LAND AND WATER RESOURCES INVENTORY

Lower St. Croix River Watershed

Boats on the St. Croix River. Photo courtesy of Dianne Towalski.

DRAFT: February 2019

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Lower St. Croix Watershed Interactive Map:

https://maps.barr.com/LSCWD/1W1P/index.html

TABLES

ACRONYMS

1W1P – One Watershed One Plan

AIS – Aquatic invasive species

AUIDs – Assessment Unit Identifications

DO – Dissolved oxygen

ECS – Ecological Classification System

GRAPS – Groundwater Restoration and Protection Strategies

GW – Groundwater

HUC – Hydrologic unit code

IBI – Index of biotic integrity

LSCR – Lower St. Croix River

MCBS – Minnesota County Biological Survey

MDA – Minnesota Department of Agriculture

MDH – Minnesota Department of Health

MG – Million Gallons

MnDNR – Minnesota Department of Natural Resources

MPCA – Minnesota Pollution Control Agency

NPS – National Park Service

PFAS – Perfluoroalkyl substances

PFCs – Perfluorochemicals

PFOs – Perfluorooctane sulfonate

SSTS – Subsurface sewage treatment system

TMDL – Total Maximum Daily Load

TP – Total phosphorus

TSS – Total suspended solids

VOCs – Volatile organic compounds

WD – Watershed District

WiDNR – Wisconsin Department of Natural Resources

WMA – Wildlife Management Area

WMO – Watershed Management Organization

WRAPS – Watershed Restoration and Protection Strategies

1. INTRODUCTION

The Lower St. Croix River (LSCR) One Watershed, One Plan (1W1P) boundary follows the boundary of the Lower St. Croix River Watershed (HUC 07030005) (Figure 1). The Lower St. Croix River Watershed is one of four major watersheds in the St. Croix River Basin. It begins just downstream of the confluence of the St. Croix and Snake rivers near Pine City and runs parallel to the St. Croix River to the confluence with the Mississippi River near the city of Prescott, Wisconsin. This watershed consists of several major tributaries that drain into the Lower St. Croix River including Rock, Rush, and Goose Creeks; the Sunrise River; Brown's Creek, Valley Branch Creek, Trout Brook, and O'Connor's Creek; and several small streams.

The Lower St. Croix River Watershed is approximately 915 square miles (585,735 acres) and lies primarily in the North Central Hardwood Forest ecoregion, with small portions of the Northern Lakes and Forests ecoregion in the north, and Western Corn Belt Plains ecoregion to the south (MPCA 2014(i)). The watershed is located in the Upper Mississippi River Basin and encompasses parts of Pine (8.5%), Chisago (47.3%), Isanti (7.2%), Anoka (6.2%), Washington (30.6%), and Ramsey (0.1%) counties. There are 60 municipalities and townships located completely or partially within the boundaries of the watershed. Additionally, there are eight watershed organizations in the watershed including the Chisago Lakes Lake Improvement District (LID), Sunrise River Watershed Management Organization (WMO), Comfort Lake-Forest Lake Watershed District (WD), Carnelian-Marine-St. Croix WD, Brown's Creek WD, Middle St. Croix WMO, Valley Branch WD, and South Washington WD (Figure 1.)

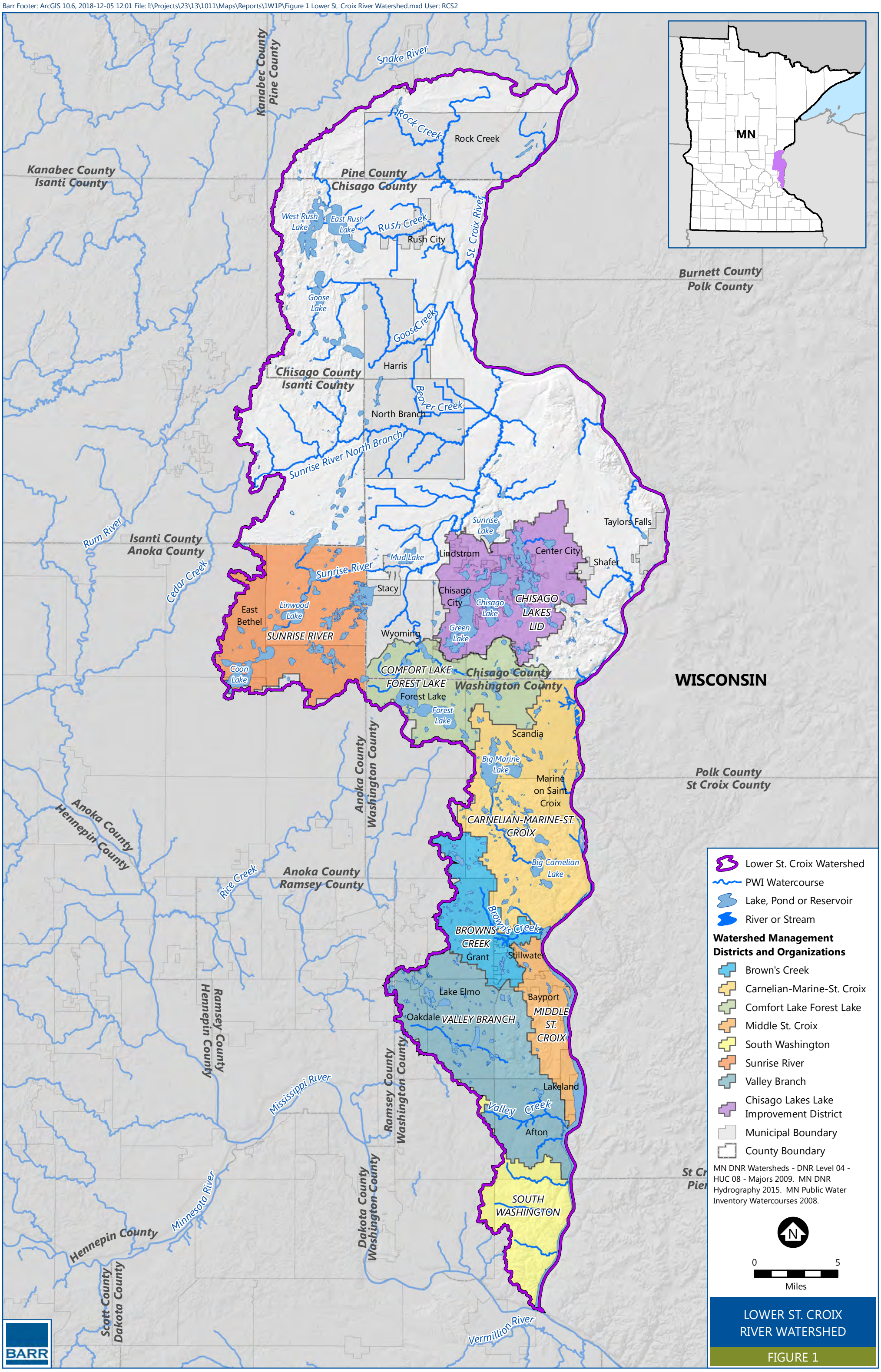
The watershed's surface waters are abundant with 127 lakes and over 1,000 miles of rivers, streams, and judicial ditches. From its source near Gordon, Wisconsin, the St. Croix River itself runs west then south for a total length of 169 miles until it meets the Mississippi River just south in Prescott WI.

As the land changes from agricultural uses in the low gradient headwater areas of the watershed to more forests near the mouths of the tributaries, the stream gradients increase as the elevation drops on the path to the St. Croix River. Gradient is particularly low in the central portion of the watershed creating areas of wetland dominated river systems. There are numerous springs along the St. Croix River corridor, creating cool water and coldwater conditions, particularly in the southern part of the watershed. Due to the presence of these springs in the forested areas of the watershed, there are 15 designated trout streams recognized by the MnDNR.

The more significant lakes in the Lower St. Croix River Watershed include Big Marine, Big Carnelian, the Chisago Lakes Chain, Coon, Elmo, Forest, Goose, Little Carnelian, Rush, Rock, and Square located in the central and southern parts of the watershed. Most of these lakes are linked through a chain of small connector waterways. Small impoundments are also a part of the Sunrise River System. These lakes and impoundments contribute to the biological communities of the adjacent tributaries.

The information contained within this Land and Water Resources Inventory is largely transcribed from the Minnesota Pollution Control Agency (MPCA) Lower St. Croix Watershed Monitoring and Assessment Report (February 2014) along with various local water management plans, watershed restoration and protection strategies, total maximum daily load studies, and the Lower St. Croix Groundwater Restoration and Protection Strategy (MDH 2018). Few maps are included in this inventory although a detailed interactive map of the entire watershed is available at: https://maps.barr.com/LSCWD/1W1P/index.html.

Barr Footer: ArcGIS 10.6, 2018-12-05 12:01 File: I:\Projects\23\13\1011\Maps\Reports\1W1P\Figure 1 Lower St. Croix River Watershed.mxd User: RCS2



LOWER ST. CROIX RIVER WATERSHED

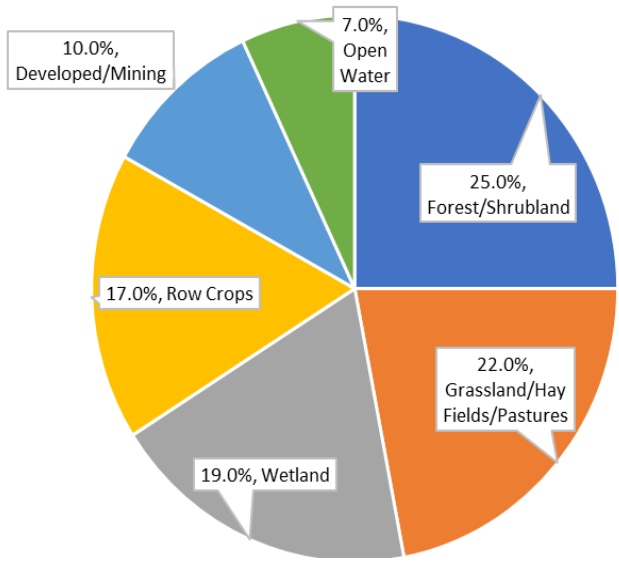
FIGURE 1

2. LAND USE

The Lower St. Croix River Watershed is comprised of rolling, wooded bluff land, and small wooded valleys. Above the bluffs, agriculture, rural residential and urban lands are the more prevalent land uses. The Lower St. Croix River was designated as a Wild and Scenic River in 1972, resulting in stricter regulations on the development of surrounding riparian land and additional protection of instream hydrological changes and water quality. This has allowed the bluffs surrounding the Lower St. Croix River to remain relatively undisturbed; this is where the majority of forests lies in this watershed (Figure 2.)

Before western settlement, the river valley was dominated by hardwood forests and mixed savannah with large white pine stands in the far northern portion of the watershed. Once the treaty of 1837 was signed, the federal government obtained the land within the Lower St. Croix Watershed, and started intensively logging it, producing 15 billion board feet of timber between 1839-1916 (MPCA, 2014(i)). The St. Croix River was used to transport large amounts of timber south to mills which shipped lumber across the country. Following the logging boom, fertile land that was cleared for logging was converted to agricultural production (MPCA, 2014(i)).

Today land cover in the watershed is distributed as follows: 25 percent forest/shrubland, 22 percent grassland/hay fields/pastures, 19 percent wetland, 17 percent row crops, 10 percent developed/mining, and 7 percent open water (Remote Sensing and Geospatial Analysis Laboratory, University of Minnesota, Landsat and Lidar, 2013) (Figure 2).



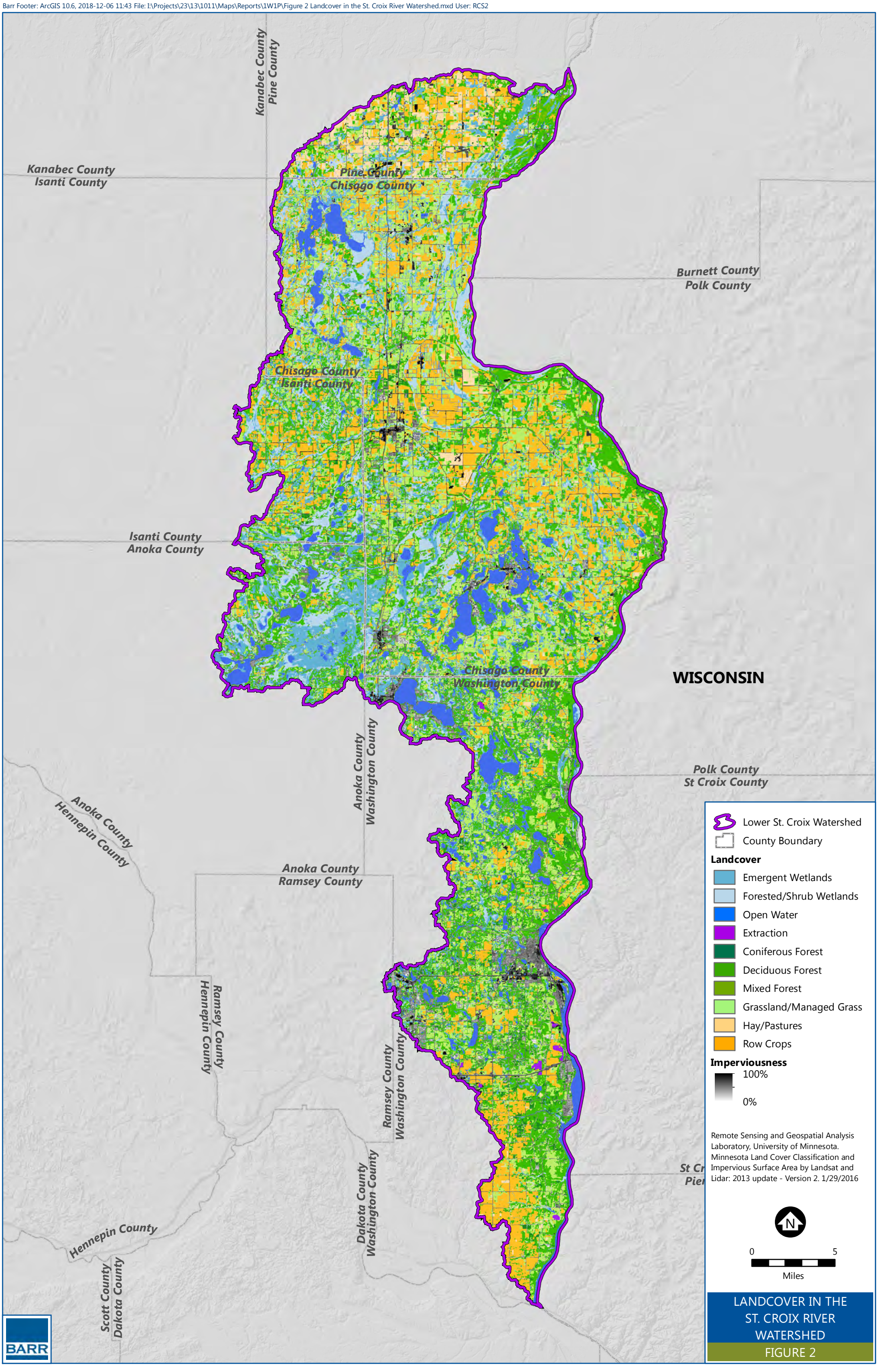
Lower St. Croix Land Cover Distribution, 2013

Farmland accounts for 115,280 and 81,237 acres in Washington and Chisago counties respectively. The number of farms in these counties has dropped by 8% and 15% between 2002 and 2007, respectively. The majority of farms in these two counties are smaller than 180 acres (MPCA, 2014(i)). There are 189 permitted feedlots in the watershed, scattered throughout the watershed with higher densities in the east and north central regions.

Significant population centers are located along the I-35 and I-94 corridors, including the eastern Twin Cities metropolitan area, Stillwater, Forest Lake, Wyoming, and North Branch. Urban sprawl has increasingly affected the southern portion of this watershed, with metropolitan communities (e.g. Oakdale, Woodbury, and Mahtomedi) expanding east further into the watershed. Woodbury was the third fastest growing city in the metropolitan area, expanding by 12,875 residents between 2000-2009 MPCA, 2014(i)). From 2000 to 2010, Washington and Chisago counties grew by 18% and 31%

respectively, among the highest growth rates for counties in Minnesota (MPCA, 2014(i)). Urban growth results in more impervious surfaces (e.g. parking lots, driveways, roads, sidewalks, rooftops) which impede natural infiltration processes, and can lead to higher runoff rates, increased sedimentation and altered thermal regimes in urban waterways.

By 2030, Chisago and Washington counties are projected to grow by 13,778 (25%) and 128,842 (55%), respectively. In Washington County alone, there is a projected need for a 57,638 (66%) household increase (Chisago Co., 2017) (Washington Co., 2009). As population centers expand and development increases, so does the need for environmental planning and regulation. Municipal and county comprehensive plans contain environmental and natural resource considerations as part of their development outlook, and generally aim to accommodate projected growth in sustainable ways. Factors cited as influencing land use include natural resource base, geographical location, cultural influences, population characteristics, and residential development patterns. While urban sprawl can negatively impact natural resources, Low Impact Development (LID) and Minimal Impact Design Standards (MIDS) aim to allow development to continue while mitigating natural resource impacts. Many local organizations such as watershed districts and watershed management organizations enforce such environmental protection regulations. It is critical to obtain buy-in and support from development authorities such as municipalities and counties in order to ensure these regulations are enforced in an efficient and effective way.



LANDCOVER IN THE ST. CROIX RIVER WATERSHED

FIGURE 2

3. ECOREGION AND SOILS

The Lower St. Croix River Watershed is located within the North Central Hardwood Forest Ecoregion, with small portions lying within the Northern Lakes and Forests Ecoregion in the north and Western Corn Belt Plains Ecoregion to the south. According to the Ecological Classification System (ECS), the watershed is located within the Eastern Broadleaf Forest Province and the Laurentian Mixed Forest Province, the Western Superior Uplands Section and the Minnesota and Northeast Iowa Morainal Section. The watershed also lays within the Mille Lacs Uplands, the St. Croix Moraine, the Anoka Sand Plain, and the St. Paul Baldwin Plains and Moraines Subsections (MnDNR, 2018(i)).

Alfisols and Entisols soil types are prominent throughout this watershed; these are usually loamy or sandy soils which allow productive row crop agricultural practices to thrive (MPCA 2014(i)). Alfisols are formed from weathering processes under forests or mixed vegetation that contributes to high clay content; making them fertile with a high moisture holding capacity. Entisols occur in areas of recently deposited parent materials or in areas where or in areas where erosion or deposition rates are faster than the rate of soil development; such as steep slopes and flood plains. Soil types are illustrated in the Lower St. Croix River One Watershed One Plan Interactive Map available at https://www.barr.com/maps/LSCWD/1W1P/index.html#/-93.0692/45.3940/9.

4. CLIMATE AND PRECIPITATION

Due to its position in the continent, Minnesota is located on the boundary between the semi-humid climate regime of the eastern U.S., and the semi-arid regime to the west. Semi-humid climates are areas where average annual precipitation exceeds average annual evapotranspiration, leading to a net surplus of water. Minnesota's ecoregion has a continental climate, characterized by warm summers and cold winters. The mean annual temperature for Minnesota is 4.5 °C (40.1 °F); the mean summer temperature for the LSCR Watershed ranges from 19 °C (67 °F) to 21 °C (70 °F); and the mean winter temperature ranges from -9 °C (15 °F) to -7 °C (18 °F) (MnDNR State Climatology Office, 2018).

Precipitation is the source of almost all water inputs to a watershed. Figure shows two representations of precipitation for calendar year 2017. The map on the left indicates total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this figure, the LSCR Watershed area received 28 to 32 inches of precipitation in 2017. The map on the right shows the amount those precipitation levels departed from normal. For the LSCR Watershed, the map shows that precipitation ranged from two (2) inches below normal to four (4) inches above normal.

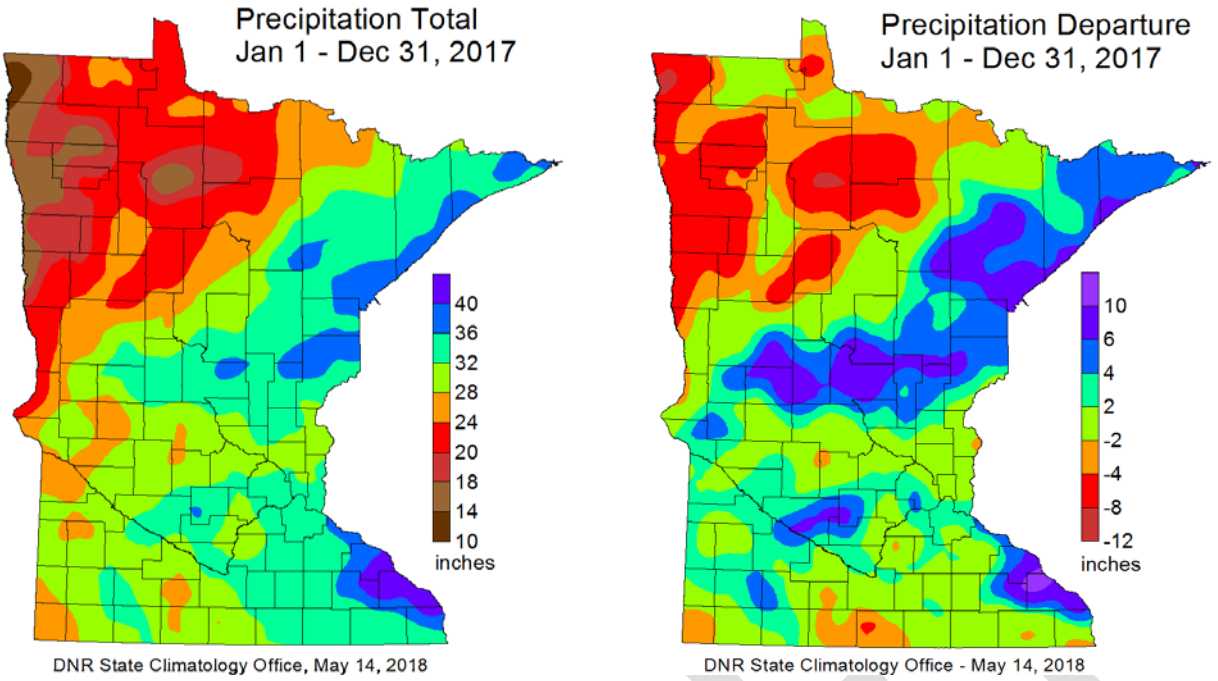


Figure 3. Statewide Precipitation Levels During 2017 (MnDNR State Climatology Office, 2018)

The LSCR Watershed is located in the east central precipitation region. Figure 4 and Figure 5 display the areal average representation of precipitation in east central Minnesota for 20 and 100 years, respectively. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. Rainfall in the east central region displays no significant trend over the last 20 years. Though rainfall has varied in intensity on an annual basis, average precipitation in east-central Minnesota has not changed dramatically over this time period. Looking further into historical records, precipitation in east-central Minnesota over the past 100 years displays a statistically significant rising trend. This long-term trend is typical for Minnesota over this time period.

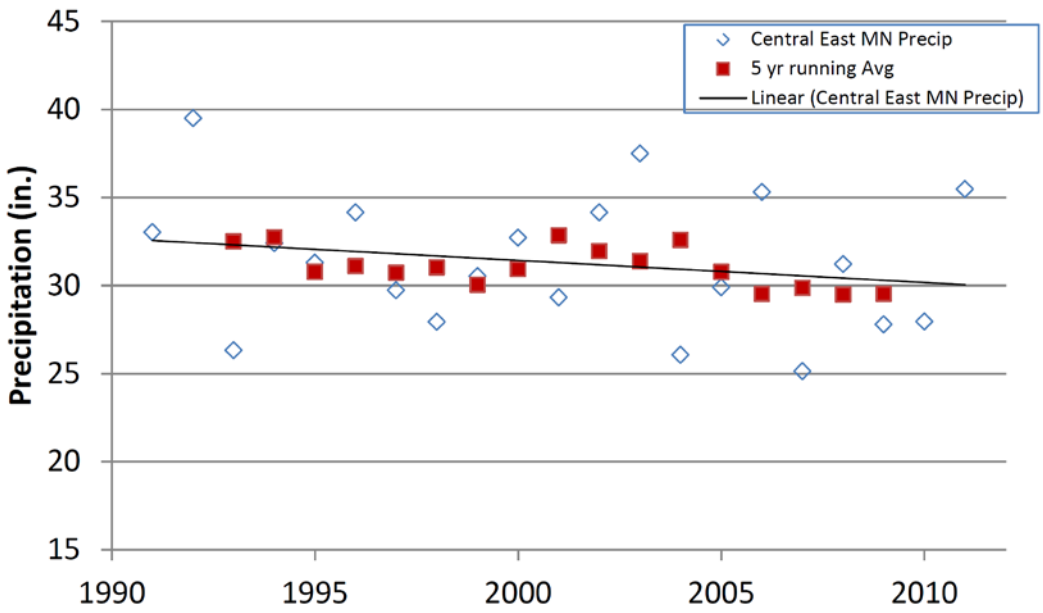


Figure 4. Precipitation Trends in East Central Minnesota (1993-2013) with Five-Year Running Average (MnDN State Climatology Office R, 2018)

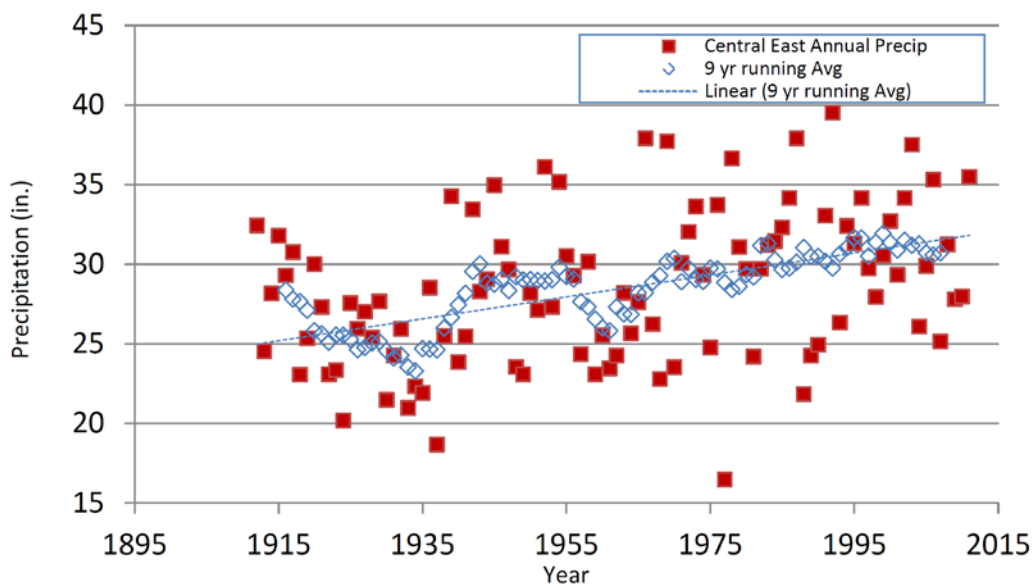


Figure 5. Precipitation Trends in East Central Minnesota (1913-2013) with Nine-Year Running Average (MnDNR State Climatology Office, 2018)

5. SURFACE WATER RESOURCES

The Lower St. Croix River Watershed begins as the mainstem of the St. Croix River flows south from the confluence with the Snake River and continues 97 miles south until its confluence with the Mississippi River in Prescott, WI. This section of river includes Lake St. Croix, the southernmost 25 miles of the river from Stillwater, MN to Prescott, WI. Combined, the St. Croix River and Lake St. Croix provide a regionally significant big river, officially designated as a National Wild and Scenic Riverway by the Federal government and an Outstanding Resource Value Water by the State of Minnesota. Recreation, transportation, habitat, and migratory flyway are among the more important uses of the river. Along this stretch, the main channel of the St. Croix River meanders through a narrow flood plain with numerous oxbow lakes, back channels and sloughs. Upon reaching the Arcola sandbar north of the city of Stillwater, the river opens up to become Lake St. Croix, a large open water basin with little flow or gradient change. The channel constricts flow at a few locations throughout Lake St. Croix; creating characteristics of a large river system with increased flow and channel development.

There are six major tributaries to the St. Croix River in the Lower St. Croix River Watershed: Rock Creek, Rush Creek, Goose Creek, Sunrise River, Browns Creek, and Valley Branch Creek. Some smaller tributaries include Lawrence Creek, Trout Brook, O'Connor's Creek, and Silver Creek. The majority of other tributaries in this watershed are unnamed, intermittent streams and some judicial ditches.

There are numerous lakes located in the central and northern portion of this watershed. Most lakes are interconnected with outlets and channels eventually flowing to the St. Croix River. The most significant lakes in the watershed include Coon, Rock, Rush, Goose, Sunrise River pools, Big Marine, Forest, Green, Chisago, North Center, North Lindstrom, South Center, South Lindstrom, Square, Carnelian, Little Carnelian, and Elmo.

Wetlands are prevalent throughout this watershed, playing a large role in the dynamics of some lakes and rivers. According to the National Wetland Inventory (2013), there are approximately 152,000 acres of wetlands throughout the watershed. The central and southern sections of the mainstem St. Croix River included in this watershed have few wetlands in the immediate riparian areas. Riparian wetlands are more prevalent in northern sections of the river. Lagoons, sloughs, and oxbow lakes are an important part of the floodplain throughout the river as the water levels fluctuate seasonally. Estimated wetland loss between the 1860's to early 1980's varied significantly across the watershed from 57% in Washington County to only 8% in Pine County. Other counties had estimated wetland loss of 36% in Chisago County, 29% in Anoka County, and 20% in Isanti County (MnDNR, Division of Waters, 1997).

In addition to significant natural features, there is a vast network of stormwater infrastructure features working to manage and move water within the built environments of the watershed. There are thirty-one MS4s across the watershed including twenty cities or townships, three counties, five watershed districts, Century College, the Minnesota Correctional Facility, and the Minnesota Department of Transportation. "MS4s" (or municipal separate storm sewer systems) are communities or institutions that own, operate, and manage stormwater conveyances or systems of conveyances including structures such as roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, etc.). These entities receive a permit to discharge stormwater through these systems. The MS4 General Permit is designed to reduce the amount of sediment and pollution that enters surface and ground water from storm sewer systems to the maximum extent practicable.

Through the MS4 General Permit, the system owner or operator is required to develop a stormwater pollution prevention program that incorporates best management practices applicable to their area.

The following sections provide an overview of the surface water resources and their conditions within the major subwatersheds and watershed management organizations in the LSCR watershed.

5.1 GOOSE CREEK WATERSHED (ROCK, RUSH, & GOOSE CREEKS)

Sources and Additional Monitoring Data:

Goose Creek Watershed Restoration and Protection Strategies Report (MPCA, 2015) *Lower St. Croix Watershed Monitoring and Assessment Report (MPCA, 2014(i))*

Chisago County Soil and Water Conservation District Water Body Assessments

The Goose Creek Watershed comprises the northern portion of the Lower St. Croix River Watershed and includes the subwatersheds of Rock Creek, Rush Creek, and Goose Creek. The watershed is approximately 184 square miles within the Northern Central Hardwood Forest ecoregion, and is located in Chisago and Pine counties and less than one square mile in Isanti County (Figure 6).

Surface waters within the Goose Creek Watershed were assessed in 2009 for pollutants and biological health and many of the waterbodies have more than one impairment. Lakes in this watershed impaired for excess nutrients include Goose Lake (North Bay and South Bay), Horseshoe Lake, Rock Lake, and Rush Lake (East and West). Continuous yearly water quality monitoring data from 2012 to the present shows improving water quality trends on Goose Lake (North Bay and South Bay), Horseshoe Lake and Rush Lake (East and West). East Rush Lake shows a long-term trend for eutrophication parameters indicating a 98% increase (improvement) in Secchi transparency depth between 1979 and 2012. Additionally, Fish Lake in the Goose Creek Watershed has one of the best water quality in all the lakes in Chisago County. Some of the smaller lakes including Rabour, Mandall, and Little Horseshoe have not been assessed due to lack of data, however, it's likely these too are impaired.

According to the Goose Creek Watershed Restoration and Protection Strategy (WRAPS) (MPCA, 2015), likely pollutant sources for lakes include upstream lake effluent, internal release of phosphorus from lake sediments, and fertilizer and manure runoff from agricultural lands.

The major streams in the Goose Creek Watershed including Rock Creek, Rush Creek and Goose Creek are described below. According to the Goose Creek WRAPS, the likely pollutant sources for the streams' bacteria (*E. Coli*) and biological impairments include upstream lake effluent and fertilizer and manure runoff from agricultural lands. Two additional unnamed creeks (07030005-729 and 07030005-741) were found to meet standards for turbidity but lacked enough data for complete assessment.

Rush Creek begins as an outlet of Rush Lake and flows east approximately 14 miles, passing through the town of Rush City before it reaches the St. Croix River. It is impaired for E. Coli, fish and macroinvertebrate IBI. Agricultural land uses make up more than half the watershed landscape. The upper two-thirds of this watershed are dominated by agricultural cropland with urban areas and small parcels of woodland present, while the lower portion is predominately forested. The most common stressors affecting stream biota are low dissolved oxygen (DO), high phosphorus levels, lack of habitat, altered hydrology, and physical connectivity. Low DO levels are present in the stream headwaters

resulting from the low gradient nature of the stream upper watersheds, and the location of impaired lakes with excess nutrients in the headwaters (Rush Lake). Stream eutrophication is a localized stressor in the stream upper reaches with DO and nutrient levels improving in the stream lower reaches. There is also a lack of habitat with low diversity of pools and riffles and the presence of fine sediments in the stream bed resulting from the wide and shallow nature of the stream and predominantly sand substrate. Several dams and a perched culvert are located along Rush Creek, impeding stream connectivity and fish migration. One dam was recently removed on the creek in Rush City; habitat restoration in that area may improve the streams ability to support diverse aquatic communities. The riparian corridor of this creek becomes forested as it flows downstream past Rush City, allowing for natural infiltration of surface water runoff. Within the Rush Creek subwatershed, two channelized tributaries (County Ditch 6 and an unnamed creek) were found to have poor fish communities and below average habitat conditions.

The headwaters of Goose Creek start with small watercourses that flow into Goose Lake, eventually draining through an outlet of Goose Lake in the Township of Fish Lake. A tributary to the creek flows from Horseshoe Lake. Flowing southeast approximately 22.2 miles, Goose Creek passes through the town of Harris and eventually into the heavily forested Wild River State Park, before its confluence with the St. Croix River. Agricultural lands comprise just over half of the watershed.

During the 2009 assessment, Goose Creek's fish community varied from poor to above average, resulting in an impairment for aquatic life. Invertebrate communities, in contrast, show improvement over previous years. Habitat quality in this creek varies from poor to good which is likely a result of small channelized sections degrading habitat, while other undisturbed portions maintain natural habitat characteristics that are supportive of healthy aquatic communities.

Rock Creek begins as an outlet of Rock Lake flows southeast approximately 15.6 miles before its confluence with the St. Croix River. Along its course Rock Creek has numerous small tributaries and three unnamed creeks. While this subwatershed is heavily agricultural, the riparian corridor along Rock Creek remains largely intact which likely contributes to the average and above average fish and macroinvertebrate communities. While the creek meets standards for biota, it's recreational use is impaired by *E. Coli*.

5.2 SUNRISE RIVER WATERSHED

Sources and Additional Monitoring Data:

North Branch Sunrise River Fecal Coliform Total Maximum Daily Load (MPCA, 2006)
Comfort Lake Forest Lake Six Lakes Total Maximum Daily Load (CLFLWD, 2010)
Comfort-Lake-Forest-Lake Watershed Management Plan Vol II (CLFLWD, 2011)
Martin and Typo Lakes Total Maximum Daily Load (MPCA, 2012)
Lake St. Croix Nutrient Total Maximum Daily Load Study (MPCA, WiDNR, 2012)
Chisago Lakes Chain of Lakes Watershed Restoration and Protection Strategy (MPCA, 2013)
Lower St. Croix Watershed Monitoring and Assessment Report (MPCA, 2014(i))
Sunrise River Watershed Restoration and Protection Strategies (MPCA, 2014(ii))
Sunrise River Watershed Total Maximum Daily Load Study (Chisago SWCD, 2013)
Sunrise River Watershed Management Plan (SRWMO, 2010)
Anoka Conservation District Water Monitoring Programs
Chisago County Soil and Water Conservation District Water Body Assessments

Isanti County Soil and Water Conservation District Water Monitoring Programs
Comfort Lake-Forest Lake Watershed District Monitoring Programs

The Sunrise River Watershed is approximately 385 square miles and is located in the North Central Hardwood Forest ecoregion. It lies in parts of four counties (Anoka, Chisago, Isanti, and Washington) with the largest area in Chisago County. The area includes eight incorporated cities (North Branch, Stacy, Wyoming, Forest Lake, East Bethel, Chisago City, Lindstrom, and Center City) and covers portions of nineteen townships. Several smaller streams combine to form the Sunrise River: the North Branch of the Sunrise River, which begins in Isanti County and flows east to its confluence with the main branch in Sunrise Township; the West Branch of the Sunrise River which begins in Anoka County and flows east to the confluence with the main stem in Stacy, MN; the South Branch of the Sunrise River which begins in Coon Lake in Anoka County and flows northeast through the pools and wetlands in the Carlo Avery Wildlife Management Area; and the main branch of the Sunrise River which starts in northern Washington County and flows north and east to its confluence with the St. Croix River at Sunrise Township (Figure 6).

The Sunrise River Watershed is a high priority subwatershed of the Lower St. Croix River Watershed. It was identified as one of the greatest contributors of phosphorus and sediment to the St. Croix River and was allocated a 33% reduction in phosphorus loading in the Lake St. Croix Nutrient TMDL (MPCA, WiDNR, 2012).

The watershed has a mixture of residential, agriculture, and forested land with approximately 8% developed, 24% in wetlands and open waters, 24% in cropland, 18% in grassland, and 26% in forest. The watershed contains numerous lakes; many are highly developed and important for recreation, while others have little or no development are important "natural environment" lakes. Of the 140 lakes (over 10 acres in size) in the watershed, 46 lakes (or bays) have been monitored for impairments to aquatic recreation with 22 being deemed "non- supporting" for aquatic recreation due to high nutrient levels. Depending on the lake, high nutrients can originate from lawns and paved surfaces in developed areas, failing septic systems along the shoreline, field and feedlot runoff in agricultural areas, and internal loading within the lake.

Of the more than 100 stream reaches (many reaches can make up one stream) within the region, only 5 were found to be fully supporting (not impaired) for aquatic life and 2 for aquatic recreation. Ten reaches were found to be non-supporting for aquatic life and 7 for aquatic recreation. Many of the other reaches were monitored, but did not have sufficient data to completely assess them. Many of these non-supporting waterbodies have approved TMDLs, and some have approved implementation plans.

5.2.1 NORTH BRANCH SUNRISE RIVER

The North Branch Sunrise River Watershed drains approximately 78 square miles in eastern Isanti and central Chisago Counties. The headwaters of the North Branch Sunrise River begin 4.75 miles east of Isanti, in the township of North Branch. The North Branch Sunrise River then flows east 24.1 miles, and through the city of North Branch before reaching its confluence with the main stem of the Sunrise River in the Township of Sunrise. Along its course, four named tributaries flow into the river: County Ditch 7, County Ditch 19, Judicial Ditch 4, and Hay Creek. Cropland comprises 40% of the land use in this watershed followed by forests (22%), grassland (19%) and wetlands/open water (11%). Developed land

comprised the remainder of the land use here. The BWSR soil erosion and water quality risk levels are high and medium, respectively.

The North Branch Sunrise River is impaired due to E. Coli and does not meet fish IBI standards. The riparian corridor of this river is largely undisturbed outside of the city of North Branch. Within the city impervious surfaces decrease natural infiltration. The North Branch Sunrise River Bacteria TMDL was completed in 2006.

County Ditch 7 was the one tributary assessed and although limited biological data were available, its fish communities were in poor condition. Overall, habitat in County Ditch 7 seemed average for supporting aquatic communities, but lack of cover for certain aquatic species could be contributing to poor diversity. The other ditches and tributaries in this subwatershed do not have enough data for assessment. The same is true for the 7 of the 8 lakes in this subwatershed (Splittstoeser, Grass, Horseleg, Horseshoe, Big Pine, Chain North and Chain South). According the MPCA's Water Quality Dashboard (accessed October 2018), Mud Lake (13-0066-00) was assessed and found to be in good condition.

5.2.2 WEST BRANCH SUNRISE RIVER

The West Branch Sunrise River Watershed is located in the west central portion of the Lower St. Croix Watershed, encompassing roughly 53 square miles in parts of Isanti, Anoka, and Chisago Counties. The West Branch Sunrise River begins in the township of Oxford, and then flows in a southeasterly direction 15.4 miles until it reaches Pool 1 of the Sunrise River just east of the town of Stacy. In that span this waterway flows through two nutrient impaired lakes (Typo and Martin) and a mix of agricultural land use and wetland complexes. Twenty-two basins are in the watershed; all but one is shallow. Forests account for almost half the land use (47%) followed by wetlands and open water at 26%, grassland (11%), developed areas (9%) and cropland (7%). In this subwatershed, the BWSR soil erosion and water quality risk levels are both ranked "medium."

According to the MPCA's assessment in 2011, fish and Invertebrate communities on the West Branch Sunrise River downstream of Martin Lake indicate an impaired condition, with tolerant species dominating the communities resulting in low fish and invertebrate IBI scores. Poor habitat quality at separate stations on the reach downstream of Martin Lake could be driving low diversity in the aquatic communities. Homogenous channel development throughout this stretch of river is characteristic of a low gradient system (i.e. absence of riffles); these stations were scored in the low gradient fish class but still fail to meet thresholds. The reach downstream of Martin Lake is impaired for aquatic life due in part to turbidity exceedances from excess algae growth, which can be attributed to the extreme nutrient impairment in Martin Lake. The reach between Typo and Martin lakes is impaired for aquatic life use due to excess turbidity and pH. Typo and Martin Lakes are highly eutrophic, and high nutrient levels and algal respiration may drive the swing in pH values observed. Dissolved oxygen levels are low in the reach upstream of Typo Lake; this reach is also completely channelized and within a large wetland complex.

With the exception of Fawn Lake, all the basins in this watershed are shallow; as a result, reductions in watershed phosphorus loads and addressing internal loading will be important to see improved water quality in the area lakes. The Martin and Typo Lakes Total Maximum Daily Load Study (MPCA, 2012) indicates that Martin Lake needs a 41% reduction in total phosphorus loading, much of which should come from reduced phosphorus exiting Typo Lake which flows into Martin Lake. The TMDL found that nutrient loading into Typo Lake comes from direct watershed runoff, in-lake contribution, Subsurface

Sewage Treatment Systems (SSTS), and atmospheric deposition. The overall reduction required to meet water quality standards in Typo Lake is 81% or 7,041 lbs/year.

The Sunrise River Watershed TMDL Study (Chisago SWCD, 2013) addressed the nutrient impairment in Linwood Lake, a eutrophic deep lake that drains into the West Branch Sunrise River. The lake needs a 21% reduction in total phosphorus loading including controlling internal loading, upgrading septic systems, increasing conservation tillage, and implementing other best management practices in the watershed.

5.2.3 SOUTH BRANCH SUNRISE RIVER AND CARLOS AVERY

As described in the Sunrise River WRAPS Report (MPCA, 2014(ii)), the South Branch Sunrise River and Carlos Avery subwatersheds cover a combined 95 square miles in Anoka and Chisago Counties. The Carlos Avery Wildlife Management Area (WMA) comprises over a third of the subwatershed with 24,000 acres (37.6 square miles). The WMA features grasslands, wetlands, and small lakes with 23 actively managed pools that provide almost 12,000 acres of waterfowl habitat. Overall, land use in these subwatersheds includes approximately 12 – 16% developed areas and cropland; with forest, grasslands, wetlands and open water comprising the remainder. Here, the BWSR soil erosion risk level is low to medium and the water quality risk level is medium.

This subwatershed includes the South Branch Sunrise River, impaired for low dissolved oxygen; and the Main Stem Sunrise River from the outlet of the North Sunrise Pool (Pool 3) to the Kost Dam, impaired for fish IBI and low dissolved oxygen.

Most of the surface water in this area has not been assessed due to insufficient data including multiple pools within the WMA, ditches, unnamed tributaries, and multiple lakes including Mud, East Twin, West Twin, South Twin, Anderson, Devil, Goose, and Little Coon. The exception is Coon Lake in Anoka County which was assessed and found to be meeting standards.

5.2.4 MAIN STEM SUNRISE RIVER

As described in the Sunrise River WRAPS Report (MPCA, 2014(ii)), the Main Stem Sunrise River subwatershed covers 51 square miles in Chisago County. It includes the bacteria-impaired reaches of Hay Creek and the Sunrise River from the North Branch Sunrise River to its confluence with the St. Croix River, the nutrient-impaired Vibo Lake, and the unimpaired Main Stem Sunrise River from the Kost Dam to the North Branch Sunrise River.

Although the reach downstream of the North Branch Sunrise River is impaired for aquatic recreation use due to excess bacteria, it has good levels of both dissolved oxygen and turbidity and is fully supporting aquatic life uses.

The reach between the Kost Dam and the North Branch Sunrise River has more gradient than other reaches, allowing for a more natural riverine environment where both fish and invertebrate communities are significantly healthier than upstream reaches. Habitat quality is in better condition in this stretch of river, providing support to healthy aquatic communities.

Vibo Lake is a 56-acre shallow, turbid lake with a watershed area of more than 7,700 acres that includes primarily cropland and developed residential properties. The lake needs a 93% reduction of total phosphorus. This lake exists in an algal state with few macrophytes and harbors curly-leaf pondweed.

5.2.5 COMFORT LAKE-FOREST LAKE SUBWATERSHED

The hydrologic area of the Comfort Lake-Forest Lake subwatershed covers 54 square miles at the southern edge of the broader Sunrise River Watershed. This subwatershed area nearly matches the area of the Comfort-Lake-Forest-Lake Watershed District (49 square miles). Over 60% of this subwatershed is covered by forests, grasslands, wetlands and open water. Developed land covers approximately 18% of the area and cropland about 21% of the area. The BWSR soil erosion and water quality risk levels are considered high.

Forest Lake lies within this subwatershed. A deep lake 2,200-acres in size, its shoreline is highly developed and it serves as an important recreational use lake. Forest Lake meets water quality standards but harbors the AIS of Eurasian watermilfoil, zebra mussels, curly-leaf pondweed, and flowering rush. Other lakes in this subwatershed meeting water quality standards include Keewahtin (formerly Sylvan/Halfbreed), Heims, Sea, and Third Lakes.

One shallow lake and six deep lakes in this subwatershed are considered impaired due to high nutrients. The impairments for Bone, Shields, Little Comfort, Comfort, School, and Moody Lakes are addressed in the Six Lakes TMDL Study (CLFLWD, 2010). Impairments for Second Lake, a deep lake in Chisago County, are addressed in the Sunrise River WRAPS (MPCA, 2014(ii)).

Many of the lakes in the Comfort Lake-Forest Lake subwatershed are connected by streams and drainage ditches. Drainage in the south-central portion of the subwatershed is characterized by short, intermittent ditches that discharge to Forest Lake. Forest Lake forms the headwaters of the Sunrise River which flows northwest out of Forest Lake and turns northeast, then flowing through Comfort Lake. The unnamed drainage through the east portion of the subwatershed flows from Moody Lake to Bone Lake to School Lake to Little Comfort Lake to Comfort Lake.

Much of the Sunrise River in this area is composed of straightened channels, as it was formerly designated Judicial Ditch 1, officially abandoned in 1997. From Comfort Lake to Pool 1, the Sunrise River is impaired for low dissolved oxygen and high bacteria and does not meet standards for fish or macroinvertebrate IBIs. Several other creeks and ditches in this subwatershed are also impaired for low dissolved oxygen and high bacteria. Judicial Ditch #2 from its headwaters to the Sunrise River is impaired due to high chlorides.

5.2.6 CHISAGO LAKES CHAIN OF LAKES SUBWATERSHED

The Chisago Lakes Chain of Lakes Watershed cover 56 square miles in Chisago County and includes 20 lakes, most of which form a chain of lakes that outlet to the Sunrise River. This subwatershed is considered high risk for both soil erosion and water quality according to the BWSR risk analyses. Many of the lakes here are important for recreation and have highly developed shorelines including Green, Chisago, North Lindstrom, South Lindstrom, North Center, and South Center Lakes.

The chain of 20 lakes ranging in size from 20 acres to over 1,500 acres are connected either through surface water tributaries or groundwater inflow/outflow. The principal outlet from the Chain of Lakes is located at Lake Ellen and flows out of that outlet at 898.2 feet above sea level; when the lakes reach 899.9 feet above sea level the outlet to Wallmark Lake functions as the secondary outlet to the Chain of Lakes. The outlet at Lake Ellen and the outlet from Chisago to Green Lake are controlled by weirs which

are opened only during times of high water. Tributaries leaving the two outlets eventually meet at Bloomquist Creek near the Sunrise River.

The Chisago Lakes Chain of Lakes WRAPS (MPCA, 2013) addresses the restoration or protection needs of the lakes in this subwatershed. Seven of the lakes currently meet water quality standards (North Chisago, South Chisago, Green, Little Green, North Lindstrom, South Lindstrom, and Spider), while a few others do not have sufficient data to make an assessment. Nine other lakes – a mixture of shallow and deep lakes - are impaired due to high nutrients (North and South Center, Emily, Ogrens, Pioneer, Wallmark, Linn, Little, and School).

Although several small unnamed creeks in this subwatershed do not have sufficient data to assess, Bloomquist Creek is impaired for excess ammonia and low dissolved oxygen.

5.3 DIRECT DRAINAGE TO ST. CROIX RIVER (SUNRISE RIVER TO WASHINGTON COUNTY)

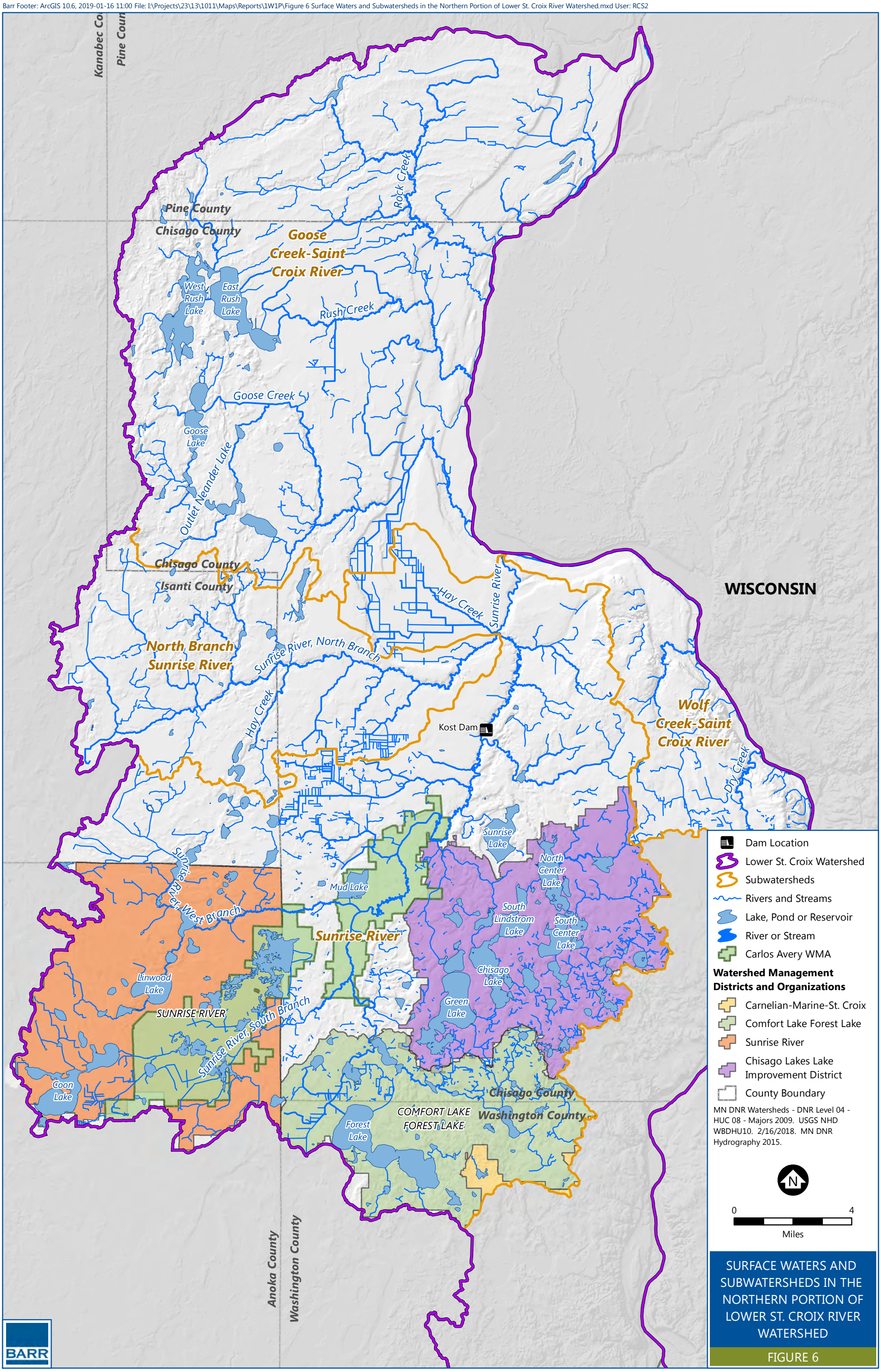
Sources:

Lower St. Croix Watershed Monitoring and Assessment Report (MPCA, 2014(i))
Sunrise River Watershed Restoration and Protection Strategies (MPCA, 2014(ii))

This subwatershed covers 79 square miles along the St. Croix National Scenic Riverway in Chisago County (Figure 6). It includes Wild River State Park and Interstate State Park. The steep ravines and bluffs as the land approaches the St. Croix River are known as the "Escarpment" in Chisago County. The BWSR soil erosion and water quality risk levels are "high" in this area, with approximately 22% of the area in crops and 8% developed. Grassland, forests and wetlands comprise the remainder of the land use here.

This area subwatershed includes Lawrence Creek, a designated coldwater fishery, beginning in the township of Shafer and flowing southeast 11.1 miles before reaching the St. Croix River near the town of Franconia. According to an assessment in 2011 (MPCA, 2014(i)), Lawrence Creek appears to be fully supporting for aquatic life use with fish and invertebrate communities that score well above the threshold. Habitat quality in Lawrence Creek is very good, accommodating diverse aquatic communities. The riparian corridor in the lower reaches of Lawrence Creek is comprised of intact forestland. In the headwaters area, agricultural land uses are more prominent in the riparian area, with small sections of the river having been channelized.

Dry Creek North, Dry Creek South, Lawrence Creek, many smaller tributaries, and a few small lakes are also within this subwatershed but do not have sufficient data to assess whether or not they meet state standards.



SURFACE WATERS AND SUBWATERSHEDS IN THE NORTHERN PORTION OF LOWER ST. CROIX RIVER WATERSHED

FIGURE 6

5.4 CARNELIAN-MARINE-ST. CROIX WATERSHED

Sources and Additional Monitoring Data:

Carnelian-Marine-St. Croix Watershed Management Plan (CMSCWD, 2015)
Carnelian-Marine-St. Croix Watershed District Multi Lakes TMDL (CMSCWD, 2012)
Carnelian-Marine-St. Croix Watershed District Water Monitoring Programs

The Carnelian-Marine-St. Croix watershed covers approximately 81.4 square miles in Washington County and home to thousands of acres of lakes and wetlands (Figure 7). There are two types of drainage within the watershed – landlocked systems and waters that drain to the St. Croix River.

In the western and central portions of the watershed, the drainage system is characterized by numerous small ponds and lakes, many of which are landlocked. For example, Long (May), Terrapin, and Mays Lakes form a chain of lakes interconnected by a defined drainage way that terminates at Clear Lake, which is landlocked. The same is true for Square Lake which overflows to a landlocked basin. These areas likely serve as important groundwater recharge areas. There are few well defined drainage systems in this area, indicating the permeable nature of the soils and the relatively flat relief of the terrain.

In the eastern half of the watershed, the drainage system is characterized by steep terrain, river terraces and well-defined water courses that, for the most part, drain to the St. Croix River. For example, Silver Creek drains a chain of lakes in the southern portion of the watershed to the St. Croix River including South and North Twin Lakes and Silver, Loon and Carol Lakes. Another example is perennial Mill Stream that drains Hay and Sand Lakes during times of high water. This portion of the watershed has a well-defined drainage system with few lakes. Many of the spring creeks are identified as trout streams by the DNR.

There are several significant creeks within the watershed including the state-designated trout streams: Fall's Creek, Willow Brook, Gilbertson's Creek and Mill Stream. Fall's Creek is considered to be the finest and most ecologically diverse natural area in Washington County and is of state-wide significance. Fall's Creek and Willow Brook have a naturally reproducing populations of Brook Trout (Salvelinus fontinalis) and the lower portion of Fall's Creek flows through the Fall's Creek Scientific and Natural Area.

Carnelian Creek is another important stream in this watershed, traversing almost 9 miles through three communities and connecting numerous wetlands along its path from Big Marine Lake through Turtle, Bass and Big Carnelian Lakes and finally on to Little Carnelian Lake. The natural watercourse of Carnelian Creek was modified by a major improvement project completed in July of 1985, referred to as the outlet project. The main purpose of the project was to alleviate flooding around Big Marine Lake, Big Carnelian Lake and along the entire watercourse. Flow on the creek is governed by a fixed weir which did not overtop between 2009 to 2016. Before 2009 and since 2016, however, there have been substantial and consistent flows draining approximately 1/2 of the watershed district and discharging to the St. Croix River.

Silver Creek is the final significant stream in the watershed, flowing perennially from Carol Lake to the St. Croix River near the St. Croix Boom Site. The upper portion of the stream's corridor encompasses a system of five good quality shallow lakes with significant areas of riparian wetland habitat. The middle reaches of the corridor contain a number of unique groundwater-dependent plant communities including rich fen and mixed hardwood seepage swamp. The lower reaches of Silver Creek are an

ecologically rich area with high quality plant communities and a high quality, groundwater-fed perennial stream.

There are 31 named lakes in the Carnelian-Marine-St. Croix watershed. Several of the lakes fall within parkland or protected areas including Big Marine, Terrapin Lake, Mays Lake, Clear Lake, Lake Alice and portions of Square Lake. The remaining lakes are generally surrounded by predominantly large lot residential homes. The Carnelian Creek chain of lakes consists of Big Marine, Turtle, Bass, Big Carnelian and Little Carnelian. Big Marine, Big Carnelian and Little Carnelian are some of the principle lakes in the District, all with exceptionally good water quality. Square Lake consistently has the best water quality of any lake in the seven-county metro area with an average Secchi disk reading of 21.1 feet. This lake maintains a groundwater base flow and continuously outlets through an artificial outlet to the south into a landlocked basin. The lake was stocked with rainbow trout until 2013 when stocking stopped due to concerns about effects on water clarity.

There are several lakes that are impaired due to high nutrients, ten of which were addressed in the Carnelian-Marine-St. Croix Watershed District Multi-Lake TMDL (CMSCWD, 2012) including East Boot, Fish, Goose, Hay, Jellum's, Long, Loon, Louise, Mud, and South Twin Lakes.

5.5 BROWN'S CREEK WATERSHED

Sources and Additional Monitoring Data:

Brown's Creek Watershed Management Plan (BCWD, 2018)
Brown's Creek Impaired Biota Total Maximum Daily Load (BCWD, 2010)
Brown's Creek Watershed District Water Monitoring Programs

The Brown's Creek watershed covers approximately 30 square miles in central Washington County (Figure 7). Land cover in the watershed includes 46% forest, 16% wetland, 12% agriculture, and 13% developed land (where impervious surfaces cover greater than 10% of the land). Brown's Creek itself is a state-designated trout stream with several distinct reaches. The reaches have been grouped by their character and functional assessment into two main sections; Main Branch and North Branch. Two tributaries feed the North Branch which then flows through a floodplain of shrub swamp and then enters a large emergent marsh wetland complex where it crosses the Gateway Trail. Downstream from the Gateway Trail, Brown's Creek reenters a mixed hardwood tamarack swamp. Further downstream, the creek shows significant signs of human alteration.

The Main Branch of Brown's Creek flows through a deep valley where the creek channel has cut into the Tunnel City Group bedrock formation. Within these reaches the cold groundwater provides a major component of the baseflow to Brown's Creek and provides one of the key elements needed to support a trout fishery. The lower sections of Brown's Creek is bordered by hardwood forests and steeply sloped uplands and is impaired for aquatic life due to dissolved oxygen, lack of coldwater assemblage and turbidity and impaired for aquatic recreation due to E. coli. The gorge runs parallel to the Brown's Creek State Trail through steep slopes with high erosion potential. There are areas of significant groundwater discharge as the gorge cuts through the Prairie Du Chien bedrock layer.

The main water quality concerns for Brown's Creek and its tributaries are total suspended solids (TSS), total phosphorus (TP), thermal loads and E. coli bacteria. Sections of both branches of Brown's Creek,

the North Branch and Main Branch are impaired for aquatic recreation and aquatic life due to low levels of dissolved oxygen, lack of a coldwater fish assemblage, and high levels of E. coli bacteria. The North Branch is also impaired due to a low score of the Minnesota Macroinvertebrate Index of Biological Integrity (M-IBI). In 2010, the Brown's Creek Watershed District completed the Brown's Creek Impaired Biota TMDL Report and Stressor Identification (BCWD, 2010). Through the stressor identification process, the primary stressors to the biota in the impaired reach of Brown's Creek were identified as high suspended solids, high temperatures, and high copper concentrations. A corresponding TMDL Implementation Plan was completed in 2012.

In addition to Brown's Creek and its tributaries, there are a number of lakes, large ponds and wetlands throughout the watershed. The most prominent lakes are Long Lake in Stillwater, Masterman Lake in Grant and South School Section Lake in Hugo. Lesser known lakes include; Lynch, Plaisted, Benz, Woodpile, and Bass East. In addition to these lakes there are several large ponds and open water wetlands that provide many of the same recreational and aesthetic benefits as larger lakes and in many cases are locally referred to as lakes. These resources include; North School Section, Bass West, Goggins, Kismet Basin, July Avenue Pond, Sinnits Pond (Formerly Jackson WMA), Pat Lake and Brewers Pond. Lakes impaired due to high nutrient levels include Benz, Long, Lynch, Plaisted, South School Section, and Goggins.

5.6 MIDDLE ST. CROIX WATERSHED

Sources and Additional Monitoring Data:

Middle St. Croix Watershed Management Plan (MSCWMO, 2015)

Middle St. Croix Watershed Management Organization Water Monitoring Programs

The Middle St. Croix watershed encompasses approximately 19.8 square miles in the east central part of Washington County (Figure 7). Land use in the watershed is evenly distributed between agricultural uses, rural residential and high-density residential/commercial land uses. The general drainage system of the watershed can be broken into two different types. The first type is located in the western area of the watershed and is characterized by numerous small ponds and lakes, many of which are landlocked. The drainage density in this area is low, indicating the permeable nature of the soils and the relatively flat relief of the terrain. The second type of drainage system is located in the northern, eastern and southern portions of the watershed. Well-defined drainage systems and few lakes, ponds and wetlands characterize this area. The drainage density of this portion of the watershed is medium, indicating the permeable nature of the soils and moderate to steep relief of the terrain. This area is also dominated by the St. Croix River bluff, which has many perennial and ephemeral streams that flow parallel to each other and into the St. Croix River.

There are four primary waterbodies in the Middle St. Croix watershed: Lily Lake, McKusick Lake, Perro Pond, and Perro Creek. Lily Lake is a 36-acre deep lake located within the City of Stillwater. It is impaired due to excess nutrients; a TMDL is slated for 2021. Lily Lake drains to McKusick Lake, a 45-acre shallow lake also located in the City of Stillwater. McKusick Lake was removed from the impaired waters list in 2012 after improvements in the watershed were installed and monitoring data indicated the lake now meets water quality standards. McKusick Lake ultimately discharges to the St. Croix River.

Perro Creek is an urban stream that runs 1.8 miles through the City of Bayport, discharging directly to the St. Croix River. The creek conveys water from two subwatersheds that encompass a total of 660 acres of urban land in the cities of Oak Park Heights, Stillwater, and Bayport. The creek is impaired due to high *E. coli* bacteria with a TMDL slated for 2021.

Perro Pond is a shallow 53-acre water body classified by the Minnesota Department of Natural Resources as a public water wetland. Perro Pond receives drainage from 340 acres of mixed urban land use primarily from the City of Oak Park Heights. The pond outlets can outlet to Perro Creek under certain conditions, or directly to the St. Croix River.

5.7 VALLEY BRANCH WATERSHED

Sources and Additional Monitoring Data:

Valley Branch Watershed Management Plan (VBWD, 2015)
Valley Branch Watershed Restoration and Protection Strategy (VBWD, 2016)
Valley Branch Watershed District Water Monitoring Programs

The Valley Branch watershed comprises approximately 70 square miles in southern Washington County (with a small portion of the watershed in northeast Ramsey County) (Figure 7). Prior to construction of a flood relief and water quality project by the Valley Branch Watershed District started in 1987 (Project 1007), all of the land within the watershed eventually drained to Valley Creek on its way to the St. Croix River. The entire watershed remains tributary to the St. Croix River, but the outflows from the northern two-thirds of watershed have been diverted from Valley Creek to a storm sewer pipe along Interstate 94.

Prominent land covers present within the Valley Creek watershed include agricultural land at 22% and forest at 17%. Developed areas with imperviousness greater than 10 percent account for approximately 21% of the watershed, with the majority of the development located in the northwest portion of the watershed.

Surface waters in the Valley Branch watershed include numerous streams, lakes, and wetlands. Perennial streams are limited to Valley Creek and Kelle's Creek. Kelle's Creek is located in a steep-sided ravine in the southern portion of the city of Afton. The creek is a spring-fed perennial creek that flows from the upper portions of the ravine to the St. Croix River, discharging into the river downstream (south) of downtown Afton. Much of the Kelle's Creek Watershed is undeveloped and the land use is primarily rural residential in the lower portions of the watershed and agricultural uses in the uplands to the southwest. Kelle's Creek is impaired due to high bacteria (*E. coli*) levels and was included in the Valley Branch Watershed District WRAPS (VBWD, 2016).

Valley Creek is the other perennial stream within the watershed. The majority of the Valley Creek watershed is located in the city of Afton and a small portion is located on the east edge of the city of Woodbury. The creek is comprised of three major branches: the North Fork, South Fork, and the Main Stem. The MnDNR designated the perennial reaches of Valley Creek as a trout stream. It sustains a naturally reproducing population of native brook trout along with large populations of brown trout, rainbow trout, and native brook lamprey.

There are 11 lakes in the watershed classified as MnDNR public waters: Sunfish, Acorn (Mud), Olson, Silver, Edith, Eagle Point, DeMontreville, Horseshoe, Jane, Elmo, and Long Lakes. Of these, Jane Lake, and DeMontreville Lake have outstanding water quality.

Lake Elmo is the largest and deepest lake in Valley Branch Watershed with a surface area of 284 acres and a maximum depth of 137 feet. It is the deepest lake in the Twin Cities metropolitan area and one of the deepest lakes in the state. The lake likely intersects the Jordan Sandstone and is a local discharge zone for that aquifer. Lake Elmo is known for its outstanding water quality. Although it is impaired for mercury in fish tissue (as are many lakes throughout the Lower St. Croix Watershed) and for perfluorooctane sulfonate (PFOS) in fish tissue, Lake Elmo and the Lake Elmo Park Reserve provide an important area of recreation to the region.

Lakes impaired due to high nutrients (Down's Lake, Echo Lake, Goose Lake South, and Sunfish Lake), were included in the Valley Branch Watershed District WRAPS (VBWD, 2016).

5.8 SOUTH WASHINGTON WATERSHED

Sources:

South Washington Watershed Management Plan (SWWD, 2016)

The most southern portion of the Lower St. Croix River Watershed includes the eastern portion of the South Washington Watershed District, with only 12 square miles draining to the St. Croix River (Figure 7). The significant water features in this area include Trout Brook which drains over 2,200 acres of agricultural, forested areas, and rural residential lands before flowing through Afton State Park and into the St. Croix River. Trout Brook is impaired due to high bacteria.

O'Conners Creek lies to the south of Trout Brook and drains over 2,400 acres of cropland and hayfields before flowing into the shallow wetland-like O'Conners Lake. Both the creek and the lake maintain good water quality.

Watershed inventory and modeling work has shown that ravine erosion (as opposed to bed or bank erosion) is a significant contributor to known sediment and nutrient levels in the District's water resources. Response to stabilize ravines is well established and relatively inexpensive. However, to date, there is little planning completed to guide that response. In partnership with MnDNR and Washington Conservation District, SWWD will complete a ravine inventory, rank the inventoried ravines based on erosion potential and downstream impact, and document standard stabilization practices to be used. Focus of this planning effort will be watersheds drained by natural streams and those with direct drainage to the Mississippi and St. Croix Rivers. Ravines in SWWD's lake watersheds will be assessed as part of lake management planning. (SWWD, 2016)

5.9 ST. CROIX RIVER AND LAKE ST. CROIX

Sources:

Lake St. Croix Nutrient Total Maximum Daily Load (MPCA, WiDNR 2012)
Carnelian-Marine-St. Croix Watershed Management Plan (CMSCWD, 2015)

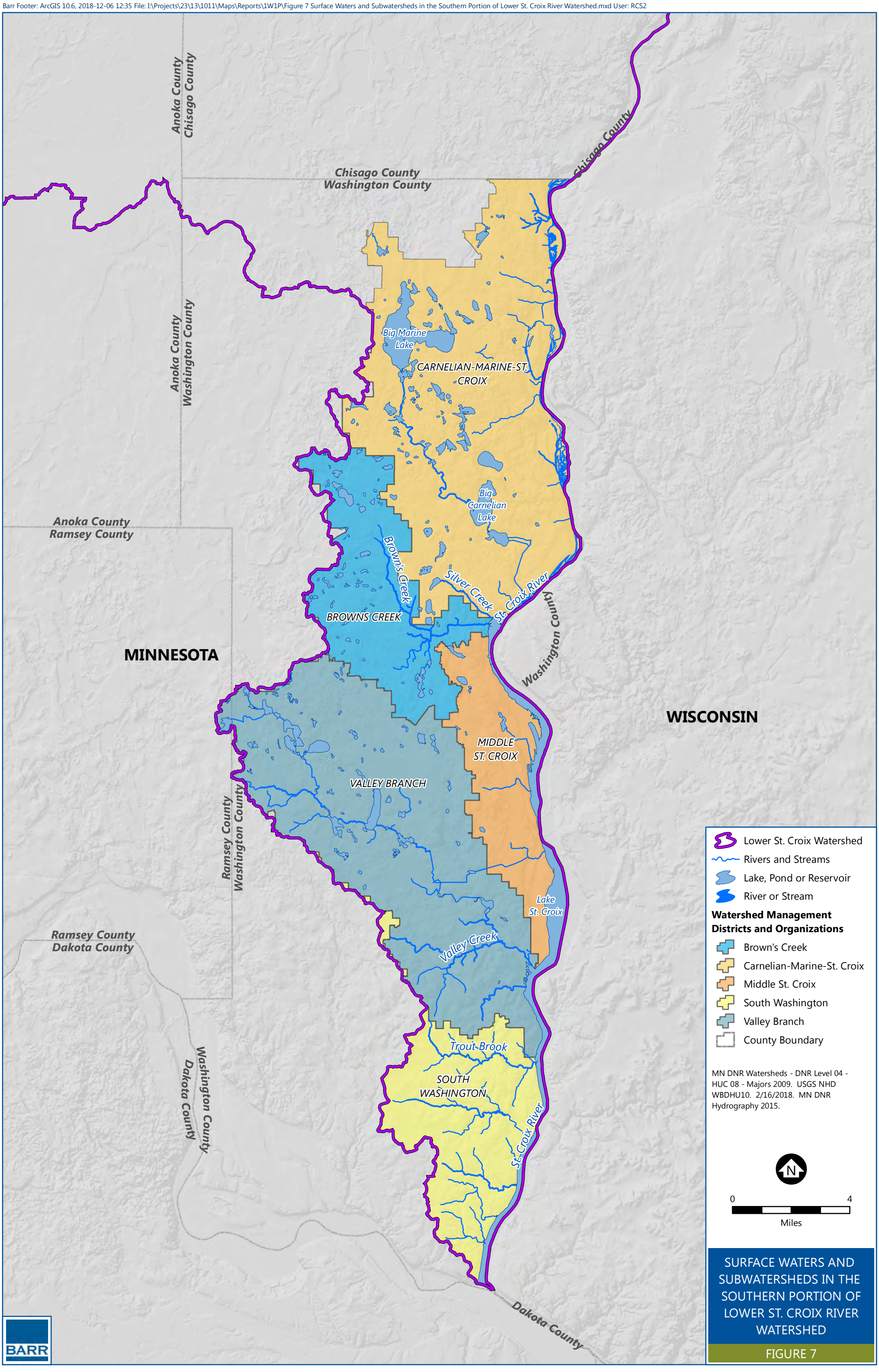
Middle St. Croix Watershed Management Plan (MSCWMO, 2015)
Valley Branch Watershed Restoration and Protection Strategy (VBWD, 2016)
South Washington Watershed Management Plan (SWWD, 2016)

The Lower St. Croix River Watershed (HUC 07030005) begins as the mainstem of the St. Croix River flows south from the confluence with the Snake River and continues 97 miles until its confluence with the Mississippi River at Prescott, WI (Figures 6 and 7). In the upper reaches of this section, the river meanders through a narrow floodplain with numerous oxbow lakes, back channels and sloughs. A regionally significant big river, the entire length of the St. Croix River is officially designated as a National Wild and Scenic Riverway by the Federal government. Called the "St. Croix National Scenic Riverway," it's recreationally managed by the National Park Service. The river is also designated as an Outstanding Resource Value Water by the State of Minnesota.

This 97-mile reach of the river along the Lower St. Croix River Watershed includes Lake St. Croix which covers the southernmost 25 miles of the river from Stillwater, MN to Prescott, WI. Upon reaching the Arcola sandbar north of the city of Stillwater, the river opens up to become Lake St. Croix, a large open water basin with little flow or gradient change. The channel constricts flow at a few locations throughout the lake creating four distinct pools: Bayport, Troy Beach, Black Bass, and Kinnickinnic Pools.

Together, the river and Lake St. Croix have relatively good water quality as compared to other metropolitan resources and the Mississippi River. They provide extensive habitat for native communities and attract recreational tourists seeking opportunities for paddling, boating, fishing, and swimming. Four Minnesota state parks (Wild River, Interstate, William O'Brien, and Afton) and numerous natural areas and public lands dot the shoreline in this watershed.

Unfortunately, the river and Lake St. Croix do have their water quality challenges. Along the entire length of the Lower St. Croix Watershed, the river and Lake St. Croix are impaired for aquatic consumption due to mercury and PCBs in fish tissues. Additionally, Lake St. Croix is impaired for aquatic recreation due to high nutrients. The Lake St. Croix Nutrient TMDL (MPCA, WiDNR, 2012) indicates the total phosphorus loading from the entire St. Croix River basin (more than 7,700 square miles in Wisconsin and Minnesota) needs to be reduced by 27% to return Lake St. Croix to the conditions that existed prior to 1950, before major ecological changes were experienced.



SURFACE WATERS AND SUBWATERSHEDS IN THE SOUTHERN PORTION OF LOWER ST. CROIX RIVER WATERSHED

FIGURE 7

6. GROUNDWATER

As the Washington County Groundwater Management Plan (Washington Co., 2014) so aptly states: There are many competing interests for the use of groundwater. The two main users are humans and natural ecosystems. Human uses include domestic, commercial, industrial, and irrigation. Natural ecosystems include streams, lakes, wetlands, and fens.

Groundwater is an important resource throughout the Lower St. Croix River Watershed. It accounts for 100% of the region's drinking water and more than 80% of groundwater withdrawal is for public water supply use. It is important to ensure that adequate supplies of high-quality groundwater remain available for the region's residents, businesses and natural resources. (MDH, 2018)

Contamination of groundwater from various pollution sources is a growing concern in the watershed. Groundwater is at greater risk to contamination in areas of high pollution sensitivity. A large band of high pollution sensitivity extends through the middle portion of the watershed through Anoka, Isanti and Chisago Counties. Much of Washington County is also considered sensitive to groundwater pollution.

6.1 GENERAL HYDROGEOLOGY

Groundwater sources within the Lower St. Croix vary according to the underlying geology. The geology in the watershed is the result of complex processes, which occurred from igneous, metamorphic, sedimentary and glacial action that took place in the region over several geologic time periods. Advancing and retreating marine seas left behind a sequence of limestone, sandstone, and shale bedrock layers dating back to the Paleozoic Era (570 to 245 million years ago). Following these events, the bedrock was subjected to a long period of erosion. Beginning about 1.5 million years ago in the Quaternary period, a sequence of glaciers advanced and retreated shaping the land and leaving in their wake formations of clay, silt, sand, and gravel on top of bedrock formations. (Washington Co., 2014). Figure 8 shows a simplified geologic cross-section of the Lower St. Croix River Watershed.

There are three major types of bedrock aquifers in the watershed including

- Basalt (volcanic rocks) in the northernmost part of the watershed
- Sandstone (Jordan Sandstone, Tunnel City Group/Wonewoc Sandstone, and Mt. Simon Sandstone aquifers) present through the middle section of the watershed and through the St. Croix River Valley
- Sandstone/carbonate mix aquifers (Prairie de Chien Dolomite, St. Peter Sandstone, and Platteville Limestone) prevalent in the southern half of the watershed

Glacial deposits in the watershed consist mainly of undifferentiated red and gray drift (predominantly till) and corresponding outwash derived from them. These outwash units form aquifers locally.

Karst conditions, which exist in much of southern Washington County, include landscape features such as sinkholes, caves, sinking streams, and springs. Dissolution of water-soluble carbonate rocks (such as limestone or dolomite) starts an erosive process and creates conduits between the surface and groundwater.

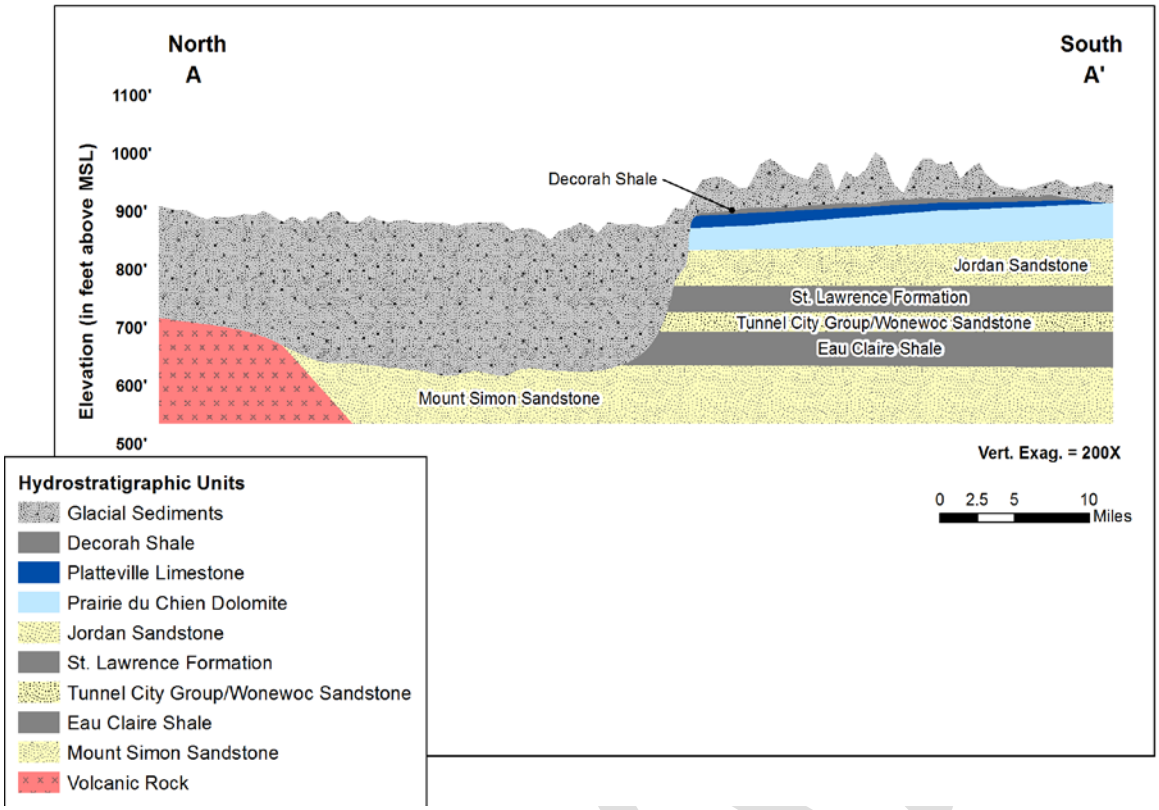


Figure 8. Lower St. Croix Watershed Simplified Geologic Cross Section (MDH, 2018)

6.2 POLLUTION SENSITIVITY

Pollution sensitivity (or aquifer vulnerability or geologic sensitivity) refers to the time it takes recharge and contaminants at the ground surface to reach the underlying aquifer. Some aquifers are deeper and more geologically protected than water table or surficial sand aquifers.

Figure 9 shows the pollution sensitivity of surficial aquifers by looking at the top ten feet of soil and geologic material. There is a mix of pollution sensitivity ratings across the watershed with the highest sensitivity in southern Washington County where karst conditions exist. A band of high pollution sensitivity reaches through portions of Chisago, Isanti, and Anoka Counites. For surficial aquifers a "highly sensitive" rating means it only takes between hours to a week for water and its corresponding pollution to travel from the surface to the surficial aquifer. Travel time in "low sensitivity" areas could be weeks to a year.

Figure 10 shows the pollution sensitivity of deeper aquifer materials in the watershed. Due to the absence of statewide data of this type, the map was created by calculating the sensitivity at individual wells and interpolating between them. The figure shows that most of the watershed with a low pollution sensitivity rating for deeper aquifers. Southern Washington County and a small band through portions of Chisago, Isanti, and Anoka Counties have a mix of moderate and high pollution sensitivity ratings. Travel time from the surface to deep aquifers in highly sensitive areas is days to months while in low sensitivity areas it would take several decades to a century.

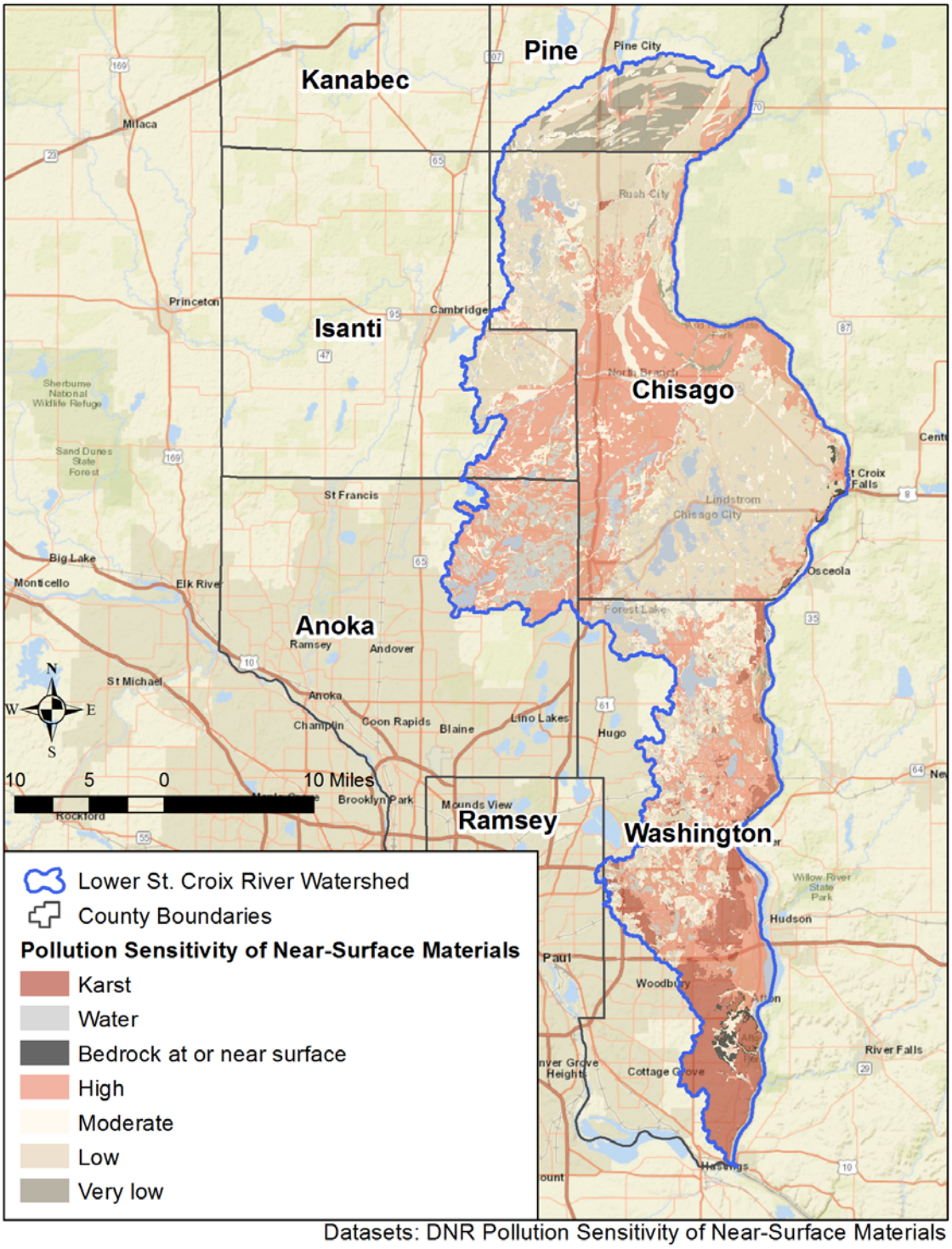


Figure 9. Lower St. Croix Watershed Pollution Sensitivity of Near-Surface Materials (MDH, 2018)

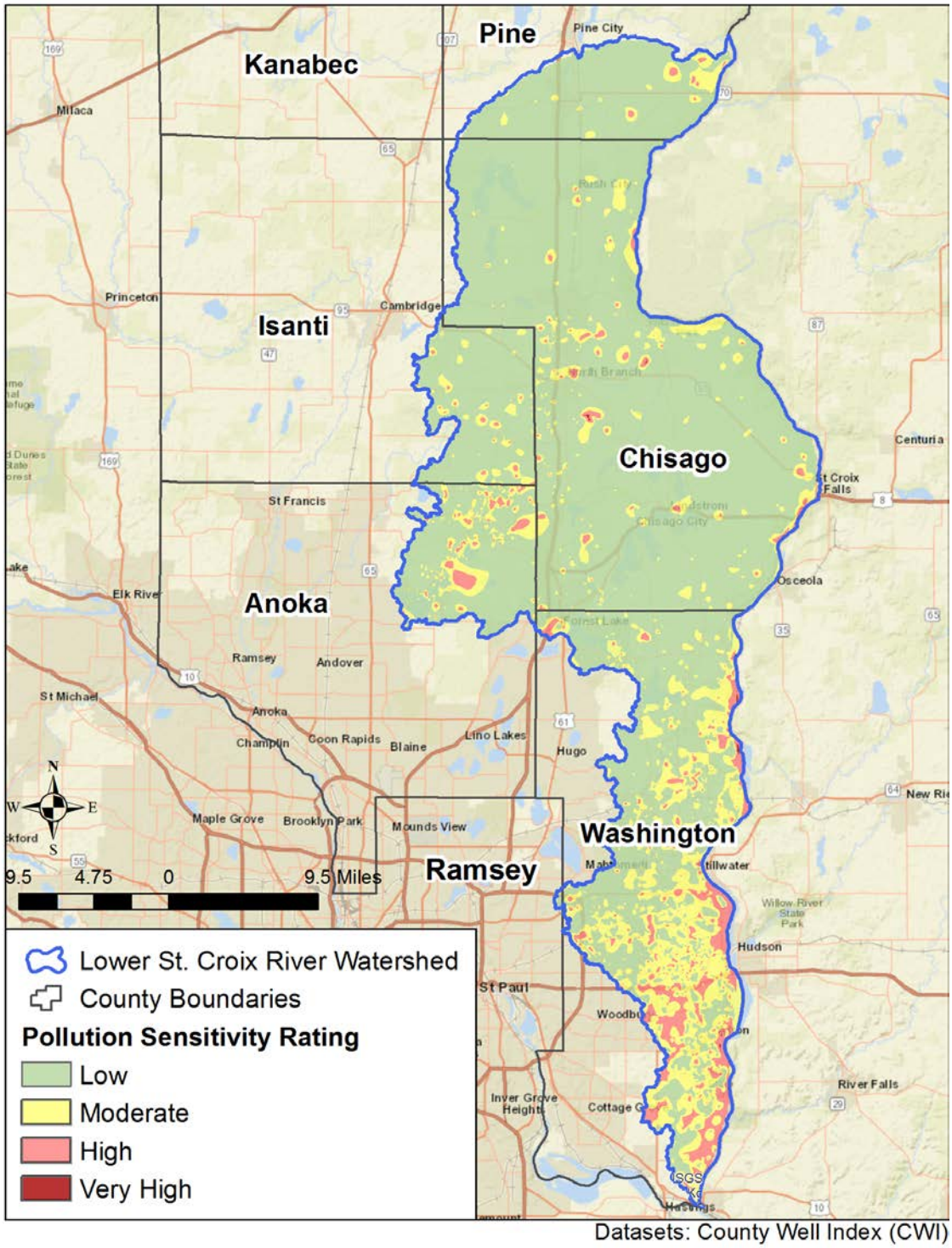


Figure 10. Lower St. Croix Watershed Pollution Sensitivity of Wells (MDH, 2018)

6.3 GROUNDWATER QUALITY

Both naturally occurring and human-made contaminants affect groundwater quality in the Lower St. Croix Watershed. Nitrate, pesticides, arsenic, radium, perfluoroalkyl substances (PFAS), and volatile organic compounds (VOCs) have been detected in wells sampled in the watershed (MDH, 2018).

Nitrate is one of the most common groundwater contaminants in Minnesota and is a public health concern where it's found in groundwater used for drinking. Non-natural sources of nitrate include animal manure, fertilizers (both agricultural and urban/suburban), failing subsurface sewage treatment systems (SSTS), and nitrous oxides from the combustion of coal and gas. Nitrate easily dissolves in water and moves readily through soil and into aquifers.

The drinking water standard and State Health Risk Limit for nitrate is 10 mg/L. Less than one percent of 12,249 wells sampled in the Lower St. Croix River Watershed had levels of nitrate at or above this standard (MDH, 2018). However, high levels of nitrate are present in areas where there are human-caused sources of nitrate and high pollution sensitivity.

In Washington County, the average nitrate level is 2.05 mg/l based on over 14,000 well water tests conducted between 1978 and 2013 (Washington Co., 2014). Nitrate levels are highest in the southern Washington County communities of Cottage Grove, Denmark Township, and Grey Cloud Island. In the southern portion of the county, the bedrock is close to the surface, covered by a thin layer of glacial material offering limited protection to the nitrate-sensitive aquifers below. Historical data collected by Washington County's Department of Public Health and Environment and supported by a MPCA study indicate 16 percent of the private wells tested in the Cottage Grove area exceed the 10.0 mg/l nitrate (MPCA, 2000).

Pesticides are used in a variety of landscapes and can cause a variety of health problems if consumed in drinking water. The Minnesota Department of Agriculture (MDA) monitors three wells in the Lower St. Croix Watershed for "common detection pesticides" used in row crop agricultural including acetochlor, alachlor, atrazine, metolachlor, and metribuzin. These wells are in regions of sensitive geology which increases the potential for groundwater contamination. A range of one to two common detection pesticides were detected in the samples and no detections exceeded human health-based drinking water standards.

In Washington County, an MPCA study in 2000 in the Cottage Grove area tested 74 private wells and found that 68 percent of the groundwater samples contained pesticide or pesticide breakdown products. None of the samples collected by the MPCA exceeded the federal and state drinking water standards for pesticides. According to the study, there was a strong correlation between pesticides and nitrate occurrences in groundwater. The MPCA states that the correlation between pesticides and nitrate indicates that agricultural practices are the most likely source of the contaminants (Washington Co., 2014).

Recently, the MDA began evaluating pesticide presence and magnitude in private residential drinking water wells as part of the Private Well Pesticide Sampling (PWPS) Project in 2014 as a companion program to the MDA Township Testing Program (TTP). Townships in different counties have been, and will continue to be, sampled every year until the project concludes in 2020. Townships in the PWPS depend on the participation of well owners and may not reflect all of the townships sampled in the TTP. In 2015, as part of the PWPS Project, 173 wells in 2 townships in Washington County (Cottage Grove and

Denmark) were sampled for pesticides. Samples were analyzed for only 22 compounds, with higher Method Reporting Levels (MRLs). One pesticide (metolachlor) was detected in two wells out of those sampled in these two townships. No levels exceeded human health reference values (MDA, 2016)

Arsenic and radium are naturally occurring chemicals found in groundwater from certain aquifers. Approximately four percent of newly constructed wells in the Lower St. Croix River Watershed have arsenic levels above the Safe Drinking Water Act standard of 10 ug/L (MDH, 2018). Human activity does not tend to exacerbate the presence or abundance of these chemicals. However, private well users should be made aware of their possible presence and health risks.

Perfluoroalkyl Substances (PFAS), also referred to as Perfluorochemicals (PFCs), are a family of manmade chemicals that have been used for decades to make products that resist heat, oil, stains, grease, and water. PFAS are extremely stable and do not breakdown in the environment if they are released through spills and disposal.

The greatest concentration of PFAS in the Lower St. Croix Watershed is concentrated in the Oakdale, Lake Elmo, and West Lakeland areas in Washington County. The contamination is traced back to PFA disposal in the former Washington County Landfill during the 1960s and 1970s and the 3M Oakdale disposal site, a Superfund site on EPA's National Priority List, used during the late 1940's to 1950's (MDH, 2018). Remediation efforts are underway by 3M, and are led by the Minnesota Pollution Control Agency (MPCA), who also work very closely with the MDH regarding testing of private and public wells. After PFAS contamination was initially discovered, a number of private wells were issued well advisories, and a treatment plan was constructed to treat the City of Oakdale's water supply. In recent years, EPA and MDH have issued new health advice which has resulted in treatments to make both private wells and public water supplies safer for residents. MDH continues to work with the MPCA to sample both public and private wells, and provides regular updates to Washington County staff on testing results, well advisories, and other pertinent information (Washington County, 2018).

Volatile Organic Compounds (VOCs) are carbon-containing compounds that evaporate easily from water into air at normal air temperatures and typically have a strong odor associated with them. They are found in a wide variety of commercial, industrial and residential products including fuel oils, gasoline, solvents, cleaners and degreasers, paints, inks, dyes, refrigerants, and pesticides. When VOCs are spilled or improperly disposed of, a portion will evaporate, but some will soak into the ground. Rain, water or snowmelt push VOCs deeper into the soil until they reach the groundwater table and can end up in wells and drinking water.

VOC contamination has been found in three areas in the Lower St. Croix Watershed including Baytown/West Lakeland Townships, Lake Elmo/Oakdale, and Lakeland/Lakeland Shores. Some public and private wells in these areas use granular activated carbon filters to treat drinking water and remove VOCs.

6.4 GROUNDWATER USE

Population growth and development impacts groundwater supply by increasing demand and reducing infiltration and recharge areas. Overuse of groundwater decreases the amount available for public and private water supplies. It also impacts water levels in some natural resources including some lakes, wetlands, and streams. With population growth there is increased development of impervious surfaces, reducing the land area available for aquifer recharge.

Weather also affects groundwater supply. The highest demand on aquifers often comes from irrigation during drought conditions. The combination of drought, decreased recharge of aquifers, and additional use for irrigation poses a serious threat to groundwater supplies. In the Twin Cities Metropolitan Area, summer water usage is 2.6 times the water usage in the winter (U of M, 2011).

In the Lower St. Croix Watershed approximately 3,700 million gallons (MG) of groundwater are pumped for consumptive uses each year, 90% of which comes from bedrock aquifers. Surficial sand (water table) and buried sand and gravel (confined) aquifers account for a small percentage of use (Figure 11). More than 80% of the groundwater is used for public water supply which has increased from 2,000 MG per year in 1990 to 3,000 MG per year in 2016. The next largest use of groundwater is industrial processing, followed by non-crop irrigation. These uses have remained stable over the years (Table 1.)

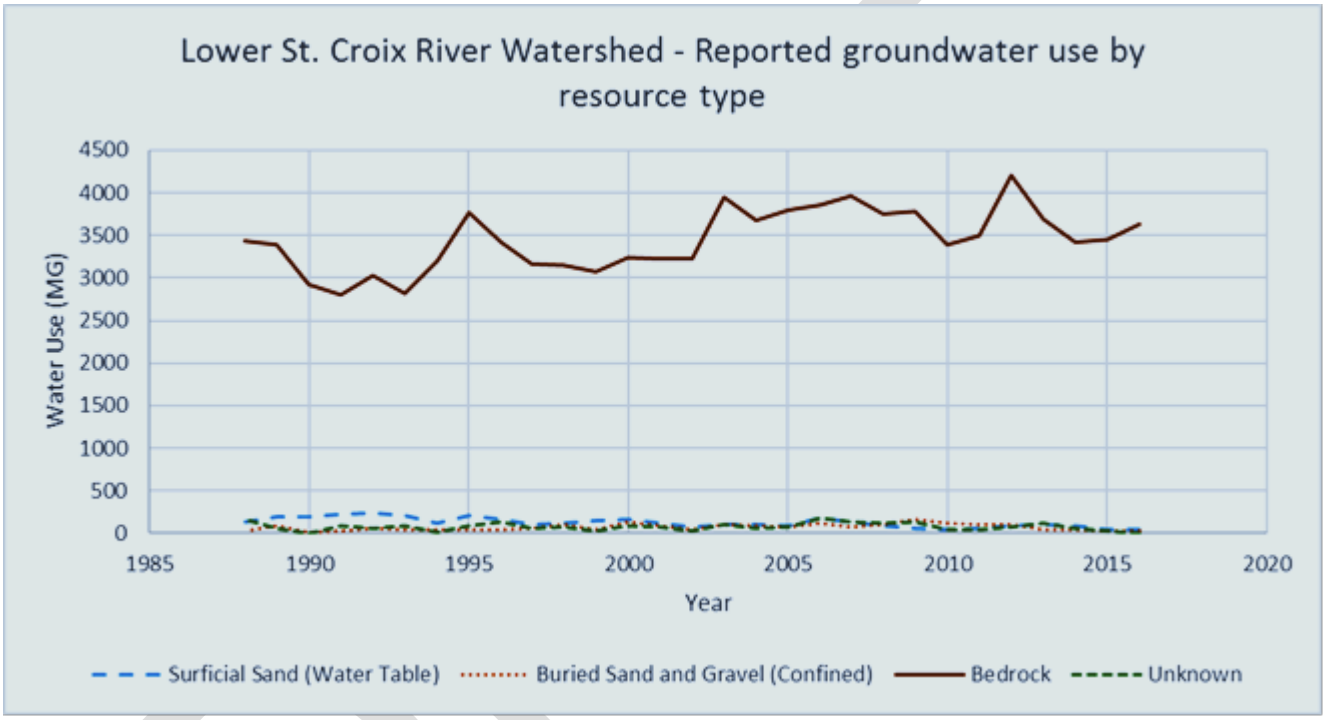


Figure 11. Reported Groundwater Use by Aquifer Type (MDH, 2018)

Table 1. Reported 2016 Water Use from DNR Groundwater Appropriation Permit Holders (MDH, 2018)

Aquifer	Water Supply	Agricultural Irrigation	Industrial Processing	Non-Crop Irrigation	Power Generation	Other	Total (MGY)	Total (percent)
Surficial Sand (Water Table)	-	2	33	-	-	15	50	1.35
Buried Sand and Gravel (Confined)	18	2	-	2	-	4	26	0.70
Bedrock	3023	64	206	154	52	125	3624	97.81
Unknown	-	5	-	-	-	-	5	0.14
Total (MGY)	3041	73	239	156	52	144	3705	100.00
Total (percent)	82.14	1.92	6.46	4.27	1.40	3.81	100.00	--

6.5 GROUNDWATER AND SURFACE WATER WITHDRAWLS

The Minnesota Department of Natural Resources (MnDNR) permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or one million gallons per year. Permit holders are required to track water use and report back to the MnDNR yearly. MnDNR has records of reported water use from 1988 to the present. The changes in withdrawal volume are a representation of water use and demand in the watershed and are taken into consideration when the MnDNR issues permits for water withdrawals. Other factors considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

The largest water user in the LSCR Watershed uses St. Croix River water for cooling at a power plant. Power plant cooling uses about 120 billion gallons per year, or 97% of the reported water use in the LSCR Watershed. Power plant cooling is mostly non-consumptive and greatly skews the water use statistics, so power plant cooling has been removed from the water use statistics for the remainder of this section.

Of all non-power plant cooling water appropriated in 2016 in the LSCR Watershed (3.8 billion gallons), approximately 97% of water appropriations were from groundwater resources with the remaining 3% of coming from surface water resources (Figure 12). Water use statistics indicate that the vast majority of historical water use within the LSCR Watershed has been from groundwater resources (MDH, 2018).

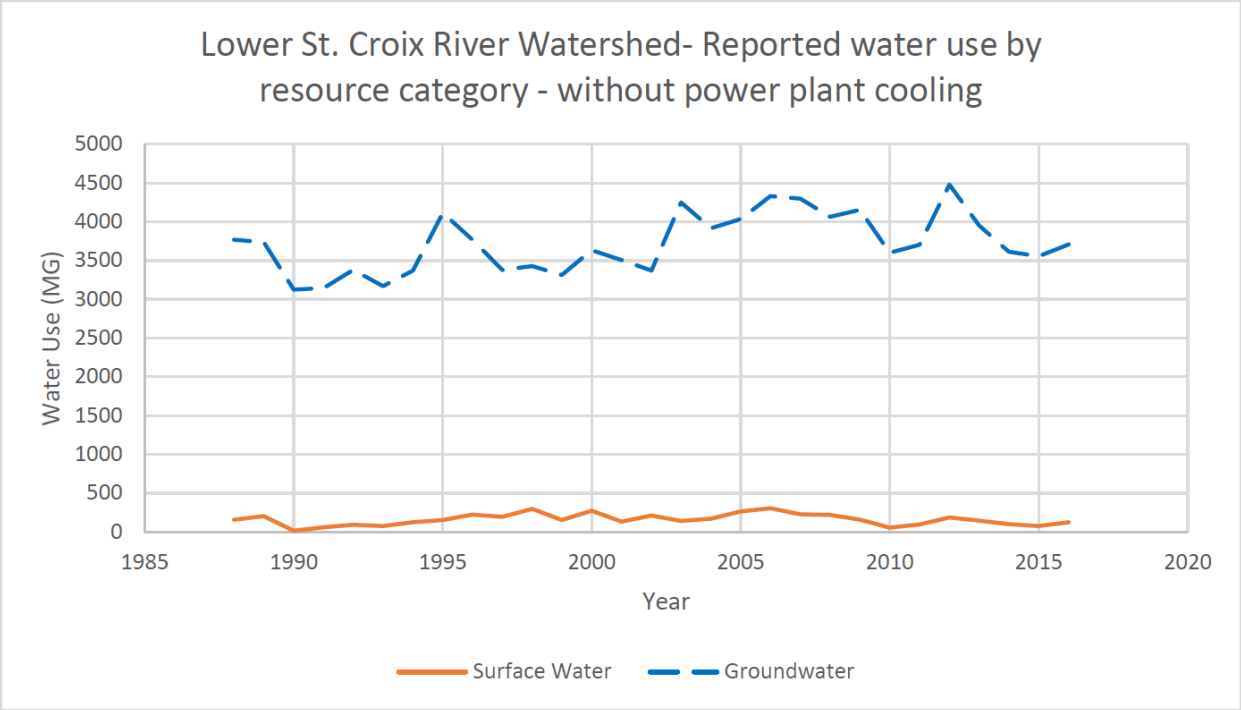


Figure 12. Reported Water Use by Resource Category (MDH, 2018)

7. FISH, WILDLIFE, AND RARE AND ENDANGERED SPECIES

7.1 FISH AND WILDLIFE HABITAT

This section provides a broad summary of fish, wildlife, and rare and endangered species within the LSCR Watershed. Specific sites, species, and more information can be found using the Lower St. Croix River One Watershed One Plan Interactive Map available at https://maps.barr.com/LSCWD/1W1P/index.html.

7.1.1 TERRESTRIAL ENVIRONMENT

The LSCR Watershed is primarily located within the North Central Hardwood Forest Ecoregion with small portions in the Northern Lakes and Forests in the north and Western Corn Belt Plains to the south. According to the Ecological Classification System (ECS), the LSCR Watershed is located within the Eastern Broadleaf Forest Province and the Laurentian Mixed Forest Province, the Western Superior Uplands Section and the Minnesota and Northeast Iowa Morainal Section. The watershed also lays within the Mille Lacs Uplands, the St. Croix Moraine, the Anoka Sand Plain, and the St. Paul Baldwin Plains and Moraines Subsections. These are further defined on the MnDNR website for the Ecological Classification System: http://www.dnr.state.mn.us/ecs/index.html (MnDNR, 2018(i)).

The St. Croix River is an important flyway for migrating birds in the spring and fall. Millions of birds travel through the St. Croix River Valley, which connects the Mississippi flyway with the western Great Lakes basin and much of central Canada. Habitat in the watershed is important to the journey of these birds and has the potential to attract an incredible diversity of species. Important birding areas include the Carlos Avery Wildlife Management Area, St Croix Bluffs Regional Park, and Lake St. Croix.

Sixteen bird species considered endangered, threatened, or of special concern by the State of Minnesota have been documented in the LSCR Watershed.

Invasive plants and animals can have a detrimental effect on wildlife habitat. Common terrestrial invasive species in the LSCR Watershed include glossy buckthorn (*Frangula alnus*), European buckthorn (*Rhamnus cathartica*), garlic mustard (*Alliaria petiolata*), spotted knapweed (*Centaurea stoebe ssp. micranthos*), wild parsnip (*Pastinaca sativa*), emerald ash borer (*Agrilus planipennis*), and brown marmorated stink bug (*Halyomorpha halys*).

The invasive fugus (*Bretziella fagacearum*, formerly *Ceratocystis fagacearum*) causes oak wilt; a deadly disease that affects all species of oaks (Quercus) found in Minnesota. The fungus invades the water-conducting vessels of oaks, eventually killing infected trees. Oak wilt is a significant concern in uplands throughout the LSCR Watershed.

Section 7.2.2 presents further information from the Minnesota County Biological Survey, Sites of Biodiversity Significance and Native Plant Communities.

7.1.2 AQUATIC ENVIRONMENT

Many lakes in the LSCR Watershed are popular fishing destinations. Some of the most common fish species found in major LSCR Watershed lakes include black bullhead, black crappie, bluegill, brown bullhead, green sunfish, hybrid sunfish, largemouth bass, muskellunge, northern pike, walleye, common carp, pumpkinseed, yellow bullhead, yellow perch, white sucker, and golden shiner (MnDNR 2018(ii)). There are multiple trout streams within the LSCR Watershed including Brown's Creek, Valley Branch and Valley Creek, Old Mill Stream, and Lawrence Creek (MnDNR, 2015).

Aquatic invasive species (AIS) can be found in or around most lakes and many wetlands throughout the LSCR Watershed. AIS can negatively impact ecological integrity as well as recreational suitability of a waterbody. Aquatic invasive plants present in the LSCR Watershed include Eurasian watermilfoil (Myriophyllum spicatum), European common reed (*Phragmites australis)*, curly-leaf pondweed (Potamogeton crispus), flowering rush (*Butomus umbellatus)*, narrow leaved cattail (Typha angustifolia), purple loosestrife (Lythrum salicaria), reed canary grass (*Phalaris arundinacea)*, watercress (*Nasturtium officinale)*, and yellow iris (*Iris pseudacorus)*. Aquatic invasive animal species include Asian clam (*Corbicula fluminea)*, Chinese mystery snail (*Cipangopaludina chinensis)*, bighead carp (*Hypophthalmichthys nobilis)*, grass carp (*Ctenopharyngodon idella)*, common carp (*Cyprinus carpio)*, rainbow smelt (*Osmerus mordax)*, rusty crayfish (*Orconectes rusticus)*, and zebra mussels (*Dreissena polymorpha)*.

The MPCA Lower St. Croix Watershed Biotic Stressor Identification Report presents a summary of key causes or "stressors" that contribute to impaired fish and aquatic macroinvertebrate communities in the LSCR (MPCA, 2016).

7.2 RARE AND ENDANGERED FEATURES

7.2.1 RARE AND ENDANGERED PLANT AND ANIMAL SPECIES

Minnesota's Endangered Species Statute (MS.84.0895) requires the MnDNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of concern. Corresponding regulations that regulate the treatment of species designated as endangered and

threatened are in Minnesota Administrative Rules (MN R.6212.1800 - 6212.2300). There are 152 species of plants and animals within the LSCR 1W1P boundary that are listed in Minnesota's List of Endangered, Threatened, and Special Concern Species (MN R. 6134), including 25 different freshwater mussels. There are 7 species of plants and animals within the LSCR 1W1P boundary that are listed as federal endangered or threatened. These include five Federally endangered freshwater mussels: Higgins Eye (*Lampsilis higginsii*), sheepnose (*Plethobasus cyphyus*), snuffbox (*Epioblasma triquetra*), spectaclecase (*Cumberlandia monodonta*), and winged mapleleaf (*Quadrula fragosa*).

7.2.2 MCBS SITES OF BIODIVERSITY SIGNIFICANCE AND NATIVE PLANT COMMUNITIES

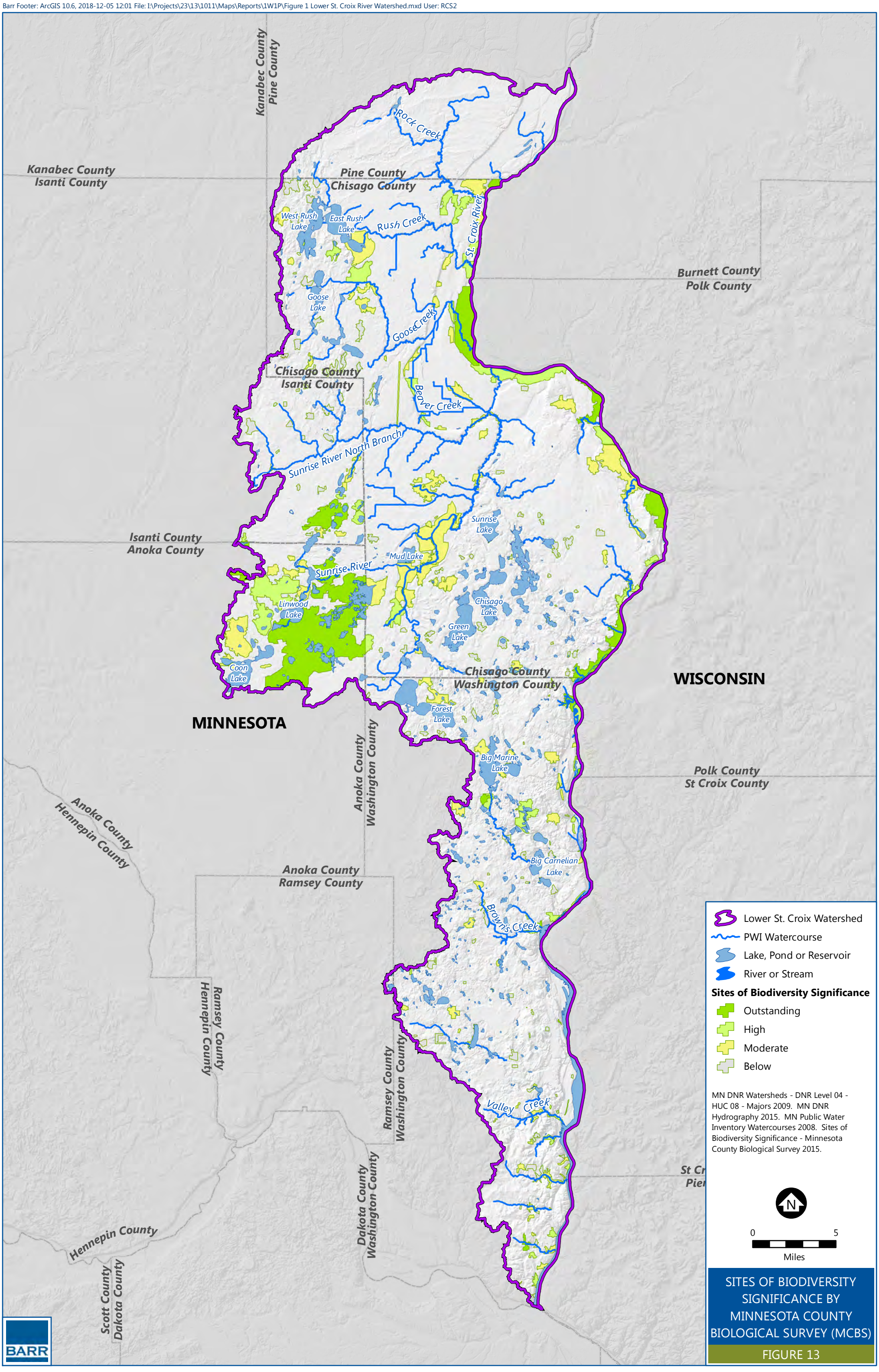
The Minnesota County Biological Survey (MCBS) is a MnDNR program within the Division of Ecological and Water Resources with the goal of identifying significant natural areas and collecting and interpreting data on the distribution and ecology of rare plants, rare animals, and native plant communities. Data collected by MCBS are entered into the Natural Heritage Information System, managed by the DNR's Division of Ecological and Water Resources. As a result of this systematic survey, the relative ecological importance of natural areas and representative ecological landscapes can be assessed.

MCBS ecologists delineated sites of biodiversity significance that helped to geographically organize the data. According to the MCBS data, there are 76 sites of "outstanding" or "high" biodiversity significance encompassing approximately 37,770 acres within the LSCR Watershed and 1,730 areas of native plant communities (16 different types of native communities) encompassing approximately 39,883 acres (Figure 13).

Along the St. Croix River itself, common native plant communities include: Mesic Hardwood Forest System, Wet Meadow/Carr System, Wet Forest System, Marsh System, Floodplain Forest System, Fire-Dependent Forest/Woodland System, and Forested Rich Peatland System. The majority of native plant community acreage is found further to the north, especially north of the city of Marine on St. Croix. Clusters of native plant communities can be found elsewhere in the watershed as well. Near Linwood Lake and the Isanti-Anoka county border, a diverse mixture of the aforementioned communities exists. South of Rush Lake in Chisago County, communities of swamp and peatland can be found. Fire-Dependent Forest/Woodland System communities are widespread near Big Marine Lake and the Warner Nature Center. Further south, communities of Upland Prairie System, Mesic Hardwood Forest System, and Fire-Dependent Forest/Woodland System are found near Afton State Park and St. Croix Bluffs Regional Park.

Sites of biodiversity significance mirror the locations of native plant communities with larger and higher quality sites being found further to the north. Significant acreages of "outstanding" biodiversity significance exist near Linwood Lake and the Isanti-Anoka county border, and in Wild River State Park and other reaches of the St. Croix River.

Minnesota Sites of Biodiversity Significance and Native Plant Communities can be viewed using the Lower St. Croix One Watershed One Plan Interactive Map at: https://maps.barr.com/LSCWD/1W1P/index.html.



SITES OF BIODIVERSITY SIGNIFICANCE BY MINNESOTA COUNTY BIOLOGICAL SURVEY (MCBS)

FIGURE 13

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