proper assessment of water quality could be made. If the minimum data criterion was not met, the stream was classified as a Category 1 resource. The following information was used in making this determination.

Data Requirements for a Category 2 Stream Classification

- At least twenty samples each with turbidity measurements collected between June and October;

Streams that did not have the data required for assessment were assigned Category 1 status. Category 1 streams are presented in Table 3 and data summary sheets of each resource are presented in Appendix B

Wetlands and Fens

The resource assessment process for wetlands and fens consisted of reviewing existing studies, data sources, and maps of wetland complexes within the District. Project research also included correspondence with City, County and State agencies. All information obtained regarding each unique water resource was compiled and is contained in the data summary sheets (Appendix C and Appendix D). Provided below is a description of the sources utilized as well as a short synopsis of the data provided.

- Minnesota County Biological Survey (MCBS) – DNR Ecological Services provided data for all surveys performed within the District. Most of the data was limited to the 1990's and early 2000's. This information provided was then compiled and condensed into a brief description, summarizing the findings.
- Natural Heritage Information System (NHIS) – NHIS staff provided field survey data and individual reports produced by DNR staff relating to

distinct features of the water resources within the District. This data includes descriptions of threatened and endangered species locations and NHIS community descriptions. Most of the data was limited to the 1990's and early 2000's.

- Minnesota Land Cover Classification System (MLCCS) study – Geographic Information System (GIS) land coverage data and reports from the available counties were retrieved and compiled. Reports from the MLCCS study were examined to assess whether the GIS coverage provided additional detailed descriptions relating to the quality of fen and marshes, as well as invasive species presence.
- DNR Ecological Services – DNR Ecological Services staff were contacted and any additional reports or data with detailed studies regarding the fens and wetlands within the District were requested. One report by Fred Harris, a 2006 survey of conditions at Seminary Fen was provided.
- Additional DNR contacts – Jeanette Leete and Doug Norris, DNR calcareous fen experts, were contacted for updated information regarding wetland and fen resources within the District. Available data was provided and compiled.
- City Governments – Surface water management plans were retrieved from city government web pages for all of the cities within the District. Where specific information regarding water resources was available, data was recorded and compiled within the data summary sheets.
- County Sources – County sources were contacted and inquires concerning additional studies were made. For each of the wetlands and fens within the District, additional data was available from web-based sites, and the data retrieved was compiled and recorded within the data summary sheets provided.
- Lower Minnesota River Watershed District - The District website was searched in an effort to retrieve studies and reports relating to any potential factors that could affect the water resources within its jurisdiction. Available reporting information was recorded and can be found within the data sheets provided.

Category 1 Resources

District water resources classified as Category 1 are presented in this section along with recommended actions that serve to enhance understanding of their condition prior to further management actions (Tables 2-4).

Lakes

Results

Fifteen of the nineteen lakes evaluated in the SRE were classified as Category 1 resources. Most of the Category 1 lakes have limited or no public access and are within the Minnesota River floodplain. However, Snelling Lake, located in Fort Snelling State Park, does have public access and contains a seasonal swimming beach and fishing pier.

Monitoring Plan and Recommendations

Although there is the potential for flooding from the Minnesota River, Snelling Lake is heavily used by the public and is recommended for further monitoring. The remaining lakes are not recommended for future monitoring because there is no public access.

It is recommended that Snelling Lake be assessed for nutrient impairment during the summers of 2014 and 2015 (one sampling event per month, June-September period) using the standard measures of secchi depth, chlorophyll-*a*, and total phosphorus. Cooperation with Fort Snelling State Park staff and training them to conduct the lake monitoring is recommended. A canoe is available on-site for collecting samples at a mid-lake location. Chlorophyll-*a* and total phosphorus sample bottles will be acquired from a state-approved analytical laboratory. Field samples should be collected just below the lake surface using the provided bottles. A secchi disk reading should be recorded during each visit. Sample bottles must be kept at 39 degrees F (4 degrees C) until delivery to the analytical laboratory. Before implementing these monitoring actions for Snelling Lake, the following pre-monitoring tasks will need to be completed:

1. Develop a project monitoring plan
2. Develop a quality assurance project plan (QAPP) in conjunction with Minnesota Pollution Control Agency (MPCA) requirements for determination of impairment
3. Train Fort Snelling State Park staff as lake monitors
4. The District will then review data from the field and analytical laboratory and develop draft and final reports based on 2014 and 2015 lake data. Upon completion of these tasks, Snelling Lake should change from a Category 1 to a Category 2 resource

Flooding from the Minnesota River has the potential to occur in the Category 1 floodplain lakes on an annual basis. Because the Minnesota River typically contains significant amounts of sediment and nutrients (e.g. nitrogen and phosphorus) during spring flood conditions, there is the potential for annual deposition of sediment and nutrients to these lakes. Projects implemented by the District to maintain or improve water quality conditions in Category 1 lakes need to consider this situation.

Streams

Results

Seven of the sixteen streams evaluated in the SRE, including five of the six trout streams, were classified as Category 1 resources due to a lack of turbidity data. The remaining nine streams are classified as Category 2 streams.

Monitoring Plan and Recommendations

The monitoring plan recommended for trout streams in the District include DO, temperature, turbidity, specific conductivity and pH sampling on a bi-weekly basis from April through October each monitoring year, resulting in 12 to 14 samples annually.

DO probes typically contain a temperature sensor as well as conductivity and pH sensors. Monitoring/sampling events are required to take place before 9AM because DO levels are typically lowest in the early morning. During each visit a monitoring probe should be used to record temperature, DO, conductivity, and pH. A "secchi tube" should then be used to measure turbidity. In order for this to be successful, it is recommended that the District coordinate this effort with Minnesota Department of Natural Resources (DNR) staff specializing in trout streams and use of volunteers to take the samples. Before starting this monitoring plan, the following pre-monitoring tasks will need to be completed:

1. Develop a project monitoring plan
2. Develop a QAPP in conjunction with MPCA requirements for determination of impairment
3. Train volunteer stream monitors
4. The District will then review data from the field and analytical laboratory and develop draft and final reports based on 2014 and 2015 stream monitoring data. Upon completion of these tasks, the trout streams will change from Category 1 to Category 2 resources

Quantitative monitoring efforts should be paired with subwatershed assessments for each stream. Hydrologic changes that result from changes to a stream's subwatershed (e.g., land use) can lead to noticeable water quality trends. Projects considered and prioritized by the District should incorporate monitoring results as well as current and anticipated subwatershed characteristics.

Wetlands and Fens

Results

Results of the SRE showed that all of the wetlands and two of the fens in the District have inconsistent data. In most of the wetland and fen locations, there have not been updated quality, value, and function assessments since the 1990s. An overall, consistent and focused assessment of all of the wetlands and fens listed in Table 4 is required to categorize the wetland and fen resources. The following is a plan, which has been vetted by DNR staff, for completing the assessment.

Wetland and Fen Assessment Recommendations

1. Update the MLCCS study data for the large wetland complexes in the Minnesota River Valley (MLCCS is the DNR land cover mapping tool for both native and non-native dominated plant communities). This would involve reviewing the initial delineations accuracy. Where there are discrepancies, the delineations should be updated to reflect changes since the MLCCS study. In most cases, the MLCCS data did not gather or show plant community makeup, nor did it indicate the presence (dominance) of invasives or provide a Floristic Quality Assessment (FQA).

   This initial step would provide the District with updated and consistent baseline data needed to perform a feasibility study of management strategies. Detailed field forms summarizing plant community types by MLCCS definitions should be used for each of the "natural" remnant communities (plant communities with little or no historical human disturbance) within the wetland complexes. This would not be required for land covers that would no longer be considered "natural" due to absolute dominance by non-native invasive species, farming, or development.

2. Perform an FQA of each of the fens, identifying three sampling points (with a 25' radius) in each fen. An FQA is a vegetation-based ecological assessment approach that can be used for wetland quality monitoring and assessment. The FQA sampling locations should be provided to the District and the DNR in a GIS format in order to act as baseline data for future assessments. Performing this detailed plant analysis provides a picture of the relative quality and/or degradation within these rare plant communities. The DNR has performed qualitative assessments over the years, but does not appear to have established a way to monitor the fens in the District. To that extent, some of the fens (Black Dog North in particular) may be too degraded for restoration. An FQA is needed in order to provide a quality, consistent baseline for each of the fens and allows a comparison of quality and degradation of these communities across the valley.

   The best time to perform the FQA, is mid June through July. Planning (i.e. identification of sampling points) should take place in advance (could happen with MLCCS work). Creating standardized methods for the FQA is an

important step in ensuring that the work is applicable and replicable in the future. The value of the FQA for the fen assessments, but not wetlands is that the tool is very plant and detail intensive, requiring identification of *all* species to the species level. It is also a quantitative method that provides a strong baseline assessment.

3. Perform Minnesota Routine Assessment Methodology (MnRAM) on all of the large wetland complexes. This should be done in conjunction with the MLCCS surveys, and as such should not add a significant additional effort to the process.

4. Baseline water level measurements were collected from 2007 to 2010 in Gun Club Lake North (two wells), Gun Club Lake South (13 wells) and Nichols Meadow (14 wells) fens. These locations should be monitored (or at least periodically updated) to verify that conditions have not changed since previous monitoring. The preferred method of data collection is using a submersible data-logging pressure transducer.

Category 2 Resources

Those resources with sufficient quantity and quality of data to perform a more detailed evaluation of their condition were deemed Category 2 resources. The results of the SRE related to these resources as well as additional assessments are discussed in this section (Tables 5-8).

Lakes

Results

Three lakes in the City of Chaska, as well as Dean Lake, in Shakopee, Minnesota were classified as Category 2 resources and are summarized in Table 6. Currently, only Dean Lake is listed as impaired, triggering the start of the Total Maximum Daily Load (TMDL) process in 2014. MPCA will begin monitoring the Dean Lake with the support of Scott Watershed Management Organization (Scott WMO) in 2014-2015 (*pers. comm.* with Brooke Asleson, MPCA).

Chaska Lakes

The City of Chaska has three quarry lakes, all DNR protected waters, somewhat unique to the Metro area. Brickyard Clayhole Lake, Courthouse Lake and Firemen's Clayhole are deep and high quality lakes with important cultural, historical and human values. Brickyard Clayhole's watershed is predominantly developed with stormwater runoff being routed either around the lake or through a series of stormwater detention ponds prior to discharging into the lake. Courthouse Lake is one of six lakes in the metro area that are stocked with trout with a watershed that is predominantly urban. Firemen's Clayhole has a watershed comprised of predominantly park and open space with a portion comprised of agriculture landuse. Firemen's Clayhole supports a beach and recreational area along its south side and a diversion manhole along its eastern flank that routes flow away from the lake.

A review of water quality data suggests that there are no apparent negative trends in water quality. For Courthouse Lake, this is likely due to the fact that the City of Chaska estimates less than one pound per year of total phosphorus and 810 pounds per year of total suspended solids are entering the lake. In the case of Courthouse Lake and Firemen's Clayhole, the current, apparent clear stable-state is likely due to active bypasses and re-routing of stormwater executed by the City of Chaska with significant reported load reductions (City of Chaska Local Surface Water Management Plan, 2007).

Dean Lake

Dean Lake is a basin influenced by groundwater, surface and channelized inflow. The lake is scheduled for the initiation of a TMDL study in 2014, but the MPCA expects to begin monitoring in the spring of 2014 with the assistance of the Scott WMO. Information on the lake starts, in earnest, with a report in 1975

characterizing the lake and providing some historical context (Samstad*, 1975*). A more detailed analysis of hydrology, hydrologic modification and channel hydraulics was published five years later (Molsather, 1980). Current DNR and MPCA water quality and lake levels data from 2002 to present exists. In addition, the Prior Lake-Spring Lake Watershed District (PLSLWD) has several monitoring stations along its outlet channel that enters the lake along its eastern edge. No in-lake core samples, vegetation or fish surveys were located. These data (reports, plan sets, etc.) were reviewed followed by an in-field reconnaissance to estimate the efficacy of implementing stormwater retrofits and channel stabilization projects tributary to Dean Lake.

Recommendations

Chaska Lakes

After a review of the water quality data, discussions with Bill Monk, Chaska City Engineer, and a rapid in-field review, a limited non-degradation approach to the watersheds is recommended. Below are two recommendations for consideration: Gully Stabilization and Iron- enhanced Sand Filters.

1. Gully Stabilization – The 2011 District Watershed Management Plan identifies un-funded gully stabilization projects for the north bluff of Brickyard Clayhole Lake. It also identifies a partially vegetated sediment delta along the north shore of Firemen's Clayhole is present; the result of an actively-eroding gully within the bluff line. Runoff from the upland agricultural field appears to be concentrated down a gully in the bluff line wooded area. It is recommended that these projects be considered before implementing additional strategies.

2. Iron-enhanced Sand Filters – The University of Minnesota's Saint Anthony Falls Research Lab, the City of Prior Lake and Prior Lake Spring Lake Watershed District (PLSLWD) in recent years, have been studying the efficacy of using iron as a means of stripping dissolved phosphorous from stormwater runoff within sand filter benches along nine detention ponds in the City of Prior Lake. Both bench testing and in-field results at these installations in the City of Prior Lake show tremendous promise for the "Minnesota Filter" (iron-enhanced sand filter; IESF). To use IESF, existing ponds feeding into Brickyard Clayhole would have to be retrofitted by creation of primary overflow filtration (lined) trenches that route the water quality flow behind a weir within the riser structures designed for larger flow conveyance.

Dean Lake

Given the current unknowns of the Dean Lake system, it is recommended that a thorough analysis of the lake and its watershed and tributary streams be performed. Data collection should be supportive of a lake and watershed model such as sediment cores, inflow outflow chemistry and rates and vegetation and fish communities. Once sufficient data have been collected, hydrologic and water quality models analysis can be run to define the lake/wetland behavior over time under different management scenarios. Currently, the District and

Scott County have begun reviewing existing data for the lake, inlet channel and watershed to begin the TMDL study.

Streams

Results

Nine of the sixteen streams evaluated are classified as Category 2 streams with sufficient turbidity measurements. Category 2 streams are summarized in Table 7. The only trout stream that has enough data for Category 2 designation is Eagle Creek, which has a long-term monitoring station run by Metropolitan Council Environmental Services (MCES). The stream reaches within the District were examined in greater detail in a feasibility study (Appendix E).

Recommendations

The primary water quality parameter of concern for the Category 2 streams is turbidity. Adjacent watershed districts and management organizations are assessing sources of turbidity and implementing relevant BMPs within their respective watersheds for Category 2 streams.

Table 8 illustrates potential actions to address erosion in four of the creeks examined in this study.

Wetlands and Fens

Results

None of the wetlands were designated Category 2 resources. Five of the seven fens had sufficient data for Category 2 classification, including Gun Club Lake North Fen, Gun Club Lake South Fen, Nicols Meadow Fen, Savage Fen, and Seminary Fen. A summary with proposed actions for preservation and protection of two critical fens is illustrated below. Additional courses of action for the remaining Category 2 fens is provided in Appendix E.

Recommendations

Seminary Fen

Seminary Fen has been described as one of the highest quality fens in Southern Minnesota. It contains several rare species plants, is in excellent condition and has been characterized as one of the most significant natural areas in the Twin Cities Metropolitan area. This unique resource's survival is dependent on maintaining its hydrology (primarily groundwater) and its species diversity. Groundwater levels are being monitored as part of the District's monitoring program outlined in the Plan. Surface hydrology does have the potential to adversely impact these unique resources, although not the primary concern for fens. Change in the quality, quantity and rate of delivery of surface water from its watershed can have a direct affect on the biodiversity of this unique resource.

The District has partnered with the City of Chaska to address the quality, quantity and rate of surface water reaching the fen and to restore the in-fen hydrology and native plant community. Phase One of the Seminary Fen restoration involved restoring a wetland on top of the bluff that had experienced hydrologic stress leading to outlet failure. The outlet experienced a blow out causing the rapid discharge of water from the wetland down the bluff line exacerbating the already present erosion problem in a long gully leading to the fen. Restoration of the outlet successfully controls effluent rates thereby metering out the wetland volume over a longer period resulting in less erosive force in the destabilized gully. In addition, the restoration of the bluff-top wetland likely provides water quality benefits given the extended detention effect on particle de-siltation as well as potentially providing a small portion of groundwater recharge beneficial to fen hydrology.

Phase Two of the project involves breaking drain tiles, removing invasive species and collecting and dispersing native seed from a source adjacent to the site. This project restores 6-acres of the fen with hydrologic and plant stressors to its system.

Phase Three of the project involves a partnership with the City of Chaska, and may include the Carver Soil and Water Conservation District. The eroding gully falling from the Phase One wetland down the bluff to the fen has deposited a substantial sediment plume along the northern boundary of the fen. Sedimentation of the fen will adversely affect its plant communities by switching it from its natural composition to an invasive-dominated community via elevated nutrients, alteration of the mineral and organic composition of the soils and through a change in hydrologic regime specific to the plume site. Controlling flows within the gully paired with soil stabilization efforts aspires to minimize sediment mobilization from the gully thereby alleviating sedimentation stress to the fen.

In addition to these projects, the District has implemented surface water management standards for new and redevelopment projects that will provide strong benefits to the wetland related to the quality, quantity and rate of upland stormwater runoff.

Savage Fen

As with Seminary Fen, groundwater levels are being monitored as part of the District's monitoring program outlined in the 2011 Water Management Plan. At this time no actions, outside of the surface water management standard outlined in Plan, are recommended.

References

Molsather. 1980. Feasibility Report: Drainage Alternatives, Dean's Lake Outlet Basin IV-A. City of Shakopee. Barr Engineering report.

Lower Minnesota River Watershed District. 2004. Guide to Implementation. Prepared by Bonestroo. May 2004. http://www.watersheddistrict.org/pdf/LMRWD%20Guidance%20-%20Final%20Report%205-20-04.pdf

Lower Minnesota River Watershed District. 2005. Groundwater Monitoring Strategy Final Report. Prepared by Bonestroo. November 2005. http://www.watersheddistrict.org/pdf/groundwater%20monitoring%20report_Nov05.pdf

Lower Minnesota River Watershed District. 2011. Third Generation Watershed Management Plan. Prepared by HDR Engineering, Inc. September 2011. http://www.watersheddistrict.org/plan.html

Minnesota Pollution Control Agency. 2012. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. http://www.pca.state.mn.us/index.php/view-document.html?gid=16988

Lawrence Samstad, 1975. *A Report on the Source of Water for Dean lake and Analysis of Potential Development of Dean Lake and Potential Hazards in Other developments Which May Concern the Future of Dean Lake*. A report written for the Lower Minnesota River Watershed District and City of Shakopee.

Lawrence Molsather, City of Shakopee. 1980. *Feasibility Report: Drainage Alternatives, Dean's Lake Outlet Basin IV-A*. Barr Engineering report.

Samstad, 1975. A Report on the Source of Water for Dean lake and Analysis of Potential Development of Dean Lake and Potential Hazards in Other developments Which May Concern the Future of Dean Lake. A report written for the Lower Minnesota River Watershed District and City of Shakopee.

Tables

Table 1: Lower Minnesota River Watershed District: Surface Water Resources

Streams and Rivers	Lakes	Wetlands	Fens
Minor streams (32)	Black Dog Lake	Blue Marsh	Black Dog Preserve Fen
Bluff Creek	Blue Lake	Chaska Marsh	Fort Snelling Fen
Carver Creek	Brickyard Clayhole	Coleman Marsh	Nicols Fen
Chaska Creek	Chaska Lake	Fisher Marsh	Savage Fen
Credit River	Coleman Lake	Grass Marsh	Seminary Fen
East Chaska Creek	Courthouse Lake	Gun Club Marsh	
Minnesota River	Dean Lake	Long Meadow Marsh	
Nine Mile Creek	Firemen's Clayhole	Rice Marsh (Hennepin Co.)	
Purgatory Creek	Fisher lake	Rice Marsh (Scott Co.)	
Riley Creek	Gifford Lake		
Spring Creek	Grass Lake		
*Assumption Creek	Gun Club Lake		
*Eagle Creek	Lake Cy Ess		
*Kennaley's Creek	Long Meadow Lake		
*Unnamed Stream #1 (Harnack Creek)	Nyssens Lake		
	Overlook Lake		
*Unnamed Stream #4 (One Mile Creek)	Rice Lake (Hennepin Co.)		
	Rice Lake (Scott Co.)		
*Unnamed Stream #7	Snelling Lake		

*Trout stream

Table 2: Lower Minnesota River Watershed District: Category 1 Lakes

Lake	Floodplain Lake?	Public Access?
Chaska Lake	Y	N
Black Dog Lake	Y	N
Gun Club Lake	Y	N
Rice Lake (Hennepin County)	Y	N
Coleman (Nine Mile) Lake	Y	N
Grass Lake	Y	N
Long Meadow Lake	Y	N
Overlook Lake	N	N
Snelling Lake	Y	Y
Blue Lake	Y	N
Fisher Lake	Y	N
Gifford Lake	Y	N
Nyssens Lake	Y	N
Rice Lake (Scott County)	Y	N
Lake Cy Ess	Y	N

Table 3: Lower Minnesota River Watershed District: Category 1 Streams

Stream
Nine Mile Creek
Purgatory Creek
*Assumption Creek
*Kennaley's Creek
*Unnamed Stream #1 (Harnack Creek)
*Unnamed Stream #4 (One Mile Creek)
*Unnamed Stream #7

*Trout stream

Table 4: Lower Minnesota River Watershed District: Category 1 Wetlands and Fens

Wetland	Fen
Chaska Marsh Gun Club Marsh Rice Marsh (Hennepin County) Blue Marsh Coleman (Nine Mile) Marsh, Grass Marsh Fisher Marsh Long Meadow Marsh Rice Marsh (Scott County)	Black Dog Fen Black Dog Lake North Fen

Table 5. Lower Minnesota River Watershed District: Category 2 Fens

Fen
Gun Club Lake North Fen
Gun Club Lake South Fen
Nicols Meadow Fen
Savage fen
Seminary Fen

Table 6: Lower Minnesota River Watershed District: Category 2 Lakes

Lake	Listed as Impaired on 2012 303(d) List?
Brickyard Clayhole	N
Courthouse Lake	N
Firemen's Clayhole	N
Dean Lake	Y

Table 7: Lower Minnesota River Watershed District: Category 2 Streams

Stream	Percent of Watershed Within the District	Impaired for Turbidity on 2012 303(d) List?
Bluff Creek	37%	Y
Carver Creek	<1%	Y
Chaska Creek	2%	N
Credit River	1%	Y
East Chaska Creek	7%	Y
Minnesota River	<1%	Y
Riley Creek	56%	Y
Spring Creek	56%	Y
*Eagle Creek	98%	N

*Trout stream

Table 8: Lower Minnesota River Watershed District: Category 2 Stream Recommendations

Stream	Suggested Action
Bluff Creek	Provide an energy dissipation structure at the tunnel exit. Apply bank stabilization measures along outside creek bends. Re-direct runoff coming off of the North Hwy 101 Bridge. Stabilize the areas around the bridge abutments.
Riley Creek	Provide an energy dissipation structure below CR 61. Redirect flows away from outside creek meanders to prevent future erosion during runoff events.
Carver Creek	Stabilize outer bends with toe protection. Grade banks to a more stable slope. Stabilize the gully to prevent future sediment from being transported downstream.
East Chaska Creek - Reach A and Reach B	*General:* *Remove debris and dead trees from the channel, address localized problems at outfalls and crossings.* *Specific suggestions are as follows:* *Outfall A – remove log jam, stabilize right bank at outfall, revegetate bank, remove sediment deposit.* *Outfall B – stabilize outfall with rock, step down the outfall, toe protection 10-ft upstream & 40-ft downstream.* *Outfall C – stabilize outfall with rock, step down the outfall, toe protection 10-ft upstream & 40-ft downstream.* *Pedestrian Bridge – re-direct runoff from bridge to channel bed, stabilize abutments 5-ft upstream and 15-ft downstream.* *Crosstown Blvd. Bridge – grade control/energy dissipation structures to step the channel down and dissipate energy away from the bridge and vulnerable banks; re-direct runoff from bridge.*
East Chaska Creek - Reach C	*Remove debris and dead trees in the channel where possible.* *Insert grade control structures.*
East Chaska Creek - Reach D	*General:* *Remove debris and dead trees in the channel, and address localized problems at outfalls and crossings.* *Specific suggestions include:* *Near Beech Street Bridge – apply grade control throughout the reach, along with toe protection and left bank stabilization.* *Upstream of E. 6th Street Bridge – repair the left bank abutment (currently presents a safety hazard).*
East Chaska Creek - Reach E	*Selective clearing, excavation, toe protection, erosion control (jute mesh), topsoil replacement and grading for approximately 2,000 feet*

Figures

Figure 1. Lower Minnesota River Watershed District, west

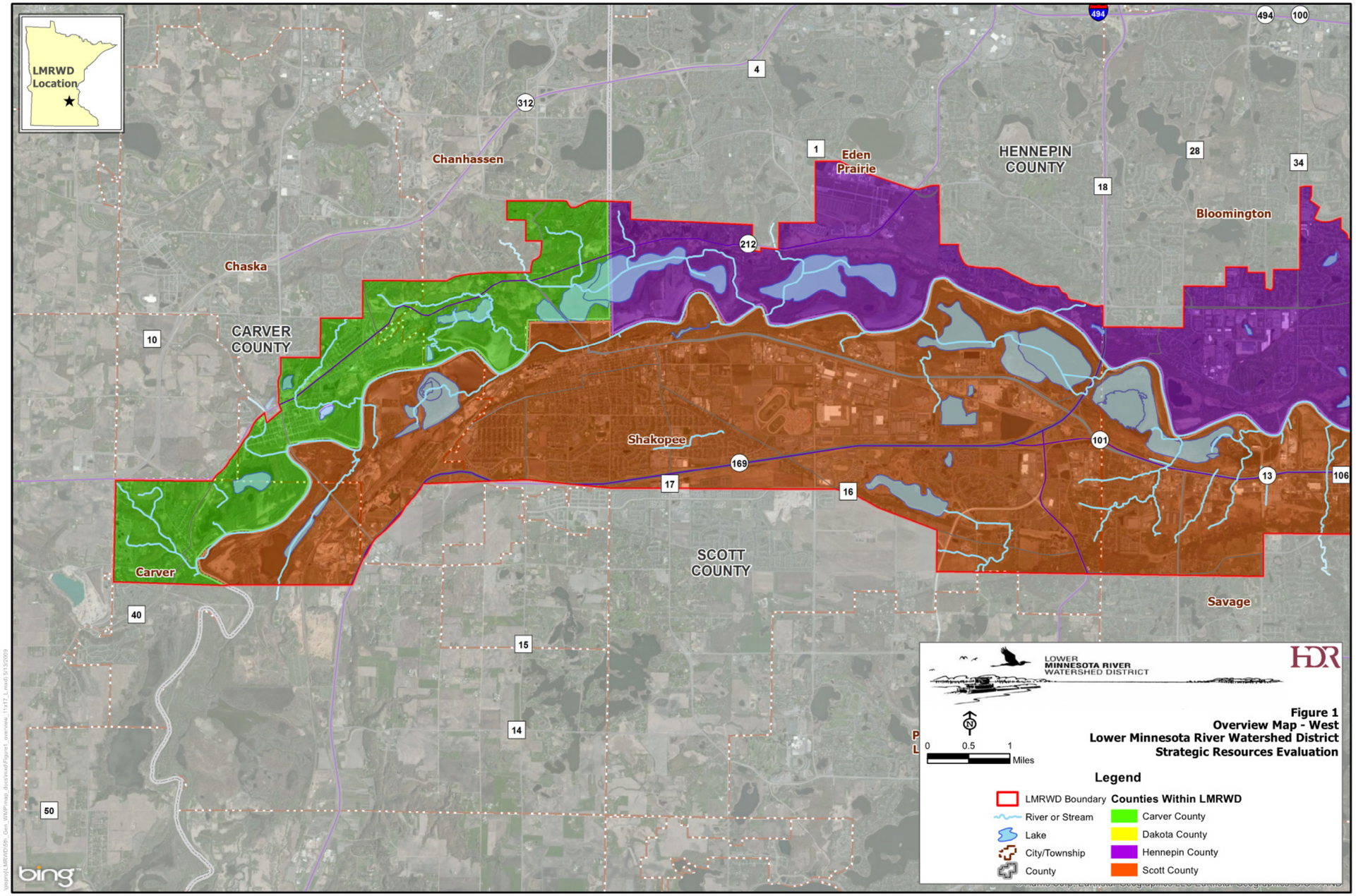


Figure 2. Lower Minnesota River Watershed District, east

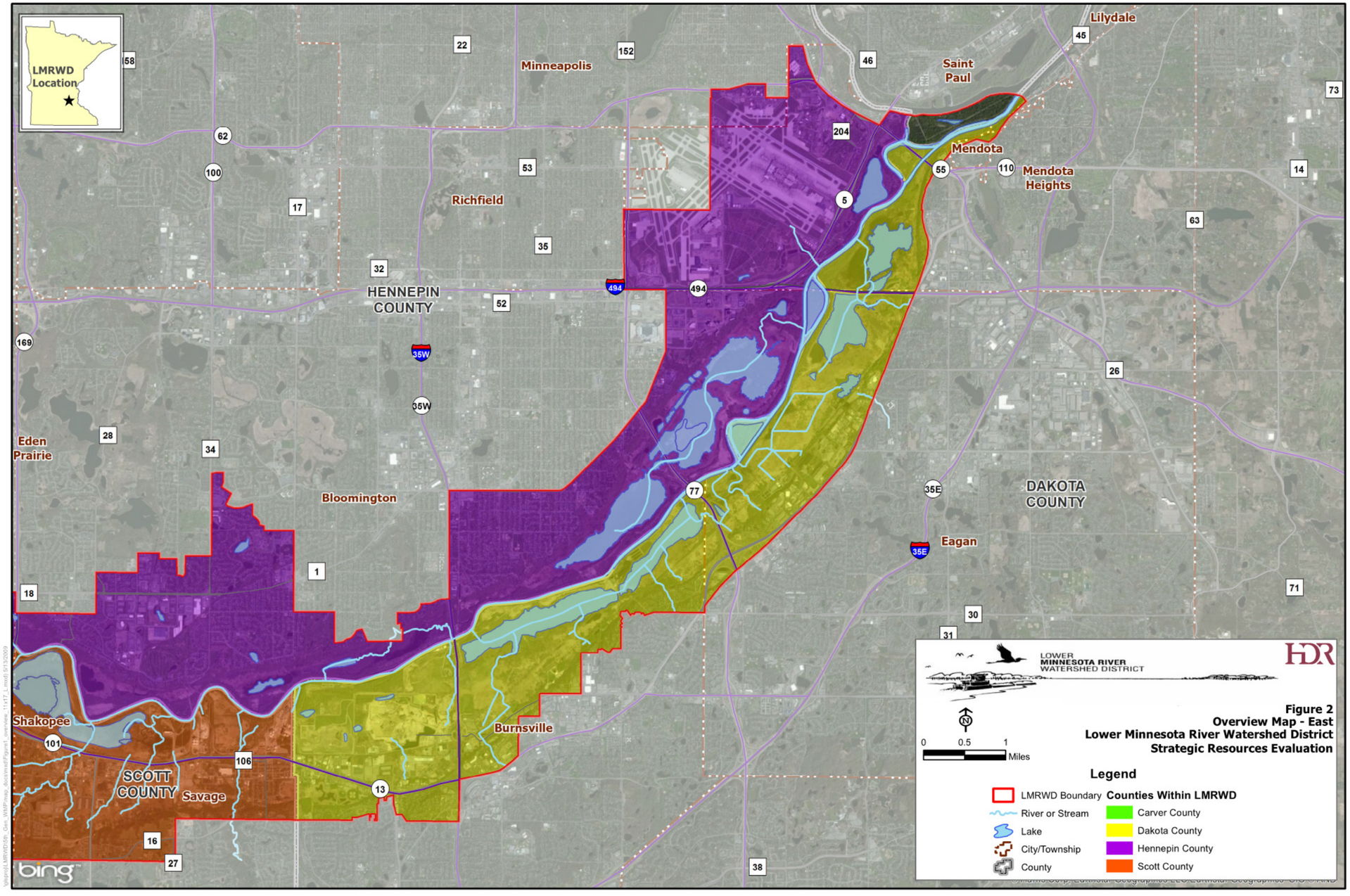


Figure 3. Category 1 resources within Lower Minnesota River Watershed District, west

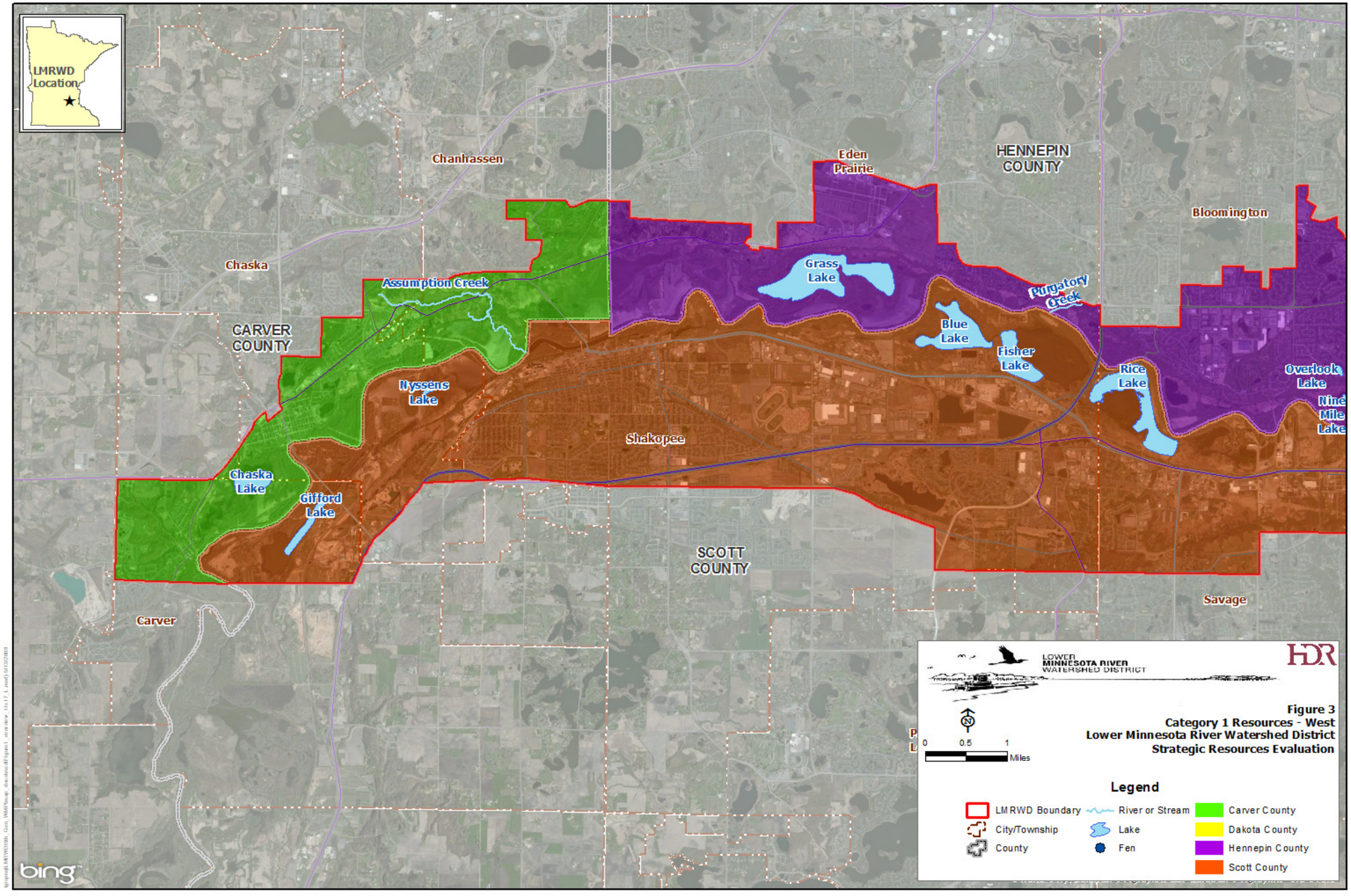


Figure 4. Category 1 resources within Lower Minnesota River Watershed District, east

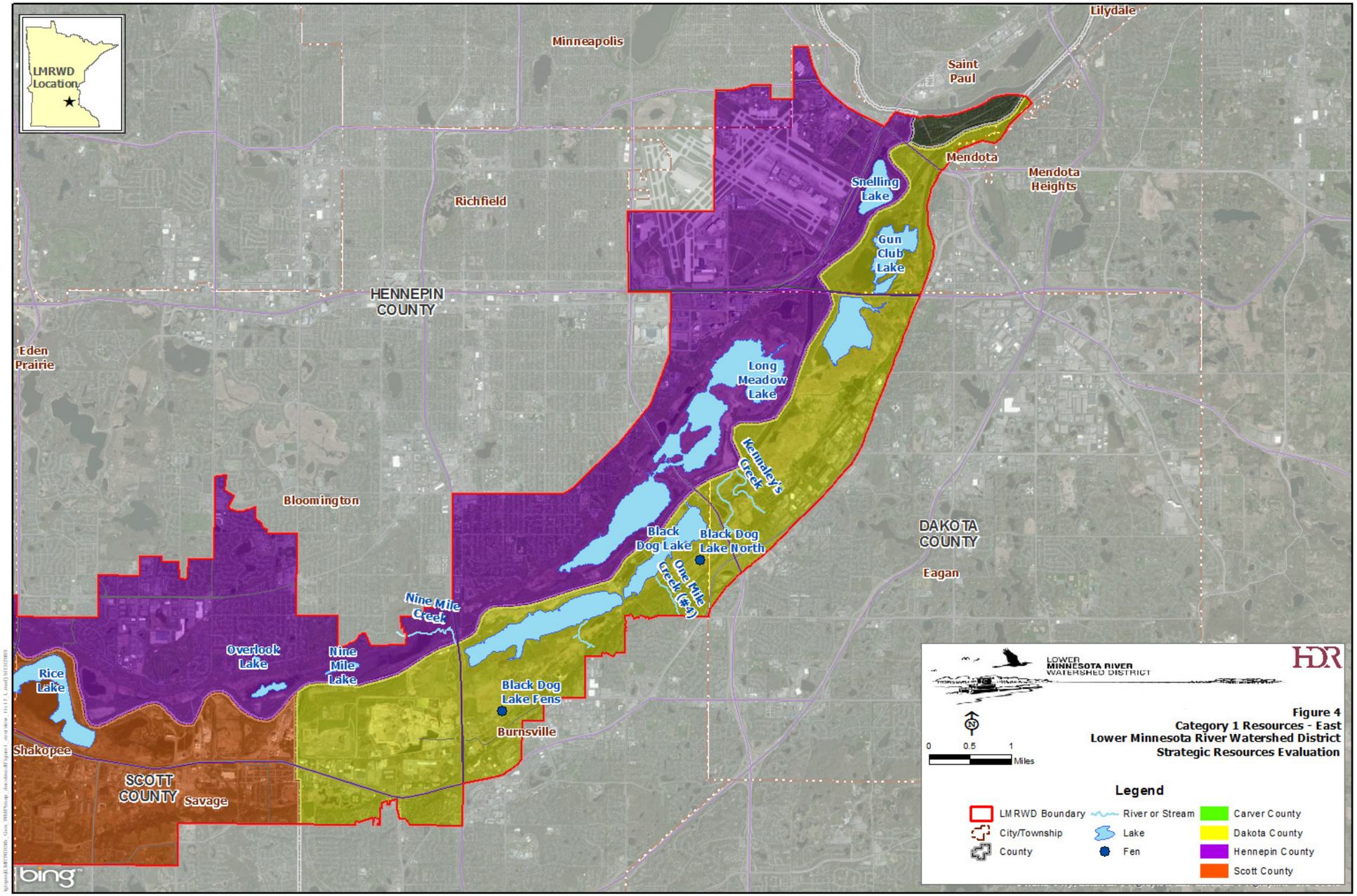


Figure 5. Category 2 resources within Lower Minnesota River Watershed District, west

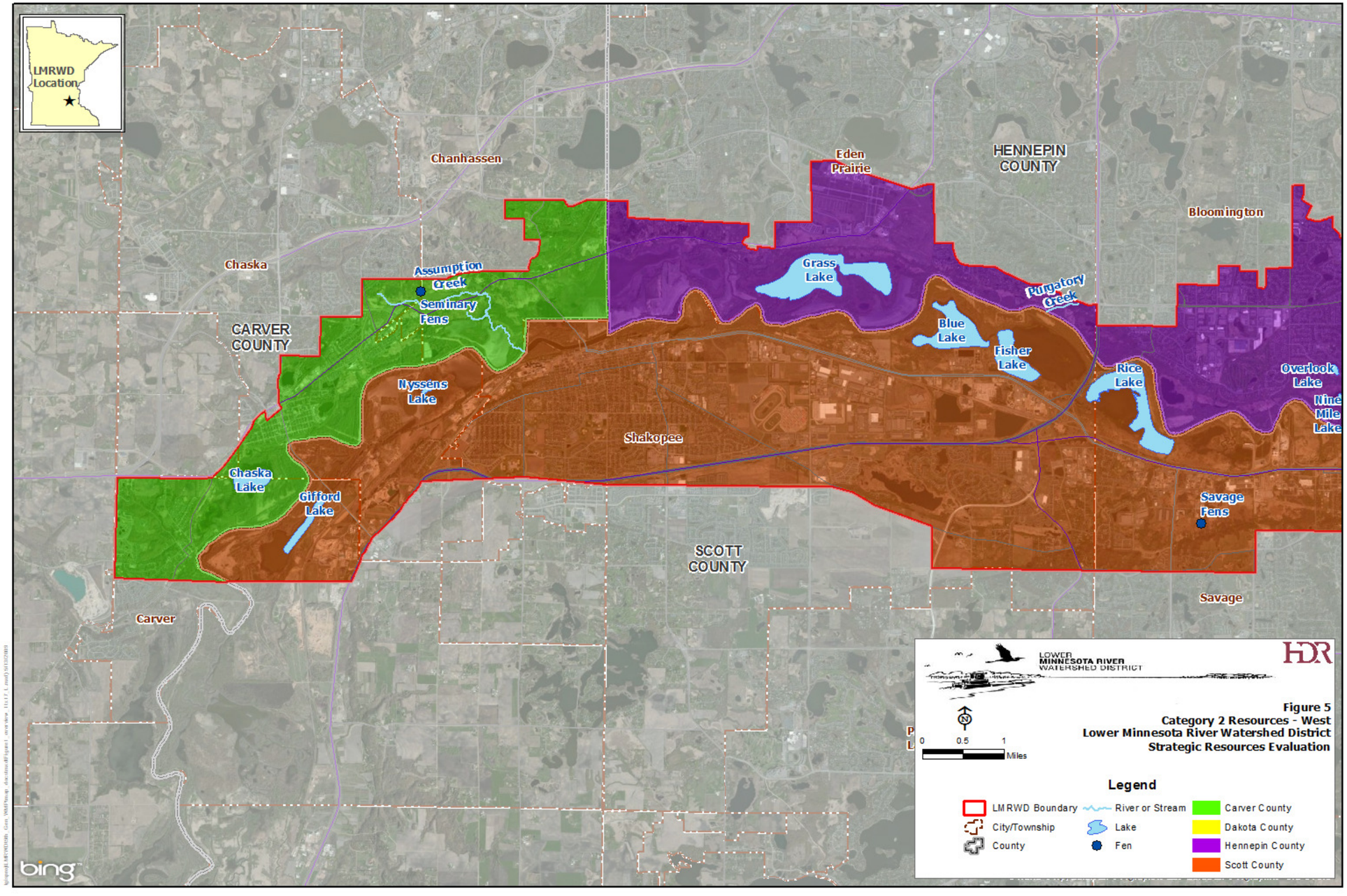
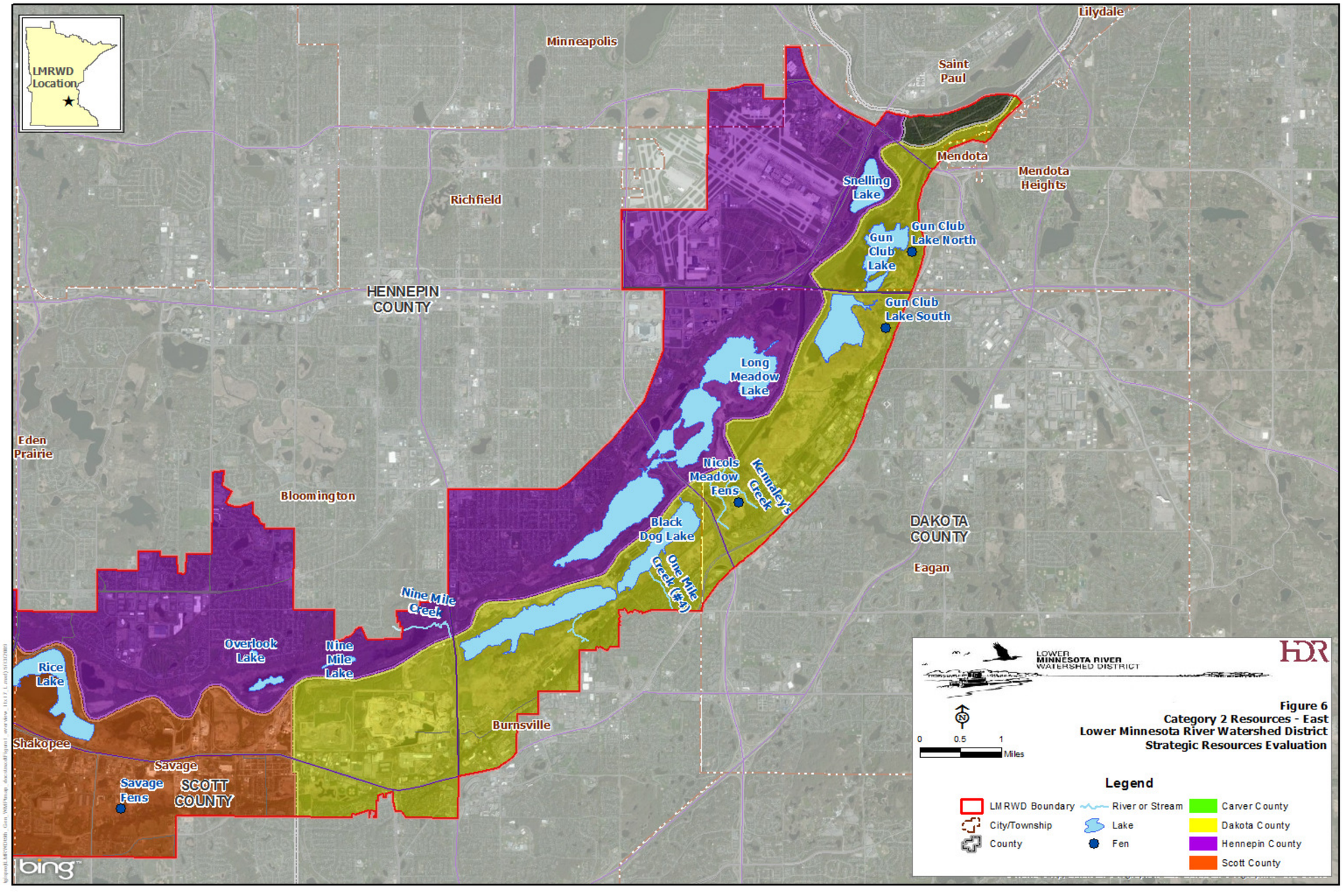


Figure 6. Category 2 resources within Lower Minnesota River Watershed District, east



Appendices

Appendix A: Lakes Data Summary Sheets

Appendix B: Streams Data Summary Sheets

Appendix C: Wetlands Data Summary Sheets

Appendix D: Fens Data Summary Sheets

Appendix E: Category 2 Streams Feasibility Study

Appendix F: Implementation Plan