5.0 Land and Water Resource Inventory

This section of the Riley Purgatory Bluff Creek Watershed District (RPBCWD or District) Watershed Management Plan (Plan) summarizes the land and water resources located within the District. It contains information on climate and precipitation, topography, soils, geology and groundwater, surface water resources, resources, water quality, water quantity, wetlands, pollutant sources, and natural areas and unique features. This important information describes the condition of the watershed and it affects decisions about infrastructure, development, and ecological preservation. Lake and creek specific resource inventories can be found by creek watershed in Section 6.0 (Bluff Creek watershed), Section 7.0 (Purgatory Creek watershed), and Section 0 (Riley Creek watershed).

5.1 Climate and Precipitation

The climate of the Twin Cities metropolitan area is a humid continental climate, characterized by moderate precipitation (normally sufficient for crops), wide daily temperature variations, and large seasonal variations in temperature (warm humid summers, and cold winters with moderate snowfall). Average total annual precipitation measured at the Minneapolis-St. Paul International Airport (MSP) is 30.6 inches (1981-2010). Snowfall averages 54.4 inches annually at the MSP station (1981-2010). The District uses precipitation data recorded at the MSP station as well as data from Chanhassen, Flying Cloud Airport, and private observers in Eden Prairie and Chanhassen. Additional precipitation gages are operated by the Metropolitan Council. Rain gage #19 has the most complete coverage of the watershed. It has a long term rainfall record from 1891 to present.

The amount, rate, and type of precipitation are important in determining flood levels and stormwater runoff rates, all of which impact water resources. Average weather imposes little strain on the typical drainage system. Extremes of precipitation and snowmelt are important for design of stormwater management and flood control systems. The National Oceanic and Atmospheric Administration (NOAA) has data on extreme precipitation events that can be used to aid in the design of stormwater management and flood control systems (see Section 5.1.1).

Additional climate information can be obtained from a number of sources, such as the following sources:

- For climate information about the Twin Cities metropolitan area: http://www.dnr.state.mn.us/climate/twin_cities/index.html
- Local data available from the Midwestern Regional Climate Center (MRCC): http://mrcc.isws.illinois.edu/
- For a wide range of climate information: https://www.climate.gov/maps-data
- For other Minnesota climate information: http://www.dnr.state.mn.us/climate/index.html

5.1.1 Precipitation-Frequency Data (Atlas 14)

NOAA published Atlas 14, Volume 8, in 2013. Atlas 14 is the primary source of information regarding rainfall in the region. 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. Improvements in Atlas 14 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.

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. Runoff from spring snowmelt is not provided in Atlas 14. The Natural Resources Conservation Service (NRCS) Technical Reference 60 (TR-60) presents maps of regional runoff volume over extended durations (NRCS, 2005). Table 5-1 lists selected rainfall and snowmelt runoff events relevant in the RPBCWD.

Table 5-1 Selected Rainfall and Snowmelt Runoff Events

Type	Event Frequency	Duration	Depth (inches)
Rainfall	2-year	24 hour	2.87
	5-year	24 hour	3.58
	10-year	24 hour	4.27
	25-year	24 hour	5.37
	50-year	24 hour	6.33
	100-year	24 hour	7.41
	10-year	10 day	6.89
	100-year	10 day	10.3
Snowmelt[1]	10-year	10 day	--
	25-year	10 day	5.8
	50-year	10 day	6.5
	100-year	10 day	7.2

Source: NOAA Atlas 14 – Volume 8. Station: Centroid of RPBCWD. T--60 Earth Dams and Reservoirs (NRCS)

[1] Snowmelt depth reported as liquid water; based on values from TR-60 Figure 2.1.

5.1.2 Climate Trends and Future Precipitation

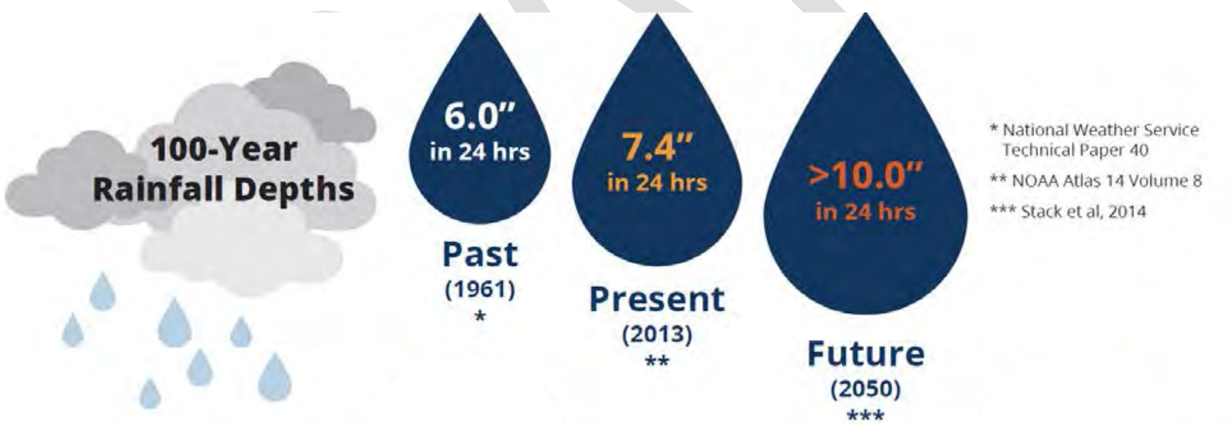
Even with wide variations in climate conditions, climatologists have found four significant recent climate trends in the Upper Midwest (Seeley, 2006):

- Warmer winters—decline in severity and frequency of severe cold
- 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 (NOAA, 2013), annual and summer precipitation amounts in the Midwest are trending upward, as is the frequency of high intensity storms. 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 records in the Twin Cities area show that the average annual precipitation has increased by roughly 20% (5.5 inches), from 1951 through 2012 (NOAA, 2012).

Recent work completed by Latham Stack and Michael Simpson (NOAA, 2014) provides information required to consider long-term extreme weather trends in the Twin Cities area. 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. A range of estimates for the mid-21st century 100-year 24-hour rainfall event were identified. 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 rainfall depth published in Atlas 14 (7.4 inches). The middle estimate is 10.2 inches, which is similar to the upper limits of the Atlas 14 90-percent confidence limits. Upper estimates of mid-21st century 100-year 24-hour rainfall exceed the 90-percent confidence limits of Atlas 14.

Increasing precipitation amounts place greater stress on natural resources and stormwater infrastructure, and increase flood risk. The District has and will continue to consider potential climate changes in its evaluation and management of flood risk (see Section 5.9.2).



NOAA determined the rainfall depth associated with a 100-year storm, which has a 1% chance of occurring in any given year, has increased from 6.0 inches to 7.4 inches as more rainfall data are collect. Research suggests that by mid-century this depth could increase to over 10 inches.

5.2 Topography

Detailed topography of the District is available through the Minnesota Department of Natural Resources' 2011 LiDAR data (MDNR, 2011). Topography within the District includes very flat to moderately rolling topography with some areas of steep slopes. Elevations vary from a maximum of approximately 1,080 feet in the headwaters of the

Riley Creek watershed to a minimum of approximately 690 feet at the Minnesota River. Figure 5-1 shows surface elevation based on the LiDAR data.

The District's topography may generally be divided into three geographic categories.

The most northern portion of the District, north of Trunk Highway 7 in the Purgatory Creek watershed, is relatively flat with poorly defined drainage patterns. Most of the drainage in this area is a result of agricultural drain systems installed in the 1920s. In 1977, the City of Minnetonka undertook a project that improved the drainage facilities in the Trunk Highway 7 and Trunk Highway 101 area.

The eastern and central portions of the District, including the downstream areas of the Riley Creek and Purgatory Creek watersheds, are characterized by gently rolling upland areas with well-defined drainage patterns and floodplain areas. Much of the floodplain through this portion of the District is marsh and wetland. Most of the District-managed lakes are located within the central portion of the District.

The southern and western portions of the District, including nearly all of the Bluff Creek watershed, are dominated by a part of the northern bluff of the Minnesota River valley. Riley Creek, Purgatory Creek, and Bluff Creek have eroded deep channels as they flow from the top of the bluff, at elevations ranging from 820 to 950 to the Minnesota River floodplain at an elevation of 700.

WATERSHED TOPOGRAPHY

FIGURE 5-1

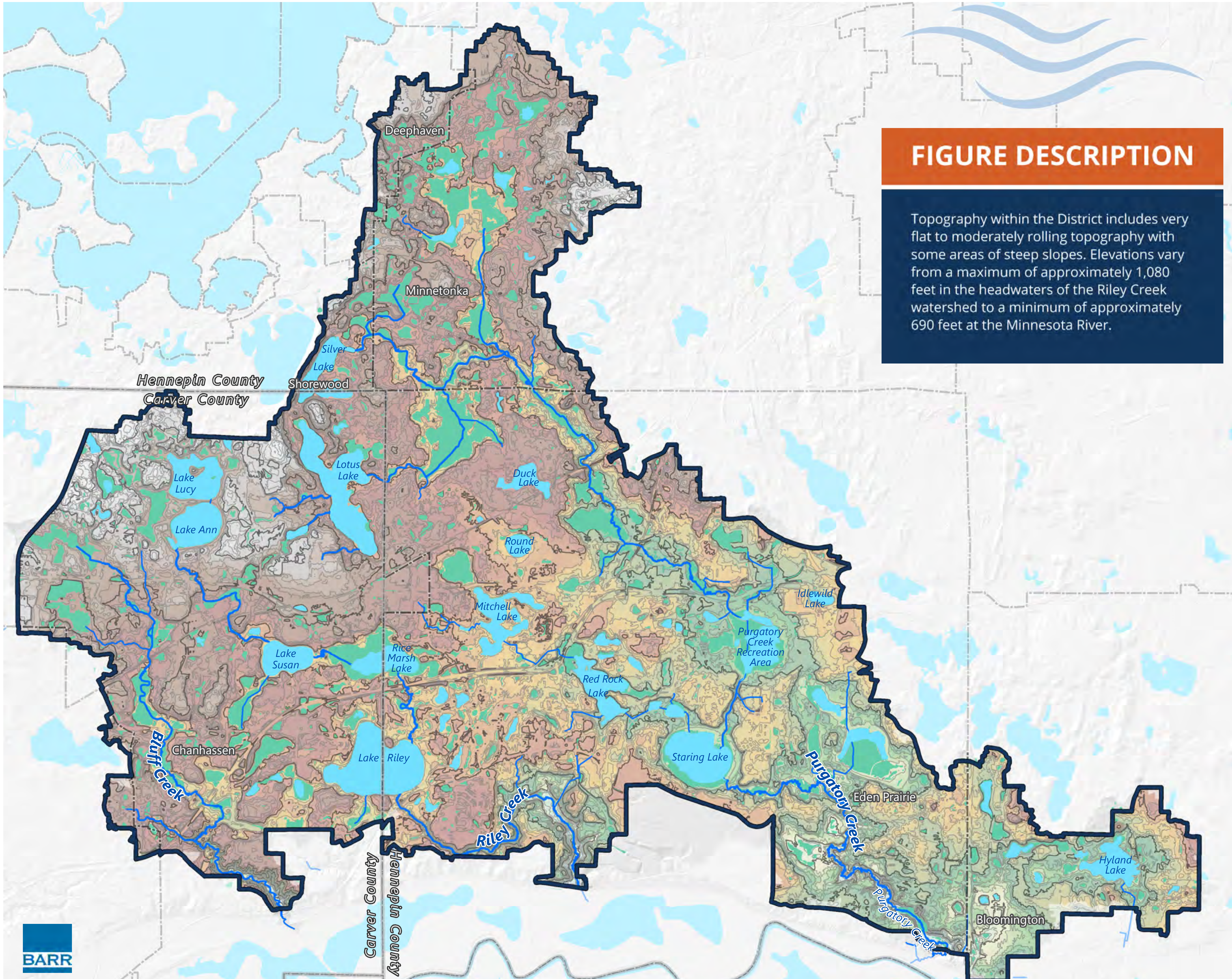


FIGURE DESCRIPTION

Topography within the District includes very flat to moderately rolling topography with some areas of steep slopes. Elevations vary from a maximum of approximately 1,080 feet in the headwaters of the Riley Creek watershed to a minimum of approximately 690 feet at the Minnesota River.

Surface Elevation
(MnDNR LiDAR, 2011)
50 Foot Contour
10 Foot Contour

Surface Elevation
High: 1,120 Feet
Low: 700 Feet

Streams/Creeks
Lake/Pond
Wetlands
District Legal Boundary
Municipalities

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RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

5.3 Land Use

Land use can be a significant factor in stormwater management, as increased impervious area results in increased rate and volume of stormwater runoff from precipitation. The Metropolitan Council maintains spatial datasets for existing (2010) and estimated future (2030) land use for the Twin Cities Metropolitan Area. Most of the land in the RPBCWD is now fully developed. Figure 5-2 shows the land use within the RPBCWD as of 2010. Single family residential land use is the major land use within the District, occupying approximately 45% of the land area. Park, recreational, or preserve land uses occupy 14% of the watershed. Approximately 12% of the watershed was classified as undeveloped in 2010 (note that the "undeveloped" land use designation may include undevelopable land such as wetlands. Most of the undeveloped land is within the Bluff Creek and Purgatory Creek watersheds).

Estimated future land use shown in Figure 5-3 illustrates fully developed conditions in the watershed. Because the watershed is mostly developed, future changes in land use are increasingly likely to occur in the form of redevelopment. Knowledge of estimated future land use is useful to identify areas where redevelopment might offer opportunities for additional stormwater treatment or retrofits of existing stormwater infrastructure. The comprehensive plans for cities within the RPBCWD contain more information about these future redevelopment areas.

Anticipated changes in land use throughout the District are summarized in Table 5-2. Significant changes include:

- Development of remaining undeveloped spaces
- Loss of nearly all remaining agricultural land use from the Bluff Creek and Riley Creek watersheds
- Increased commercial and office land use in the Bluff Creek, Purgatory Creek, and Riley Creek watersheds
- Creation of additional park, recreational, and conservation land uses
- Increased residential land use, primarily in the Bluff Creek and Riley Creek watersheds

Table 5-2 Land Use Changes within the RPBCWD

Land Use[1]	2010 Land Use[2]		2030 Land Use[2]		Change
	Acres	%	Acres	%	Acres
Airport	530	1.7%	598	2.0%	69
Agricultural	671	2.2%	3	0.0%	-668
Commercial/Office	1,161	3.8%	2,323	7.6%	1,162
Golf Course	771	2.5%	479	1.6%	-292
Industrial	840	2.7%	676	2.2%	-164
Institutional	977	3.2%	398	1.3%	-580
Mixed Use	32	0.1%	183	0.6%	151
Open Water	2,000	6.5%	1,974	6.5%	-25
Park, Recreational, or Conservation	4,227	13.8%	5,258	17.2%	1,030
Multifamily Residential	566	1.9%	397	1.3%	-169
Single Family Residential	14,020	45.9%	17,152	56.1%	3,132
Right-of-Way	981	3.2%	1,134	3.7%	153
Undeveloped	3,799	12.4%	0	0.0%	-3,799
Total	30,575	100%	30,575	100%	0

[1] Land use classifications differ from 2010 and 2030 datasets. Similar land uses have been grouped for comparison purposes

[2] Data from Metropolitan Council

METROPOLITAN COUNCIL LAND USE (2010)

FIGURE 5-2

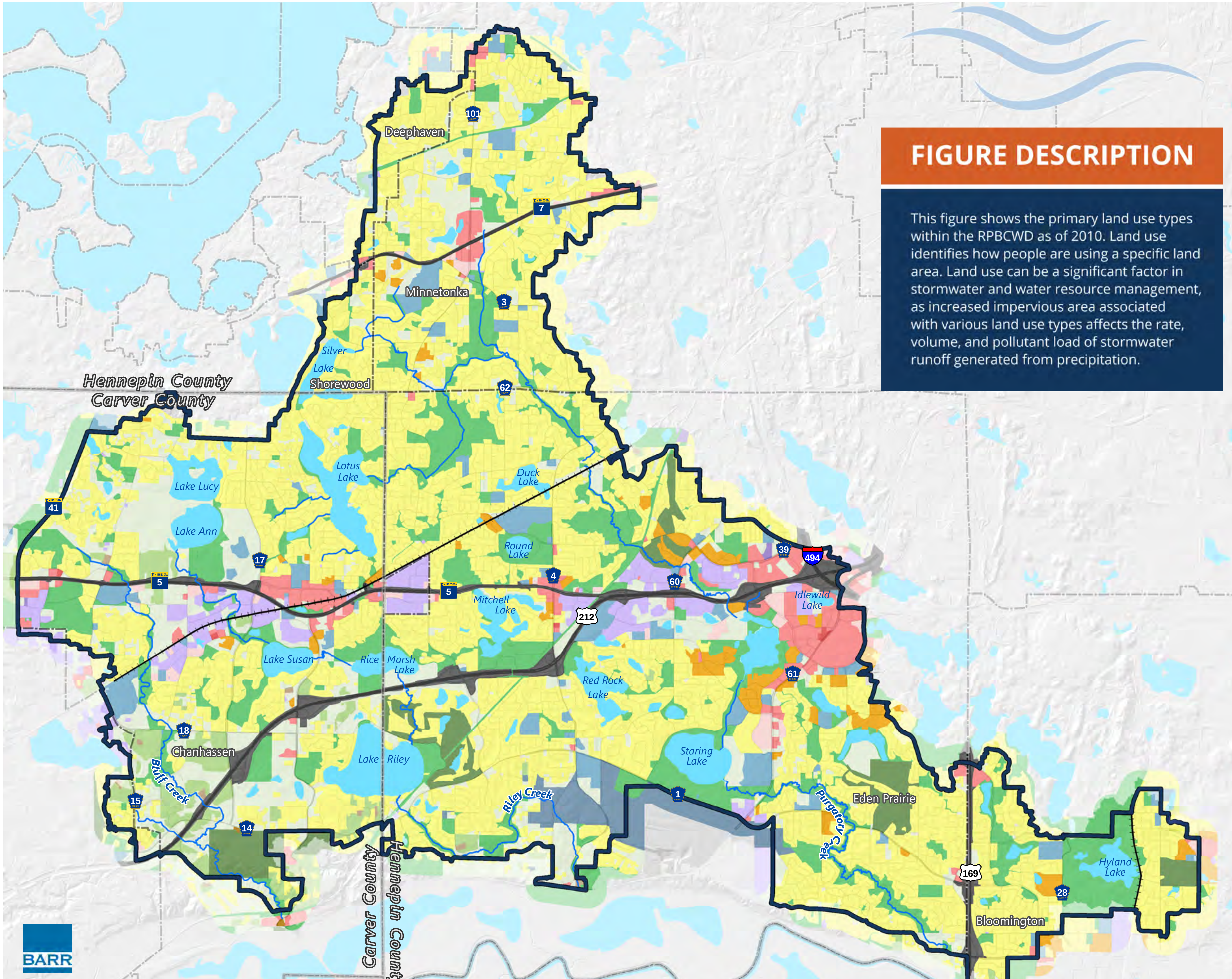

FIGURE DESCRIPTION

This figure shows the primary land use types within the RPBCWD as of 2010. Land use identifies how people are using a specific land area. Land use can be a significant factor in stormwater and water resource management, as increased impervious area associated with various land use types affects the rate, volume, and pollutant load of stormwater runoff generated from precipitation.

District Legal Boundary

2010 Land Use (MetCouncil)

- Farmstead
- Single Family
- Multifamily
- Retail and Other Commercial
- Office
- Mixed Use Residential
- Mixed Use Industrial
- Mixed Use Commercial
- Industrial and Utility
- Institutional
- Park, Recreational or Preserve
- Golf Course
- Major Highway
- Airport
- Agricultural
- Undeveloped
- Water

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

METROPOLITAN COUNCIL LAND USE (2030)

FIGURE 5-3

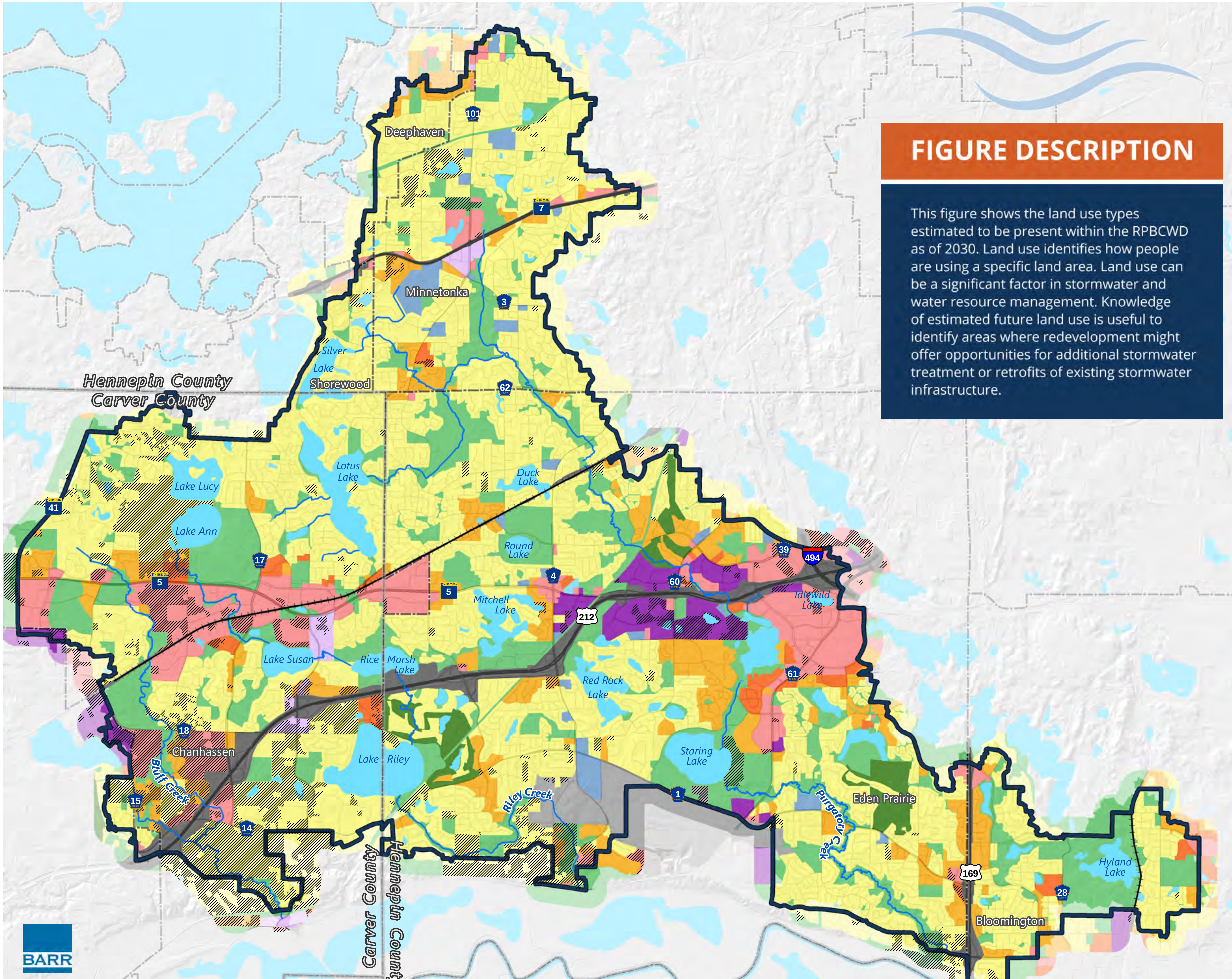

FIGURE DESCRIPTION

This figure shows the land use types estimated to be present within the RPBCWD as of 2030. Land use identifies how people are using a specific land area. Land use can be a significant factor in stormwater and water resource management. Knowledge of estimated future land use is useful to identify areas where redevelopment might offer opportunities for additional stormwater treatment or retrofits of existing stormwater infrastructure.

District Legal Boundary

Future Land Use Change

Future 2030 Land Use (MetCouncil, 2017)

- Residential - Low Density
- Residential - Medium Density
- Residential - High Density
- Mixed Use
- Commerical/Office Space
- Industrial
- Institutional/Religious
- Park, Recreational or Conservation
- Golf Course
- Open Water or Wetland
- Airport
- Transportation Right-of-Way

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

5.4 Soils

The distribution of soil types in the District is the direct result of glacial action. The soils of the area consist primarily of till and outwash materials deposited by Late Wisconsinan glaciations and more recent organic, lacustrine, and alluvial deposits. This advance, known as the Grantsburg Sublobe of the Des Moines Lobe, is primarily responsible for the topography and surficial geology of the watershed and deposited grey drift over the area approximately 10,000 years ago. Near the surface, this material appears brown because of the oxidation; however, in deeper reaches it has a distinctive grey coloring. The moraine areas are typified by rolling hills and depressions usually filled lakes and marshes.

During the period when the glacier receded, there were numerous areas where blocks of ice were left in place while adjacent ice melted or was carried away. In these areas, the presence of ice blocks prevented the deposition of tills and outwash soils. Later, after the deposition of materials had ended, the ice blocks melted, leaving depressions in the landscape. These depressions filled with water, resulting in the lakes and basins which prevail throughout the District.

Soil boring information in the area indicates that the subsurface soils are intermixed and are spatially heterogeneous. Many soil borings indicate layers of sand beneath the grey till which indicates the area had been subjected to outwash conditions prior to the last deposition of till over the surface. Surface soil composition may impact water resources by affecting infiltration capacity, runoff rates, and erosion potential (see Section 5.4.1).

Additional soils information for the District is available in the soil surveys for Hennepin County and Carver County published by the NRCS and available from the NRCS website at: https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=MN

The NCRS regularly updates soils data and maintains an online soils data viewing tool at: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

5.4.1 Hydrologic Soil Groups and Infiltration

Soil composition, slope, and land management practices determine the impact of soils on water resource issues. Infiltration capacities of soils affect the amount of direct runoff resulting from rainfall. Higher infiltration rates result in lower potential for runoff from the land, as more precipitation is able to 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 has established four general hydrologic soil groups based on infiltration rate:

- Group A Low runoff potential—high infiltration rate
- Group B Moderate infiltration rate
- Group C Slow infiltration rate
- Group D High runoff potential—very slow infiltration rate

Soils may also be classified as types A/D, B/D, and C/D, with the first letter describing the soil infiltration rate in drained conditions and the "D" identifying very low infiltration rates under saturated, or undrained, conditions. Combined with land use, the hydrologic soil grouping symbols (A-D) may be used to estimate the amount of runoff that will occur over a given area for a particular rainfall amount. The most current soils data for the RPBCWD watershed are based on the Soil Survey Geographic dataset (SSURGO) from the NRCS and are presented in Figure 5-4.

Of the total watershed area, Type A soils occupy 19 percent, Type B occupy 30 percent, Type C occupy 13 percent, and Type C/D soils occupy 21 percent. The remaining area is made up of A/D and B/D soils. Generally, the sandy Type A soils are more prevalent in the south and southeastern portions of the watershed. The finer-grained Type B, C, and C/D soils are widely found in the western half of the district in the Bluff and Riley Creek watersheds, but also along the more upstream reaches of Purgatory Creek. Approximately 10 percent of the District is classified as "Not Rated/Not Available" in the SSURGO dataset. This classification is typically assigned to areas where development has altered the existing soil or data were unavailable prior to development; hydrologic soil groups or infiltration rates are typically not determined after development.

Overall, infiltration rates within the district are moderately low, owing to the prevalence of type C and D soils. However, the hydrologic soil groups map (Figure 5-4) provide only general guidance about the infiltration capacity of the soils throughout the watershed. Soils should be inspected on a site-by-site basis as projects are considered.

HYDROLOGIC SOIL GROUPS

FIGURE 5-4

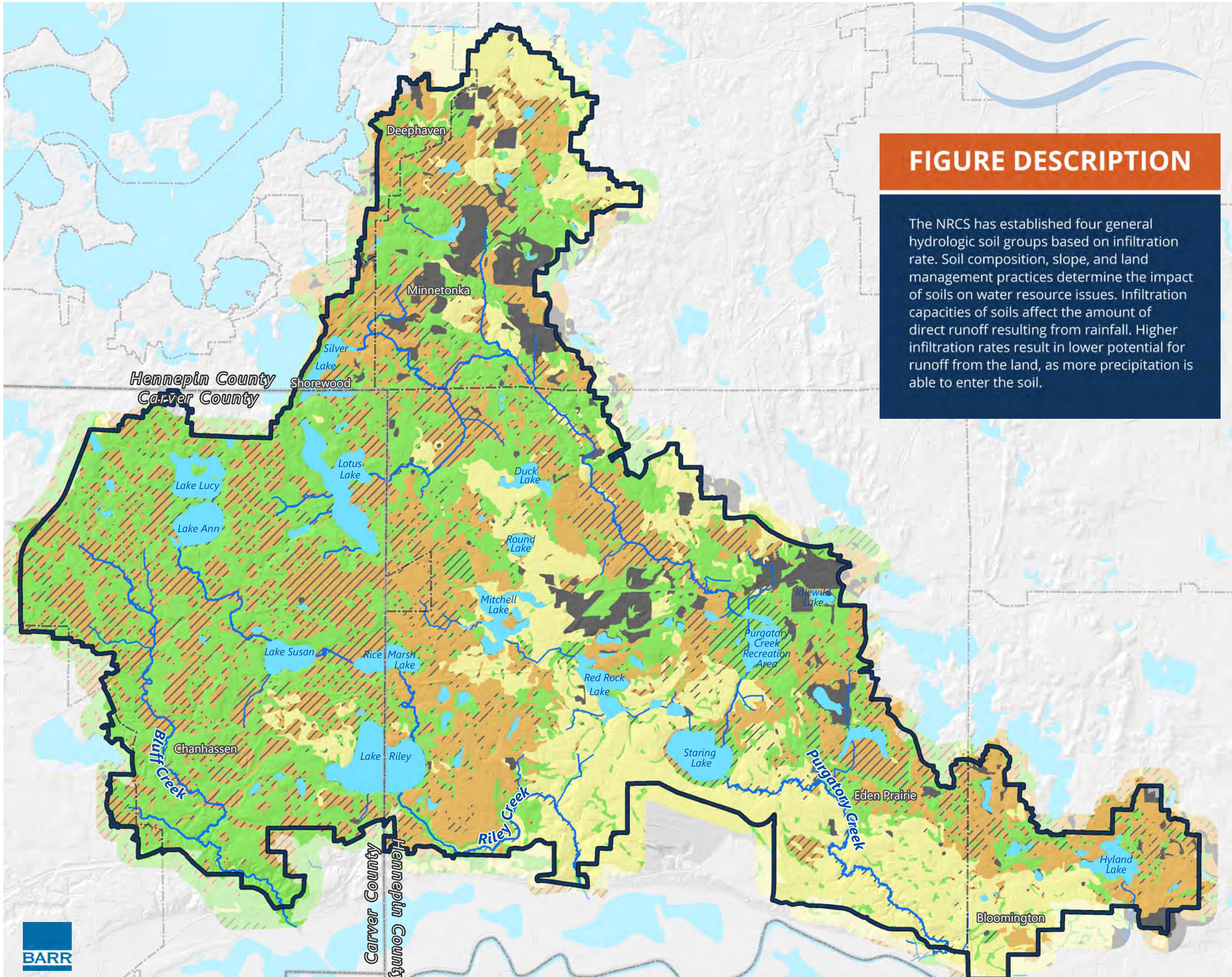

FIGURE DESCRIPTION

The NRCS has established four general hydrologic soil groups based on infiltration rate. Soil composition, slope, and land management practices determine the impact of soils on water resource issues. Infiltration capacities of soils affect the amount of direct runoff resulting from rainfall. Higher infiltration rates result in lower potential for runoff from the land, as more precipitation is able to enter the soil.

NRCS Hydrologic Soil Groups (HSG)

- A - Low Runoff Potential, High Infiltration Rates (gravel or sands)
- A/D*
- B - Moderate Infiltration Rates (sandy loams and loamy sands)
- B/D*
- C - Slow Infiltration Rates (loams, silts, clay loam, etc.)
- C/D*
- Urban Soils - Areas disturbed by development when NRCS conducted survey
- Streams/Creeks
- Lake/Pond
- District Legal Boundary
- Municipalities

** Dual HSG designation indicates infiltration rate in drained and undrained condition.*

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RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

5.5 Geology

The geology of the RPBCWD includes a layer of unconsolidated Quaternary deposits (glacial drift) underlain by multiple layers of bedrock. The glacial drift varies in thickness from between 100- to 150-feet in some areas to over 400 feet in the southeast part of the District, but is between 150- and 250-feet thick throughout most of the district.

The glacial drift is underlain primarily by St. Peter Sandstone in the northern part of the district (i.e., Minnetonka). The Prairie du Chien group (dolomite) underlies most of the rest of the district. The southeastern portion of the District is bisected by two buried erosional valleys below the City of Bloomington. These areas have the thickest overburden and are underlain by Jordan Sandstone and the St. Lawrence and Franconia formations.

More detailed information about the surficial and bedrock geology in the District is available in the Geologic Atlas of Hennepin County (Minnesota Geological Survey (MGS, 1989)) and the Geologic Atlas of Carver County (MGS, 2009). County geologic atlas data is available from the MDNR at: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status_list.html

5.6 Groundwater Resources

Nearly all of the residents within the District obtain their drinking water from groundwater. The groundwater system in the District is comprised of the glacial drift water table (i.e., surficial aquifers) and the underlying bedrock aquifers that are partially in an artesian condition, meaning that water in the bedrock is maintained under pressure by confining upper layers.

> *Did you know?*
> *The Freshwater Society recently published The Water Underground, Stretching Supplies (Jennings, 2017), the second in a three-part series on Minnesota groundwater.*

Groundwater flows from high pressure areas to a low pressure areas. For example, in the Duck Lake area of Eden Prairie, the glacial drift water table is at an elevation of approximately 870 and the Jordon pressure is at approximately elevation 840. This indicates that, in the absence of a confining layer, a groundwater flow from the glacial drift to the Jordon Sandstone exists. This situation is reversed along the southern boundary of the District, where the opposite pressure gradient creates flow from the

Jordan aquifer to the glacial drift in this area. In many places along the southern boundary of the District, the Jordan Formation is a source of water to Riley, Purgatory, and Bluff Creeks. The interrelationship between surface water and groundwater resources requires that each resource must be managed with consideration for the other.

5.6.1 Surficial Aquifers (Quaternary Aquifers)

Surficial aquifers (also known as glacial drift aquifers or quaternary aquifers) are water-bearing layers of sediment, usually sand and gravel, which lie close to the ground surface. Many private domestic wells in the watershed draw water from these aquifers. Since the surficial aquifers are more susceptible to pollution, they are generally not used for municipal or public supply wells. In some locations in the RPBCWD, the aquifer could provide sufficient water yield for some non-potable industrial uses. The depth of the water table varies across the watershed, but is on the order of tens of feet. The glacial drift aquifer system includes a buried drift aquifer that is hydrologically separated from the water table aquifer in the western part of the District.

Recharge to the surficial aquifers is primarily through the downward percolation of local precipitation. The ponds, lakes, and wetlands scattered throughout the watershed may also recharge the groundwater, depending on the gradient between the waterbody and local water table. Some of these waterbodies are landlocked and their only outlet is to the groundwater; some landlocked lakes may be perched above the regional level of the shallow groundwater in the watershed. Some surficial aquifers may also be recharged during periods of high stream stage. Surficial aquifers may discharge to local lakes, creeks, or to the underlying bedrock. The nature of surface water and groundwater interactions for specific waterbodies must be evaluated on a case-by-case basis.

Information about quaternary aquifer water table elevation and aquifer yields is available from the Hennepin and Carver County geologic atlas data available from the MDNR at:
http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status_list.html

5.6.2 Bedrock Aquifers

There are four major bedrock aquifers below the District (in order of increasing depth): (1) St. Peter Sandstone, (2) Prairie du Chien-Jordan, (3) Wonewoc Sandstone (formerly Ironton-Galesville Sandstone), and (4) Mt. Simon-Hinckley Sandstone. 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. This is the most heavily used aquifer within the District.

The potentiometric water level (i.e., the water level if unconfined) in the Prairie du Chien-Jordan aquifer varies from about 750 feet to 850 feet above mean sea level within the RPBCWD ((MGS, 1989) and (MGS, 2009)). 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. However, hydrogeologic characteristics suggest this recharge would be a minimal contribution to the aquifer flow. Regional recharge of the Prairie du Chien-Jordan aquifer occurs to the south of the Minneapolis-St. Paul metropolitan area. Groundwater movement in the aquifer is generally from northwest to southeast. The pressure levels in the Prairie du Chien-Jordan aquifer indicate that, in the absence of a confining layer, a groundwater flow from the glacial drift to the Prairie du Chien-Jordan aquifer exists. The MDNR closely reviews permits for groundwater withdrawals from the Prairie du Chien-Jordan aquifer to ensure that the withdrawals will not cause drawdown effects on nearby water resources of regional significance.

The regional aquifer with the highest water quality is the Mt. Simon-Hinckley aquifer, but it is more expensive to use than the Prairie du Chien-Jordan because of its greater depth. 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 potentiometric water level of the Mt. Simon-Hinckley ranges from about 650 to 750 feet above mean sea level within the RPBCWD. Recharge of the Mt. Simon-Hinckley takes place north of the District, where the bedrock is closer to the surface, and occurs by percolation through the overlying drift and bedrock. The pattern of flow in the Mt. Simon-Hinckley aquifer differs greatly from the pattern in the overlying Prairie du Chien-Jordan aquifer. Groundwater movement in the aquifer below the District is generally to the northeast towards a cone of depression located northeast of the District and formed by major pumping centers such as public water utilities and private industrial users. In general, the Mt. Simon-Hinckley aquifer has little or no hydraulic connection with the surficial groundwater system or major streams.

More information about bedrock aquifer water table elevation and aquifer yields is available from the Hennepin and Carver County geologic atlas data available from the MDNR at:
http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status_list.html

5.6.3 Wellhead Protection Areas

The Minnesota Department of Health (MDH) is responsible for the protection of groundwater quality and aims to prevent contaminants from entering the recharge zones of public water supply wells through its wellhead protection program. As part of the MDH wellhead protection program the MDH published guidance to limit potential for groundwater contamination and requires cities that obtain drinking water from groundwater to develop well-head protection plans (WHPPs). Each of the communities within the RPBCWD that obtains its municipal water supply from groundwater has an MDH-approved wellhead protection plan (WHPP). shows the delineated wellhead protection areas within the RPBCWD.

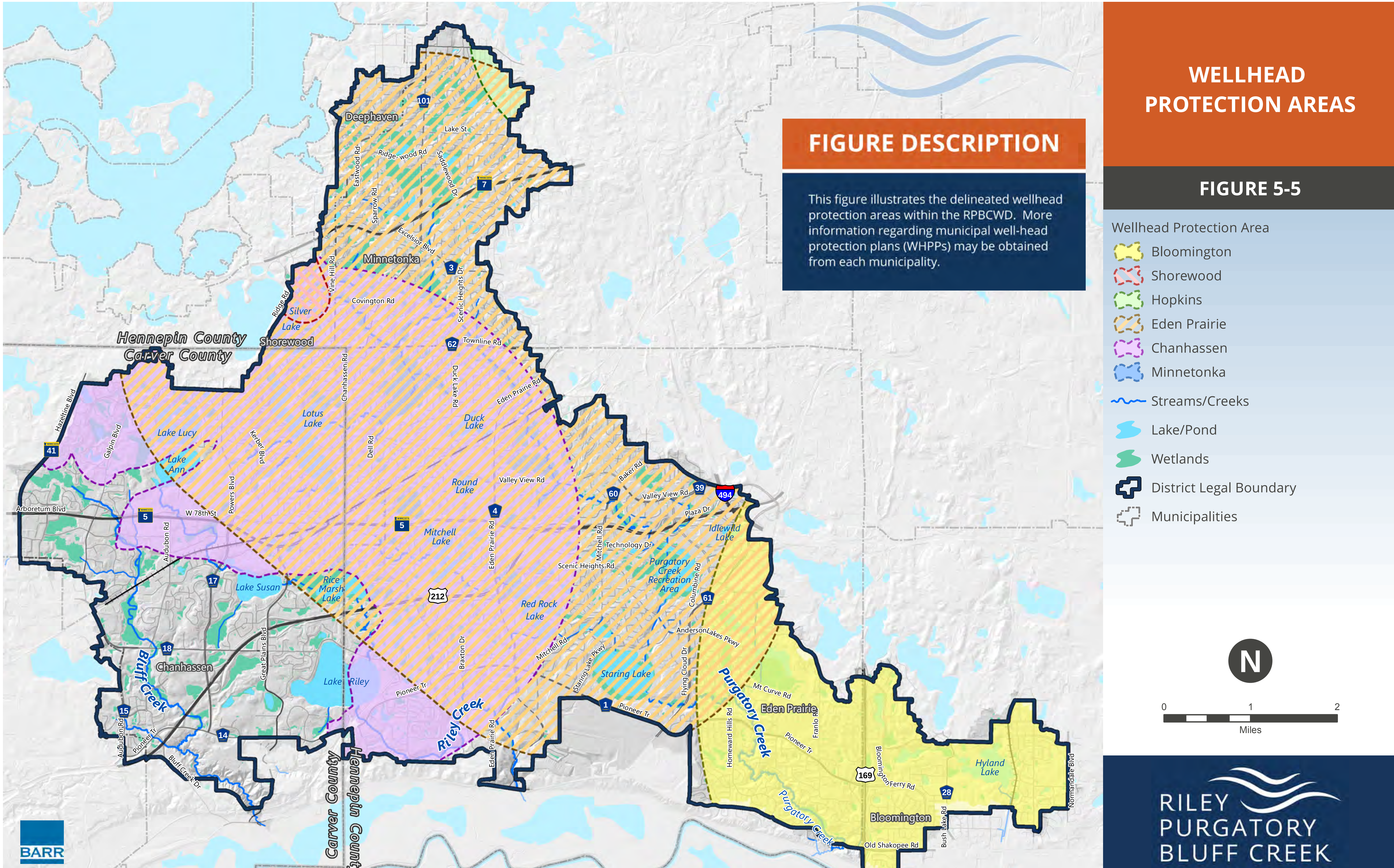
Protecting groundwater quality has become complicated by the increased use of infiltration as a means to improve surface water quality and promote sustainable groundwater supplies. More information regarding municipal WHPPs may be obtained from each municipality.

WELLHEAD PROTECTION AREAS

FIGURE 5-5

FIGURE DESCRIPTION

This figure illustrates the delineated wellhead protection areas within the RPBCWD. More information regarding municipal well-head protection plans (WHPPs) may be obtained from each municipality.



RILEY PURGATORY BLUFF CREEK **WATERSHED DISTRICT**

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Barr Footer: ArcGIS 10.4.1, 2017-10-23 11:50 File: I:\Client\RPBC_WD\Work_Orders\2016\TO16_Plan_Update\Maps\Reports\Plan_2017\Section_5\Fig 5-05 Wellhead Protection Areas.mxd User: mbs2

5.6.4 County Groundwater Management

5.6.4.1 Carver County Groundwater Plan

Carver County developed a 2016-2025 groundwater management plan (Carver County, 2016) with goals to protect groundwater quality, groundwater supply, and groundwater dependent natural resources to meet current needs without compromising future availability of groundwater resources. The Carver County Groundwater Plan focuses on four key roles: planning, education, cost share, and research and monitoring. Primary objectives included in the plan include:

- Coordinate groundwater quality data resources
- Monitor groundwater quality
- Prevent adverse health impacts
- Coordinate groundwater quantity data resources
- Monitor groundwater quantity, and participate in sub-regional workgroups
- Preserve water supplies and groundwater dependent natural resources
- Increase the County's understanding of groundwater and surface water interactions
- Increase public awareness about groundwater dependent natural resources

District staff participated as a stakeholder in the development of the Carver County Groundwater Plan. The District will continue to cooperate with Carver County, as opportunities allow, to achieve shared groundwater goals. The Carver County Groundwater Plan is available from the Carver County website at: www.co.carver.mn.us/departments/public-services/planning-water-management/planning/plans/groundwater-plan

5.6.5 Hennepin County Plan

Hennepin County addresses groundwater management in the Hennepin County Natural Resources Strategic Plan 2015-2020 (Hennepin County, 2016). An objective of the Hennepin County plan is to protect groundwater resources through strategies including:

- **Support planning and education efforts to protect groundwater resources** - To effectively protect and improve groundwater resources, the county will support cooperative planning efforts that will evaluate existing data, identify additional data needs, and assess the susceptibility of our surface and groundwater resources to current and projected levels of groundwater withdrawal, contamination and other threats.

- **Advocate for the cleanup of contaminated sites with the potential to significantly impact groundwater resources** – The County will evaluate the locations of contaminated sites with the goal of identifying contaminated sites that may pose significant risks to groundwater resources. The county will work with state regulatory agency staff (e.g., MPCA, Minnesota Department of Health), municipalities, and landowners to advocate for the cleanup of sites that pose a high risk to the environment and/or human health.

- **Seal abandoned wells to reduce the potential for groundwater contamination** – The county will continue to provide cost-share grants to landowners, using a combination of county and state funding as available, to seal high-priority abandoned wells that are located within municipal wellhead protection areas or have other environmental factors that increase the potential for contamination.

The District will cooperate with Hennepin County as it implements different parts of its plan and use it to guide watershed management with respect to impact upon groundwater. The Hennepin County Natural Resources Strategic Plan 2015-2020 is available from the Hennepin County website at: www.hennepin.us/naturalresources

5.7 Surface Waters and Drainage Patterns

The drainage system throughout the District is defined and subdivided according to the three major creeks: Bluff Creek, Purgatory Creek, and Riley Creek. Also present in the watershed are numerous wetlands, lakes, ponds and conveyance systems which all eventually drain to the Minnesota River. A subwatershed represents an area of land that drains directly to a common waterbody (or series of connected waterbodies). The major subwatersheds identified in Figure 5-6 are further broken down into minor subwatersheds (not shown) for specific management purposes (e.g., establishing 100-year flood levels, estimating pollutant loading).

Waterbodies and drainage patterns within each of the major subwatersheds are discussed in greater detail within the watershed sections for Bluff Creek (Section 6.0), Purgatory Creek (Section 7.0), and Riley Creek (Section 0). Many of the waterbodies within the District also fall under the regulatory jurisdiction of other agencies with their own classification systems and management roles.

5.7.1 Judicial and County Ditches

Judicial ditches and county ditches are public drainage systems. They are established under Chapter 103E of Minnesota Statutes and are under the jurisdiction of the county. Per Minnesota Statute 363B.61, cities or watershed management organizations (WMOs) within Hennepin County may petition the county to transfer authority over public ditches to the city or WMO.

Historically there were five county ditches and two judicial ditches in the District. The location of each ditch is shown on Figure 5-7. The original function of public ditches was to provide drainage for agricultural lands. The seven county and judicial ditches within the watershed were divided into three general systems. Judicial Ditch 2 and County Ditches 38 and 42 formed one system at the source of the main stem of Purgatory Creek within the city of Minnetonka. This ditch system begins immediately north of the Minneapolis and St. Louis Railroad right-of-way and extends to the headwall structure in Purgatory Creek located approximately 500 feet south of Hennepin County Road 3. A second system comprised of Judicial Ditch 3 and County Ditch 43 was located immediately south of Trunk Highway 5 in the city of Eden Prairie. Judicial Ditch 3 historically formed the main channel of Purgatory Creek between Trunk Highway 5 and Staring Lake. With the completion of the Purgatory Creek Park project in the early 2000's the portion upstream from the Purgatory Creek park outlet structure was abandoned. The third ditch system, comprised of County Ditch 36 and County Ditch 37, is located in the Neill Lake area in the city of Eden Prairie. A small portion of this system forms a part of the main channel of Purgatory Creek.

There are no county or judicial ditches in the Riley Creek or Bluff Creek Watersheds. Some of the systems shown as public ditches are no longer in existence, but the public ditch designation has not been removed.

5.7.2 Public Waters (Minnesota Department of Natural Resources)

Figure 5-7 shows the MDNR public waters within District. The MDNR designates certain 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 both “public waters” 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 waterbasins and watercourses that meet the criteria set forth in Minnesota Statutes section 103G.005, subdivision 15 that are identified on public water inventory maps and lists authorized by Minnesota Statutes section 103G.201. Public waters wetlands include all type 3, type 4, and type 5 wetlands, as defined in U.S. Fish and Wildlife Service Circular No. 39, 1971 edition, that are 10 acres or more in size in unincorporated areas or 2.5 acres or more in size in incorporated areas (see Minnesota Statutes section 103G.005, subdivisions 15a and 17b.)

RPBCWD MAJOR SUBWATERSHEDS

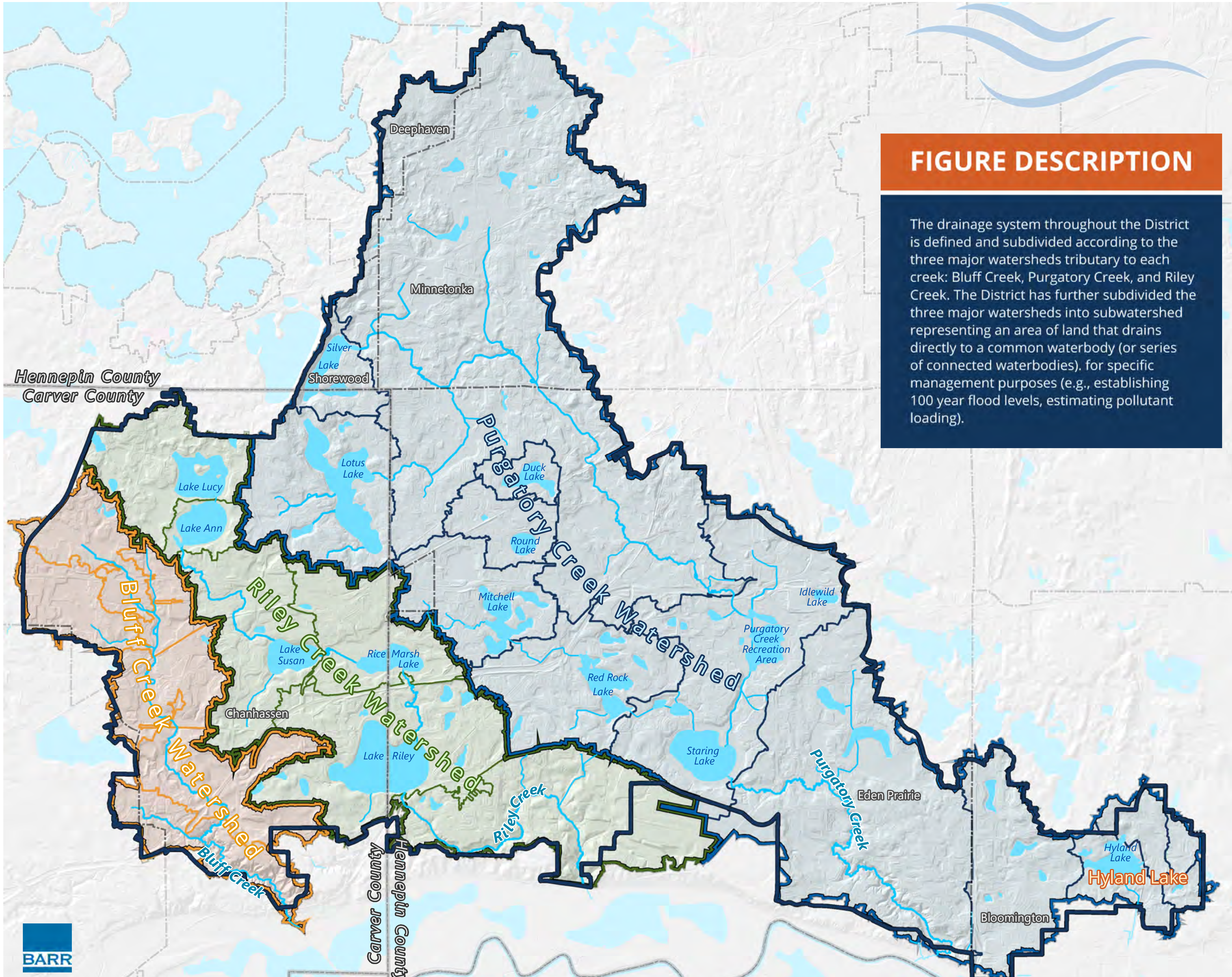
FIGURE 5-6

Major Watersheds

- Bluff Creek
- Riley Creek
- Purgatory Creek
- Streams/Creeks
- Lake/Pond
- District Legal Boundary
- Municipalities

FIGURE DESCRIPTION

The drainage system throughout the District is defined and subdivided according to the three major watersheds tributary to each creek: Bluff Creek, Purgatory Creek, and Riley Creek. The District has further subdivided the three major watersheds into subwatershed representing an area of land that drains directly to a common waterbody (or series of connected waterbodies). for specific management purposes (e.g., establishing 100 year flood levels, estimating pollutant loading).



RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

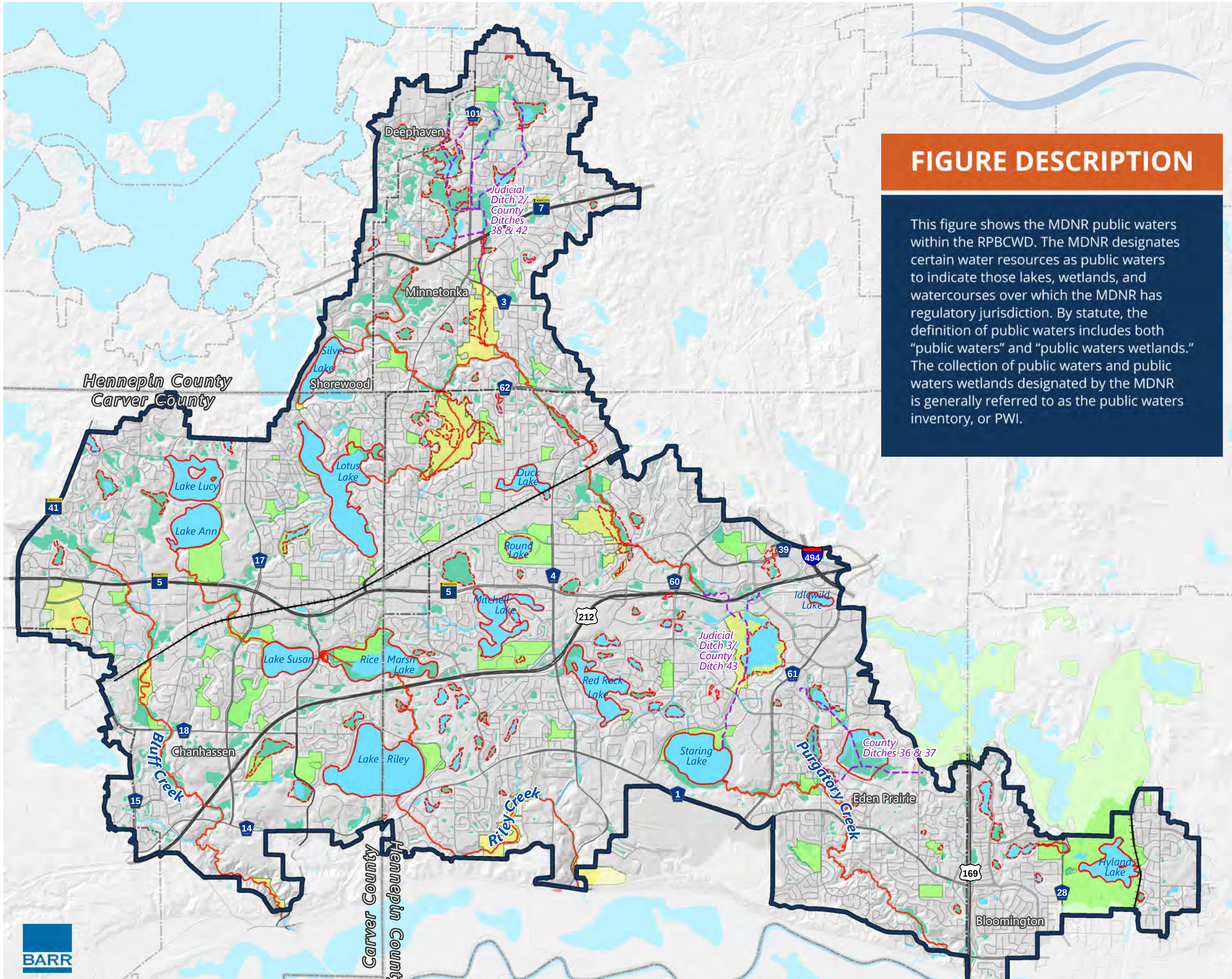


FIGURE DESCRIPTION

This figure shows the MDNR public waters within the RPBCWD. The MDNR designates certain 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 both "public waters" 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.

MDNR PUBLIC WATERS AND PUBLIC DITCHES

FIGURE 5-7

MDNR Public Waters Inventory
- Public Water Basin
- Public Water Wetland
- Intermittent or Perennial Stream
- Public Ditch
- Park/Playground
- Preserve/Recreation Area
- Streams/Creeks
- Lake/Pond
- Wetlands
- District Legal Boundary
- Municipalities

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RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

Barr Footer: ArcGIS 10.4.1, 2017-10-23 11:46 File: I:\Client\RPBC_WD\Work_Orders\2016_TO16_Plan_Update\Maps\...Plan_2017\Section_5\Fig 5-07 MDNR Public Waters and Public Ditches.mxd User: mbs2

The MDNR uses county-scale maps to show the general location of the public waters and public waters wetlands under its regulatory jurisdiction. These maps are commonly known as public waters inventory (PWI) maps. PWI maps also show public waters watercourses and ditches. The regulatory boundary of these waters and wetlands is called the ordinary high water level (OHWL). A MDNR permit is required for work within designated public waters. PWI maps are available on a county-by-county basis. Additionally, county-by-county lists of these waters are available in tabular form. The MDNR also maintains a web-based mapping tool for viewing PWI maps. The PWI maps and lists are available on the MDNR's website: http://www.MDNR.state.mn.us/waters/watermgmt_section/pwi/maps.html

5.8 Water Quality

The lakes, ponds, streams, and wetlands of the RPBCWD watershed are important community assets. These resources supply aesthetic and recreational benefits, in addition to providing wildlife and fisheries habitat and refuge. The District recognizes the need for good water quality in the waterbodies in its jurisdiction, including groundwater, and has taken steps to protect and improve these resources. These steps include adopting water quality management goals and strategies, collecting water quality data, participating in developing TMDLs, developing an implementation program to meet District water quality goals, establishing water quality performance standards, and reviewing proposed projects for conformance with District rules.

Stormwater runoff carries with it a number of contaminants affecting water quality. The principal pollutants found in runoff include nutrients, sediments, organic materials, pathogens, hydrocarbons, metals, pesticides, chlorides, trash and debris.

Table 5-3 summarizes the source of these pollutants and their impacts. Of these pollutants, the RPBCWD recognizes that phosphorus and suspended sediment are particularly detrimental to the ecological health and recreational use of lakes and streams. The District has established rules intended to minimize the impact of development and redevelopment activity on water quality.

Table 5-3 Pollutants Commonly Found in Stormwater Runoff

Stormwater Pollutant	Examples of Sources	Related Impacts
Nutrients: Nitrogen, Phosphorus	Decomposing grass clippings, leaves and other organics, animal waste, fertilizers, failing septic systems, atmospheric deposition	Algal growth, reduced clarity, other problems associated with eutrophication (oxygen deficit, release of nutrients and metals from sediments)
Sediments: Suspended and Deposited	Construction sites, other disturbed and/or non-vegetated lands, eroding streambanks and shorelines, road sanding	Increased turbidity, reduced clarity, lower dissolved oxygen, deposition of sediments, smothering of aquatic habitat including spawning sites, sediment and benthic toxicity
Organic Materials	Leaves, grass clippings	Oxygen deficit in receiving waterbody, fish kill, release of nutrients.
Pathogens: Bacteria, Viruses	Domestic and wild animal waste, failing septic systems	Human health risks via drinking water supplies, contaminated swimming beaches
Hydrocarbons: Oil and Grease, PAHs (Naphthalenes, Pyrenes)	Tar-based pavement sealant, industrial processes; automobile wear, emissions & fluid leaks; waste oil.	Toxicity of water column and sediment, bioaccumulation in aquatic species and through food chain
Metals: Lead, Copper, Cadmium, Zinc, Mercury, Chromium, Aluminum, others	Industrial processes, normal wear of auto brake linings and tires, automobile emissions & fluid leaks, metal roofs	Toxicity of water column and sediment, bioaccumulation in aquatic species and through the food chain, fish kill
Pesticides: PCBs, Synthetic Chemicals	Pesticides (herbicides, insecticides, fungicides, rodenticides, etc.), industrial processes	Toxicity of water column and sediment, bioaccumulation in aquatic species and through the food chain, fish kill
Chlorides	Road salting and uncovered salt storage	Toxicity of water column and sediment
Polycyclic Aromatic Hydrocarbons (PAH's)	Tar based pavement sealant	Carcinogenic to humans
Trash and Debris	Litter washed through storm drain networks	Degradation of the beauty of surface waters, threat to wildlife
Based on *Minnesota Urban Small Sites BMP Manual* (Barr Engineering Co., 2001).		

5.8.1 Water Quality Monitoring

A thorough understanding the water quality condition of its waterbodies is critical to developing and carrying out an implementation program that will achieve the District's water quality goals. To that end, the District performs regular water quality monitoring of the lakes and creeks within its jurisdiction.

5.8.1.1 Lake Water Quality Monitoring

Through partnerships with the cities of Chanhassen and Eden Prairie, Three Rivers Park District, the University of Minnesota (UMN), and the Metropolitan Council, the RPBCWD monitors several lakes within the District. Historically, this has included:

Purgatory Creek Watershed	Riley Creek Watershed	Bluff Creek Watershed
• Silver Lake • Lotus Lake • Duck Lake • Round Lake • Mitchell Lake • Red Rock Lake • Staring Lake • Hyland Lake	• Lake Lucy • Lake Ann • Lake Susan • Rice Marsh Lake • Lake Riley	There are no lakes in the Bluff Creek watershed.

District lake monitoring includes assessment of chemical water quality (e.g., total phosphorus, nitrogen chlorophyll a, transparency, pH, dissolved oxygen, conductivity), and water clarity (Secchi disc transparency). Regular lake sampling is conducted on each lake approximately every two weeks throughout the growing season (June-September). Beginning in 2013, the District began taking monthly samples from the Riley Chain of Lakes and stormwater ponds draining into Purgatory Creek during winter/early spring months (January-April) to monitor chloride levels. Lake water quality monitoring locations are shown in Figure 5-8.

In addition to chemical water quality, lake levels are continuously recorded from ice out to ice in. Lake water samples are also collected and analyzed in early summer for the presence of zebra mussel veligers. Additionally, during every sampling event, boat launch areas and zebra mussel monitoring plates are scanned for adult zebra mussels. Zooplankton samples are also collected on lakes to assess the overall health of the population as it applies to the fishery and water quality. Plant surveys are also conducted to assess overall health of the plant community and to search for invasive plants.

The District evaluates lake water quality data for statistically significant trends and compares the data against applicable Minnesota Pollution Control Agency (MPCA) eutrophication water quality standards (see Section 5.8.2). Lake monitoring methods and data collected by the District is published in annual reports available from the District website at: www.rpbcwd.org.

RPBCWD MONITORING LOCATIONS

FIGURE 5-8

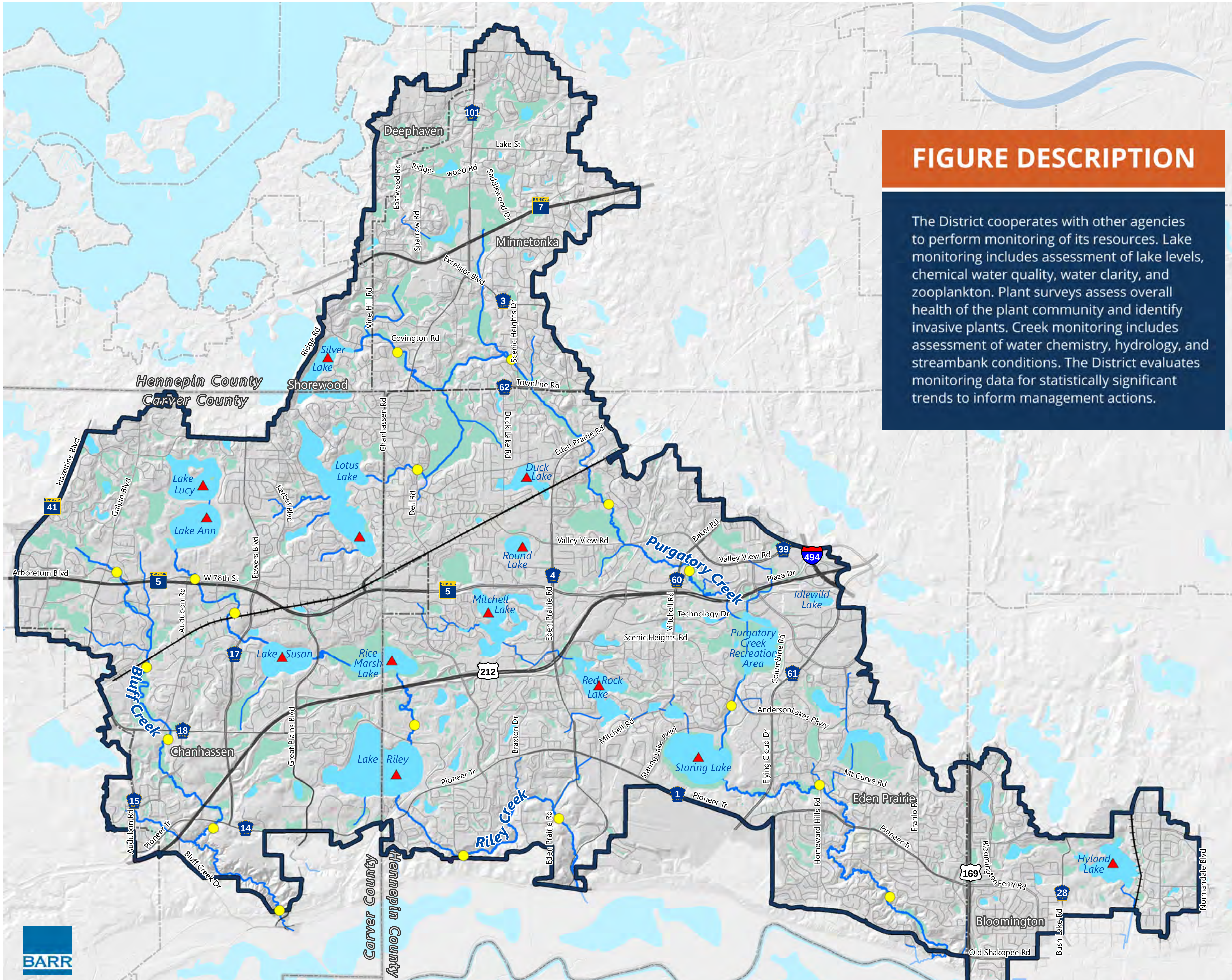

FIGURE DESCRIPTION

The District cooperates with other agencies to perform monitoring of its resources. Lake monitoring includes assessment of lake levels, chemical water quality, water clarity, and zooplankton. Plant surveys assess overall health of the plant community and identify invasive plants. Creek monitoring includes assessment of water chemistry, hydrology, and streambank conditions. The District evaluates monitoring data for statistically significant trends to inform management actions.

Monitoring Location*

- Creek
- Lake
- Streams/Creeks
- Lake/Pond
- Wetlands
- District Legal Boundary
- Municipalities

** Project specific monitoring is also conducted at project locations as needed.*

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RILEY PURGATORY BLUFF CREEK **WATERSHED DISTRICT**

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Barr Footer: ArcGIS 10.4.1, 2017-10-23 14:48 File: I:\Client\RPBC_WD\Work_Orders\2016_TO16_Plan_Update\Maps\Reports\Plan_2017\Section_5\Fig 5-08 RPBCWD Monitoring Locations.mxd User: mbs2

5.8.1.2 Creek Water Quality Monitoring

The District works with the Metropolitan Council to monitor the water quality and condition of Bluff Creek, Purgatory Creek, and Riley Creek. The District collects water quality samples as several locations on each creek approximately twice per month from April through September. Stream flow and velocity are also measured during each monitoring event. The Metropolitan Council also has continuous monitoring stations near the outlet of each creek as part of its long-term watershed outlet monitoring program (WOMP) which identifies pollutant loads.

In addition to water quality monitoring, creek walks are also conducted to gather more information about the current stream conditions in the District. This information is included in the District's Creek Restoration Action Strategy (CRAS), which was developed by the District to identify and prioritize future stream restoration sites. Bank pin data is also collected near each of the water quality monitoring sites to measure generalized sedimentation and erosion rates across all three streams.

The District evaluates stream water quality data for statistically significant trends and compares the data against applicable Minnesota Pollution Control Agency (MPCA) eutrophication water quality standards (see Section 5.8.2). Stream monitoring methods and data collected by the District is published in annual reports available from the District website at: www.rpbcwd.org.

5.8.2 Water Quality Standards and Impaired Waters

The federal Clean Water Act (CWA) requires states to adopt water quality standards to protect the nation's waters. In Minnesota, the MPCA developed eutrophication criteria for lakes and streams to establish water quality goals and determine appropriate uses of the lakes and streams, as outlined in the guidance document *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (MPCA, 2016).

Standards for lakes vary by MPCA ecoregion and whether the MPCA classifies a lake as "shallow" or "deep." The MPCA defines "shallow" lakes as having a maximum depth of 15 feet or less or having at least 80% of the lake area shallow enough to support aquatic plants. The MPCA's listing of waterbodies on the impaired waters 303(d) list depends upon their classification of a waterbody as a wetland, shallow lake, or deep lake. Generally, the MPCA does not list waterbodies classified as wetlands as impaired for biological indicators. Eutrophication-related water quality standards applicable to RPBCWD waterbodies are presented in Table 5-4.

The MPCA also established water quality standards for parameters in addition to those presented in Table 5-4; these standards are published in Minnesota Rules 7050 and are applicable to District lakes, ponds, and streams. Standards for several parameters included in Minnesota Rules 7050 vary according to the MPCA-determined designated use of the waterbody (e.g., drinking water, industrial use).

In compliance with Section 303(d) of the CWA, the MPCA identifies and establishes priority rankings for waters that do not meet the water quality standards. The list of impaired waters, sometimes called the 303(d) list, is updated by the MPCA every 2 years.

Several waterbodies within the District have been listed on the MPCA impaired waters (303(d)) list for a variety of impairments. Waterbodies on the impaired waters list are required to have an assessment completed that addresses the causes and sources of the impairment. This process is known as a total maximum daily load (TMDL) analysis.

Bluff Creek, Riley Creek, and six lakes within the RPBCWD are included on the MPCA's 2016 impaired waters 303(d) list. The MPCA's draft 2018 impaired waters 303(d) list will include new impairments a Purgatory Creek below Staring Lake and, Rice Marsh Lake and additional impairments for Lotus Lake, Lake Riley, and Riley Creek. The Minnesota River, located immediately downstream of the District, is also impaired. Locations of impaired waters are shown in Figure 5-9.

Table 5-5 summarizes the impaired waters within and immediately downstream of the RPBCWD. Waterbody specific water quality data, impairments and TMDLs are discussed in greater detail in the major watershed sections for Bluff Creek (Section 6.0), Purgatory Creek (Section 7.0), and Riley Creek (Section 8.0). Current impaired waters listings are available from the MPCA website: www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/impaired-waters-list.html

Table 5-4 MPCA Water Quality Standards

Water Quality Parameter	Water Quality Standard by MPCA Waterbody Type [1]		
	Shallow Lakes[2]	Deep Lakes[2]	Stream
Total Phosphorus (summer average, µg/L)	60	40	100
Chlorophyll *a* (summer average, µg/L)	20	14	18
Secchi Disc Transparency (summer average, m)	1.4	1.0	NA
Total Suspended Solids (mg/L)	NA	NA	30
Daily Dissolved Oxygen Flux (mg/L)	NA	NA	3.5
Biological Oxygen Demand (5 day) (mg/L)	NA	NA	2
Escherichia coli (# per 100 mL)	126 [3]	126 [3]	126 [3]
Chloride (mg/L)	230	230	230

[1] MPCA standards included in MN Rules 7050. Revisions to MN Rules 7050 will supersede this table. Note that MN Rule 7050.0220 includes standards for additional parameters that are enforced by the MPCA.

[2] Shallow lakes have a maximum depth less than 15 feet or littoral area greater than 80% of the total lake surface area.

[3] 126 organisms per 100 mL as a geometric mean of not less than five samples within any month, nor shall more than 10% of all samples within a month exceed 1,260 organisms per 100 mL.

Table 5-5 Impaired Waters Within and Immediately Downstream of the RPBCWD

Waterbody	Impaired Use	Pollutant or Stressor	Year Listed	TMDL Study Target Start	TMDL Study Target Completion	TMDL Study Approved
Bluff Creek[1]	Aquatic Life	Turbidity	2002	--	--	2013
	Aquatic Life	Fish Bioassessments	2004	--	--	2013
Purgatory Creek[4]	Aquatic Life[4]	Aquatic Macroinvertebrate Bioassessments	2018		2019	
	Aquatic Recreation[4]	Escherichia coli	2018		2019	
Riley Creek	Aquatic Life	Turbidity	2002	2014	2019	--
	Aquatic Life[4]	Aquatic Macroinvertebrate Bioassessments	2018		2019	
	Aquatic Life[4]	Fishes Bioassessments	2018		2019	
	Aquatic Recreation[4]	Escherichia coli	2018		2019	
Lotus Lake	Aquatic Recreation	Nutrients/Eutrophication[6]	2002	2014	2019	--
	Aquatic Consumption	Mercury in Fish Tissue	2002	--	--	2007[2]
	Aquatic Life[4]	Fishes Bioassessments	2018		2019	
Silver Lake	Aquatic Recreation	Nutrients/Eutrophication[6]	2016	2014	2019	--

Waterbody	Impaired Use	Pollutant or Stressor	Year Listed	TMDL Study Target Start	TMDL Study Target Completion	TMDL Study Approved
Round Lake	Aquatic Consumption	Mercury in Fish Tissue	2002	--	--	2008[2]
Mitchell Lake[3]	Aquatic Recreation	Nutrients/Eutrophication[6]	2002	2014	2019	Delisted[3]
Red Rock Lake[3]	Aquatic Recreation	Nutrients/Eutrophication[6]	2002	--	--	Delisted[3]
	Aquatic Consumption	Mercury in Fish Tissue	2002	--	--	2008[2]
Hyland Lake	Aquatic Recreation	Nutrients/Eutrophication[6]	2008	2014	2019	--
Lake Lucy	Aquatic Consumption	Mercury in Fish Tissue	2002	--	--	2007[2]
Lake Ann	Aquatic Consumption	Mercury in Fish Tissue	2002	--	--	2007[2]
Lake Susan	Aquatic Recreation	Nutrients/Eutrophication[6]	2010	2014	2019	--
	Aquatic Consumption	Mercury in Fish Tissue	1998	--	--	2008[2]
Rice Marsh Lake[4]	Aquatic Recreation[4]	Nutrients/Eutrophication[6]	2018[4]	--	2019[4]	--
Lake Riley	Aquatic Recreation	Nutrients/Eutrophication[6]	2002	2014	2019	--
	Aquatic Consumption	Mercury in Fish Tissue[5]	2002	2002	2020	--
	Aquatic Life[4]	Fishes Bioassessments	2018		2019	
Staring Lake	Aquatic Recreation	Nutrients/Eutrophication[6]	2002	2014	2019	--
	Aquatic Consumption	Mercury in Fish Tissue[5]	1998	1998	2025	--
Minnesota River	Aquatic Life	Nutrients/Eutrophication	2016	2014	2019	--
	Aquatic Life	Turbidity	1996	2014	2019	--
	Aquatic Consumption	PCB in Fish Tissue	1998	1998	2025	--
	Aquatic Consumption	Mercury in Water Column	1998	--	--	2008[2]
	Aquatic Consumption	Mercury in Fish Tissue	1998	--	--	2008[2]

[1] Bluff Creek is a “high risk stream” for chloride impairment per the MPCA’s 2014 Metro Chloride Assessment, but is not listed as impaired for chloride.

[2] Covered under the statewide mercury TMDL, approved in 2007.

[3] Red Rock Lake was delisted for aquatic recreation due to nutrients/eutrophication in 2016. Mitchell Lake was delisted for aquatic recreation due to nutrients/eutrophication in 2018.

[4] Included on the MPCA’s Draft 2018 impaired waters list.

[5] Mercury impairments for Lake Riley and Staring Lake are not covered by the statewide mercury TMDL due to mercury in fish tissue exceeding a threshold value of 0.57 mg/kg.

[6] Lake specific water quality data, impairments, and TMDLs are presented in greater detail in the major watershed sections for Purgatory Creek (Section 7.0) and Riley Creek (Section 8.0). Information used to determine the impairments is available from the MPCA.

IMPAIRED WATERS

FIGURE 5-9

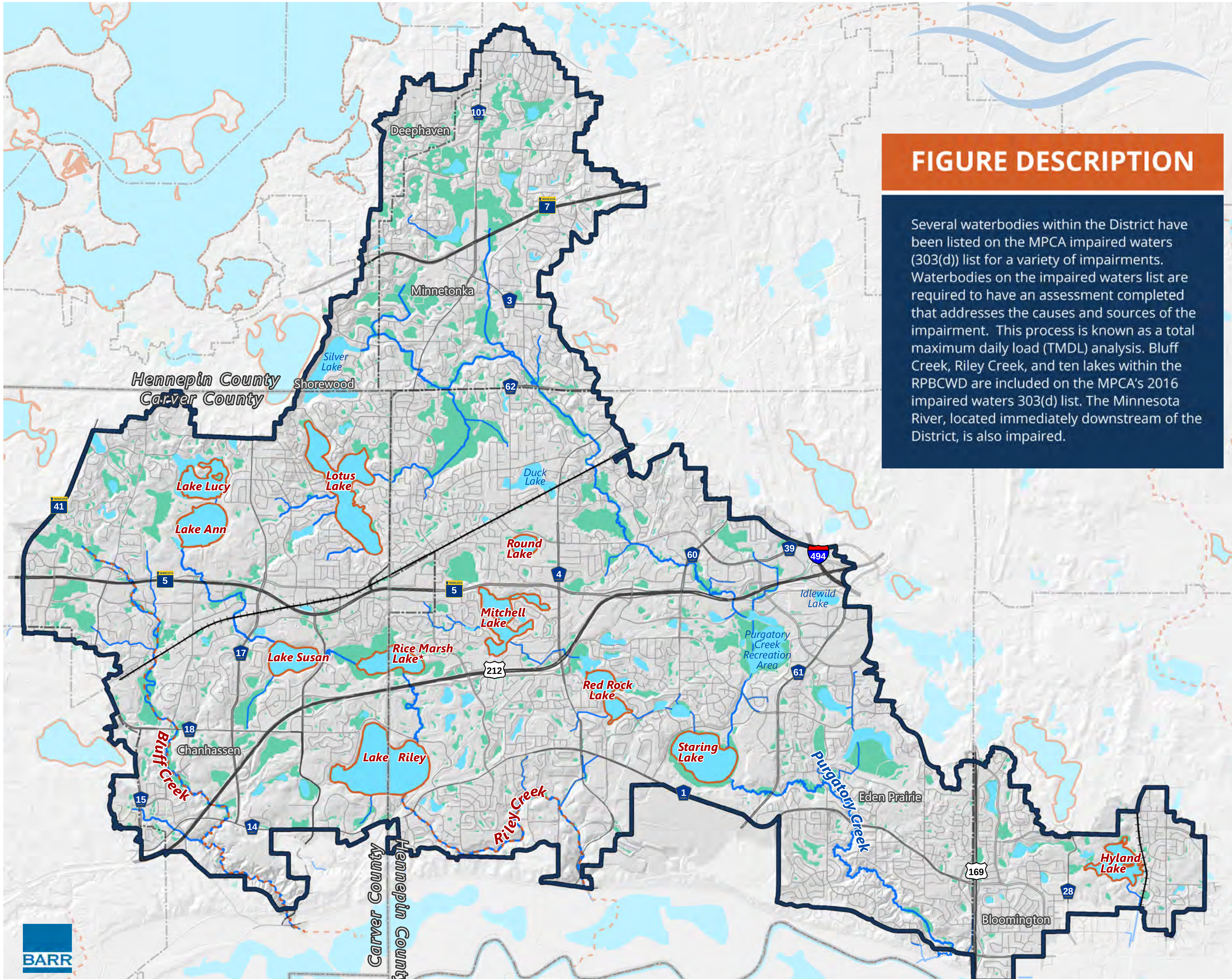

FIGURE DESCRIPTION

Several waterbodies within the District have been listed on the MPCA impaired waters (303(d)) list for a variety of impairments. Waterbodies on the impaired waters list are required to have an assessment completed that addresses the causes and sources of the impairment. This process is known as a total maximum daily load (TMDL) analysis. Bluff Creek, Riley Creek, and ten lakes within the RPBCWD are included on the MPCA's 2016 impaired waters 303(d) list. The Minnesota River, located immediately downstream of the District, is also impaired.

MPCA 2016 Draft Impaired Waters*

- Impaired Lakes
- Impaired Streams
- Streams/Creeks
- Lake/Pond
- Wetlands
- District Legal Boundary
- Municipalities

Rice Marsh Lake is anticipated to be included on MPCA's 2018 Impaired Waters list.

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RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

Barr Footer: ArcGIS 10.4.1, 2017-10-23 12:08 File: I:\Client\RPBC_WD\Work_Orders\2016_TO16_Plan_Update\Maps\Reports\Plan_2017\Section_5\Fig 5-09 MPCA Impaired Waters.mxd User: mbs2

5.9 Water Quantity and Floodplains

Since its creation in 1969, the District has addressed water quantity and flood risk issues through capital projects, studies, education, and rules, as well as through cooperative actions with its cities. The District's permitting program address issues such as minimum building elevations and stormwater runoff rate control to prevent or minimize the impact of flooding issues in the future.

The District has cooperated with developers and local municipalities to construct projects to address flooding issues. Many of these projects incorporate secondary benefits for water quality, habitat improvement, or other uses. The District also cooperates with developers and cities to incorporate flood risk reduction elements into projects intended to achieve other primary goals.

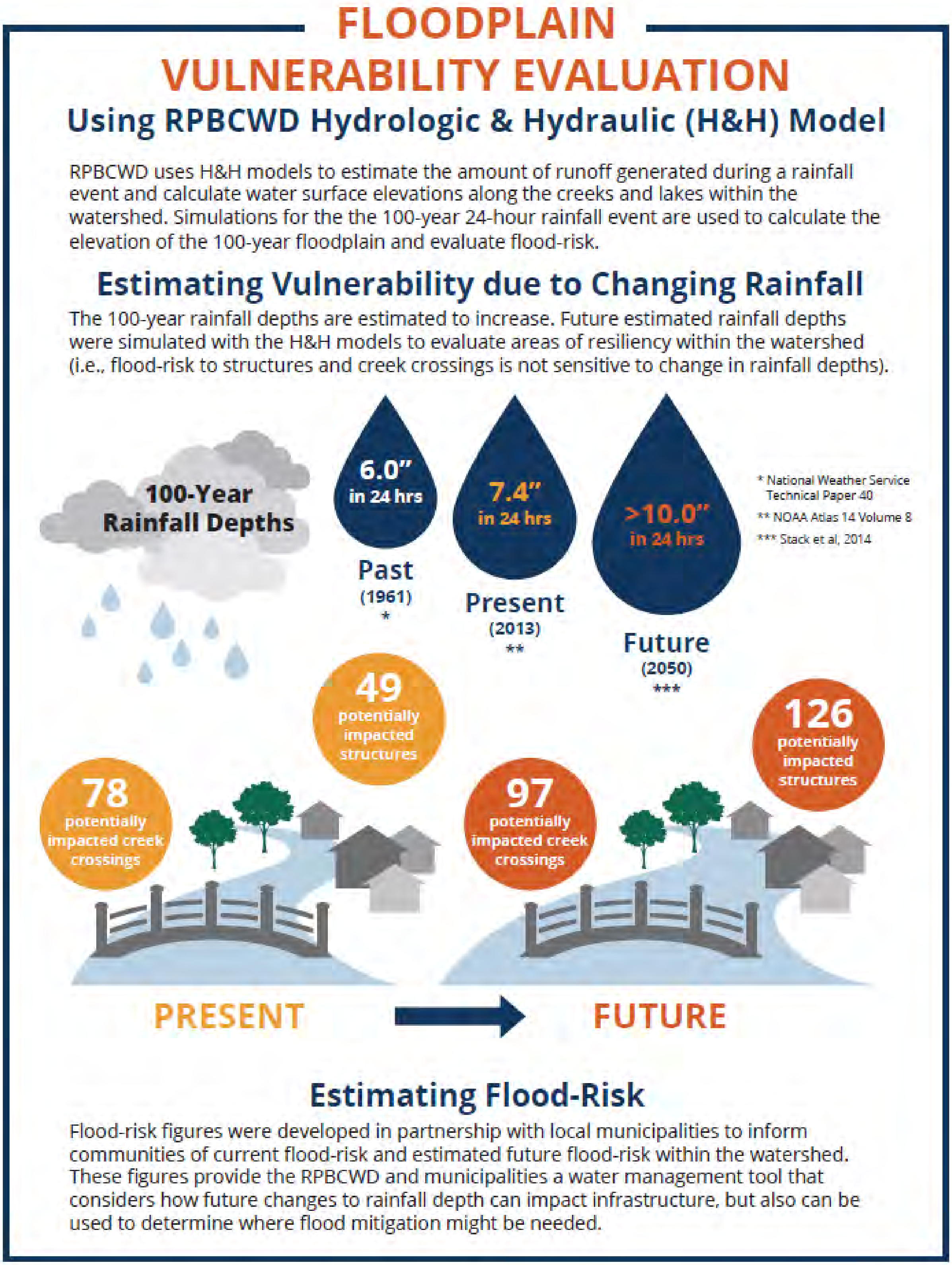
5.9.1 District Floodplains and Flood Risk Mapping

The District establishes 100-year flood levels for all District-managed waterbodies based on hydrologic and hydraulic modeling using Atlas 14 precipitation data (see Section 5.9.2). Model results are used to estimate areas inundated during storm events of varying frequencies (e.g., 100-year floodplain), as well as the cumulative risk of flooding within a 30-year period. The most recent District analysis is published in the *Engineer's Report 100-Year Floodplain Vulnerability Evaluation* (Climate Adaptation) (Barr Engineering Co., 2016) and summarized in Figure 5-10; current inundation mapping is available from the District website at: www.rpbcwd.org.

The District's rules and permitting program (see Section 9.4) references the District floodplain. The District rules define minimum building elevations relative to the District-established 100-year flood levels and require a District permit for activities located within the 100-year floodplain.

Note that the District 100-year water surface elevations published in this Plan, the District website, or subsequent studies may differ from base flood elevations determined by the Federal Emergency Management Agency (FEMA) for individual waterbodies (in part due to the flood insurance study (FIS) within the District having been adopted prior to the publication of Atlas 14).

Figure 5-10 Floodplain Vulnerability Evaluation



5.9.1.1 FEMA-established Floodplains

The Federal Emergency Management Agency (FEMA) performs flood insurance studies (FIS) and develops floodplain maps to determine areas prone to flooding during the 100-year storm events. The water level corresponding to the 100-year storm event is referred to as the Base Flood Elevation (or BFE) and is the basis for the FEMA-mapped floodplain extent. Each of the cities within the RPBCWD has a FIS. The FIS, together with a city's floodplain ordinance, allow the city to take part in the national flood insurance program (NFIP). Homeowners within FEMA-designated floodplains are required to purchase flood insurance. In some cases, homes within FEMA-designated floodplains on the FEMA floodplain maps may actually not be in the floodplain. To waive the mandatory flood insurance requirements for their homes, residents must remove their homes from the FEMA-designated floodplain by obtaining a Letter of Map Amendment (LOMA). Note that these programs are implemented independently of the District and are described herein for informational purposes.

Additional flooding information is also available from the Flood Insurance Studies (FIS) for the cities within the RPBCWD. FEMA-established floodplains are available from FEMA at: msc.fema.gov/portal.

5.9.2 Water Quantity Modeling

Water quantity modeling is necessary to establish flood levels and determine floodplain extents, design hydraulic structures adequate to meet their intended functions, evaluate hydraulic impacts of projects proposed by the District and other entities, and assess vulnerability to future climate scenarios.

The District maintains a hydrologic and hydraulic model. The hydrologic portion of the model is used to transform rainfall into watershed runoff while the hydraulic components of the model route the watershed runoff downstream through a conveyance system. The District most recently updated the model from 2015-2016. Updates to the model included:

- Incorporating rainfall depths published in Atlas 14 (see Section 5.1.1).
- Evaluating conditions under potential future rainfall amounts
- Updating spatial inputs with most recent data (e.g., topography, soil data)
- Incorporating municipal storm sewer data and projects permitted by the District

The updated model allows the district to identify areas at risk of flooding, including areas not previously identified. The updated model may also be used to assess areas at greatest risk for flooding under future conditions. The model results allow the district to more effectively prioritize infrastructure improvement projects to address these flood-prone areas.

The District completed its most recent modeling effort with considerable cooperation from the District's Technical Advisory Committee (TAC). Continued cooperation and input from city staff is needed to maximize the accuracy of District models and produce results that are beneficial to both District and municipal flood risk reduction efforts.

District hydrologic and hydraulic modeling documentation, including maps of inundation areas, is available from the District website at: www.rpbcwd.org.

5.10 Wetland Resources

Wetlands in the RPBCWD are important community and ecological assets. These resources provide significant wildlife habitat and refuge, while also supplying aesthetic, recreational, and water quality treatment benefits. The RPBCWD includes many wetlands; some wetland areas within the watershed were drained or filled as cities developed (prior to the establishment of regulations protecting wetlands). Presently, wetlands are protected by the Wetland Conservation Act (WCA). While the District currently does not administer the Wetland Conservation Act (WCA), the District would consider assuming WCA authority from any of the cities presently administering the law if asked to do so.

Wetland in the Purgatory creek watershed

The extent of wetlands inventoried within the watershed varies by city. Nationally, the U.S. Fish and Wildlife Service (USFWS) is responsible for mapping wetlands across the country, including those in Minnesota. Using the National Aerial Photography Program (NAPP) in conjunction with limited field verification, the USFWS identifies and delineates wetlands, produces detailed maps on the characteristics and extent of wetlands, and maintains a national wetlands database as part of the National Wetland Inventory (NWI). The NWI is periodically updated based on available imagery.

Figure 5-11 shows the location of all NWI wetlands within the RPBCWD, including a cranberry bog. There may be additional wetlands (especially those smaller than 0.5 acre) in the watershed that are not included in the NWI. In order to better manage the resources within its jurisdiction, the District plans to complete a District wetland inventory (see Section 9.11).

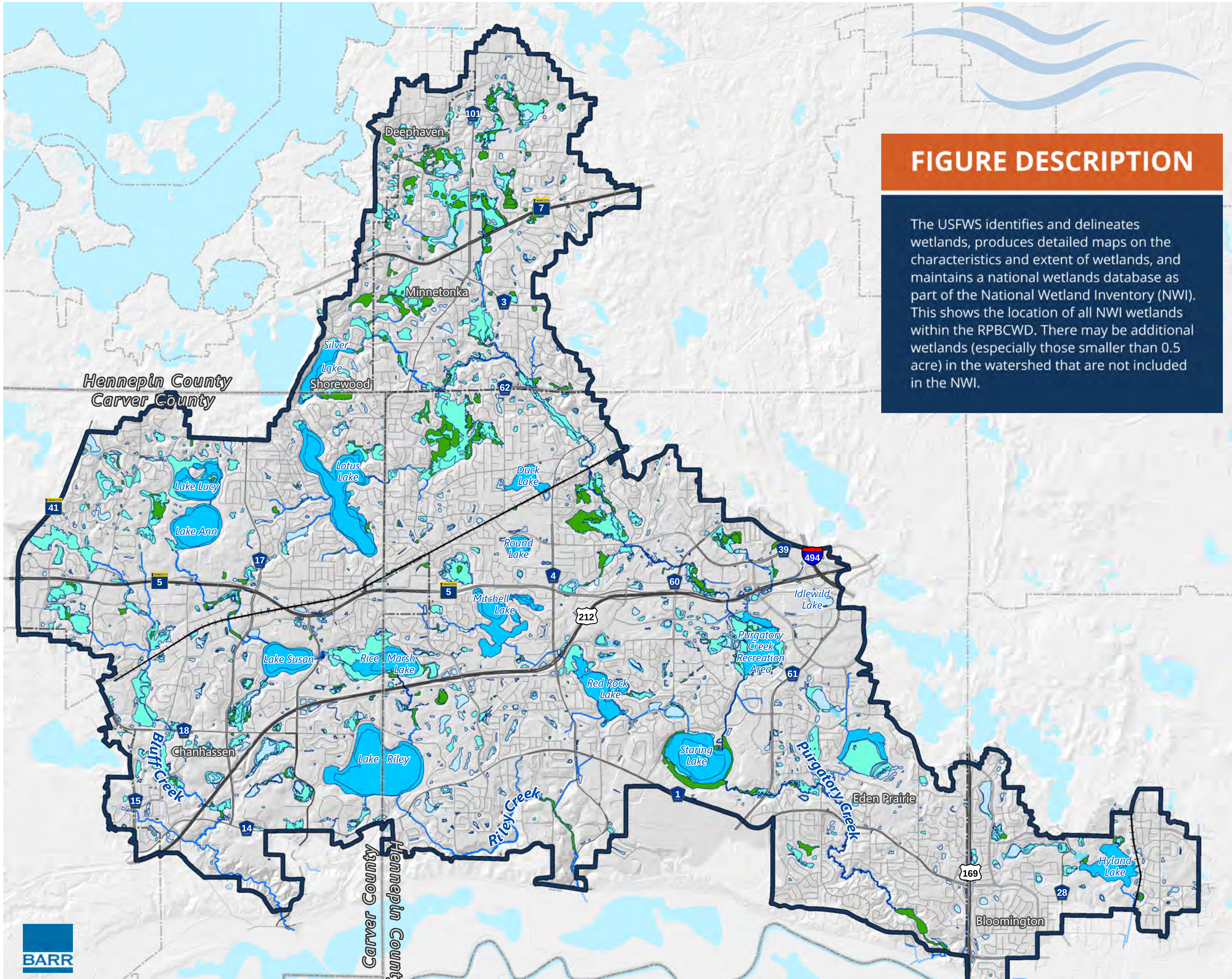
5.11 Stormwater Systems

Various units of government and private entities have jurisdiction over different parts of the stormwater system network within the RPBCWD. These stormwater systems includes pipes, ponds, lakes, wetlands, ditches, streams, swales, and other drainageways.

The Minnesota Department of Transportation (MnDOT) is responsible for maintaining the stormwater systems within their rights-of-way, such as interstate highways (i.e., I-494), U.S. highways (i.e., Highway 169 and Highway 212), and state highways (i.e., Highway 5 and Highway 7). Carver and Hennepin counties are responsible for maintaining at least part of the stormwater systems within their rights-of-way, such as county roads and county state aid highways.

The cities within the District have jurisdiction over the lateral (also called primary) stormwater systems (i.e., street gutters, pipes, and ditches) and are responsible for system maintenance and improvements. All of the cities within the District are owners and operator of stormwater systems that require each city to obtain a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. Each city's MS4 permit and associated Storm Water Pollution Prevention Program (SWPPP) detail the city's stormwater system maintenance procedures and best management practices.

Owners of private stormwater systems are responsible for maintaining their facilities, unless that responsibility is transferred by agreement. The RPBCWD does not own and operate stormwater facilities requiring an MS4 permit.



Barr Footer: ArcGIS 10.4.1, 2017-10-23 12:46 File: I:\Client\RPBC_WD\Work_Orders\2016_TO16_Plan_Update\Maps\...Plan_2017\Section_5\Fig 5-11 National Wetlands Inventory.mxd User: mbs2

NATIONAL WETLANDS INVENTORY

FIGURE 5-11

FIGURE DESCRIPTION

The USFWS identifies and delineates wetlands, produces detailed maps on the characteristics and extent of wetlands, and maintains a national wetlands database as part of the National Wetland Inventory (NWI). This shows the location of all NWI wetlands within the RPBCWD. There may be additional wetlands (especially those smaller than 0.5 acre) in the watershed that are not included in the NWI.

National Wetlands Inventory

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Streams/Creeks
- Lake/Pond
- District Legal Boundary
- Municipalities

N

0 1 2
Miles

RILEY PURGATORY BLUFF CREEK
WATERSHED DISTRICT

5.12 Pollutant Sources

There are many potential sources of water pollution in the RPBCWD. There are many permitted sites, hazardous waste generators, and contaminated sites within the District. The MPCA maintains a database of these sites, which includes permitted sites (air, industrial stormwater, construction stormwater, wastewater discharge), hazardous waste generating sites, leak sites, petroleum brownfields, tank sites, unpermitted dump sites, and sites enrolled in the Voluntary Investigation and Cleanup (VIC) program. This information is available online through the MPCA's What's In My Neighborhood program and is shown in Figure 5-12. The presence of potentially contaminated or hazardous waste sites should be considered as sites are redeveloped and BMPs are implemented. The presence of soil contamination at many of these sites, if not removed, may limit or prevent infiltration as a stormwater management option.

In contrast to sites with known hazards, non-point source pollution cannot be traced to a single source or pipe. Instead, pollutants are carried from land to water in stormwater or snowmelt runoff, in seepage through the soil, and in atmospheric transport. Discharge from stormwater pipes is considered a non-point source discharge as the pollutants coming from the pipe are generated across the watershed contributing to the pipe, not at a single location. Point sources frequently discharge continuously throughout the year, while non-point sources discharge in response to precipitation or snowmelt events. For most waterbodies, non-point source runoff, especially stormwater runoff, is the major contributor of pollutants.

Table 5-3 summarizes the principal pollutants found in stormwater runoff and provides example sources and possible impacts of each pollutant.

Some areas within the RPBCWD are served by subsurface sewage treatment systems (SSTS). Non-functioning SSTS may be a non-point source of pollutants. Improperly sited, installed, or maintained systems may achieve inadequate treatment of sewage. In addition to the public health risks of untreated or inadequately treated sewage (e.g., contamination of wells), sewage contains the nutrient phosphorus, which if discharged into waterbodies can cause excessive algae and aquatic plant growth leading to degradation in water quality. The MPCA implements an SSTS regulatory program to manage the environmental and public health impacts of SSTS.

POLLUTANT SOURCES (MPCA WHAT'S IN MY NEIGHBORHOOD)

FIGURE 5-12

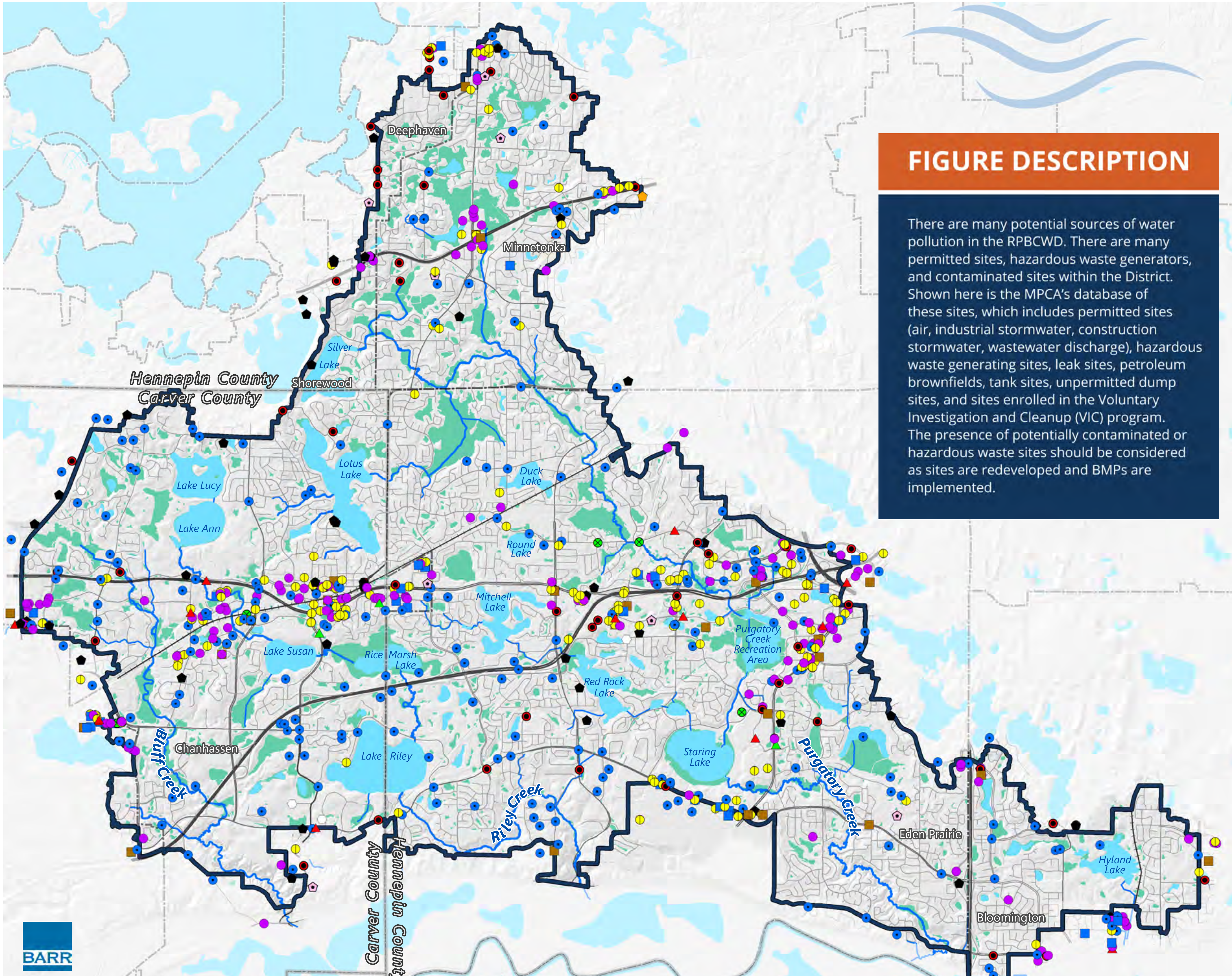


FIGURE DESCRIPTION

There are many potential sources of water pollution in the RPBCWD. There are many permitted sites, hazardous waste generators, and contaminated sites within the District. Shown here is the MPCA's database of these sites, which includes permitted sites (air, industrial stormwater, construction stormwater, wastewater discharge), hazardous waste generating sites, leak sites, petroleum brownfields, tank sites, unpermitted dump sites, and sites enrolled in the Voluntary Investigation and Cleanup (VIC) program. The presence of potentially contaminated or hazardous waste sites should be considered as sites are redeveloped and BMPs are implemented.

Pollutant Sources (MPCA, 2017)

- Air Quality
- Site Assessment
- Brownfield/Superfund Site
- Feedlots
- Hazardous Waste
- Solid Waste
- Petroleum Leak
- Underground Tanks
- Aboveground Tanks
- Construction Stormwater
- Industrial Stormwater
- Wastewater
- Multiple Activities (some combination of above)

Streams/Creeks

District Legal Boundary

Municipalities

N

0 1 2

Miles

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

As part of their MS4 responsibilities, cities maintain illicit discharge detection and elimination (IDDE) programs to minimize discharge of prohibited materials to stormwater systems, reducing the risk of water pollution.

More information about potential pollutant sources is available from the MPCA website: http://www.pca.state.mn.us/index.php/data/wimn-whats-in-my-neighborhood/whats-in-my-neighborhood.html

5.13 Natural Areas and Unique Features

The MDNR, through the Minnesota Biological Survey (MBS) and Natural Heritage and Non-game Research Program (NHNRP), collects and maintains data on unique animals, plant communities, and functional landscapes. This includes information about state-designated natural and scientific areas containing rare and endangered species as well as other features, such as waterfalls, springs, historic mills, and heritage elements. More information about these programs is available from the MDNR Ecological Resources website at: www.dnr.state.mn.us/eco/index.html.

The MBS *Natural Communities and Rare Species of Carver, Hennepin, and Scott Counties, Minnesota* (MBS, 1998) identifies pre-settlement vegetation. Prior to settlement, the RPBCWD was covered predominantly by oak forest interrupted by wet prairie and marsh. Small areas of upland deciduous forest covered the far western part of the watershed, while river bottom forest occupied the south boundary of the watershed along the Minnesota River. Areas of maple-basswood forest and oak forest remain adjacent to the lower reaches of Bluff Creek and Riley Creek. The MBS identifies scientific natural areas and classifies areas as having "outstanding," "high," "moderate," or "low" biodiversity significance based on the combination of landscapes, plant communities, and species present. Areas of biodiversity significance within the District are shown on Figure 5-13.

Just outside of the District boundary in Chanhassen is a calcareous seepage fen known as Seminary Fen. Located near the southwest border of the District (south of Bluff Creek Drive), Seminary Fen is a rare wetland type created by groundwater that comes to the surface along the limestone bluffs of the Minnesota River. Many rare plants and valuable wildlife habitat are found in and around fens. This type of fen is protected under the Wetlands Conservation Act (WCA). Seminary Fen is identified as an outstanding resource value water (pursuant to Minnesota Rules 7050.0335) and thus subject to additional water quality protections. Even though this fen is not located within the District, any project that has the potential to impact this sensitive and natural resource must address impacts through the preparation of a Fen Management Plan.

Under the Minnesota WCA, impacts to calcareous seepage fens are regulated by the Department of Natural Resources. According to the WCA, calcareous fens may not be filled, drained, or otherwise degraded, wholly or partially, by any activity, unless the commissioner of natural resources, under an approved management plan, decides some alteration is necessary (Minn. Statutes 103G.223).

The MDNR purchased over 100 acres of the 600-acre Seminary Fen wetlands complex in 2008 and is developing a stewardship plan for long-term management and preservation of the fen. The Lower Minnesota River Watershed District also implements strategies, including a volunteer program, to help preserve the Seminary Fen. Potential detrimental impacts may include such actions as upslope development that alters the qualities of surface water entering the fen and groundwater appropriations that would affect the hydrology of the fen including its recharge area. The District will cooperate with the Lower Minnesota River Watershed District in the development of a special protection plan for this fen, should that District determine one to be necessary.

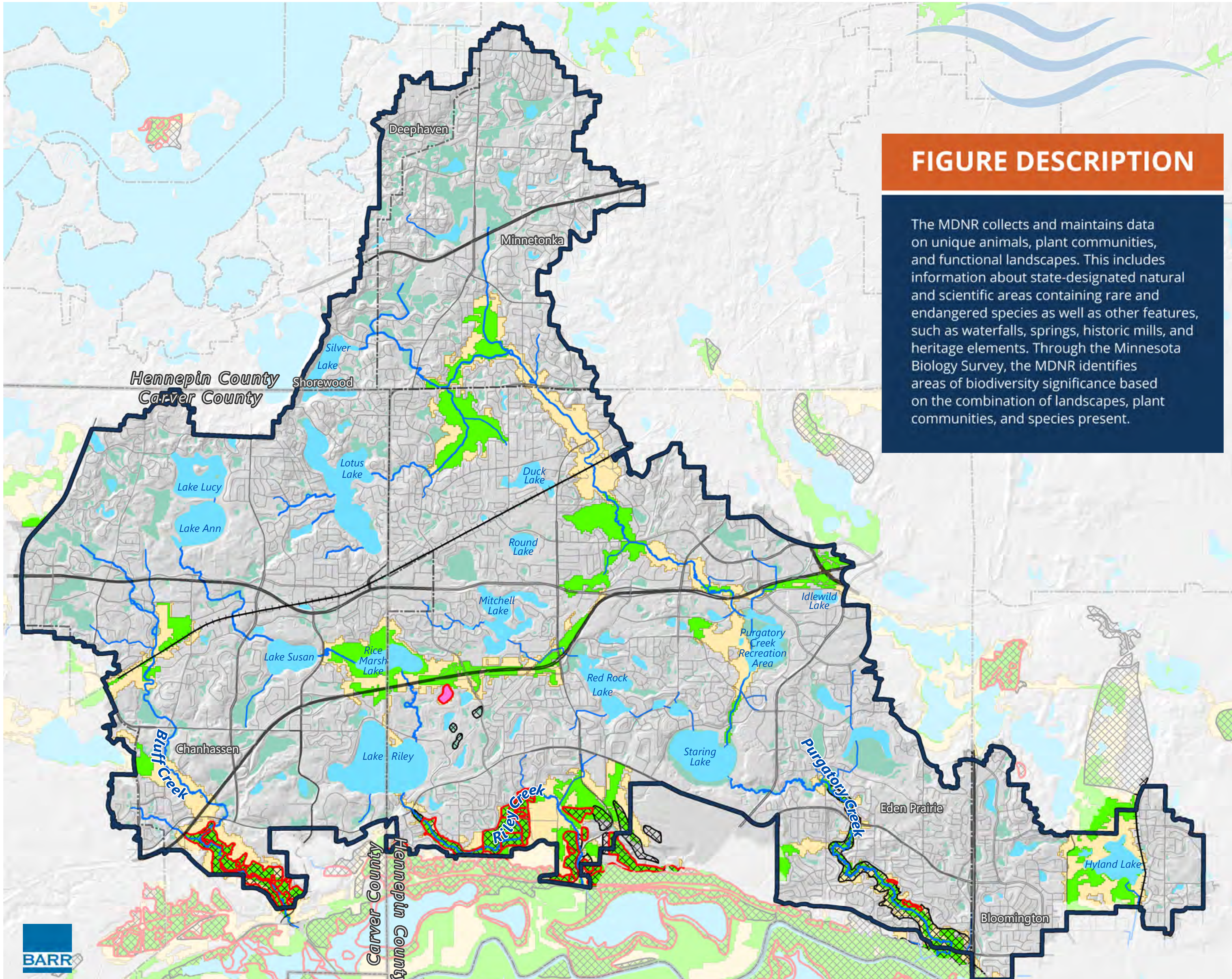
There is a unique cranberry bog within the District. The District, in conjunction with the MDNR and the United States Army Corps of Engineers, developed a monitoring program to assess, avoid and mitigate impacts upon this bog.

MDNR AREAS OF BIOLOGICAL SIGNIFICANCE AND CONSERVATION CORRIDORS

FIGURE 5-13

FIGURE DESCRIPTION

The MDNR collects and maintains data on unique animals, plant communities, and functional landscapes. This includes information about state-designated natural and scientific areas containing rare and endangered species as well as other features, such as waterfalls, springs, historic mills, and heritage elements. Through the Minnesota Biology Survey, the MDNR identifies areas of biodiversity significance based on the combination of landscapes, plant communities, and species present.



Cranberry Bog

Native Plant Community (DNR)

Site of Biodiversity Significance (DNR)

Regionally Significant Ecological Area (DNR, 2008)

Regional Ecological Corridor (DNR, 2008)

Streams/Creeks

Lake/Pond

District Legal Boundary

Municipalities

RILEY PURGATORY BLUFF CREEK **WATERSHED DISTRICT**

5.14 Water Based Recreational Areas

There are many parks, trails, and water recreation areas within the RPBCWD accessible to the public. Many of the lakes within the watershed include adjacent parks swimming beaches, fishing piers, and/or public boat access. Such features are important for establishing and maintaining high quality of life within the District and provide economic, public health, and environmental benefits. Public access to outdoor recreation areas may also foster connections between residents and natural resources and promote good stewardship of these resources.

Parks, trails, and water based recreation areas located within the District are shown in Figure 5-14. Most of these features are maintained by the respective cities in which they are located. Water based recreational features are summarized by waterbody in Table 5-6.

Table 5-6 Water Based Recreational Areas in the RPBCWD

Watershed	Waterbody	Public Access	Swimming Beach	Boat Access	Fishing Pier
Purgatory Creek	Silver Lake	NA	No	No	No
	Lotus Lake	Carver Beach; South Lotus Lake Park	Yes (2)	Yes	No
	Duck Lake	From Duck Lake Trail	No	Yes	No
	Round Lake	Round Lake Park	Yes	Yes	Yes
	Mitchell Lake	Miller Park	No	Yes	Yes
	Red Rock Lake	Red Rock Lake Park	No	Yes	No
	Staring Lake	Staring Lake Park	No	Yes	Yes
	Hyland Lake	Hyland Lake Part Preserve	Yes	Yes	Yes
Riley Creek	Lake Lucy	NA	No	Carry-in	No
	Lake Ann	Lake Ann Park	Yes (2)	Yes	Yes
	Rice Marsh Lake	NA	No	Carry-in	No
	Lake Susan	Lake Susan Park	Yes	Yes	Yes
	Lake Riley	Lake Riley Park	Yes	Yes	Yes

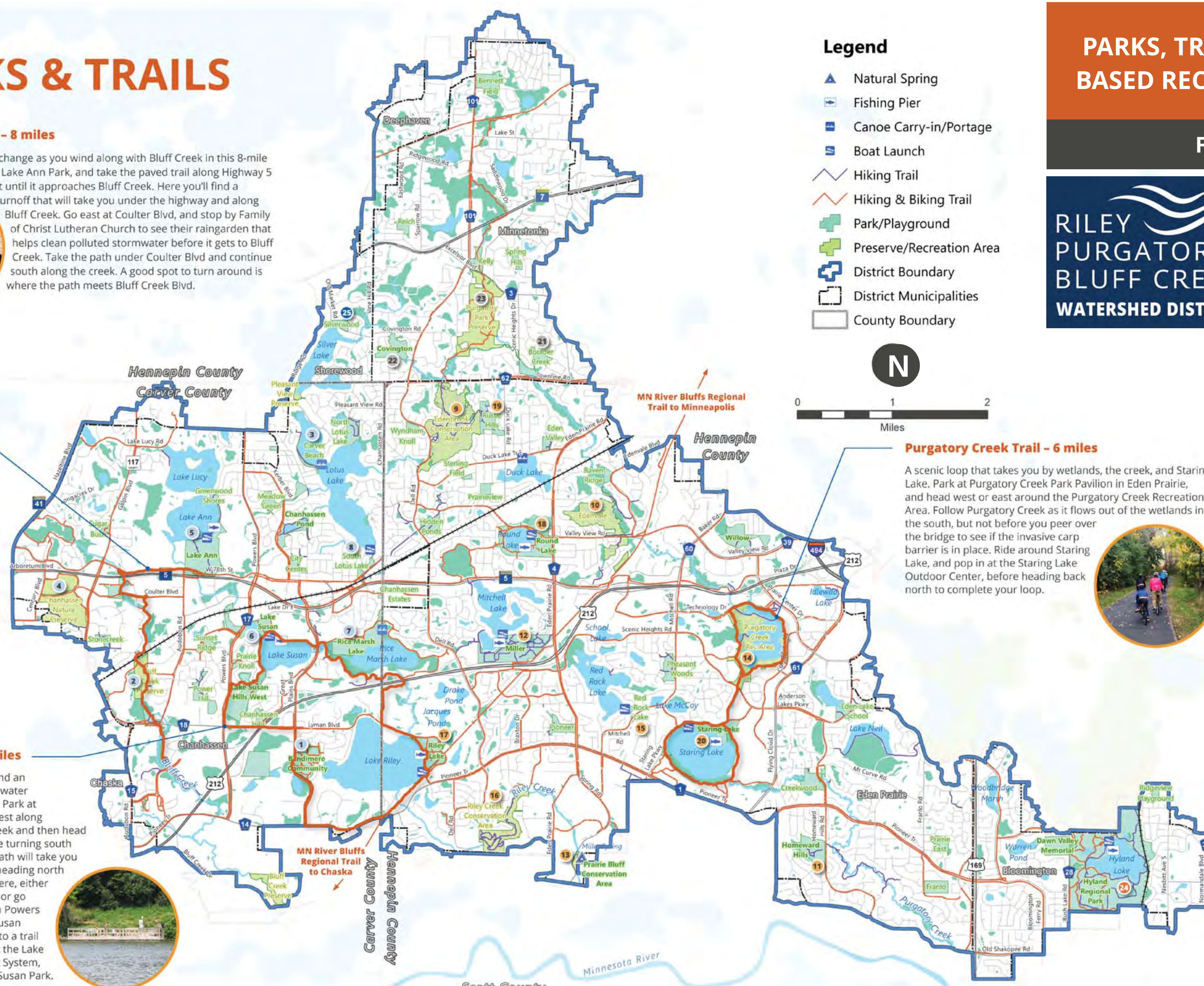
PARKS, TRAILS, AND WATER-BASED RECREATIONAL AREAS

FIGURE 5-14

PARKS & TRAILS

Bluff Creek Trail – 8 miles

Watch the landscape change as you wind along with Bluff Creek in this 8-mile out-and-back. Park at Lake Ann Park, and take the paved trail along Highway 5 west until it approaches Bluff Creek. Here you'll find a turnoff that will take you under the highway and along Bluff Creek. Go east at Coulter Blvd, and stop by Family of Christ Lutheran Church to see their raingarden that helps clean polluted stormwater before it gets to Bluff Creek. Take the path under Coulter Blvd and continue south along the creek. A good spot to turn around is where the path meets Bluff Creek Blvd.



RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Purgatory Creek Trail – 6 miles

A scenic loop that takes you by wetlands, the creek, and Staring Lake. Park at Purgatory Creek Park Pavilion in Eden Prairie, and head west or east around the Purgatory Creek Recreation Area. Follow Purgatory Creek as it flows out of the wetlands in the south, but not before you peer over the bridge to see if the invasive carp barrier is in place. Ride around Staring Lake, and pop in at the Staring Lake Outdoor Center, before heading back north to complete your loop.

Key	Park Name
CHANHASSEN	
1	Bandimere Community Park
2	Bluff Creek Preserve
3	Carver Beach Park
4	Chanhassen Nature Preserve
5	Lake Ann Park
6	Lake Susan Park
7	Rice Marsh Lake Park
8	South Lotus Lake Park
EDEN PRAIRIE	
9	Edenbrook Conservation Area
10	Edenvale Conservation Area and Park
11	Homeward Hills Park
12	Miller Park
13	Prairie Bluff Conservation Area
14	Purgatory Creek Recreation Area
15	Red Rock Lake Park
16	Riley Creek Conservation Area
17	Riley Lake Park
18	Round Lake Park
19	Rustic Hills Park
20	Staring Lake Park
MINNETONKA	
21	Boulder Creek Park
22	Covington Park
23	Purgatory Park Preserve
BLOOMINGTON	
24	Hyland Lake Park Preserve
SHOREWOOD	
25	Silverwood Park

BARR

Riley Creek Trail – 8 miles

See three lakes, one creek, and an innovative project to protect water quality, all in one 8-mile ride. Park at Lake Susan Park and head west along the trail. You'll cross Riley Creek and then head along Rice Marsh Lake before turning south toward Lake Riley. A gravel path will take you down to Pioneer Trail. Start heading north at Great Plains Blvd. From there, either head back up to Lake Susan, or go west at Lyman Blvd, north on Powers Blvd, and then left on Lake Susan Hills Drive. You'll find access to a trail here which will take you past the Lake Susan Spent Lime Treatment System, and eventually back to Lake Susan Park.

Barr Footer: ArcGIS 10.4.1, 2017-09-11 11:27 File: I:\Client\RPBC_WD\Work_Orders\2016_TO16_Plan_Update\Maps\Reports\Plan_2017\Section_5\Fig 5-14 Parks Trails and Water Based Recreational Areas v2.mxd User: mbs2