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Memorandum

To: Black Dog Watershed Management Organization (BDWMO) Commissioners
From: Greg Williams, PE, Barr Engineering Co.
Subject: Draft watershed management plan internal review process (revised)
Date: April 12, 2022
Project: 23191455
c: Daryl Jacobson, BDWMO Administrator

Requested BDWMO Commission actions:

1. Consider the proposed draft Plan review schedule (revised from last month) and authorize Barr to distribute the draft Plan for formal 60-day review following the completion of the informal review period (April 13 – April 27, 2022) and subsequent Plan revisions (as needed).

1.0 Background

The Black Dog Watershed Management Organization (BDWMO) commissioners are in the process of updating the BDWMO Watershed Management Plan (Plan). At the March 16, 2022, BDWMO meeting, Barr Engineering Co. (Barr) staff presented a proposed Plan review timeline. That review timeline will likely not allow sufficient time for approval by the Minnesota Board of Water and Soil Resources (BWSR) prior to September 26, 2022 (expiration date of the current Plan).

2.0 Proposed Plan Review Schedule (revised)

To allow maximum time for official review and BWSR approval closer to September 26, 2022, we proposed the following schedule for internal Plan review and distribution for official 60-day review:

April 13 – A complete draft Plan is linked in the BDWMO April meeting packet; the draft Plan is also submitted directly to the BWSR Board Conservationist

April 13 to April 27 – A two-week internal review period begins with the April meeting packet/link distribution, with comments due directly to Barr staff by **April 27** at gwilliams@barr.com.

April 27 to May 9 – Barr staff will revise the Plan to address feedback and comments received from internal review, including any comments provided by BWSR during that time.

May 9 – Barr will submit the revised draft Plan for formal 60-day review as required by Minnesota Statutes 8410. We will compile and organize the comments received on the draft Plan (excluding minor edits such as typos) into a table along with proposed responses and/or edits to the draft Plan.

Barr staff will not submit the draft Plan for formal 60-day review prior to the May 18, 2022, BDWMO meeting if Barr staff or the BDWMO Administrator determine that the comments received during informal review require additional commissioner discussion/approval. In that case, commissioner input would be sought at the May 18, 2022, BDWMO meeting.

The schedule proposed above accelerates the formal review period and should allow BWSR approval closer to, but not necessarily before, expiration of the current Plan on September 26, 2022. Barr staff and the BDWMO Administrator will contact the BWSR Board Conservationist to determine if a brief extension of the current Plan is necessary.

3.0 Next Steps

Commissioners and member city staff will review the draft Plan (link provided in the meeting packet) and provide comments to Greg Williams at gwilliams@barr.com by April 27, 2022.

Watershed Management Plan

2022-2031

Prepared for the
Black Dog Watershed Management Organization

April 2022 – **INTERNAL REVIEW DRAFT**

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Watershed Management Plan

April 2022 – **INTERNAL REVIEW DRAFT**

Contents

List of Tables

List of Figures

List of Appendices, Attachments, or Exhibits

Certifications

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

	TBD
Sterling G. Williams Jr. PE #: 47642	Date

Acronyms

Acronym	Description
AIS	Aquatic Invasive Species
BDWMO	Black Dog Watershed Management Organization
BMP	Best Management Practice
BWSR	Minnesota Board of Water and Soil Resources
CAMP	Citizen Assisted Monitoring Program
CLP	Clean Lakes Program
CWA	Clean Water Act
DWSMA	Drinking Water Supply Management Area
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FiN	Fishing in the Neighborhood (MDNR Program)
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
JPA	Joint Powers Agreement
LA	Load Allocation
LGU	Local Governmental Unit
LiDAR	Light Detection and Ranging
LMRWD	Lower Minnesota River Watershed District
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
OHWL	Ordinary High Water Level
PWI	Public Waters Inventory
SCS	Soil Conservation Service
SSURGO	Soil Survey Geographic Dataset
SSTS	Subsurface Sewage Treatment System
SWA	Subwatershed Assessment
SWCD	Soil and Water Conservation District
SWMM	Stormwater Management Model
SWMP	Surface Water Management Plan
SWPPP	Storm Water Pollution Prevention Program
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

VIC	Voluntary Investigation and Cleanup
VRWJPO	Vermillion River Watershed Joint Powers Organization
WCA	Wetland Conservation Act
WHPP	Wellhead Protection Plan
WLA	Waste Load Allocation
WMO	Watershed Management Organization
WOMP	Watershed Outlet Monitoring Program
WRAPS	Watershed Restoration and Protection Strategy

Executive Summary

The Black Dog Watershed Management Organization (BDWMO) *Watershed Management Plan* (Plan) sets the vision and guidelines for protection, restoring, and managing surface waters within the boundaries of the BDWMO. The WMP provides resource data and background information, identifies and prioritizes watershed-wide and resource-specific issues, establishes measurable goals, sets policies and performance standards for the BDWMO and its cities, and lays out a 10-year implementation schedule including projects and programs. The Plan is organized into five major sections, summarized as follows:

Section 1 – Introduction

Section 1.0 of this Plan summarizes the BDWMO's role as a watershed management organization (WMO), its location and history, and management structure. Like all WMOs, the BDWMO is a special purpose unit of local government that manages water resources on a watershed basis. The BDWMO's jurisdiction spans approximately 26 square miles in Dakota County and includes portions of the Cities of Apple Valley, Burnsville, Eagan, and Lakeville. The BDWMO is governed by a five-member Board of Commissioners including three members representing Burnsville, one member representing Lakeville, and one member representing Eagan and Apple Valley. The powers of the Board are detailed in the most current iteration of the BDWMO joint powers agreement (JPA, see Appendix A) and are summarized in Section 1.0.

Section 1.0 also presents the vision of the BDWMO:

> ***Water resources and related ecosystems are managed to sustain their long-term health and aesthetic beauty to contribute to the well-being of the citizens within the watershed.***

Section 2 – Land and Water Resources Inventory

Section 2.0 of this Plan contains information about the water and natural resources located within the BDWMO. Information is provided as text, tables, and maps and organized according to the following topics and resources:

- Climate and precipitation
- Topography and drainage
- Population, demographics, and land use
- Soils
- Geology
- Groundwater
- Surface water resources (lakes, ponds, and wetlands)
- Water monitoring and studies
- Water quality and BDWMO management classifications
- Water quantity and flooding
- Natural communities and rare species
- Fish and wildlife habitat
- Open space and recreational areas
- Pollutant sources

Understanding the condition of water and natural resources present in the BDWMO is key to identifying priority issues, establishing goals, and targeting the actions of the BDWMO, its member cities, and other partners.

Section 3 – Priority Issues and Resources

Section 3.0 of the Plan presents and discusses the priority issues and resources that will be the focus of the BDWMO during the life of this Plan. As part of Plan development, the BDWMO commissioners solicited input on priority issues and concerns from residents, state agencies, member cities, and regional partners through multiple stakeholder engagement activities illustrated in Figure ES-1.

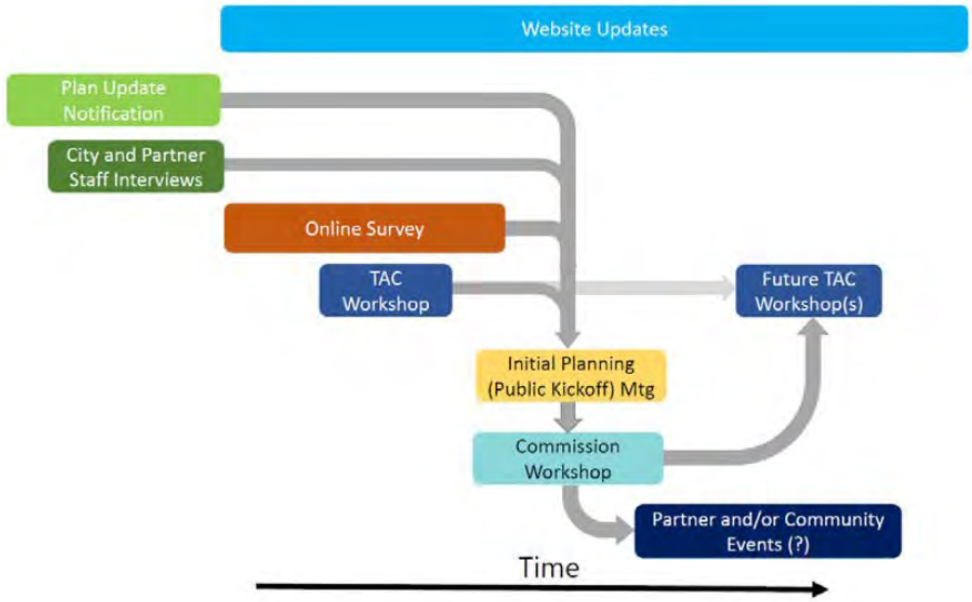


Figure ES-1 Stakeholder engagement workflow

Stakeholder engagement and issue identification activities are summarized in Appendix B. With consideration for the stakeholder engagement and data review activities, the BDWMO established the following Plan priorities:

Higher Priority Issues	Lower Priority Issues
• **Water quality**, including: o Stormwater runoff quality o In-lake water quality o Impairments (Keller Lake) • **Lake ecology and habitat**, including: o Habitat quality o Invasive species management • **Groundwater management**, including o Pollution prevention o Conservation and sustainability • **Education and Engagement**	• **Flooding and water levels** • **Wetland management** • **Upland and natural area management**

The BDWMO also classified the following lakes as **strategic waterbodies** to be the focus of BDWMO activities**:**

- Crystal Lake
- Keller Lake
- Kingsley Lake
- Lac Lavon
- Orchard Lake

The priority issues and the resource and issue prioritization process are described in greater detail in Section 3.0.

Section 4 – Goals and Policies

Section 4.0 presents the goals and policies of the BDWMO. Goals in Section 4.0 are generally organized according to the resource or operational issue they most closely address along with the policies to support those goals. Where possible, BDWMO goals contain measurable targets to evaluate progress (see Section 5.4.2). Key goals included in Section 4.0 include:

A. Maintain or improve water quality in BDWMO strategic waterbodies to meet applicable state standards or existing 10-year (2012 – 2021) summer average water quality, if better than state standards, including:

   - Keller Lake – 60 ug/L total phosphorus, 20 ug/l chlorophyll *a*, and 1.0 meter Secchi disc transparency (i.e., applicable state shallow lake water quality standards for eutrophication)

   - Crystal Lake – 26 ug/L total phosphorus, 13 ug/l chlorophyll *a*, and 2.1 meter Secchi disc transparency

   - Kingsley Lake – 17 ug/L total phosphorus, 2.3 ug/l chlorophyll *a*, and 3.0 meter Secchi disc transparency

   - Lac Lavon – 13 ug/L total phosphorus, 2.9 ug/l chlorophyll *a*, and 4.2 meter Secchi disc transparency

   - Orchard Lake – 21 ug/L total phosphorus, 6.2 ug/l chlorophyll *a*, and 2.5 meter Secchi disc transparency

D. Work with member cities to reduce chloride loading relative to current conditions through practices consistent with the Twin Cities Metropolitan Area Chloride Management Plan (MPCA, 2016) and Minnesota Statewide Chloride Management Plan (MPCA, 2021).

N. Maintain or improve the ecological and habitat quality of BDWMO strategic waterbodies to achieve applicable standards for floristic quality index (FQI ≥ 17.8) and native species diversity of submerged vegetation (at least 11 species).

O. Support member city and partner actions to prevent the increase or reduce the occurrence of aquatic invasive species within BDWMO strategic waterbodies.

S. Increase awareness and knowledge of residents, local officials, and city staff regarding water resources and stormwater management through actions coordinated with member cities, Dakota SWCD, and other partners, including:
    - presentations at K-12 schools
    - electronic newsletters/social media posts presenting information on priority issues
    - resource clean-up events or similar volunteer activities.

T. Increase community capacity to implement water and natural resource stewardship action through:
    - increased participation in volunteer activities
    - increased participation in small-scale BMP cost share projects
    - consistently providing data through accessible media

The BDWMO Plan includes policies to support the achievement of BDWMO goals and establishes performance standards that member cities must enforce through ordinance, local water management plans, or other means. Among these, the BDWMO requires that member cities shall maintain or strengthen stormwater management, erosion and sediment control, wetland, floodplain and shoreland official controls.

Section 5 – Implementation Program

Section 5.0 describes the significant components of the BDWMO implementation program; the program reflects the BDWMO's goals and organizational authorities. Activities included in the BDWMO's implementation schedule (see Table 5-2) are divided among the following categories described in Section 5.0:

- Administration
- Engineering and Planning
- Education and Outreach
- Monitoring
- Projects, Studies, and Capital Improvements

The BDWMO implementation schedule includes the continuation of ongoing activities as well as new activities to address emerging issues and changing priorities. New or expanded activities include algal community monitoring and chloride monitoring of strategic waterbodies, expanded water chemistry monitoring of Keller Lake and Kingsley Lake, and targeted outreach to address chloride loading. The implementation schedule also identifies opportunities to use watershed-based implementation funding (WBIF) to support member city projects for stormwater treatment, shoreline improvement, and aquatic plant management for strategic waterbodies.

Section 5.0 describes the funding mechanisms used and available to the BDWMO, assessment and reporting practices, and the process for amending this Plan. Requirements for City local water management plans consistent with Minnesota Statutes 103B.235 and Minnesota Rules 8410.0160 are also presented in this section.

1.0 Introduction

The Black Dog Watershed Management Organization (BDWMO) *Watershed Management Plan* sets the vision and guidelines for managing surface water within the boundaries of the BDWMO. This section summarizes the history, purpose, authorities, and vision of the BDWMO.

1.1 The Role of Watershed Management Organizations

Like all watershed management organizations (WMOs), the BDWMO is a special purpose unit of local government that manages water resources on a watershed basis. Watershed management organization boundaries generally follow natural watershed divides, rather than political boundaries. Thus, they may include several municipalities and counties.

Recognizing that water does not follow political boundaries, the State of Minnesota established the Watershed Act (Minnesota Statutes 103D) in 1955, which provided for the creation of watershed districts anywhere in the state. In 1982, the Minnesota Legislature enacted the Metropolitan Surface Water Management Act (Minnesota Statutes 103B.201 – 103B.255). This act required the formation of a WMO, and the development and implementation of a watershed management plan, for each of the watersheds in the seven county Twin Cities metropolitan area. WMOs can be organized as joint powers agreement organizations among municipalities (e.g., BDWMO), as watershed districts (e.g., Lower Minnesota River Watershed District (LMRWD)), or under county government (e.g., Vermillion River JPO).

Per Minnesota Statutes 103B.201, the purposes of WMO water management programs are as follows:

1. Protect, preserve, and use natural surface and groundwater storage and retention systems;
2. Minimize public capital expenditures needed to correct flooding and water quality problems;
3. Identify and plan for means to effectively protect and improve surface and groundwater quality;
4. Establish more uniform local policies and official controls for surface and groundwater management;
5. Prevent erosion of soil into surface water systems;
6. Promote groundwater recharge;
7. Protect and enhance fish and wildlife habitat and water recreational facilities; and
8. Secure the other benefits associated with the proper management of surface and groundwater.

1.2 Black Dog Watershed Management Organization

Watershed planning is an important process for developing a coordinated approach to identify and resolve water resource management problems. Addressing these problems at the watershed scale is important because water does not respect political boundaries. Activities occurring in one city may cause impacts in another community. By managing water resources on a watershed basis, communities within the watershed can jointly plan to prevent, minimize, and correct problems, and coordinate and equitably pay for projects.

1.2.1 Location

The BDWMO is located in northwestern Dakota County. Figure 1-1 shows the location of the BDWMO in relation to the adjacent watershed management organizations in the seven-county metropolitan area. The majority of the BDWMO discharges through the Lower Minnesota River Watershed District (LMRWD) before reaching the Minnesota River. However, the Murphy-Hanrehan, Kingsley Lake, and Orchard Lake subwatersheds are tributary to the Credit River located west of the BDWMO. Water management activities in these subwatersheds are of particular interest to Scott County (Scott WMO), the City of Savage, and the City of Credit River.

The BDWMO is moderately developed with generally suburban land use (see Figure 2-3). The total drainage area of the BDWMO is 25.9 square miles (about 16,600 acres) and includes part of four cities:

- Apple Valley
- Burnsville
- Eagan
- Lakeville

1.2.2 History and Accomplishments since the 2012 Plan

The BDWMO was first established by a joint powers agreement (JPA) between the member cities that went into effect in 1985. At the time of its formation, the BDWMO covered 20.2 square miles (12,900 acres) including parts of the cities of Apple Valley, Burnsville, Eagan, Lakeville, and Savage. In 1999, the JPA was revised and restated along, with a new memorandum of understanding with Scott County, when the portion of the former Credit River WMO in Dakota County was incorporated into the BDWMO, increasing the BDWMO to its current area of 25.9 square miles (16,600 acres). In 2010, a new JPA went into effect as did an additional memorandum of understanding between the BDWMO and Scott County when the City of Savage was removed from the BDWMO and incorporated into the Scott WMO. The JPA was amended in 2020 to revise the 2010 JPA and extend its duration to January 1, 2030. The JPA will continue to be revised as necessitated by the policies of this Plan, future amendments, or other actions taken by the Commission (e.g., jurisdictional changes, membership, funding formulas).

The 2020 amended JPA is included as Appendix A to this Plan.

Since its formation, the BDWMO has developed and adopted four watershed management plans. This document, adopted by the BDWMO in 2022, is the fourth generation BDWMO Plan and supersedes the third-generation plan adopted in December 2012. This Plan shall extend 10-years from the date of BWSR approval (through 2032), unless otherwise superseded. Accomplishments of the BDWMO since the adoption of the 2012 Plan include:

- Ongoing management level water quality monitoring, trend analysis, and water quality reporting for three of the BDWMO strategic waterbodies: Crystal Lake, Lac Lavon, and Orchard Lake

- Habitat monitoring of submergent, emergent, and upland vegetation and shoreline conditions for all BDWMO strategic waterbodies: Crystal Lake, Keller Lake, Kingsley Lake, Lac Lavon, and Orchard Lake
- Funding annual water quality monitoring of all BDWMO strategic waterbodies through the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP)
- Publishing of the BDWMO watershed annual report (newsletter) and the annual activity report (submitted to BWSR) to document work performed in the prior year
- Funding educational workshops and implementation of small-scale shoreline restoration and runoff capture projects via Dakota County's Landscaping for Clean Water program
- Working with member cities and the Minnesota Pollution Control Agency (MPCA) to remove Crystal Lake, Lee Lake, and Earley Lake from the impaired waters list following water quality improvement
- Assisting the City of Burnsville in successfully obtaining a BWSR Clean Water Fund grant for their Crystal Beach Park water quality improvement project
- Completing a feasibility assessment and subsequent in-lake alum treatment of Keller Lake, including obtaining funding from the BWSR Clean Water Fund grant program
- Facilitating the distribution of BWSR Clean Water Fund WBIF funds
- Distributing educational materials to support natural resources stewardship through the BDWMO website and member city communication channels

1.2.3 Management Structure

The BDWMO Board of Commissioners consists of five commissioners and three alternates appointed by the member cities to a three-year term. The City of Burnsville appoints three commissioners, the cities of Apple Valley and Eagan appoint the fourth commissioner, and the City of Lakeville appoints the fifth commissioner. Member city staff attend board meetings on a regular basis as informal technical advisors. Regular meetings are held on the 3rd Wednesday of the month at the City of Burnsville offices. The public is invited to attend the BDWMO Commission meetings. Meeting schedules, agendas, and materials are posted on the BDWMO website at: www.blackdogwmo.org

1.2.4 BDWMO Vision and Guiding Principles

Within the context of the statutory authority granted to WMOs and contained in the JPA, the BDWMO Board has established the following vision to provide strategic direction to its work. The following vision helps to focus the organization's efforts and is a reminder of what the BDWMO is working to achieve:

> ***Water resources and related ecosystems are managed to sustain their long-term health and aesthetic beauty to contribute to the well-being of the citizens within the watershed.***

In addition to the statutory authority and functions identified in the JPA, the BDWMO has further clarified its mission in relationship to it members. The following guiding principles of the BDWMO helped the organization establish its Goals and Policies in Section 3.0:

- Keep regulation at the local level—the BDWMO will not administer a permit program.

- Assist member communities with intercommunity floodplain and runoff planning and with mediation of water management disputes between communities.
- Monitor, classify and manage strategic water resources to meet their intended use. Strategic resources are waterbodies that have broad watershed significance.
- Monitor, evaluate and/or model stormwater runoff quality.
- Improve the quality of the stormwater runoff reaching the Minnesota River.
- Manage intercommunity stormwater runoff, flooding, and other water quantity issues.
- Develop policies to be implemented by the cities to protect the BDWMO's water resources.
- Assess performance of the BDWMO and the member cities toward achieving the goals stated in this Plan.
- Provide member cities with useful information about the BDWMO, its activities, and water resource management.
- Educate all watershed citizens and member cities in water resource issues and BDWMO activities.
- Assist member cities with funding water quality projects through grants and other funding available directly to watershed organizations.

1.2.5 Authority Granted by the Joint Powers Agreement

The authority of the BDWMO is established by Minnesota Statutes 103B and by the JPA. The responsibilities of the BDWMO, taken from the JPA, include, but are not limited to:

1. Prepare and adopt a watershed management plan.
2. Review and approve municipal water management plans.
3. Provide any member city with technical data or other information to assist the city in preparing its local water management plan.
4. Regulate use and development of land in the watershed, either as authorized by a member city, or in the absence of an approved local water management plan, or for projects requiring a variance from the local water management plan or implementation program of the member city.
5. Publish and distribute a newsletter at least annually.
6. Establish and maintain devices for acquiring and recording hydrological and water quality data.
7. Enter upon lands to make surveys and investigations to accomplish the BDWMO's purposes.
8. Order any member city to carry out the BDWMO-approved local water management plan, including any capital improvements.
9. Acquire, operate, construct, and maintain only the capital improvements, if any, delineated in the adopted BDWMO plan.
10. Obtain an annual audit of the books and accounts of the BDWMO.
11. Adopt an annual work plan.
12. Accumulate reserve funds and invest funds not currently needed for BDWMO operations.
13. Collect money from the BDWMO members and from any other BDWMO-approved source.
14. Make contracts, employ consultants, incur expenses, and make expenditures.
15. Enter into contracts or cooperate with governmental agencies, private/public organizations, or individuals to accomplish the purposes for which the BDWMO is organized.
16. Contract for or purchase insurance, as needed.

17. Exercise all other powers necessary and incidental to the implementation of the purposes and powers set forth in the joint powers agreement.
18. Investigate complaints relating to water pollution and take appropriate action to alleviate the pollution and to assist in protecting and improving the water quality of surface water in the watershed.
19. Coordinate its planning activities with contiguous WMOs and counties conducting water planning and implementation under Minnesota Statutes 103B.

Barr Footer: ArcGIS 10.8.1, 2022-04-07 16:04 File: I:\Client\Blackdog\Work_Orders\23191455_2022_Plan_Update\Maps\Reports\Figure 1-1 Location of the BDWMO.mxd User: cml3

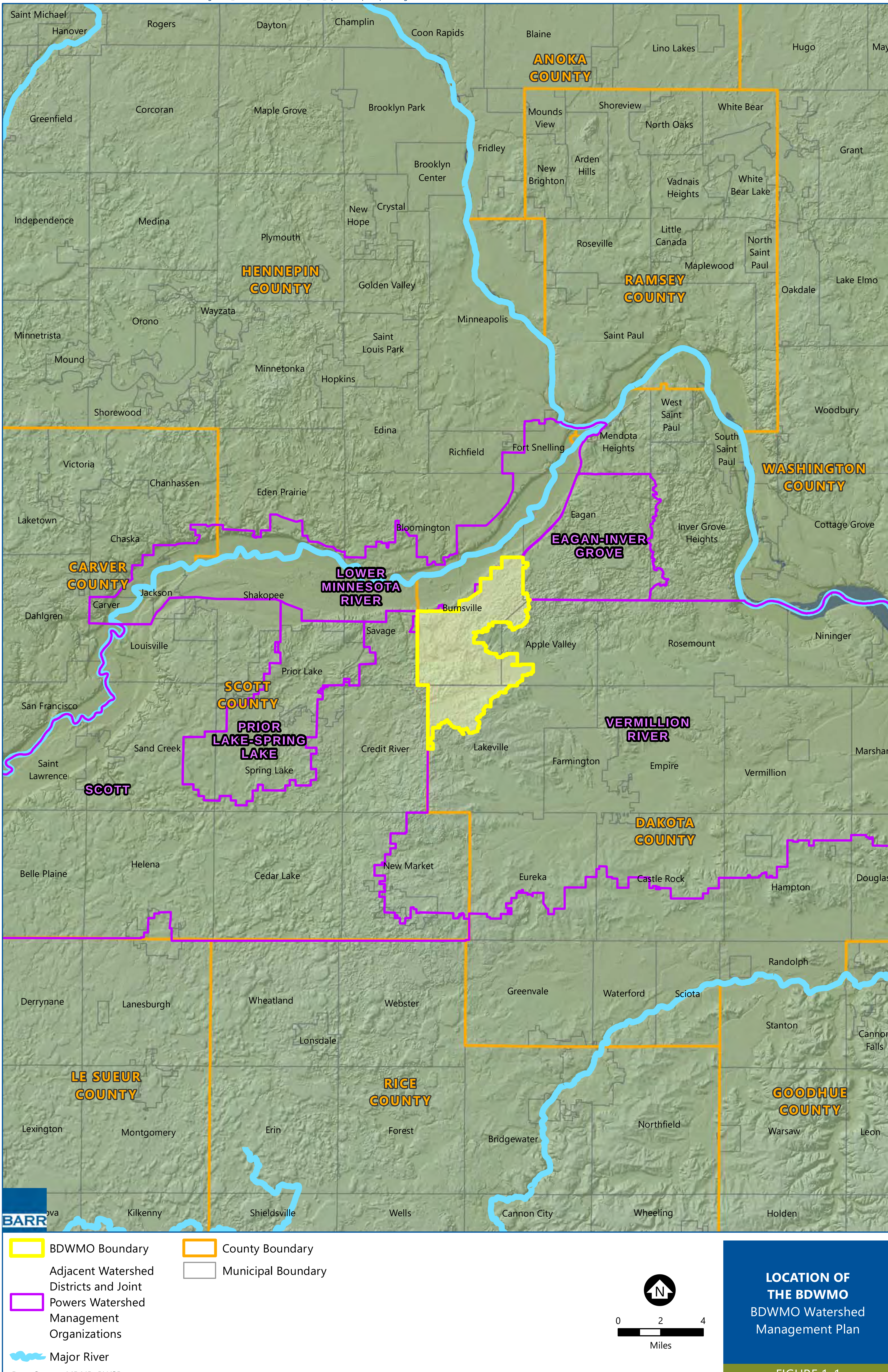


FIGURE 1-1

2.0 Land and Water Resources Inventory

This section summarizes the land and water resources located within the BDWMO. It contains information on climate and precipitation, topography and drainage, land use, soils, geology, groundwater, surface waters, natural areas, habitat, and rare species, recreation, and potential pollutant sources. Land and water resource information is important because it describes the condition of the watershed that may impact decisions about infrastructure, development, and resource management.

2.1 Climate and Precipitation

The climate of the seven county Twin Cities Metropolitan Area is a humid continental climate, characterized by moderate precipitation (normally sufficient for crops), wide daily temperature variations, large seasonal variations in temperature, warm humid summers, and cold winters with moderate snowfall. Climate data is often presented according to 30-year “climate normal” periods, the most recent spanning the period from 1991-2020. Several of the wettest years on record have been observed during the most recent climate normal period, including several wet years since 2010. Climate trends are discussed in Section 2.1.2. Climate data presented in this section is based on the 30-year period from 1991 through 2020, unless otherwise noted.

The mean annual temperature as measured at the Minneapolis-St. Paul international airport (MSP) is 46.6°F (1991-2020). Mean monthly temperatures vary from 15.9°F in January to 74.1°F in July (1991-2020). For the 1991-2020 climate normal period, the average frost-free period (growing season) is approximately 160 days.

Table 2-1 summarizes monthly precipitation data for the approximate centroid of the BDWMO, based on the Minnesota Climatology Working Group gridded precipitation dataset for the most recent complete climate normal period (1991-2020) and 10-year period (2011-2020). Average total annual precipitation is 34.6 inches (1991-2020). The mean monthly precipitation varies from 5.1 inches in June to 1.0 inches in January and February (1991-2020). From May to September, the growing season months, the average rainfall (1991-2020) is 22.0 inches, or 64% of the average annual precipitation. Snowfall averaged 52 inches annually at the MSP station during the 1991-2020 climate normal period.

Additional information about local and regional climate is available from the Minnesota Department of Natural Resources (MDNR) State Climatology office and NOAA at:

- Minnesota State Climatology Office: https://www.dnr.state.mn.us/climate/index.html
- National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC): https://www.ncdc.noaa.gov/cdo-web/

Table 2-1 Monthly Precipitation Data (Climate Normal and 10-year Average)

Month	1981-2010 Precipitation (inches)	1991-2020 Precipitation (inches)	2011-2020 Precipitation (inches)
January	0.92	0.98	0.90
February	0.79	0.97	1.29
March	1.96	1.86	1.75
April	2.71	2.96	3.52
May	3.79	4.45	5.54
June	4.56	5.05	5.62
July	4.16	4.42	5.09
August	4.86	4.82	4.17
September	3.40	3.30	2.80
October	2.61	2.81	2.85
November	1.80	1.66	1.44
December	1.12	1.35	1.63
Total	**32.79**	**34.62**	**36.60**

Source: Minnesota Climatology Working Group gridded precipitation dataset

2.1.1 Precipitation-Frequency Data (Atlas 14)

The amount, rate, and type of precipitation are important in determining flood levels and stormwater runoff rates. While average weather poses little risk to human health and property, extreme precipitation events may result in flooding that threatens infrastructure and public safety. NOAA published Atlas 14, Volume 8, in 2013. Atlas 14 is the primary source of information regarding rainfall amounts and frequency in Minnesota. Atlas 14 provides estimates of precipitation depth (i.e., total rainfall in inches) and intensity (i.e., depth of rainfall over a specified period) for durations from 5 minutes up to 60 days. Atlas 14 supersedes publications Technical Paper 40 (TP-40) and Technical Paper 49 (TP-49) issued by the National Weather Bureau (now the National Weather Service) in 1961 and 1964, respectively. Atlas 14 improvements in precipitation estimates include denser data networks, longer (and more recent) periods of record, application of regional frequency analysis, and new techniques in spatial interpolation and mapping. Comparison of precipitation depths between TP-40 and Atlas 14 indicates increased precipitation depths for more extreme (i.e., less frequent) events. Table 2-2 lists selected rainfall events within the BDWMO. The BDWMO member cities typically use Atlas 14 design precipitation depths specific to their jurisdictions.

Runoff from spring snowmelt is not provided in Atlas 14 and current regional snowmelt runoff data is not available (Minnesota Stormwater Manual, 2019). Older estimates of snowmelt runoff come from the

Hydrology Guide for Minnesota (USDA Soil Conservation Service – NRCS, 1975, see Table 2-2). Snowmelt and rainstorms occurring during snowmelt in early spring are significant in this region. The volumes of runoff generated, although they occur over a long period, can have significant impacts where the contributing drainage area to a lake or pond is large and the outlet is small.

Table 2-2 Selected Rainfall Events Used for Design Purposes

Type	Frequency	Duration	Depth (in)
Rainfall	2-year	24 hour	2.82
	5-year	24 hour	3.50
	10-year	24 hour	4.18
	25-year	24 hour	5.30
	50-year	24 hour	6.30
	100-year	24 hour	7.42
	10-year	10 day	6.77
	100-year	10 day	10.1
Snowmelt	10-year (10%)	10 day	4.7
	25-year (4%)	10 day	5.7
	50-year (2%)	10 day	6.4
	100-year (1%)	10 day	7.1

Source: NOAA Atlas 14 – Volume 8 interpolated to approximate centroid of BDWMO; depths reflect the 50% exceedance limit. Snowmelt values from Hydrology Guide for Minnesota (USDA Soil Conservation Service – NRCS) and reported as liquid water.

2.1.2 Climate Trends and Future Precipitation

There are typically wide variations in climate conditions in the BDWMO. However, climatologists found four significant recent climate trends in the Upper Midwest (NOAA, 2013):

- Warmer winters—decline in severity and frequency of severe cold; warming periods leading to mid-winter snowmelt
- Higher minimum temperatures
- Higher dew points
- Changes in precipitation trends – more rainfall is coming from heavy thunderstorm events and increased snowfall

According to NOAA's 2013 assessment of climate trends for the Midwest, annual and summer precipitation amounts in the Midwest are trending upward, as is the frequency of high intensity storms. Annual precipitation in the BDWMO averaged 34.6 inches from 1991-2020, a 1.8 inch increase over the

1981-2010 climate normal period (32.8 inches). Annual precipitation exceeded the previous climate normal average (34.6 inches) in 7 of 10 years since 2010.

Higher intensity precipitation events typically produce more runoff than lower intensity events with similar total precipitation amounts; higher rainfall intensities are more likely to overwhelm the capacity of the land surface to infiltrate and attenuate runoff. Precipitation data from the Mississippi River-Twin Cities basin dating back to 1895 (available from the MDNR climate trends website) indicates that annual precipitation, averaged over 30-year climate normal periods, is increasing (see Figure 2-1).

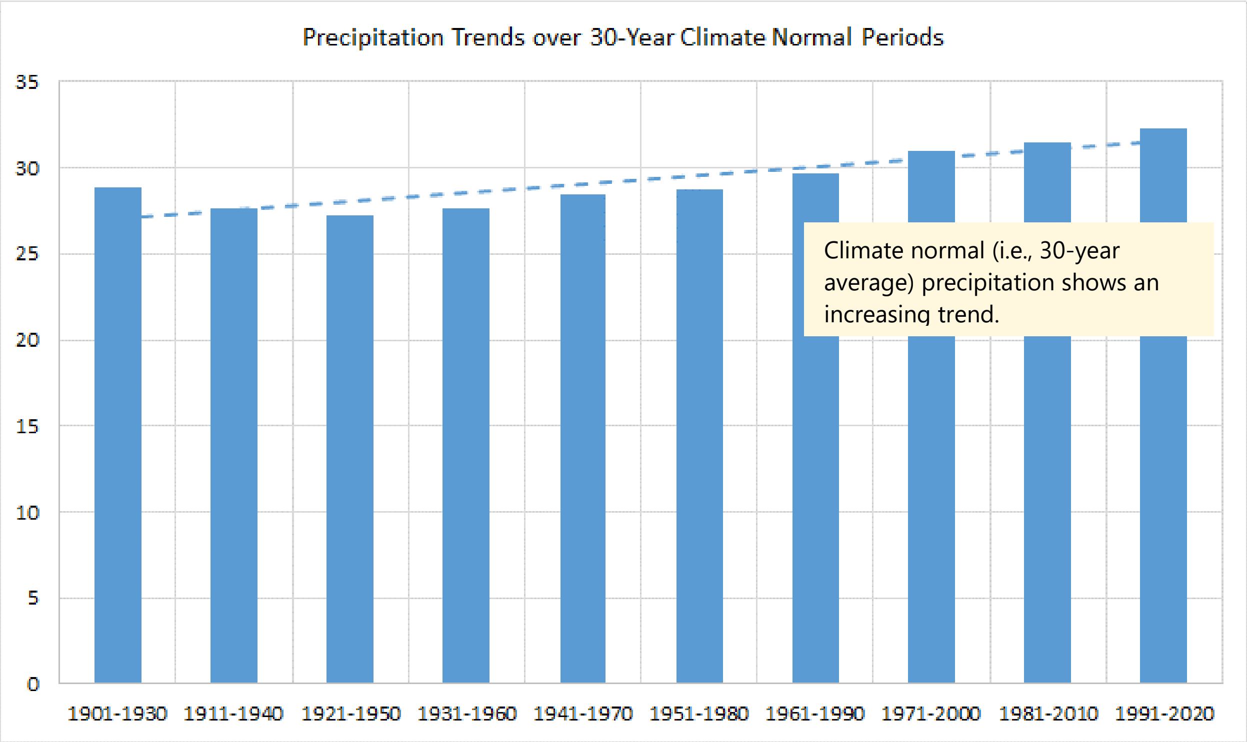


Figure 2-1 Trends in Average Annual Precipitation (Twin Cities Region)

Work completed by the University of Minnesota (Moore et al., 2016) provides information useful to consider long-term extreme weather trends in the region. The study of long-term extreme weather trends found that precipitation amounts are predicted to increase significantly over what is historically used in floodplain assessments and infrastructure design. Stack et al. (2014) identified a range of estimates for the mid-21st century 100-year 24-hour rainfall event applicable to the Twin Cities metro area. The lower estimate for the mid-21st century 100-year, 24-hour rainfall estimate was approximately 7.3 inches, which is similar to the current mean 100-year, 24-hour rainfall depth published in Atlas 14 (7.8 inches). The middle estimate is 10.2 inches, which is similar to the upper limits of the Atlas 14 90-percent confidence limits for the 100-year rainfall depth (10.4 inches). Upper estimates of mid-21st century 100-year 24-hour rainfall exceed the 90-percent confidence limits of Atlas 14.

Additional information about climate change is available from NOAA and the Minnesota Department of Natural Resources (MDNR) at:

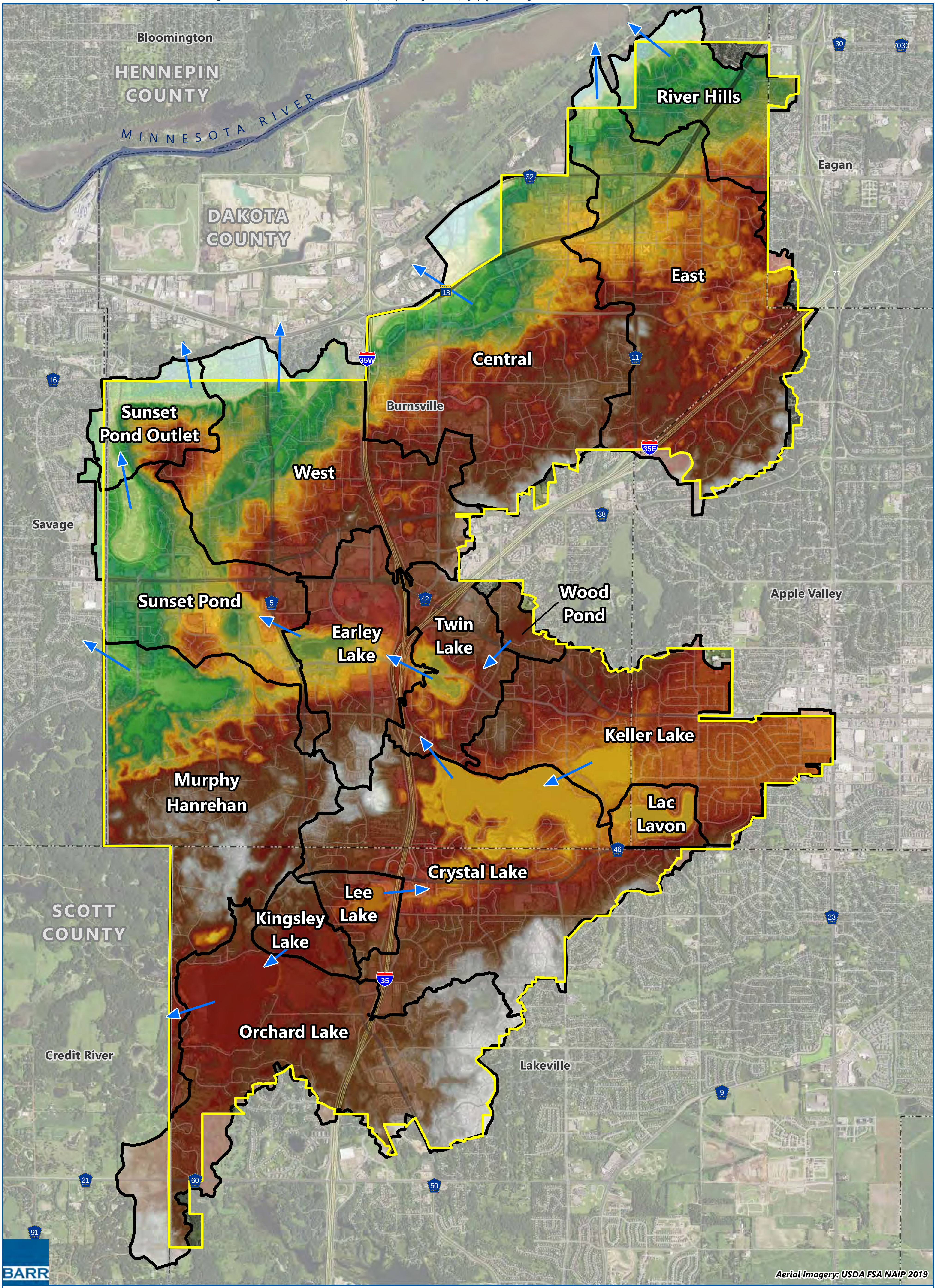
- https://www.noaa.gov/categories/climate-change
- https://www.dnr.state.mn.us/climate/climate_change_info/index.html

2.2 Topography and Drainage

The topography of the watershed consists of rolling to hilly terrain and generally slopes from the southwest to the north towards the Minnesota River and east to the Credit River. At the southern end of the watershed, an upland ridge slopes down to Crystal Lake. High ground in the southwest of the watershed separates the area draining north to the Minnesota River and the area draining west to the Credit River. Continuing north, the upland transitions into an undulating glacial outwash plain. This area is pitted with shallow depressions surrounded by mounds of glacial till. Further north, the pitted outwash plain gives way to an outwash terrace, just above the Minnesota River floodplain. This transition corresponds roughly to the jurisdictional boundary between the BDWMO and the Lower Minnesota River Watershed District.

The highest point within the watershed is Buck Hill, in the City of Burnsville, at an elevation of 1,195 above mean sea level (MSL). The lowest point within the watershed is approximately 720 feet MSL at the northern boundary of the BDWMO. Figure 2-2 presents LiDAR elevation data collected in 2011 by the MDNR. Local topography creates some landlocked basins for which outlets have not been constructed. Lac Lavon is a significant waterbody that is landlocked under normal hydrologic conditions.

The BDWMO includes areas that drain to the Minnesota River (north of the BDWMO) and the Credit River watershed (west of the BDWMO). The area of the BDWMO is subdivided among watersheds of varying levels of detail as defined by the MDNR and USGS. The BDWMO further subdivided the watershed for water resource planning purposes. Figure 2-2 presents BDWMO planning level subwatersheds.



BDWMO Boundary
Watershed Boundary
County Boundary
Municipal Boundary
River

Elevation (ft)
High : 1,210 ft
Low : 700 ft

N

0 1,750 3,500
Feet

TOPOGRAPHY AND DRAINAGE PATTERNS
BDWMO Watershed Management Plan

FIGURE 2-2

Topography Source: MnDNR 3-meter DEM

2.3 Population, Demographics, and Land Use

The BDWMO is located within the Twin Cities Metropolitan Area, in northwest Dakota County. Land use within the watershed (2016 data provided by the Metropolitan Council) is summarized in Table 2-3 and Figure 2-3.

Over time, the land within the BDWMO has been transformed from a natural landscape, first to agricultural land use and, over time, to more urban and suburban land uses. Agricultural land use now occupies approximately less than 1% of the watershed. Residential land use occupies approximately 54% of the watershed; approximately 94% of residential land use is single-family. The watershed is mostly developed, with approximately 1,480 acres (about 9% of the watershed) remaining undeveloped. Higher intensity land uses (typically commercial and industrial development) are clustered along I-35W, County Road 42 and Highway 13. Most of the remaining undeveloped areas are concentrated in the City of Lakeville. Some areas currently identified as undeveloped may not be suitable for future development.

Development of the watershed has coincided with population growth among the member cities. Population within the BDWMO member cities by grew by approximately 400% between 1970 and 2000. Since 2000, population within the BDWMO has increased by approximately 10% per decade. Continued population grown of between 5% and 10% per decade is anticipated through 2040. In addition to population increase, the population within the BDWMO (and greater Dakota County) is expected to age and grow more racially and ethnically diverse (Dakota County, 2019). Additional information about population and demographic trends is available in the comprehensive plans of the BDWMO member cities and Dakota County.

The conversion of natural areas and vegetation over time for residential, commercial, and other land uses increases the amount of impervious surfaces (i.e., surfaces through which water cannot infiltrate), resulting in increases in stormwater runoff volume and associated pollutant loading. Thus, local governmental units' (LGU's) continued implementation of stormwater management performance standards for development and redevelopment are key to addressing water quality and water quantity issues.

Because much of the watershed is already developed, most land use changes and construction activity within the watershed will likely occur through redevelopment. Figure 2-4 presents the estimated 2040 land use, as available from the Metropolitan Council. Redevelopment presents an opportunity to implement stormwater best management practices previously omitted or augment existing practices. Possible redevelopment anticipated by BDWMO member cities include possible locations along Cedar Avenue and County Road 42.

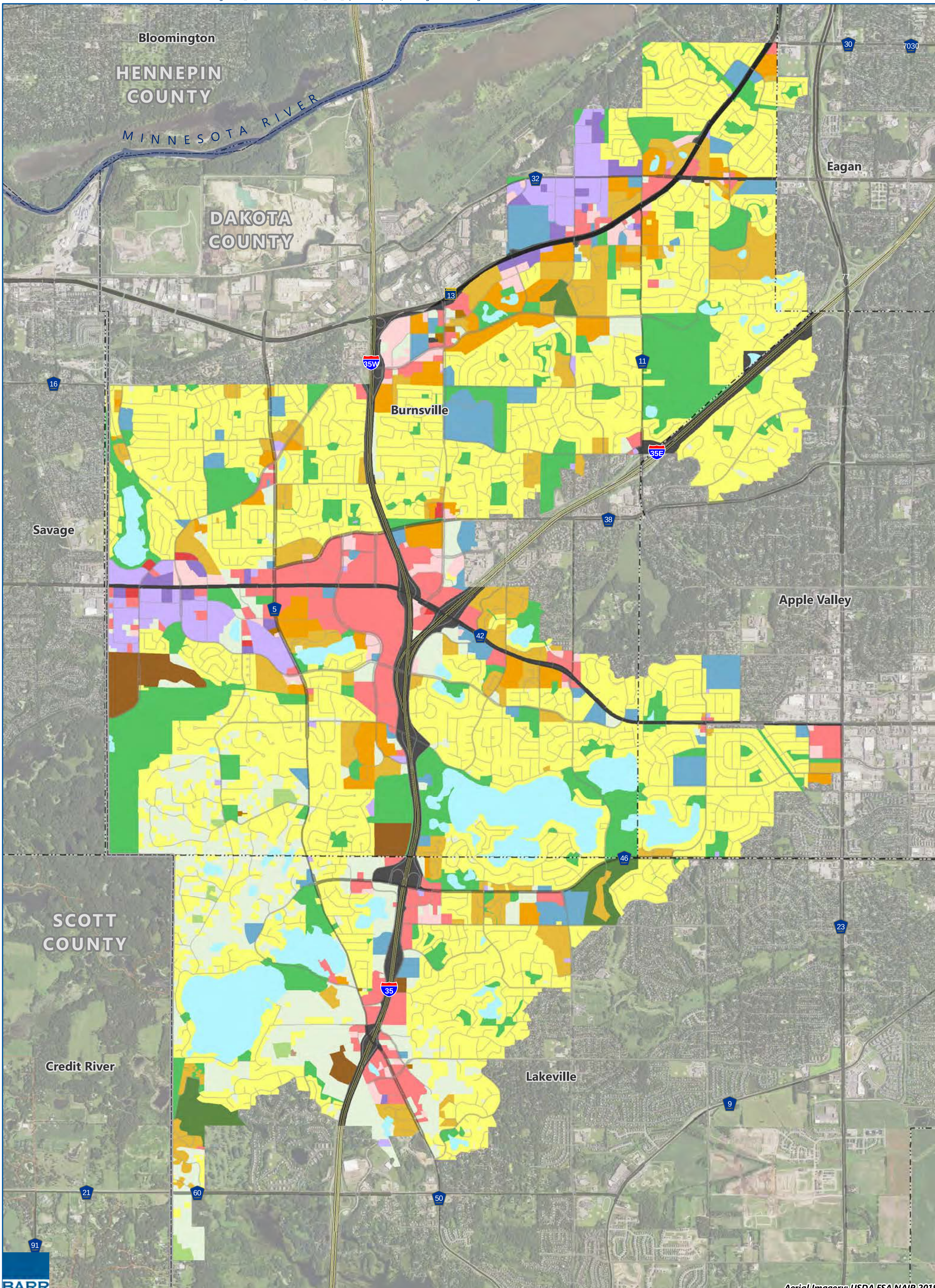
More detailed information about current and future land use, anticipated population growth, and land development is presented in the 2040 comprehensive plans for the BDWMO member cities.

Table 2-3 Existing Land Use (2016)

Land Use	Acres	Percent Area
Agricultural or Farmstead	44	0.3%
Commercial or Retail	918	5.5%
Office	246	1.5%
Golf Course	156	0.9%
Industrial and Utility	425	2.6%
Institutional	562	3.4%
Mixed Use	148	0.9%
Open Water	998	6.0%
Park, Recreational, or Preserve	1,864	11.2%
Residential, Single Family	8,387	50.5%
Residential, Multifamily	525	3.2%
Transportation (Highway, Rail, Airport)	677	4.1%
Undeveloped	1,476	8.9%
Other	194	1.2%
Total	16,620	100%

Source: Metropolitan Council

Barr Footer: ArcGIS 10.8.1, 2022-04-07 16:04 File: I:\Client\Blackdog\Work_Orders\23191455_2022_Plan_Update\Maps\Reports\Figure 2-3 Existing Land Use (2018).mxd User: cml3



County Boundary
Municipal Boundary
River

Existing Land Use

- Farmstead
- Seasonal/Vacation
- Single Family Detached
- Manufactured Housing Park
- Single Family Attached
- Multifamily
- Retail and Other Commercial
- Office
- Mixed Use Residential
- Mixed Use Industrial
- Mixed Use Commercial and Other
- Industrial and Utility
- Institutional
- Park, Recreational or Preserve
- Golf Course
- Major Highway
- Agricultural
- Undeveloped
- Water

Data Source: Generalized Land Use 2016, Metropolitan Council, 2016.

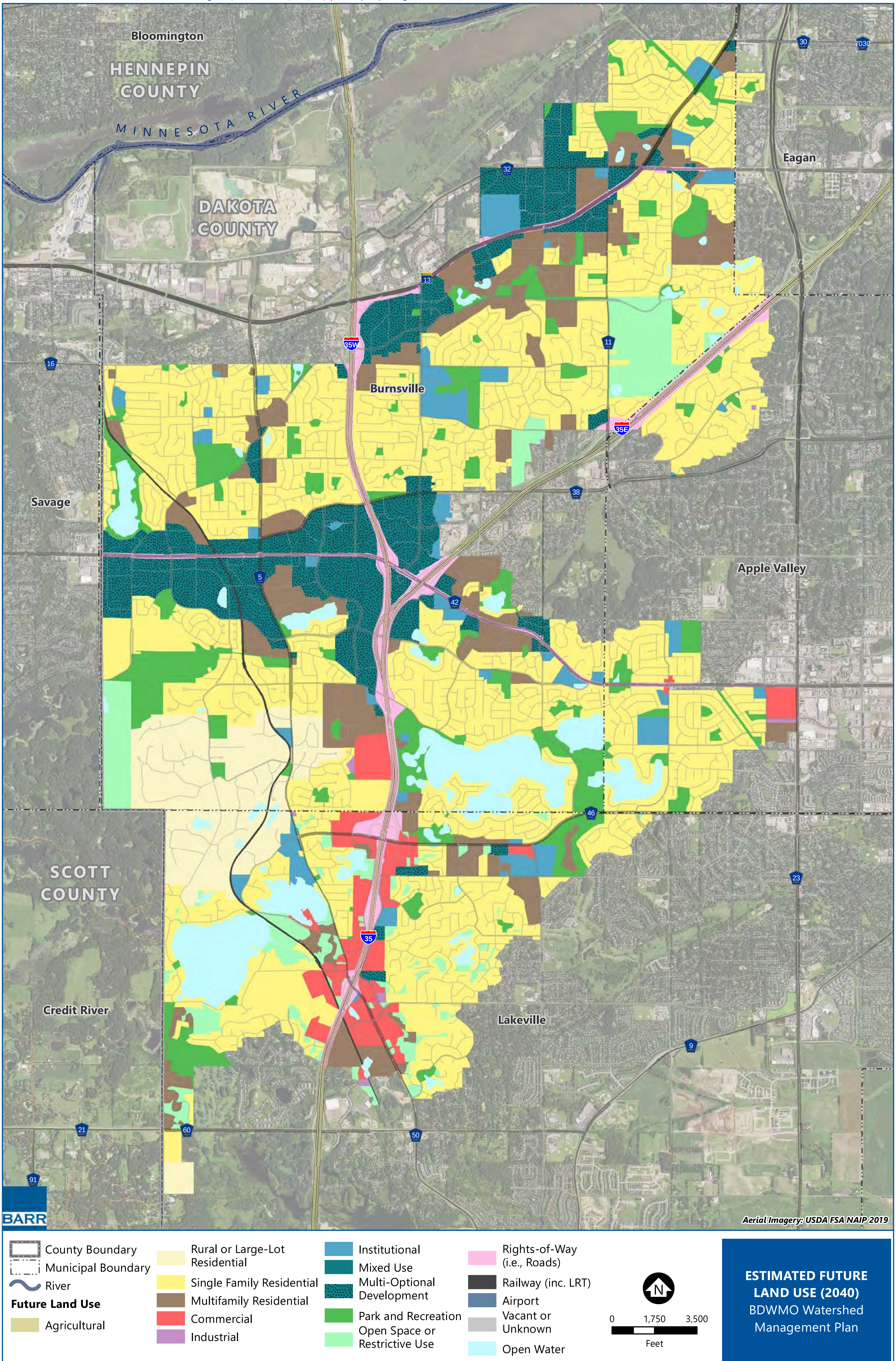
N

0 1,750 3,500
Feet

EXISTING LAND USE (2018)

BDWMO Watershed Management Plan

FIGURE 2-3



Data Source: Regional Planned Land Use - Twin Cities Metropolitan Area, Metropolitan Council, 2020.

ESTIMATED FUTURE LAND USE (2040)
BDWMO Watershed Management Plan

FIGURE 2-4

2.4 Soils

Soil composition and slope are important factors affecting the rate and volume of stormwater runoff. The shape and stability of aggregates of soil particles—expressed as soil structure—influence the permeability, infiltration rate, and erodibility (i.e., potential for erosion) of soils. Slope is important in estimating stormwater runoff rates and susceptibility to erosion.

Prevalent soil series located within the watershed are described in the Dakota County Soil Survey, available online from the Natural Resources Conservation Service (NRCS). General soil map units prevalent in the BDWMO portion of Dakota county include:

> The **Waukegan-Wadena-Hawick** unit includes well drained soils on glacial outwash plains and terraces. These soils vary from level to very steep. These soils are formed in loamy or silty sediments and generally underlain by sandy outwash. These soils are well suited for agricultural land use and building but are sensitive to groundwater pollution (USDA SCS, 1983).
>
> The **Kingsley-Mahtomedi** unit includes well drained soils that range from gently sloping to very steep. These soils are formed in loamy and sandy glacial till and outwash in uplands and outwash plains. Soils within this unit are complex and intermixed. These soils are not well suited to agricultural land use and can be subject to erosion on steeper slopes (USDA SCS, 1983).

Detailed mapping of soil series present in Dakota County and the BDWMO is available from the NRCS Web Soil Survey at: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Soil infiltration capacity affects the amount of direct runoff resulting from rainfall. Higher infiltration rates result in lower potential for runoff, as more precipitation can enter the soil. Conversely, soils with low infiltration rates produce high runoff volumes and high peak discharge rates, as most or all of the rainfall moves as overland flow. The NRCS (formerly the Soil Conservation Service) has established four general hydrologic soil groups (HSGs). These groups are:

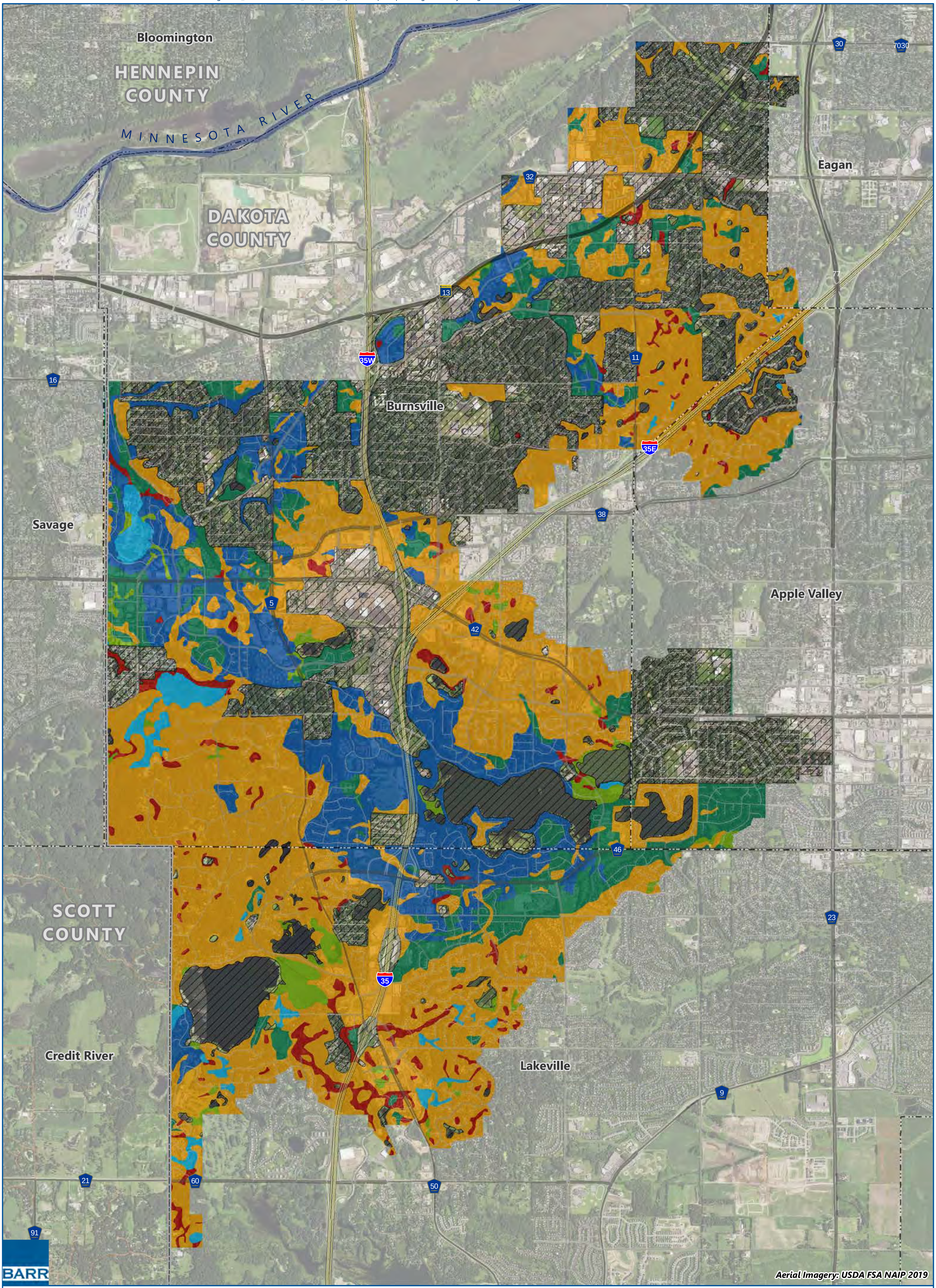
> **Hydrologic Soil Group A**— (Low runoff potential): Group A soils have a high infiltration rate and are typically composed of more than 90% sand and gravel.
>
> **Hydrologic Soil Group B—** (Moderately low runoff potential): Group B soils have a moderate infiltration rate and are typically composed of 50-90% sand.
>
> **Hydrologic Soil Group C—** (Moderately high runoff potential): Group C soils have a slow infiltration rate and are composed of less than 50% sand.
>
> **Hydrologic Soil Group D**— (High runoff potential): Group D soils have a very slow infiltration rate and are composed of more than 40% clay. These soils have a combination of high swelling potential, a permanently high water table, and a clay layer at or near the surface.

Dual HSGs (types A/D, B/D, and C/D) are soils that are considered D soils primarily because of a high water table. However, if the soil were drained it would be classified into a different group. The second group listed for dual HSG soils is for an undrained condition. To evaluate infiltration capacity, dual HSGs are usually considered as D soils. Figure 2-5 presents the most current HSG data within the watershed, which are based on the Soil Survey Geographic dataset (SSURGO) from the NRCS.

Large areas concentrated in the northern part of the watershed are not rated with respect to HSG. The "Not Rated/Not Available" classification is typically assigned to areas where development has altered the existing soil, or data were unavailable prior to development. Development may increase the potential for high volumes of runoff. As land is developed for urban use, much of the soil is covered with impervious surfaces, and soils in the remaining areas are significantly disturbed and altered. Development often results in consolidation of the soil and tends to reduce infiltration capacity of otherwise permeable soils, resulting in significantly greater amounts of runoff. Grading, plantings, and tended lawns tend to dominate the pervious landscape in urbanized areas and may become more important factors in runoff generation than the original soil type.

Figure 2-5 provides general guidance about the infiltration capacity of soils. Site specific data such as geologic borings, piezometers, and other engineering studies are necessary to evaluate soil infiltration capacity for individual project sites.

Barr Footer: ArcGIS 10.8.1, 2022-04-07 16:07 File: I:\Client\Blackdog\Work_Orders\23191455_2022_Plan_Update\Maps\Reports\Figure 2-5 Hydrologic Soil Groups.mxd User: cml3



County Boundary
Municipal Boundary
River

Hydrologic Soil Group

- A
- A/D
- B
- B/D
- C
- C/D
- Not Rated

0 1,750 3,500
Feet

HYDROLOGIC SOIL GROUPS
BDWMO Watershed Management Plan

FIGURE 2-5

Data Source: Soil Survey Staff, NRCS USDA, Soil Survey Geographic (SSURGO) Database. Accessed 2/26/2021.

2.5 Geology

2.5.1 Surficial Geology

The geology of the watershed includes consolidated bedrock formations overlain by unconsolidated glacial and non-glacial sediments (also known as quaternary deposits). Unconsolidated glacial sediments are from glacial deposits left from the quaternary geologic period and modified by post-glacial erosion and soil formation processes. Most of the quaternary deposits in the watershed were deposited approximately 12,000 to 20,000 years ago by the Superior lobe and Des Moines lobe of the Wisconsin Glaciation (the most recent local glacial episode) (Balaban and Hobbs, 1990). Glacial till underlies most of the BDWMO, with loamy till more common in the south and sandy till more common in the north.

The depth of the surficial deposits varies across the watershed, but generally ranges from 100 to 200 feet think. Areas of surficial deposits less than 50 feet occur in the northwest of the BDWMO. Thicker surficial deposits (more than 300 feet) occur in minor buried bedrock valleys present in the watershed; there is little to no relationship between surface topography and the location of buried bedrock valleys.

More information about the surficial geology of the BDWMO is available from the Dakota County Geologic Atlas at: https://conservancy.umn.edu/handle/11299/58494

2.5.2 Bedrock Geology

Consolidated bedrock formations (bedrock deposits) are much older than, and lie below, the glacial deposits. They include overlapping sequences of sandstones, limestones, dolostones, and shales from the Cambrian or Ordovician series. The uppermost layer of bedrock varies with location within the watershed and includes:

- Platteville and Glenwood dolostone, limestone, and shale (youngest)
- St. Peter sandstone
- Prairie du Chien dolomite
- Jordan sandstone
- St. Lawrence shale (oldest)

These bedrock units are sedimentary rocks deposited by shallow seas during late Cambrian and Ordovician times, approximately 500 million years ago. The bedrock formations form part of a gently sloping bowl-like structure centered under the Minneapolis-St. Paul metropolitan area, known as the Twin Cities basin. Bedrock characteristics are summarized in Table 2-4.

Table 2-4 Bedrock geology characteristics

Geologic Unit	Approximate Thickness (feet)	Description	Approximate Subcropping Locations	Water-Bearing Characteristics
Glacial Drift	<50 to 300+	Till, sand, gravel, lake deposits	Present throughout watershed, varying in thickness by location	May yield small supplies for domestic use
Platteville and Glenwood Formation	0-40	Fine-grain dolostone and limestone over green, sandy shale	Portions of Burnsville and eastern Lakeville	Low yield; acts as a confining layer
St. Peter sandstone	0-160	Fine to medium-grain quartzose sandstone, underlain by siltstone and shale	Present throughout, but concentrated in the eastern BDWMO	Widely used for domestic wells
Prairie du Chien dolomite	150-300	Thin-bedded with thin beds of sandstone and chert	Far northern portion of the BDWMO and Murphy-Hanrehan subwatershed	Major high-capacity aquifer
Jordan Sandstone	100	Medium- to coarse-grain quartzose sandstone	Does not subcrop within the BDWMO	Major high-capacity aquifer
St. Lawrence Formation	100-200	Dolomitic siltstone and sandstone	Does not subcrop within the BDWMO	Confining bed with little yield

Source: Dakota County Geologic Atlas (plates 2 and 4)

More information about the surficial geology of the BDWMO is available in the Dakota County Geologic Atlas at: https://conservancy.umn.edu/handle/11299/58494

2.6 Groundwater

The glacial and bedrock deposits form layered sequences of aquifers and confining units. An aquifer is a geologic formation capable of supplying sufficient quantities of water to a well. A confining unit is a geologic deposit that impedes the flow of water between aquifers.

The uppermost aquifers in the BDWMO are glacial deposits. Glacial aquifers (also known as surficial aquifers) include the water table and buried glacial aquifers, which are primarily used for domestic and irrigation purposes in Dakota County. The elevation of the surficial (or quaternary) water table beneath the watershed generally ranges from approximately 900 to 1,000 feet; less in the north, and greater in the south. The depth of the water table ranges widely from tens of feet (e.g., around Crystal Lake) to upwards of 200 feet (e.g., areas of high ground elevation) (Balaban and Hobbs, 1990). Glacial aquifers are variable in location and yield. Water yield from surficial aquifers in the BDWMO ranges from less than 5 gallons per minute in the eastern portion of the watershed to between 50 and 250 gallons per minute in the western portion of the watershed. Groundwater quality in glacial aquifers is often correlated to the quality of the water that is infiltrating at the surface; these aquifers are not used locally for public water supplies due to their susceptibility to contamination (Balaban and Hobbs, 1990).

Surficial groundwater may be a source or a sink for local surface waters depending on relative elevation, soil conditions, and other factors. Generally, data characterizing the relationship between surficial groundwater and surface water features in the BDWMO is limited due in part to the lack of surficial aquifer use within the watershed (Palen, 1990).

Most high-capacity wells draw water from bedrock aquifers. Below the surficial aquifers, six bedrock aquifers are present under the BDWMO. The major bedrock aquifers are, in order of use and development:

1. Prairie du Chien-Jordan
2. Mount Simon-Hinckley
3. St. Lawrence-Tunnel City
4. Wonewoc
5. St. Peter
6. Platteville

The aquifer used most often for water supply in the area is the Prairie du Chien-Jordan aquifer. The Prairie du Chien-Jordan aquifer is high yielding, more easily tapped than deeper aquifers, has very good water quality, and is continuous throughout most of the area.

Groundwater levels in the Prairie du Chien-Jordan aquifer range from than 700 feet MSL to more than 900 feet MSL (Balaban and Hobbs, 1990). The aquifer is recharged in areas where thin permeable drift overlies the limestone layers. Some recharge of this aquifer occurs locally from percolation through the overlying glacial deposits or St. Peter sandstone. Local recharge to the aquifer is generally low. Regional recharge of the Prairie du Chien-Jordan aquifer occurs to the south, in Freeborn and Mower Counties. Groundwater movement in the aquifer is generally from south to north, toward the Minnesota and Mississippi Rivers.

The aquifer with the highest water quality and highest possible yields is the Mt. Simon-Hinckley aquifer, but it is more expensive to use than the Prairie du Chien-Jordan aquifer because of its greater depth; also, there are limitations to its use. Minnesota statutes limit appropriations from the Mt. Simon-Hinckley aquifer to potable water uses, where there are no feasible or practical alternatives, and where a water conservation plan is incorporated with the appropriations permit. The water level of the Mt. Simon-Hinckley aquifer is approximately 700 feet MSL. Recharge of the Mt. Simon-Hinckley aquifer takes place far north of the watershed, where the bedrock is closer to the surface, and occurs by percolation through the overlying drift and bedrock. Groundwater movement in the aquifer is generally to the southeast.

Municipal water supply wells within Apple Valley, Burnsville, Eagan, and Lakeville draw drinking water from a combination of the Prairie du Chien – Jordan and the Mount Simon Hinckley aquifers. Users of groundwater meeting certain use criteria are required to obtain a water appropriation permit from the MDNR; more information is available from:
https://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/index.html

The Metropolitan Council completed the *Regional Water Supply, Enhanced Groundwater Recharge, and Stormwater Capture and Reuse Study for the Southeast Metro Study Area* in 2016. Groundwater modeling performed as part of the study estimates future drawdown of local aquifers from continued development of groundwater sources, as well as potential recovery if other water sources are developed. The study estimates continued development of the Prairie du Chien – Jordan aquifer may result in 20 to 40 feet of drawdown by 2040. Conversely, scenarios including reduced groundwater development show similar levels of aquifer recovery.

Additional information about the aquifers within the watershed is available from the following sources:

- Dakota County Geologic Atlas (Balaban and Hobbs, 1990), available at: https://conservancy.umn.edu/handle/11299/58494
- Metropolitan Council Water Supply Planning, available at: https://metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning.aspx

2.6.1 Groundwater Recharge

Recharge to groundwater occurs throughout the watershed. The local surficial geologic characteristics affect the rate, volume, and distribution of recharge. Water infiltrates most rapidly into sandy deposits and flows easily through sandy materials; clay deposits tend to slow and impede infiltration and subsurface flows. Relative to natural conditions, impervious surfaces (e.g., buildings, streets, parking lots) in developed areas have reduced the amount of open space and decreased the amount of land available to infiltrate runoff and recharge groundwater.

Groundwater recharge reaches the water table (i.e., quaternary or surficial aquifer) at a fast rate through sandy geologic deposits. The presence of sandy soils within portions of the BDWMO creates potential for high local infiltration rates and associated groundwater contamination from pollutants carried from the ground surface. Groundwater sensitivity to pollution is presented in Figure 2-6.

Surficial aquifers usually have higher static water levels than deeper aquifers, indicating that water flows downward into the aquifer system and that surficial aquifers help recharge deeper aquifer systems. Deeper bedrock aquifers are recharged through bedrock valleys, leakage through confining layers, fractures in tills and confining layers, improperly constructed wells, and other areas where good hydraulic connections and unforeseen flow paths exist within upper aquifer units.

The Metropolitan Council's *Regional Water Supply, Enhanced Groundwater Recharge, and Stormwater Capture and Reuse Study for the Southeast Metro Study Area* (Metropolitan Council, 2016) considered opportunities for enhanced recharge within Dakota County based on infiltration rate and depth of the water table. The study identified approximately 900 acres of priority infiltration areas in the BDWMO, located primarily in the western portion of the BDWMO, north of Orchard Lake.

2.6.2 Drinking Water Supply, Wellhead Protection, and Pollution Prevention

Residents within the BDWMO obtain their drinking water entirely from groundwater via municipal groundwater wells as well as private domestic wells. Municipal wells serving the BDWMO member cities tap the Mt. Simon-Hinckley and Prairie du Chien – Jordan aquifers.

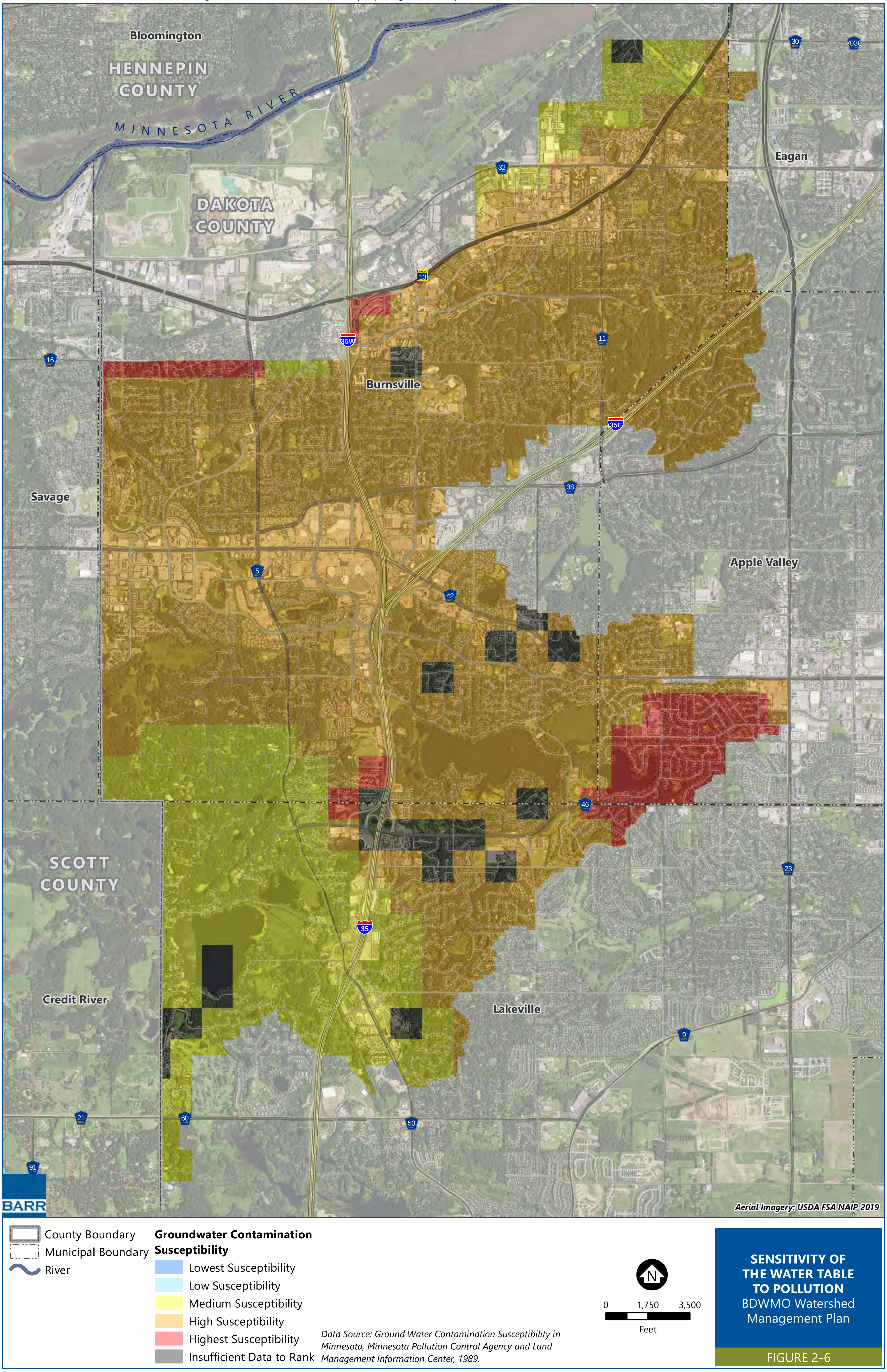
In 1989 the state of Minnesota instituted the Minnesota Groundwater Protection Act, which identified the Minnesota Department of Health (MDH) as responsible for the protection of groundwater quality. Through its wellhead protection program, the MDH administers and enforces the Minnesota Water Well Code, which regulates activities such as well abandonment and installation of new wells. The MDH also administers the Wellhead Protection Program, which is aimed at preventing contaminants from entering the recharge zones of public well supplies. In 1997, the Wellhead Protection Program rules (Minnesota Rules 4720.5100 to 4720.5590) went into effect.

Some public water suppliers are required to prepare wellhead protection plans (WHPPs), including the BDWMO member cities of Apple Valley, Burnsville, Eagan, and Lakeville. Through these wellhead protection plans, public water suppliers delineate drinking water supply management areas (DWSMA) for groundwater wells, assess the water supply's susceptibility to contamination from activities on the land surface, and establish management programs, such as identification and sealing of abandoned wells and education/public awareness programs. The DWSMA represents the boundaries of the recharge area to the well and is the area to be protected and managed by the wellhead protection plan. Figure 2-7 presents the DWSMAs located within the BDWMO.

The BDWMO and its cities rely on infiltration practices to improve water quality and reduce stormwater runoff volumes. Thus, the BDWMO and its member cities will continue to consider the possible impacts of infiltrated stormwater on groundwater quality. The MDH and Minnesota Pollution Control Agency (MPCA) also provide guidance for evaluating infiltration projects in areas with vulnerable groundwater supplies; the guidance considers the presence of wellhead protection areas, aquifer characteristics, land use, and other factors. For example, infiltration is not allowed within DWSMA emergency response zones. Infiltration guidance is available from the MPCA website: https://stormwater.pca.state.mn.us/index.php/Stormwater_and_wellhead_protection

Additional information regarding groundwater resource protection and management is available from the following sources:

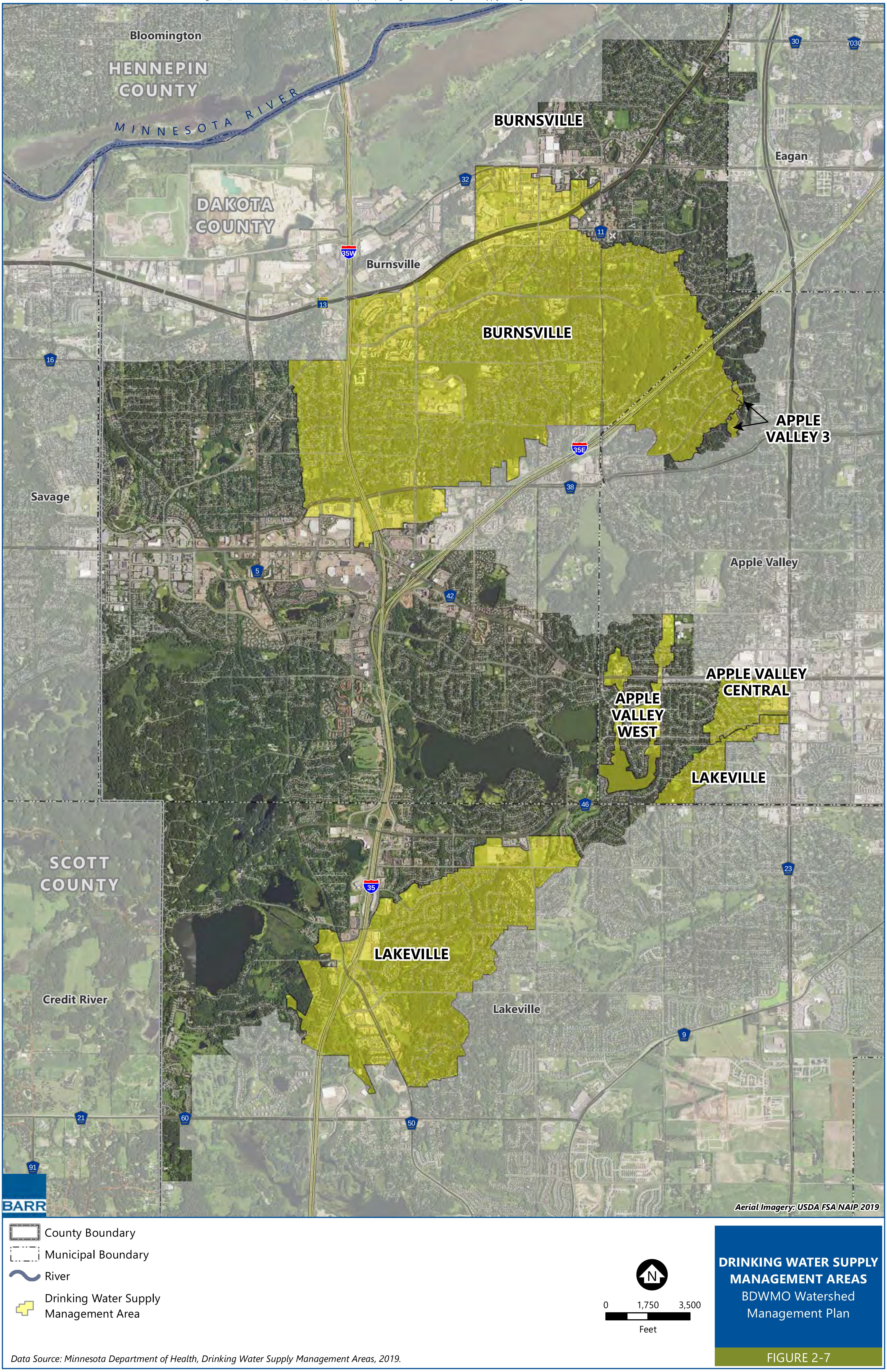
- 2020-2030 Dakota County Groundwater Plan available at: https://www.co.dakota.mn.us/Environment/WaterResources/Groundwater/Pages/groundwater-plan.aspx
- Metropolitan Council Water Supply Planning, available at: https://metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning.aspx



Data Source: Ground Water Contamination Susceptibility in Minnesota, Minnesota Pollution Control Agency and Land Management Information Center, 1989.

SENSITIVITY OF THE WATER TABLE TO POLLUTION
BDWMO Watershed Management Plan

FIGURE 2-6



DRINKING WATER SUPPLY MANAGEMENT AREAS

BDWMO Watershed Management Plan

FIGURE 2-7

Data Source: Minnesota Department of Health, Drinking Water Supply Management Areas, 2019.

2.6.3 Groundwater Monitoring and Groundwater Quality

Limited groundwater monitoring data is available within the watershed and includes data collected by Dakota County, the Minnesota Department of Agriculture, MPCA, U.S. Geological Survey (USGS), and others. Pesticide and nitrate concentrations within northwest Dakota County and the BDWMO are low (Dakota County, 2021). Figure 2-12 presents groundwater quality monitoring locations within the BDWMO. Groundwater quality monitoring information and data are available online from the MPCA at: https://www.pca.state.mn.us/water/groundwater-monitoring

Potential sources of groundwater contamination in the watershed include commercial and industrial waste disposal, landfills, leaking petroleum tanks, unsealed wells, non-compliant subsurface sewage treatment systems (SSTS), fertilizer/pesticide applications, animal waste, and road salt application (see also Section 2.14). Emerging contaminants include pharmaceuticals, industrial effluents, personal care products, fire retardants, and other items that are washed down drains and not able to be processed by municipal wastewater treatment plants or septic systems.

The MDNR also coordinates an observation well network and collects static groundwater-level data to assess groundwater resources, determine long term trends, interpret impacts of pumping and climate, plan for water conservation, and evaluate water conflicts. The observation well network includes 4 wells located within the BDWMO (see Figure 2-12). More information is available from the MDNR at: https://www.dnr.state.mn.us/waters/cgm/program.html

2.7 Surface Water Resources

Figure 2-2 shows the major watersheds, tributary areas, and drainage patterns within the BDWMO. Development of the land within the BDWMO member cities has resulted in alterations to the natural hydrologic system. To facilitate development, natural drainages were diverted or piped, wetlands were drained or filled, and stormwater infrastructure was constructed.

Figure 2-8 shows the surface waters classified by the MDNR as public waters. The MDNR designates specific water resources as public waters to indicate those lakes, wetlands, and watercourses over which the MDNR has regulatory jurisdiction. By statute, the definition of public waters includes “public waters basins” (i.e., lakes), “public waters watercourses” (i.e., rivers and streams) and “public waters wetlands.” The collection of public waters and public waters wetlands designated by the MDNR is generally referred to as the public waters inventory, or PWI.

Public waters are all water basins (i.e., lakes, ponds, wetlands) and watercourses (i.e., streams, rivers) that meet the criteria set forth in Minnesota Statutes, Section 103G.005, Subd. 15 that are identified on public water inventory maps and lists authorized by Minnesota Statutes, Section 103G.201. The regulatory boundary of public waters and public water wetlands is called the ordinary high water level (OHWL). For watercourses, the OHWL is generally the elevation of the top of the bank of the channel. A MDNR permit is required for work within designated public waters. Additionally, shoreland development requirements may exist for public waters with shoreland classifications. Table 2-5 summarizes the public waters located within the watershed. PWI maps and lists are available on the MDNR's website: http://www.dnr.state.mn.us/waters/watermgmt_section/pwi/maps.html.

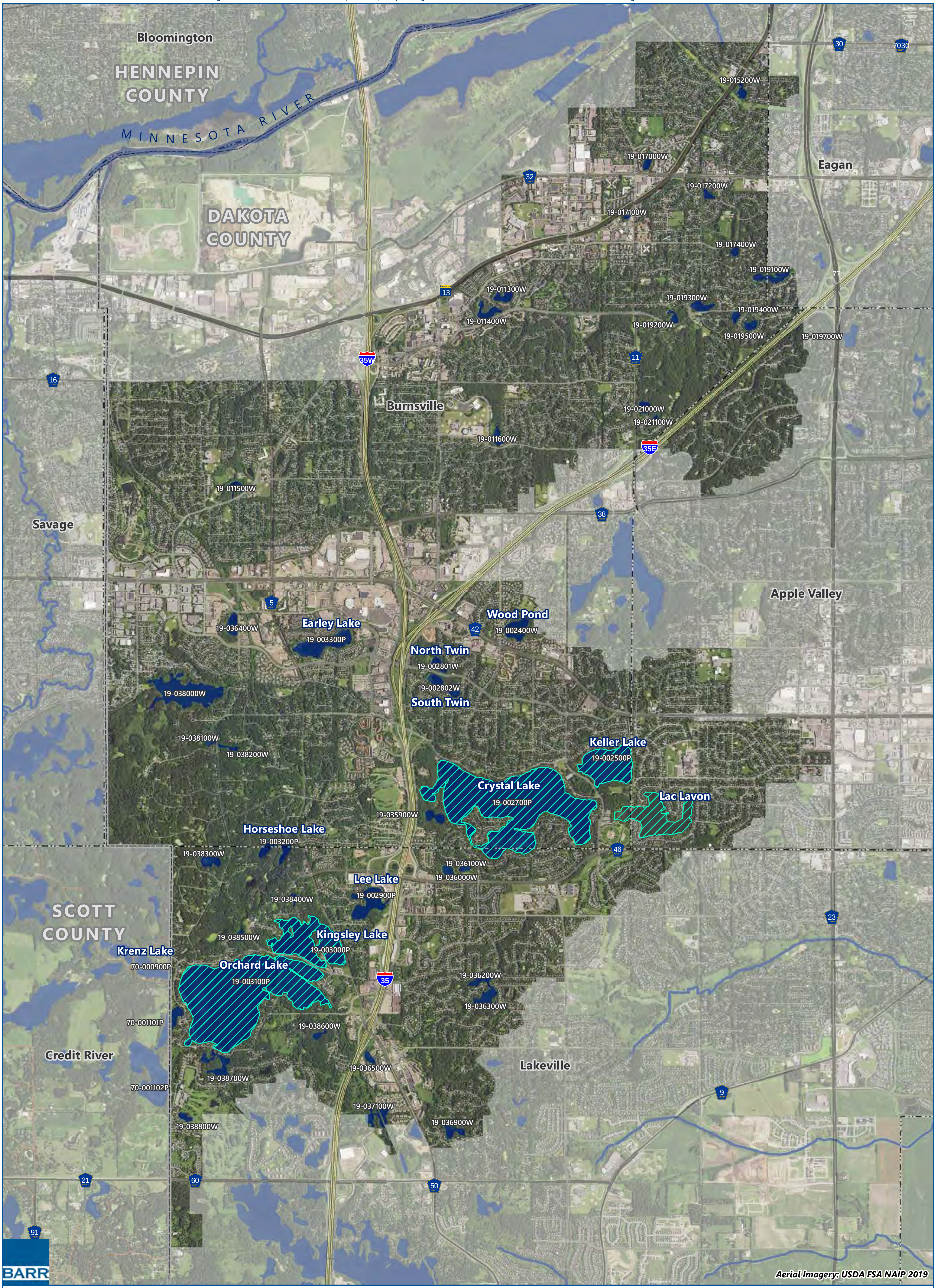
Table 2-5: Summary of BDWMO PWI and Physical Characteristics

			MDNR Identification		Physical Characteristics								
BDWMO Water Body	Municipality	Downstream Receiving Water	MDNR Public Waters ID Number	PWI Class	Water Area (acre)	Perimeter (mi)	Littoral Area (acre)	Average Depth (feet)	Max Depth (feet)	Direct Watershed Area, including Lake Surface Area (acre)	Total Watershed Area including All Upstream Lakes (acre)	Normal Water Level (ft MSL)	100-Year Flood Elevation (ft MSL)
Lakes													
Crystal	Burnsville & Lakeville	Minnesota River	19-0027	P	292	5.3	208	10	35	2013	3852	933.5	935.8
Keller	Burnsville	Minnesota River	19-0025	P	52	1.2	52.0	4.8	8	1447	1447	934.3	938.6
Orchard	Lakeville	Credit River	19-0031	P	243	4.7	177	10	33	2045	2260	N/A	979.1
Kingsley	Lakeville	Credit River	19-0030	P	51	3.0	51.0	N/A	10.2	216	216	N/A	982.4
Lac Lavon	Apple Valley & Burnsville	Minnesota River	19-0446	N/A	60	2.1	39	N/A	32	184	184	Landlocked	933.1
Sunset Pond	Burnsville	Minnesota River	19-0451	N/A	60.0	2.5	60.0	N/A	10.5	1019	6311	N/A	854.8
Lee	Lakeville	Minnesota River	19-0029	P	19.0	1.2	19.0	7.0	15	206	206	948.5/ 947.0	951.9
Earley	Burnsville	Minnesota River	19-0033	P	23.3	1.1	23.3	3.8	7.8	757	5292	905	910.1
Horseshoe	Lakeville	Credit River	19-0032	P	11.7	0.9	--	--	--	--	--	--	--
Wetlands													
Wood Pond	Burnsville	Minnesota River	19-0024	W	14.0	0.6	14.0	10	14	110	110	1000.9	1003.6
Twin (South)	Burnsville	Minnesota River	19-0028	W	11.7	1.0	11.7	3.6	11	574	4536	918	920.2
Twin (North)					5.1		5.1	6.6	12				
Unnamed (Cam Ram Wetland)	Burnsville	Credit River	19-0380	W	51.2	2.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0113	W	5.6	0.5	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0114	W	6.9	0.7	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0115	W	4.7	0.5	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0116	W	4.3	0.5	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0152	W	3.3	0.4	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0170	W	3.0	0.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0171	W	1.0	0.2	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0172	W	2.5	0.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0174	W	2.2	0.2	--	--	--	--	--	--	--
Unnamed	Burnsville & Eagan	Minnesota River	19-0191	W	8.6	0.8	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0192	W	2.5	0.4	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0193	W	5.7	0.5	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0194	W	2.4	0.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0195	W	3.4	0.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Credit River	19-0197	W	0.2	0.1	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0210	W	4.2	0.3	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0211	W	1.2	0.2	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0359	W	5.7	0.5	--	--	--	--	--	--	--
Unnamed (Goose Lake)	Lakeville	Minnesota River	19-0360	W	5.3	0.4	--	--	--	--	--	--	--
Unnamed	Lakeville	Minnesota River	19-0361	W	3.2	0.3	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0362	W	4.9	0.5	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0363	W	11.4	0.9	--	--	--	--	--	--	--
Unnamed	Burnsville	Minnesota River	19-0364	W	7.3	0.4	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0365	W	2.9	0.3	--	--	--	--	--	--	--

Table 2-5: Summary of BDWMO PWI and Physical Characteristics

BDWMO Water Body	Municipality	Downstream Receiving Water	MDNR Identification: MDNR Public Waters ID Number	PWI Class	Physical Characteristics: Water Area (acre)	Perimeter (mi)	Littoral Area (acre)	Average Depth (feet)	Max Depth (feet)	Direct Watershed Area, including Lake Surface Area (acre)	Total Watershed Area including All Upstream Lakes (acre)	Normal Water Level (ft MSL)	100-Year Flood Elevation (ft MSL)
Unnamed	Lakeville	Credit River	19-0369	W	5.8	0.5	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0371	W	10.1	1.2	--	--	--	--	--	--	--
Unnamed	Burnsville	Credit River	19-0381	W	2.3	0.2	--	--	--	--	--	--	--
Unnamed	Burnsville	Credit River	19-0382	W	2.2	0.4	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0383	W	6.9	0.5	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0384	W	2.4	0.4	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0385	W	3.3	0.3	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0386	W	2.6	0.4	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0387	W	11.2	1.3	--	--	--	--	--	--	--
Unnamed	Lakeville	Credit River	19-0388	W	2.7	0.3	--	--	--	--	--	--	--

Barr Footer: ArcGIS 10.8.1, 2022-04-07 16:30 File: I:\Client\Blackdog\Work_Orders\23191455_2022_Plan_Update\Maps\Reports\Figure 2-8 Public Waters within the LMRWMO and BNWMO strategic waterbodies.mxd User: cml3



County Boundary

Municipal Boundary

Public Water Inventory Basin

Public Water Inventory Watercourse

Strategic Waterbodies

0 1,750 3,500
Feet

PUBLIC WATERS WITHIN THE LMRWMO AND BNWMO STRATEGIC WATERBODIES

BDWMO Watershed Management Plan

FIGURE 2-8

Data Source: Minnesota Department of Natural Resources, Public Waters (PW) Basin and Watercourse Delineation, 2020.

2.7.1 Lakes and Ponds

This section summarizes some of the lakes and ponds of local significance within the BDWMO. The BDWMO classified some of these waterbodies as strategic waterbodies to aid in prioritizing BDWMO activities (see Section 5.0 – Implementation Program).

2.7.1.1 Crystal Lake (MDNR #19-0027P)

Crystal Lake is a 292-acre lake located in the cities of Burnsville and Lakeville in the southern portion of the BDWMO. The lake is a major recreational resource for the area. A public beach and public boat landing provide opportunities for swimming, fishing, water skiing and aesthetic viewing. Crystal Lake is a BDWMO strategic waterbody and is classified as a deep lake by the MPCA. The MPCA listed Crystal Lake as impaired in 2002 due to excessive nutrients, leading to the completion of the *Crystal, Keller, Lee, and Earley Lakes Total Maximum Daily Load* (TMDL) (MPCA, 2011). Crystal Lake was removed from the impaired waters list in 2018 following improved water quality achieved in part by actions taken by the BDWMO and member cities.

Crystal Lake consists of five basins: Bluebill Bay, Mystic Bay, Maple Island Bay, Buck Hill Bay, and the main lake basin. The lake outlet is located at the northwest end of the lake in Buck Hill Bay and consists of a box weir with an overflow elevation of 933.5 feet NGVD29. The lake has 5.3 miles of shoreline, a mean depth of 10 feet, and a maximum depth of 35 feet. The area of the lake shallow enough (15 feet deep or less) for aquatic plants to grow (the littoral area) is approximately 210 acres. Crystal Lake is a dimictic lake – it mixes two times per year (during the spring and fall turnover events). The lake thermally stratifies during the growing season.

Crystal Lake receives runoff from a 3,852-acre tributary watershed that includes the direct watershed and the watersheds of Keller Lake, Lee Lake, and Lac Lavon (Lac Lavon's 185-acre watershed is typically landlocked). The tributary watershed to Crystal Lake includes portions of the cities of Apple Valley, Burnsville, and Lakeville. Crystal Lake receives outflows from Keller Lake and Lee Lake and drains northwest through a series of storm sewer pipes to Twin and Earley Lakes, ultimately reaching the Minnesota River via Sunset Pond.

The Crystal Lake watershed (including the Keller and Lee Lake watersheds) is almost fully-developed, with only a few small parcels available for new development. Low density residential land use is the major land use (41%), followed by highway (20%) and open water (11%). Other land uses include medium density residential, natural, park, and open space, commercial, developed parks, golf course, high density residential, institutional, and industrial/office. The portion of the watershed located in Lakeville has developed significantly since 2000, with the most intense development occurring along I-35, where the undeveloped land was converted to commercial use. For the commercial area of Lakeville within the Crystal Lake watershed, the city restricts the maximum amount of impervious cover to 70% for new development sites.

The BDWMO began operating a ferric chloride treatment system in 1996 to remove phosphorus from the deepest part of Crystal Lake. The treated water was discharged to a nearby storm sewer and conveyed to

Keller Lake. The project was a cooperative venture of the BDWMO, the MPCA, and the United States Environmental Protection Agency (U.S. EPA) under the Clean Lakes Program (CLP). The system operated during the 1996 and 1997 recreation seasons and half of the 1998 season. Operation was suspended in July 1998 after strong neighborhood opposition to the odor (a side effect of the treatment). Operation was discontinued in April 1999 with consideration for public input, operating costs, and marginal water quality benefit during the summer.

A recommendation of the *Crystal & Keller Lake Use Attainability Analysis (UAA)* (BDWMO, 2003) was to modify the ferric chloride treatment system to withdraw surface waters and resume operating the system. The BDWMO implemented the recommendation to reduce the total phosphorus concentration and suppress the growth of curly-leaf pondweed in Keller Lake to reduce the phosphorus loading to Crystal Lake.

The BDWMO resumed operation of the ferric chloride treatment system for varying time periods during the summers of 2003, 2004, 2005, 2006, 2007, and 2008, following the recommendation in the *Crystal & Keller Lake UAA* (BDWMO, 2003). In 2009, the BDWMO again decided to terminate operation of the ferric chloride system because of concerns over operating costs and limited benefits.

Lake monitoring data indicate that operation of the ferric chloride treatment system was successful in reducing the total phosphorus concentration in the deepest portions of Crystal Lake but had negligible impact on overall lake water quality, including phosphorus concentrations measured at the lake surface or water clarity measured during the summer season. The operation of the hypolimnetic withdrawal system did maintain water levels and improve water quality in Keller Lake.

2.7.1.2 Keller Lake (MDNR #19-0025P)

Keller Lake is an approximately 50-acre lake located in the cities of Burnsville and Apple Valley in the southern portion of the BDWMO. The lake is used primarily for fishing, canoeing, and wildlife viewing by the local residents. There is a park on the south side of Keller Lake but no beach or public access. Keller Lake is a BDWMO strategic waterbody and is considered a shallow lake by the MPCA. The MPCA listed Keller Lake as impaired in 2002 due to excessive nutrients and remains on the impaired waters list. This impairment was evaluated in the completion of the *Crystal, Keller, Lee, and Earley Lakes Total Maximum Daily Load* (TMDL) (MPCA, 2011). The BDWMO conducted an alum and sodium aluminate treatment on Keller Lake in Spring 2019, resulting in improved water quality in 2019 and 2020 compared to the previous decade. The BDWMO conducted a second alum treatment in Fall 2021.

Keller Lake discharges to the northeast side of Crystal Lake over a weir structure, at an elevation of 934.3 feet NGVD29, through a 72-inch diameter RCP arch pipe. Keller Lake has an average depth of 4.8 feet and a maximum depth of about 8 feet. Because the lake is so shallow, aquatic plants can grow over the entire lakebed and thermal stratification typically does not occur during the summer. The lake is polymictic (mixes several times per year) due in part to intermittent wind mixing.

The Keller Lake watershed is 1,447 acres (including the lake surface area). The Keller Lake watershed is fully-developed. Analysis performed as part of the TMDL found that runoff from 46% of the drainage area reached Keller Lake without first passing through some form of water quality treatment. Low density residential land use is the primary land use within the watershed (52.6%), followed by highway (20.5%) and natural, park, and open space (8%). Other land uses include medium density residential, open water, commercial, developed parks, high density residential, and institutional. There is a large wetland area adjacent to the southwest side of Keller Lake.

2.7.1.3 Orchard Lake (MDNR #19-0031P)

Orchard Lake is a 243-acre lake located in Lakeville, in the southwest portion of the BDWMO. The lake is used primarily for fishing, but swimming, boating and aesthetic and wildlife viewing are also popular recreational uses of the lake. Over seventy private homes are located on the lake. Three city parks are located on Orchard Lake: a public boat access on the south shore (Orchard Lake Park), a public beach on the west shore (Orchard Lake Beach), and Wayside Park. Orchard Lake is a BDWMO strategic waterbody and is classified as a deep lake by the MPCA. Orchard Lake is not currently listed as impaired by the MPCA.

Orchard Lake's maximum depth is 33 feet, and its average depth is 10 feet. The littoral area (the portion less than 15 feet deep where submerged aquatic plants can grow) covers approximately 75 percent of the lake. The total watershed area tributary to Orchard Lake is 2,260 acres and includes the Kingsley Lake watershed. The lake outlet is located on the west shore and discharges to the Credit River watershed through Murphy-Hanrehan Park Reserve.

Current land use within the watershed includes a mixture of residential, commercial, institutional, park, golf course and undeveloped land. The commercial and high-density residential land uses are in the central portion of the watershed. Much of the Orchard Lake watershed is developed at low density. The portion of the watershed along the I-35 corridor has undergone recent development, but portions of the watershed remain undeveloped.

2.7.1.4 Kingsley Lake (MDNR #19-0030P)

Kingsley Lake is a 63-acre lake located in Lakeville in the southwest portion of the BDWMO (the lake area is approximately 80 acres including adjacent wetlands and floating mats). There is no public beach or access on Kingsley Lake, but the lake provides boating and canoeing opportunities for shoreline residents. Kingsley Lake is a BDWMO strategic waterbody and is considered a shallow lake by the MPCA. Kingsley Lake is not currently listed as impaired by the MPCA.

Kingsley Lake has a maximum depth of about 10 feet and the littoral area (the portion over which submerged aquatic plants can grow) covers the entire lake. A summer thermocline does not develop in Kingsley Lake due to its shallow depth. Kingsley Lake flows to Orchard Lake and ultimately to the Minnesota River via the Credit River watershed. In Fall 2020, the City of Lakeville replaced the damaged 1993 outlet with a new outlet of the same size and at the same elevation.

The watershed area tributary to Kingsley Lake is 216 acres. Existing land use conditions in the Kingsley Lake watershed include low density residential, undeveloped, commercial, and a small amount of institutional and very low density residential. Undeveloped land in the watershed is expected to convert to institutional and commercial land uses.

2.7.1.5 Lac Lavon

Lac Lavon is a 60-acre lake occupying a former gravel pit. The lake is located on the border of Burnsville and Apple Valley. Lac Lavon is used primarily for fishing, swimming, and wildlife and aesthetic viewing. The City of Burnsville's Lac Lavon Park, with ballpark, tennis courts, paved trails, picnic shelter, play equipment and boat access, and the City of Apple Valley's Lac Lavon Park, with a fishing pier, canoe rack and access, picnic shelter, paved trails, and children's play equipment provide for most of the lake's recreational use. Because Lac Lavon is a former gravel pit, it is not part of the original MDNR public waters inventory. Lac Lavon is a BDWMO strategic waterbody and is classified as a deep lake by the MPCA. Lac Lavon continues to demonstrate excellent water quality and is not currently listed as impaired by the MPCA.

Lac Lavon is a landlocked basin under normal hydrologic conditions. The only surface water outlet from Lac Lavon is a 12-inch diameter emergency overflow outlet to Keller Lake. A valve controls the flows in the overflow pipe; under normal conditions the valve is closed. Water levels are primarily maintained by groundwater outflow.

The area tributary to Lac Lavon is 184 acres and includes portions of the cities of Apple Valley and Burnsville. Current land use in the watershed is primarily low-density residential and park land, which results in little pollutant loading to Lac Lavon. Significant land use changes in the Lac Lavon watershed are not anticipated.

2.7.1.6 Sunset Pond (MDNR #19-011500W)

Sunset Pond is a 60-acre stormwater pond located in Burnsville in the western portion of the BDWMO. Sunset Pond is located at the downstream end of a series of waterbodies that includes Keller Lake, Lee Lake, Lac Lavon, Crystal Lake, Wood Pond, Twin Lake, and Earley Lake.

Sunset Pond functions as a stormwater detention basin. The City of Burnsville's Sunset Pond Park is located on the southeast side of Sunset Pond and the pond is surrounded by a walking trail. Aquatic recreation facilities are not present, but there is a fishing pier. The MDNR previously managed Sunset Pond as a youth fishing pond through its Fishing in the Neighborhood (FiN) program. Sunset Pond is not a BDWMO strategic waterbody. Sunset Pond is not classified as a lake by the MPCA because it is a constructed waterbody, although it meets the physical criteria of a shallow lake.

The City of Burnsville created Sunset Pond in 1983 by constructing a dam along the northern end of a natural low marshy depression. The pond is shallow (with a maximum depth of about 10.5 feet) and includes areas of open water, islands, and aquatic plants. The littoral area covers the entire lake. The Sunset Pond outlet is located on the north side of the pond. Outflows flow into Willow Creek and drain north out of the BDWMO, through the Kraemer Nature Preserve (in the Lower Minnesota River Watershed District) towards the Minnesota River.

The direct watershed to Sunset Pond is 1,019 acres and includes land in Burnsville and a small amount of land in Savage (outside of the BDWMO jurisdictional boundary). The total area tributary to Sunset Pond is 6,311 acres (6,127 acres excluding the Lac Lavon watershed, which is typically landlocked). Current land use within the direct watershed is a mixture of industrial, low density residential and park land. The City of Burnsville intends to maintain the park areas around Sunset Pond as a nature preserve.

2.7.1.7 Lee Lake (MDNR #19-0029P)

Lee Lake is an approximately 19-acre waterbody located entirely within the City of Lakeville in the southern portion of the BDWMO. Lee Lake is surrounded by privately owned property and has no public access. The BDWMO did not classify Lee Lake as a strategic waterbody based on the lack of public access. It is classified as a shallow lake by the MPCA. The MPCA listed Lee Lake as impaired due to excess nutrients in 2002. Lee Lake was removed from the impaired waters list in 2014 based on water quality data that indicate the lake supports its intended recreational and aquatic life uses.

Prior to 1993, Lee Lake was landlocked and experienced periodic flooding. The City of Lakeville constructed a gated outlet discharging to Crystal Lake in 1993. The Lee Lake outlet is located on the east side of the lake and is a stop log weir (at elevation 948.5 feet NGVD29) followed by a 36-inch-wide gated structure (at an elevation of 947 feet NGVD29). Water level monitoring data shows that lake levels are typically one to two feet below the outlet invert elevation (948.5 feet NGVD29). The average lake depth is 7 feet and the maximum depth is about 15 feet. Lee Lake is dimictic; it mixes two times each year (during the spring and fall turnover events). The lake thermally stratifies throughout the growing season.

The watershed tributary to Lee Lake is 206 acres. The Lee Lake watershed is nearly fully-developed. Low density residential land use is the major land use (38%), followed by highway (29%) and open water (12%). Other land uses include natural, park, and open space, commercial, and institutional.

2.7.1.8 Earley Lake (MDNR #19-0033P)

Earley Lake is an approximately 23-acre lake located in the City of Burnsville in the central portion of the BDWMO. Recreational uses of Earley Lake primarily include aesthetics and wildlife viewing, as there are no public beaches or boat access. Day Park is located on the southwest side of the lake and a walking trail surrounds the lake. The BDWMO did not classify Earley Lake as a strategic waterbody. The MPCA classifies Earley Lake as a shallow lake. The MPCA previously listed Earley Lake as impaired due to excess nutrients. Earley Lake was removed from the impaired waters list in 2010 based on water quality data.

Earley Lake is a shallow lake, with a mean depth of 3.8 feet and a maximum depth of 7.8 feet. Because of the shallow conditions, macrophyte growth is prevalent throughout most of the lake, and the entire lake is littoral area. The lake outlet consists of a three-sided box weir, with a total length of 12 feet and an overflow elevation of 905.0 feet above MSL (NGVD29). Earley Lake discharges to the southwest into the Sunset Pond watershed; the discharge from the lake is conveyed westward through a 36-inch diameter RCP pipe to Judicial Pond prior to reaching Sunset Pond.

The direct watershed tributary to Earley Lake is approximately 757 acres. Earley Lake also receives inflows from the Lee Lake, Keller Lake, Crystal Lake, Lac Lavon, Wood Pond, and Twin Lake watersheds, bringing the total tributary area to 5,292 acres (5,108 acres excluding Lac Lavon, which is typically landlocked). The Earley Lake watershed is characterized by heavy commercial land use (including all of Burnsville Center), as well as low-, medium-, and high-density residential use.

2.7.1.9 Wood Pond (MDNR #19-0024W)

Wood Pond is approximately 14 acres and is located in the City of Burnsville in the central portion of the BDWMO. Wood Pond is used for canoeing, fishing, aesthetic viewing, and wildlife habitat. Wood Park is located along the northeast shoreline of Wood Pond. There is no public boat or swimming access on the lake. In 2007, a public fishing dock was constructed at Wood Park, as part of the MDNR FiN Program. The BDWMO did not classify Wood Pond as a strategic waterbody. The MDNR classifies Wood Pond as a public water wetland.

Wood Pond is a shallow waterbody. The average water depth is 10 feet and the maximum depth is 14 feet (the littoral area covers the entire lake). The water level in the lake is controlled at elevation 1000.9 ft MSL (NGVD29) by an 18-inch diameter inlet/outlet pipe located at the west side of the lake, although the lake rarely discharges and is typically landlocked. From there, the trunk storm sewer system conveys discharge from the lake south beneath Portland Avenue and eventually into Twin Lake.

The Wood Pond watershed is approximately 110 acres and is fully developed, with no significant changes in land use classification expected for the foreseeable future. The Wood Pond watershed includes predominantly low- and medium-density residential land use. There is also some right-of-way land use in the watershed as well as some commercial land use southeast of the lake along County Road 42.

2.7.1.10 Twin Lake (MDNR #19-0028W)

Twin Lake is approximately 17 acres and includes north and south basins separated by Southcross Drive. North Twin Lake and South Twin Lake are approximately 5 acres and 12 acres, respectively. The lake is located within the City of Burnsville in the central portion of the BDWMO. Twin Lake is used for canoeing, fishing, aesthetic viewing, and wildlife habitat. Twin Lake Park surrounds the north basin and it borders the north shore of the south basin. There is no public beach or boat access on the lake. The BDWMO did not classify Twin Lake as a strategic waterbody. The MDNR classifies Twin Lake as a public water wetland.

Twin Lake is a shallow waterbody. South Twin has a mean depth of 3.6 feet and a maximum depth of 11 feet. North Twin Lake has a mean depth of 6.6 feet and a maximum depth of 12 feet. Because of the shallow conditions, macrophyte growth is often prevalent throughout both basins.

Outflows from Crystal Lake and local stormwater runoff enter on the south side of South Twin Lake via a 48-inch diameter RCP storm sewer. Twin Lake is also downstream of Wood Pond; Wood Pond is typically landlocked and discharges to Twin Lake only under high water conditions. The outlet from Twin Lake is located at the southwest side of the north basin and consists of a three-sided box weir, with a total length of 12 feet and an overflow elevation of 918.0 feet above MSL (NGVD29). Discharge from Twin Lake is conveyed in a westward direction through a 36-inch diameter RCP to Earley Lake.

South Twin Lake and North Twin Lake are connected by a 36-inch diameter culvert underneath Southcross Drive which acts as an equalizer pipe. Typically, water flows from the south basin to the north basin. During significant storm events, however, runoff to the north basin can exceed discharge capacity and stormwater can backup and flow to the south basin.

The direct watershed tributary to Twin Lake watershed covers approximately 574 acres (or 683 acres when the Wood Pond watershed is included). The total watershed that flows to Twin Lake includes the areas tributary to Lee Lake, Keller Lake, Lac Lavon, Crystal Lake, and Wood Pond and is 4,352 acres (excluding the area to Lac Lavon, which is typically landlocked). Land use is the watershed is predominantly residential and park land, except for a large commercial area between I-35W and I-35E that drains to North Twin Lake.

2.7.2 Streams and Open Channels

Although there are many lakes and wetlands throughout the BDWMO, there are very few natural streams within the watershed. Much of the watershed is fully-developed and flows that were once conveyed through surface drainages and streams now flow through underground storm sewer.

Flows from the southwestern portion of the BDWMO that pass through Kingsley Lake, Orchard Lake, and the Cam Ram Wetland ultimately reach the Credit River (MDNR ID 07020012-517) in the Scott WMO. Flows from the remainder of the BDWMO discharge to the Minnesota River (MDNR ID 07020012-505) in the Lower Minnesota River Watershed District (LMRWD). In addition, flows from the northern portion of the watershed (in the River Hills subwatershed, see Figure 2-2) reach a MDNR-designated trout stream (in the LMRWD) that flows into Black Dog Lake and eventually the Minnesota River.

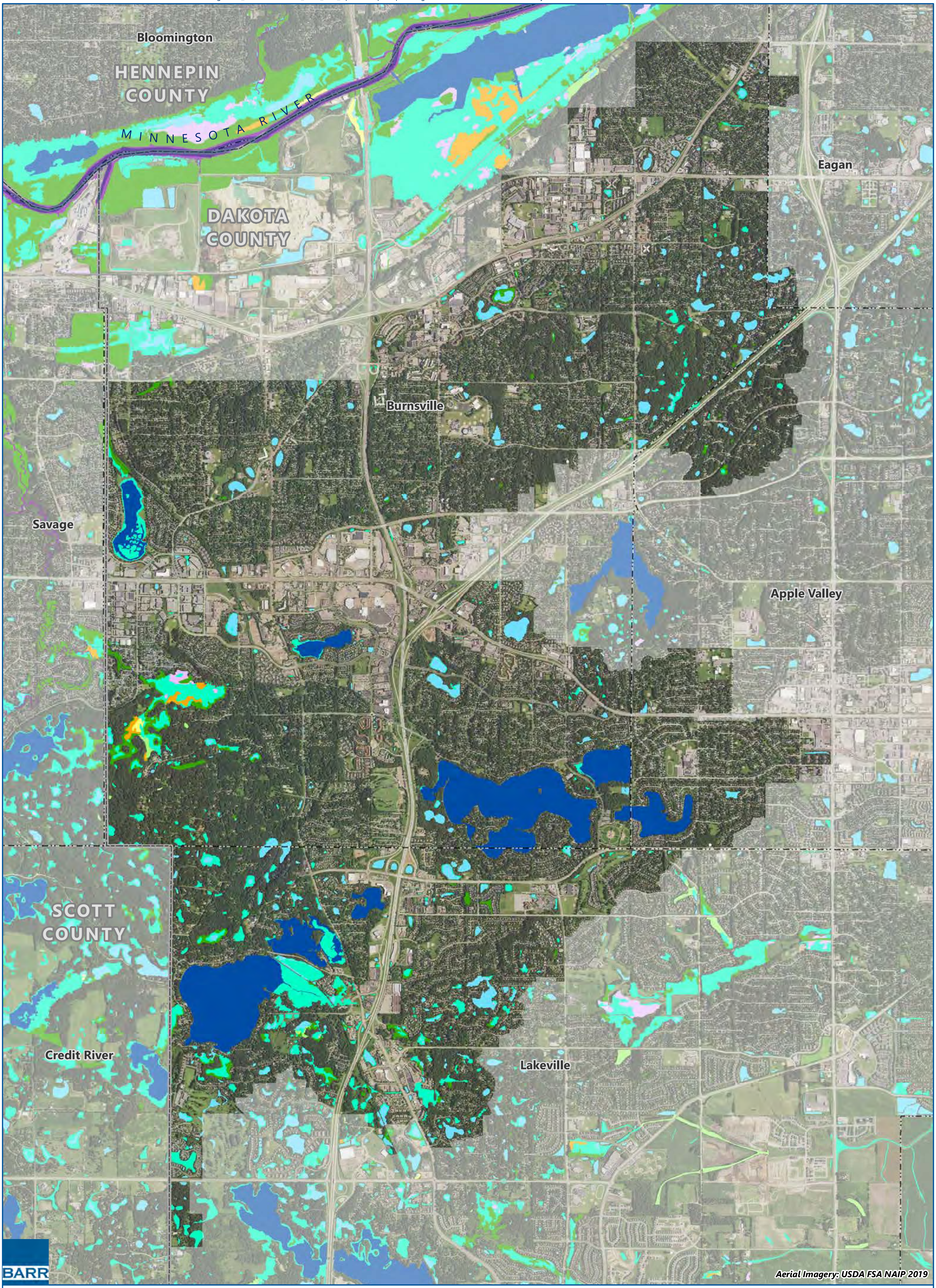
2.7.3 Wetlands

Wetlands in the BDWMO are important community and ecological assets. Wetlands provide recreational value, runoff storage and retention, nutrient and sediment reduction, groundwater recharge, and wildlife habitat benefits. To protect these valuable resources, the BDWMO and its member cities cooperate to manage wetlands to achieve no net loss of acreage, functions, and value. Within the watershed, the member cities serve as the Local Government Units (LGUs) responsible for administration of the Wetland Conservation Act (WCA) (except for on Minnesota Department of Transportation projects). More information about WCA guidance is provided at the BWSR website: https://bwsr.state.mn.us/wetlands-regulation-minnesota

The US Fish and Wildlife Service (USFWS) maintains an inventory of wetlands known as the National Wetland Inventory (NWI). Figure 2-9 presents the wetlands identified in the NWI. The NWI is periodically updated. The Cities of Apple Valley, Burnsville, and Lakeville have also developed city-wide wetland inventories with wetland classification systems based on the Minnesota Rapid Assessment Method (MnRAM) or similar framework. The City of Eagan assessed 100 priority wetlands in developing its comprehensive wetland protection and management plan and uses a MnRAM-based classification system.

BDWMO member cities classified wetlands for protection, restoration, and/or improvement according to their condition, function, and individual municipal goals. Member city wetland classifications are included in each city's local water management plan and/or wetland inventory. Wetland inventory and classification data from Apple Valley and Burnsville are presented in Figure 2-10. Wetlands classified as protection wetlands in the BDWMO include several wetlands within the Murphy-Hanrehan Park Reserve, wetlands adjacent to Crystal Lake, and select wetlands adjacent to the Interstate 35E corridor in northeast Burnsville and Apple Valley.

Within all BDWMO member cities, wetlands are inventoried on an individual basis as part of development proposals. The BDWMO requires functional values assessment of wetlands to be performed using the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM), version 3.2, or similar methodology. Information about wetland functional assessment is available from BWSR at: www.bwsr.state.mn.us/wetlands/mnram/index.html.



County Boundary
Municipal Boundary
River

National Wetlands Inventory

- Freshwater Emergent Wetland
- Freshwater Forested Wetland
- Freshwater Forested/ Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Freshwater Pond
- Freshwater Shrub Wetland
- Freshwater Shrub/ Emergent Wetland
- Lake
- Riverine

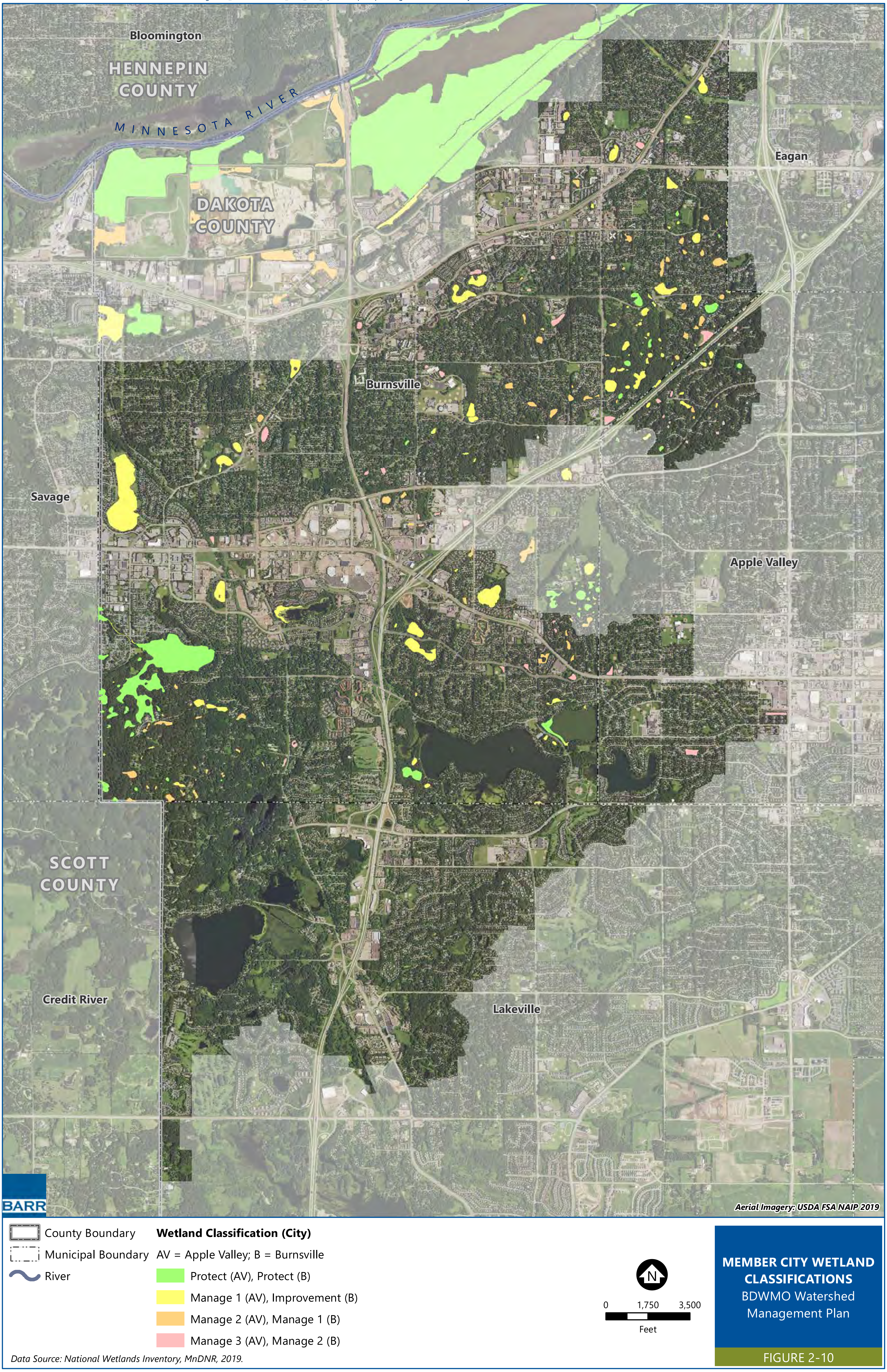
0 1,750 3,500
Feet

Data Source: National Wetlands Inventory, MnDNR, 2019.

NATIONAL WETLANDS INVENTORY

BDWMO Watershed Management Plan

FIGURE 2-9



Data Source: National Wetlands Inventory, MnDNR, 2019.

MEMBER CITY WETLAND CLASSIFICATIONS

BDWMO Watershed Management Plan

FIGURE 2-10