South Fork Crow River Watershed Restoration and Protection Strategy Report

October 2018

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Key Terms

Assessment Unit Identifier (AUID): The unique waterbody identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-*a*, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Minnesota River Basin is assigned a HUC-4 of 0702 and the Pomme de Terre River Watershed is assigned a HUC-8 of 07020002.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic Integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and nonpollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

What is the WRAPS Report?

Minnesota has adopted a watershed approach to address the state's 80 major watersheds. The Minnesota watershed approach incorporates **water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results** into a 10-year cycle that addresses both restoration and protection.

Figure 1: Watershed Approach 10-year cycle.

Along with the watershed approach, the Minnesota Pollution Control Agency (MPCA) developed a process to identify and address threats to water quality in each of these major watersheds. This process is called Watershed Restoration and Protection Strategy (WRAPS) development. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired and Total Maximum Daily Load (TMDL) studies are developed for them. TMDLs are incorporated into WRAPS. Waters not meeting state standards are listed as impaired and TMDL studies are developed for them. TMDLs are incorporated into WRAPS. In addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as the basis for addressing U. S. Environmental Protection Agency's (EPA) Nine Minimum Elements of watershed plans to help qualify applicants for eligibility for Section 319 implementation funds.

Purpose	•Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning •Summarize Watershed Approach work done to date including the following reports: •*South Fork Crow River Watershed Monitoring and Assessment* •*South Fork Crow River Watershed Biotic Stressor Identification* •*South Fork Crow River Watershed Total Maximum Daily Loads* •*Pioneer-Sarah Creek TMDL/WRAPS project*
Scope	•Impacts to aquatic recreation and impacts to aquatic life in streams •Impacts to aquatic recreation in lakes
Audience	•Local working groups (local governments, Soil and Water Conservation Districts (SWCDs), watershed management groups, etc.) •State agencies (MPCA, DNR, BWSR, etc.)

1. Watershed Background & Description

The South Fork Crow River Watershed drains 1,279 square miles and is located in the Upper Mississippi River Basin in central Minnesota. It encompasses portions of Kandiyohi, Meeker, Renville, McLeod, Carver, Sibley, Wright, and Hennepin Counties (Figure 2). The South Fork Crow River flows out of Little Kandiyohi Lake in Kandiyohi County and then flows east through Meeker, McLeod, Carver, and Wright Counties, finally converging in Rockford with the North Fork Crow River. Buffalo Creek, a major tributary to the South Fork Crow River, originates in Renville County and flows east through McLeod County. The Buffalo Creek joins the South Fork Crow River in Carver County, just across the Carver/McLeod County line.

The South Fork Crow River Watershed is predominately located within the Western Corn Belt Plains Ecoregion in Minnesota, while a small segment rests in the North Central Hardwood Forest Ecoregion.

The watershed is home to 72,284 people who live in rural areas of the watershed and in a number of cities including Cosmos, Delano, Glencoe, Hutchinson, Lester Prairie, Mayer, and Watertown. As a state water trail, the river provides 104 miles of paddling opportunities for canoeists and kayakers who are looking for a gentle ride. Additionally, there is access to the Luce Line State Trail, city and county parks, and camping facilities.

Table 1 lists additional information sources for the South Fork Crow River Watershed.

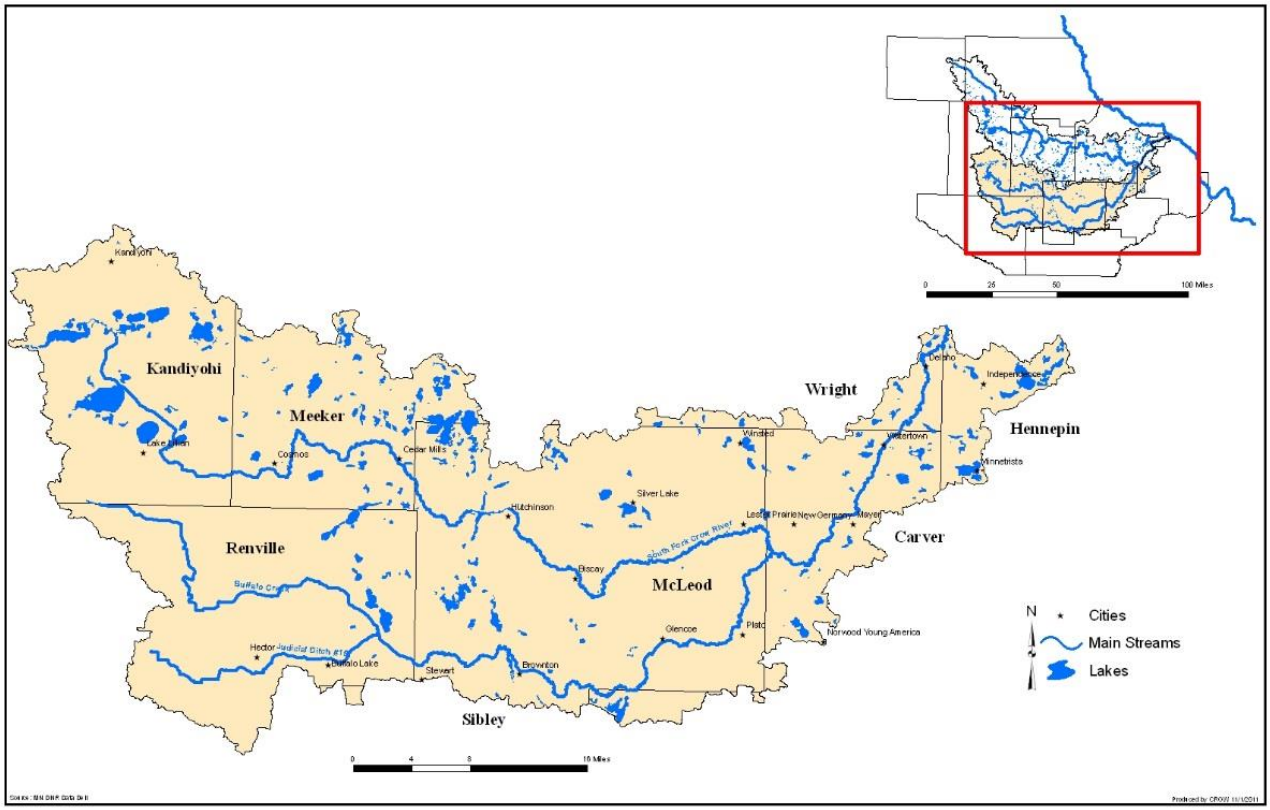


Figure 2: South Fork Crow River Watershed Map, inset with North Fork Crow River Watershed

Table 1: Previous Studies in the South Fork Crow River Watershed

Study Name	Year Completed	Contractor	Summary
Crow River Diagnostic Study	2005	Crow River Organization of Water	This study evaluated potential nutrient sources in a comprehensive manner that helped identify problem areas in the watersheds. Numerical, measurable, and achievable short and long term goals were set for both watersheds in the Crow Subbasin. Can be found at www.crowriver.org
South Fork Crow River Lakes TMDL Implementation Plan	2010	Carver County Water Management Organization	This study evaluates the excess nutrient impairments and conditions in shallow Eagle, Oak, and Swede Lakes. https://www.pca.state.mn.us/sites/default/files/wq-iw8-23c.pdf
South Fork Crow River Watershed: Water Plans	2014	Minnesota State University, Mankato: Water Resource Center	This document summarizes the local water plans that dictate the allocation of resources in the South Fork Crow River Watershed for restoration and protection. http://mrbdc.mnsu.edu/mnnutrients/sites/mrbdc.mnsu.edu.mnnutrients/files/public/watershed/pm_waterplans/untitled%20folder/19_sfrkc_wp.pdf
Crow River: Fast Facts	2014	Metropolitan Council	A quick summary of the results borne from long-term water quality monitoring and its implications for water use in the Twin Cities. https://metrocouncil.org/
Pioneer-Sarah Creek TMDL/WRAPS project	2017	Wenck Associates, Inc.	https://www.pca.state.mn.us/water/tmdl/pioneer-sarah-creek-watershed-restoration-and-protection-strategy-tmdl-project

Additional South Fork Crow River Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the South Fork Crow River Watershed:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/rwa/?cid=nrcs142p2_023594

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the South Fork Crow Watershed:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb19.pdf

Minnesota Department of Natural Resources (DNR) State Water Trails for Crow River, South Fork:
http://www.dnr.state.mn.us/watertrails/southforkcrowriver/index.html

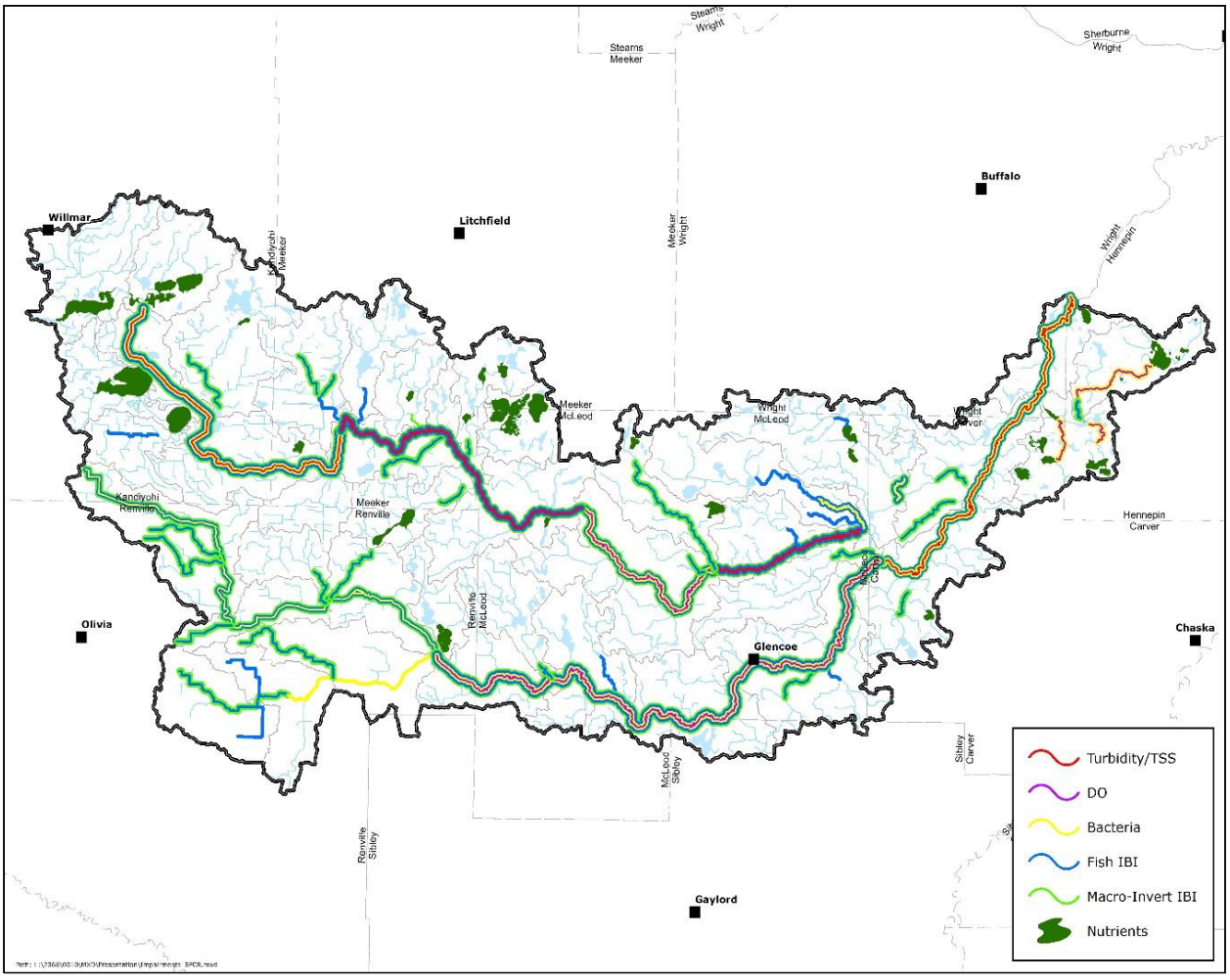
Minnesota Nutrient Planning Portal (MSU-M WRC) South Fork Crow River:
http://mrbdc.mnsu.edu/mnnutrients/watersheds/south-fork-crow-river-watershed

South Fork Crow River Watershed Health Assessment Scores:
http://mrbdc.mnsu.edu/mnnutrients/sites/mrbdc.mnsu.edu.mnnutrients/files/public/watershed/pm_what/southforkcrow.pdf

2. Watershed Conditions

Water body condition refers to water bodies' status with regard to fishable and swimmable water quality standards. The standards represent the minimum condition needed to support fishable and swimmable water uses. This section summarizes condition information, including water quality data and associated impairments. For waterbodies found not able to support fishable, swimmable standards, the reason for these poor conditions – the pollutants and/or stressors – are identified. Refer to Section 2.1 for tables of impairments, stressors, and pollutants by stream reach and lake. More information on individual streams and lakes, including water quality data and trends, can be reviewed on the Environmental Data Application (MPCA 2015b). This report covers only impairments to aquatic recreation and aquatic life (Figure 3). Several other lakes and stream reaches are listed as impaired for aquatic consumption use (due to mercury and polychlorinated biphenyls [PCBs]).

Figure 3: South Fork Crow River Watershed Impairments



2.1 Condition Status

This section summarizes the impairment status of the lakes and streams assessed within the South Fork Crow River Watershed. Table 2 is a summary of streams that have been assessed for aquatic life parameters, including dissolved oxygen (DO), index of fish biotic integrity (Fish IBI) and macroinvertebrate index of biotic integrity (Invert IBI), and turbidity. Additionally, a number of sites were assessed for aquatic recreation suitability using bacteria (fecal coliform or *E. coli*) as a reference. Lakes in Table 3 have been evaluated for aquatic recreation using total phosphorus (TP) as a parameter. Some of the waterbodies in the South Fork Crow River Watershed are impaired by mercury; however, this report covers only impairments to aquatic recreation and aquatic life. Several lakes and stream reaches are listed as impaired for aquatic consumption use (due to mercury and PCBs). The State-wide Mercury TMDL (MPCA 2007a) has been published and Fish Consumption Advice (MDH 2018) is available from the Department of Health.

In general, impaired water quality of lakes and streams is widespread throughout the watershed from the headwaters to its outlet into the main stem of the Crow River near Rockford. Many of the impairments in the watershed are typical of a predominantly agricultural watershed, where a significant number of watercourses have been channelized, the landscape has been drained, and nutrients are easily transported to nearby waterbodies.

Streams

Sixty-two Assessment Unit Identifier (AUID) stream segments have been assessed for aquatic life or aquatic recreation. As mentioned previously, the parameters used to assess aquatic life are IBI, DO, and turbidity, while the parameter used to assess aquatic recreation is bacteria (*E. coli* and fecal coliform). The 62 AUIDs were assessed using the aforementioned criteria are summarized in Table 2, which is organized by HUC-10 watershed, listed from west to east. Of the 62 that have been assessed, five fully support aquatic life and four fully support aquatic recreation, while 26 are impaired for aquatic life use and 13 are impaired for aquatic recreation use.

TMDLs have not yet been completed for stream reaches that were added to the 303(d) impaired waters list in 2016.

Table 2: Assessment status of stream reaches in the South Fork Crow River Watershed, presented (mostly) from north to south

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life							Aq Rec
				Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	Ammonia	Bacteria
Headwaters South Fork Crow River	541	County Ditch 23A	T119 R35W S23, west line to Wagonga Lk	NA	NA	NA	NA	NA	NA	NA	NA
	592	Unnamed ditch	Headwaters to S Fk Crow R	NA	NA	NA	NA	NA	NA	NA	NA
	607	Big Kandiyohi Channel	Wagonga Lk to Unnamed lk (34-0440-00)	SUP	SUP	NA	NA	NA	NA	NA	NA
	608	State Ditch Branch 2	Unnamed ditch to Unnamed ditch	IMP	IMP	NA	NA	NA	NA	NA	NA
	610	County Ditch 24A	Unnamed ditch to Unnamed ditch	IMP	NA	NA	NA	NA	NA	NA	NA
	612	Unnamed ditch	CD 51 to S Fk Crow R	SUP	SUP	NA	NA	NA	NA	NA	NA
	650	Unnamed ditch	Unnamed cr to -94.939 45.1036	NA	NA	NA	NA	NA	NA	NA	NA
	658	Crow River South Fork	Headwaters to 145th St	IMP	SUP	IF	IMP	SUP	SUP	SUP	IMP
	557	Unnamed ditch	Unnamed lk (34-0440-00) to Big Kandiyohi Lk	NA	NA	NA	NA	NA	NA	NA	NA
	556	County Ditch 24A	Unnamed ditch to S Fk Crow R	NA	NA	NA	NA	NA	NA	NA	NA
Judicial Ditch No 28A	502	Buffalo Creek	Headwaters to JD 15	IMP	IMP	IF	SUP	SUP	SUP	SUP	IMP
	504	Judicial Ditch 67	Headwaters to Buffalo Cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	528	County Ditch 4	Unnamed ditch to Buffalo Cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	625	Judicial Ditch 9	Headwaters to Buffalo Cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	630	Unnamed ditch	Headwaters to Buffalo Cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	631	County Ditch 7A	Unnamed cr to Buffalo Cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	568	Unnamed creek	Preston Lk to JD 28A (Buffalo Cr)	NA	NA	NA	SUP	NA	NA	NA	NA
	566	Unnamed creek	Lk Allie to Preston Lk	NA	NA	NA	IF	NA	NA	NA	NA

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life							Aq Rec
				Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	Ammonia	Bacteria
Judicial Ditch No 15	509	JudicialDitch15	HeadwaterstoT115R32 WS31,eastline	IMP	IMP	NA	NA	NA	NA	NA	NA
	513	JudicialDitch15	T115R32WS32,westline toBuffaloCr	NA	NA	IF	NA	NA	SUP	SUP	IMP
	626	JudicialDitch15branch	HeadwaterstoJD15mainstem	IMP	NA	NA	NA	NA	NA	NA	NA
	627	JudicialDitch15branch	HeadwaterstoJD15mainstem	IMP	NA	NA	NA	NA	NA	NA	NA
	628	JudicialDItch15branch	HeadwaterstoJD15mainstem	IMP	IMP	NA	NA	NA	NA	NA	NA
City of Hutchinson – South Fork Crow River	506	Judicial Ditch 29	Headwaters to S Fk Crow R	SUP	SUP	NA	NA	NA	NA	NA	NA
	533	Unnamed creek	Unnamed cr to Unnamed cr	IMP	IMP	NA	NA	NA	NA	NA	NA
	549	Belle Creek	Headwaters to JD 18	IMP	IMP	NA	NA	NA	NA	NA	NA
	550	Judicial Ditch 18	Belle Cr to S Fk Crow R	IMP	SUP	NA	NA	NA	NA	NA	NA
	609	County DItch 18	Headwaters to S Fk Crow R	IMP	IMP	NA	NA	NA	NA	NA	NA
	613	King Creek T118 R32W S36	north line to S Fk Crow R	IMP	SUP	NA	NA	NA	NA	NA	NA
	620	Judicial Ditch 1	Unnamed cr to S Fk Crow R	SUP	SUP	NA	NA	NA	NA	NA	NA
	621	Unnamed creek	Unnamed cr to S Fk Crow R	SUP	IMP	NA	NA	NA	NA	NA	NA
	623	Unnamed creek	Unnamed cr to JD 18	IMP	IMP	NA	NA	NA	NA	NA	NA
	659	Crow River South Fork	145th St to Hutchinson Dam	IMP	IMP	IF	IMP	SUP	SUP	SUP	IMP
	656	Unnamed creek	140th St to Unnamed cr	IMP	IMP	IF	IF	SUP	SUP	SUP	SUP
	655	Unnamed creek	Hoff Lk to 140th St	NA	NA	NA	NA	NA	NA	NA	NA
City of Lester Prairie – South Fork Crow River	510	Crow River South Fork	Hutchinson Dam to Bear Cr	IMP	IMP	IMP	SUP	NA	SUP	SUP	IMP
	511	Crow River South Fork	Bear Cr to Otter Cr	IMP	IMP	IF	IMP	SUP	SUP	SUP	IMP
	515	Bear Creek	Headwaters to S Fk Crow R	IMP	IMP	NA	NA	NA	NA	NA	NA

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life							Aq Rec
				Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	Ammonia	Bacteria
	611	County Ditch 26/27	165th St to S Fk Crow R	IMP	IMP	NA	NA	NA	NA	NA	NA
	616	McCuen Creek	Headwaters to S Fk Crow R	SUP	SUP	NA	NA	NA	NA	NA	NA
	622	Unnamed creek	T116 R27W S5, west line to S Fk Crow R	IMP	NA	NA	NA	NA	NA	NA	NA
	641	Silver Creek (County Ditch 13)	Unnamed cr to S Fk Crow R	IMP	IMP	NA	NA	NA	NA	NA	NA
	617	Unnamed creek	Headwaters to Otter Cr	IMP	NA	NA	NA	NA	NA	NA	NA
	642	Otter Creek	Headwaters to Cable Ave	IMP	NA	NA	NA	NA	NA	NA	NA
	643	Otter Creek	Cable Ave to S Fk Crow R	IMP	SUP	IF	IF	SUP	SUP	SUP	IMP
	571	Judicial Ditch 1	Winsted Lk to Unnamed ditch	SUP	NA	NA	NA	NA	NA	NA	NA
	572	Judicial Ditch 1	Unnamed ditch to Unnamed cr	IMP	IMP	IMP	IF	SUP	SUP	IF	IMP
	585	Unnamed creek	CD 11 to Winsted Lk	IMP	SUP	NA	NA	NA	NA	NA	NA
	647	Crane Creek	-94.043, 44-9292 to T117 R27W S25, south line	NA	NA	NA	NA	NA	NA	NA	NA
South Fork Crow River	624	Unnamed creek	Unnamed cr to Lippert Lk	IMP	IMP	NA	NA	NA	NA	NA	IMP
	508	Crow River South Fork	Buffalo Cr to N Fk Crow R	IMP	IMP	IF	IMP	IMP	SUP	SUP	IMP
	618	Unnamed creek	Unnamed cr to Eagle Lk Outlet	IMP	IMP	NA	NA	NA	NA	NA	NA
	648	County Ditch 9	Headwaters to -93.9053 44.9055	IMP	IMP	NA	NA	NA	NA	NA	NA
	535	Unnamed creek (Eagle Lake Outlet)	Eagle Lk to Unnamed cr	NA	NA	NA	NA	NA	NA	NA	SUP
	710	Unnamed creek	Headwaters to Lk Rebecca	NA	NA	IF	SUP	SUP	SUP	NA	NA
	564	Unnamed creek	Rice Lk to N Fk Crow R	NA	NA	IF	SUP	SUP	SUP	IF	SUP
	654	Pioneer Creek	T118 R24W S31, north line to T118 R24W S31, south line	IMP	IMP	NA	NA	NA	NA	NA	NA

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life							Aq Rec
				Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	Ammonia	Bacteria
	593	Unnamed creek	Mud Lk (10-0094-00) to Rice Lk (86-0032-00)	NA	NA	IMP	SUP	SUP	SUP	SUP	IMP
	526	Spurzem Creek	Winterhaller Lk to Lk Independence	NA	NA	NA	SUP	NA	NA	NA	NA
	564	Unnamed creek	Rice Lk to N Fk Crow R	NA	NA	IF	SUP	SUP	SUP	IF	SUP
	653	Pioneer Creek	Lk Independence to T118 R24W S30, south line	NA	NA	IMP	SUP	SUP	SUP	SUP	IMP
	594	Deer Creek	Unnamed cr to Ox Yoke Lk	NA	NA	IMP	SUP	SUP	SUP	SUP	IMP

SUP = found to meet the water quality standard; **IMP** = does not meet the water quality standard and therefore, is impaired; **IF** = the data collected was insufficient to make a finding; **NA** = not assessed

Lakes

All 90 lakes assessed in the North Fork Crow River Watershed are classified as class 2B waters for which aquatic life and recreation are the protected beneficial uses (Table 3). Minnesota standards for all class 2 waters states, "…there shall be no material increase in undesirable slime growths or aquatic plants including algae." In order to evaluate whether a lake is in an impaired condition, the MPCA developed "numeric translators" for the narrative standard for purposes of determining which lakes should be included in the Section 303(d) list as being impaired by nutrients. Aquatic life impairments are determined using nutrient criteria parameters that include TP, Secchi depth measurements, and chlorophyll-*a* (Chl-*a*).

Of the 51 lakes assessed, 72.5% have impaired aquatic recreation, 7.8% fully support aquatic recreation, and 19.6% have insufficient data to make an assessment.

Table 3: Assessment status of lakes in the South Fork Crow River Watershed, presented (mostly) from north to south

HUC-10 Subwatershed	Lake Name	Lake ID	Aquatic Recreation
Buffalo Creek	Eagle	43-0098-00	IF
City of Hutchinson – South Fork Crow River	Marion	43-0084-00	IMP
	Belle	47-0049-01	IMP
	Boon	65-0013-00	IMP
	Cedar	43-0115-00	IMP
	Goose	47-0127-00	IMP
	Greenleaf	47-0062-00	IMP
	Hoff	47-0106-00	IMP
	Otter (Main Basin)	43-0085-01	IMP
	Sioux	47-0060-00	IF
	Stahl's	43-0104-00	SUP
	Star	47-0129-00	IF
	Willie	47-0061-00	IMP
Headwaters South Fork Crow River	Big Kandiyohi	34-0086-00	IMP
	Carrie	34-0032-00	SUP
	Eleanor	34-0097-00	IF
	Elizabeth (Main Lake)	34-0022-02	IF
	Ella	34-0033-00	IF
	Johnson	34-0012-00	IMP
	Kasota	34-0105-00	IMP
Judicial Ditch No 28A	Allie	65-0006-00	IF
	Preston	65-0002-00	IMP
	Ardmore	27-0153-00	IMP
	Eagle	10-0121-00	IMP
	Half Moon	27-0152-00	IMP
	Independence	27-0176-00	IMP
	Irene	27-0189-00	IMP
	Mud	10-0094-00	IMP
	North Little Long	27-0179-01	SUP
	North Whaletail	27-0184-01	IMP
	Oak	10-0093-00	IMP
	Ox Yoke	27-0178-00	IF
	Peter (North Bay)	27-0147-02	IMP
	Rebecca	27-0192-00	IMP
	Rice	86-0032-00	IMP
	Robina	27-0188-00	IMP
	South Little Long	27-0179-02	SUP
	South Whaletail	27-0184-02	IMP
	Spurem	27-0149-00	IMP
	Swede	10-0095-00	IMP

HUC-10 Subwatershed	Lake Name	Lake ID	Aquatic Recreation
	Lillian	34-0072-00	IMP
	Little Kandiyohi	34-0096-00	IMP
	Minnetaga	34-0076-00	IMP
	Mud	34-0021-00	IF
	Thompson	47-0159-00	IMP
	Wakanda (Main Basin)	34-0169-03	IMP

HUC-10 Subwatershed	Lake Name	Lake ID	Aquatic Recreation
South Fork Crow River			
City of Lester Prairie – South Fork Crow River	Bear	43-0076-00	IMP
	Silver	43-0034-00	IMP
	South	43-0014-00	IMP
	Swan	43-0040-00	IF
	Winsted	43-0012-00	IMP

Imp = impaired for impacts to aquatic recreation, Sup = fully supporting aquatic recreation, IF = insufficient data to make an assessment

2.2 Water Quality Trends

Long-term monitoring trends are lacking for the South Fork Crow River due to limited monitoring stations; however, the Metropolitan Council has a single sampling location near Mayer, Minnesota (Station ID- 19-082-001, USDA- 05279000, NWS ID: MAYM5). Using QWTREND, a U.S. Geological Survey (USGS) program, a trend analysis of TP, nitrate (NO_3), total suspended solids (TSS), and Chl-*a* was completed for both the historical and recent record (Met Council 2014). The site is located 20.3 miles upstream from the confluence with the North Fork Crow River, where it continues at the main stem of the Crow River. Monitoring included continuous flow monitoring, event-based composite sampling, continuous *in situ* water temperature measurements, and seasonal flow readings conducted by the Minnesota Department of Natural Resources (DNR).

Crow River Organization of Water (CROW) staff, working through the MPCA, collected 27 water quality samples in 2015 and 35 samples in 2016. These samples were evaluated for phosphorus, nitrogen, and TSS. Figures 4 and 5 below show the flow measurements for the season, along with select samples that highlight the changing water conditions in response to precipitation events. The rather large changes seen in the TP and Nitrite/NO_3 results is considered to be likely due to episodic rain events and are probably not indicative of an overall change in water quality during these time periods.

Figure 4: 2016 Delano Event-based Sampling and Secchi Readings (in centimeters)

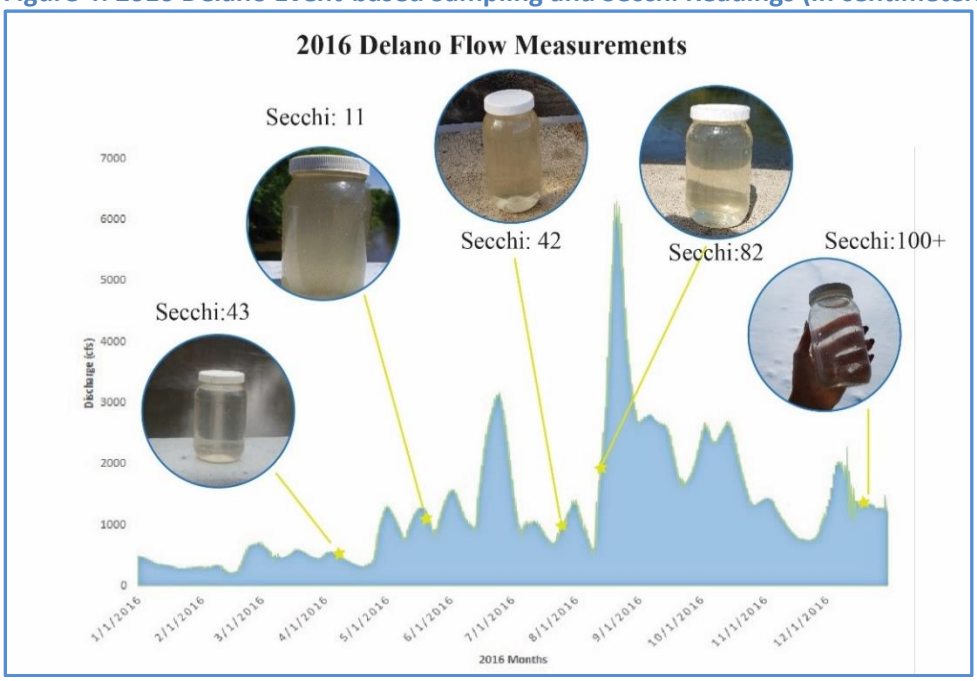


Figure 5: 2015 Delano Event-based Sampling and Secchi Readings

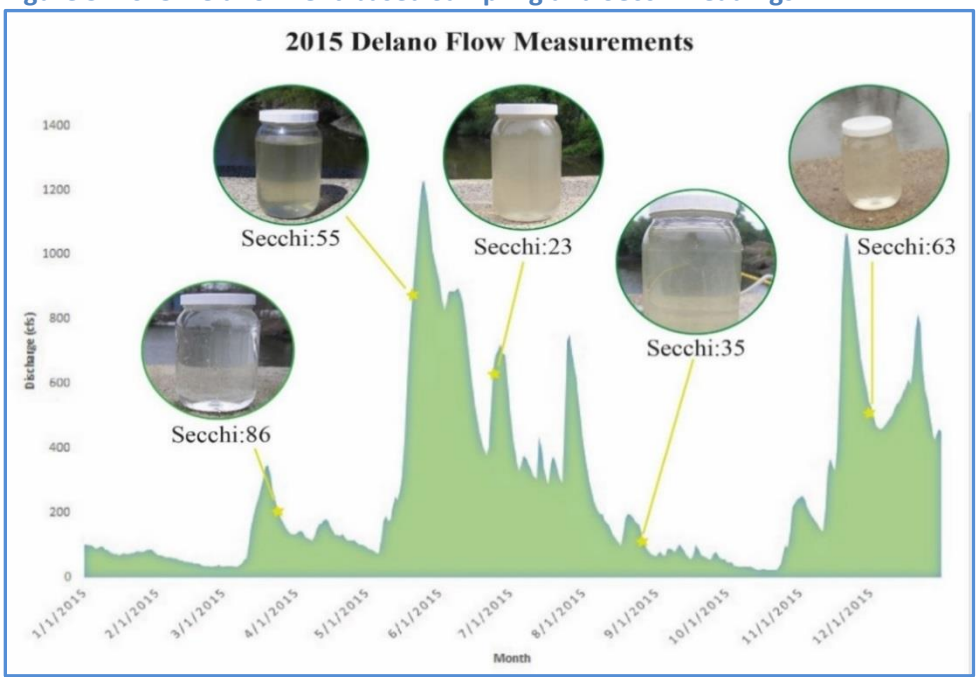


Table 4: Water quality trends of the South Fork Crow River at Mayer, Minnesota; green values indicate an improving trend in water quality while red values indicate a degrading trend in water quality for the parameter. The substantial change in nitrate trends indicated here could be due to low flow vs. high flow cycles.

Parameter	Historical Trend	Recent Trend (1998-2012)	Recent Trend (2001-2006)	Recent Trend (2007-2012)	Recent Trend (2001-2012)
Total Suspended Solids (Met Council 2014)	No Trend	-34%			
Biochemical Oxygen Demand	No Trend	No Trend			
Chloride	No Trend	No Trend			
Chlorophyll A (Met Council 2014)	No Trend	No Trend			
Nitrite/ Nitrate (Met Council 2014)	No Trend		+82%	-69%	
Total Phosphorus (Met Council 2014)	No Trend				-28%

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or pollution sources impacting or threatening them must be identified and evaluated. Biological stressor identification (SID) is done for streams with either fish or macroinvertebrate biota impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g., altered hydrology, fish passage, habitat). Pollutant source assessments are done where a biological SID process identifies a pollutant as a stressor, as well as for the typical pollutant impairment listings. Section 3 provides further detail on stressors and pollutant sources. The discussion below highlights some of the major pollutant sources in the South Fork Crow River identified through the MPCA's assessment process, SID, and TMDL studies.

Altered Hydrology

Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and the intensity of low flow periods.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting both sediment loading in the stream and biological communities that rely on clean substrate for habitat. When unmitigated, water delivered by tile drains is typically high in nutrients (NO_3 and dissolved phosphorus), which can pose a significant threat to downstream lakes, streams, and rivers.

It is estimated that over 90% of the watercourses in the South Fork Crow River Watershed have been altered/channelized (Figure B-2 in Appendix B), and a Geographic Information System (GIS) model completed for this report (Figure B-3 in Appendix B) suggests approximately 45% of the cropland in the watershed has likely been altered with subsurface drain tile. The South Fork Crow River Watershed SID Report (MPCA 2016) identified altered hydrology as a primary stressor in 29 of the 40 biotic impairments throughout the watershed. HSPF model results completed in support of the five main stem Buffalo Creek and South Fork Crow River TSS-impaired reaches suggest that 44% to 77% of the sediment load in these reaches comes from bank erosion and bedload processes. These results are further supported by a radioisotope fingerprinting study (Schottler 2010) that quantified the relative contributions of erosion from field and non-field erosion sources in the main stem South Fork Crow River. This study concluded that approximately 40% of the total sediment load in the South Fork Crow River is from field sources, while 60% is from non-field sources. The aforementioned assessments, studies, and modeling suggest that altered hydrology and increased flow events are having a significant impact on many of the impaired reaches throughout the South Fork Crow River Watershed and the processes causing bank erosion and other in-channel processes.

Livestock and Manure Management

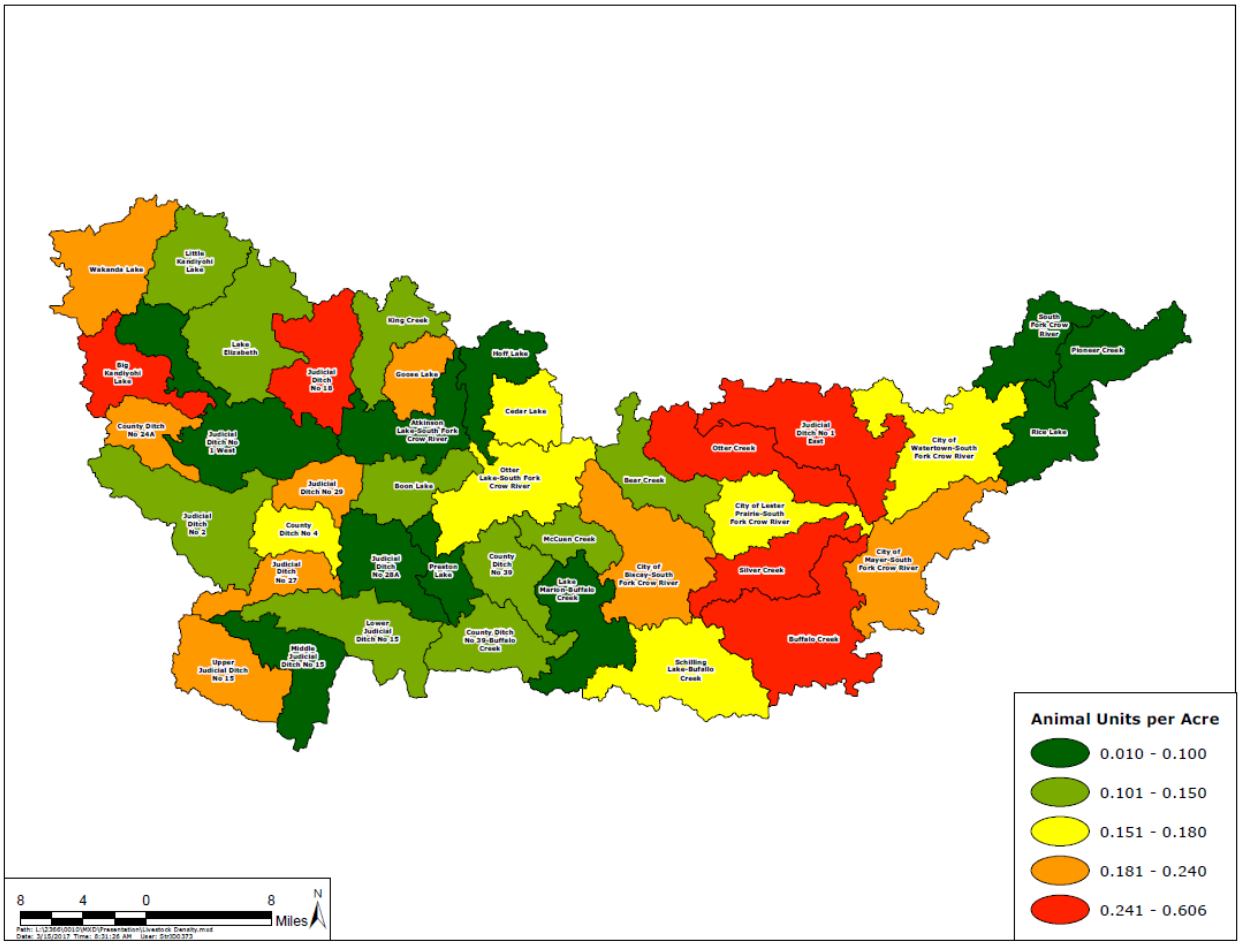
Livestock can contribute pollutants to the watershed through runoff from feedlot facilities and cropland with applied manure. Manure is a byproduct of animal production and large numbers of animals create large quantities of manure. This manure is usually stockpiled and then spread over agricultural fields to help fertilize the soil. When applied at the right times, amounts, and locations, manure helps build soil health and provides essential crop nutrients. One concern in the watershed is that there may be a significant amount of late winter solid manure application (before the ground thaws). During this time, the manure can be a source of nutrients, bacteria, and oxygen demand in rivers and streams, especially during precipitation events.

There are approximately 811 active feedlot facilities with over 138,000 registered livestock animal units (AUs) throughout the South Fork Crow River Watershed. There are also 17 Concentrated Animal Feedlot Operations (CAFOs) in the South Fork Crow River Watershed, most of which are located in the western portion of the watershed. Facility and livestock numbers, based on the MPCA record of registered feedlot facilities, are listed in Table 5. The subwatershed analysis database created for this WRAPS study also includes detailed MPCA registered feedlot information for each HUC12 subwatershed (see Section 3.1 and Figure 6). There are 129 feedlots located within 1,000 feet of a lake or 300 feet of a stream or river, an area generally defined as shoreland. One hundred seventeen of these feedlots in shoreland have open lots. Open lots present a potential pollution hazard if the runoff from the open lots is not treated prior to reaching surface water.

Table 5: MPCA registered feedlots in the South Fork Crow River Watershed.

Description	South Fork Crow River Watershed
Total Feedlots	811
Total Animal Units (AUs)	138,768
Primary Animal Type	Cows 58% Swine 23% Poultry 16%
CAFOs	17 feedlots 27,179 AUs
Open Lot Feedlots	714 feedlots 89,283 AUs
Feedlots in Shoreland	129 feedlots 15,556 AUs
Open Lot Feedlots in Shoreland	117 feedlots 12,812 AUs

Figure 6: MPCA registered feedlots in the South Fork Crow River Watershed.



Soil Erosion

Soil erosion from cropland and pastureland are significant sources of sediment, phosphorus, and other pollutants in the South Fork Crow River Watershed. There are currently five main stem Buffalo Creek and South Fork Crow River reaches impaired by TSS/turbidity, and the SID Report identified TSS as a primary stressor in several of the biotic impairments throughout the watershed. The South Fork Crow River sediment fingerprinting study and HSPF model both estimate that at least 40% of the sediment loading in the watershed comes from field sources. In addition to the HSPF model, soil erosion was modeled using the Revised Universal Soil Loss Equation (RUSLE). This model was used to identify the HUC12 subwatersheds with the highest potential upland soil erosion (see Section 3.1, Appendix A, and Figure B-5 in Appendix B), as well as specific soil erosion "hot spots" within each subwatershed.

Urban Stormwater Management

Storm sewer systems in urban areas have the potential to deliver sediment, nutrients, and bacteria to surface waters from sediment build-up and runoff on impervious surfaces, pet waste, wildlife, leaves, lawn clippings, fertilizers, automobiles, construction sites, and poorly buffered areas near streams/ditches. Urban land currently accounts for approximately 6% of the land cover in the South Fork Crow River Watershed. There are nine municipalities that are completely within or have a portion of their city boundary in the South Fork Crow River Watershed, which are subject to the MPCA's Municipal Separate Stormwater System (MS4) Permit program (Section 2.4 TMDL Summary). Six of these municipalities are located in the far eastern portion of the watershed and are within the Twin Cities Metropolitan Area: Corcoran, Independence, Loretto, Maple Plain, Medina, and Minnetrista. The cities of Willmar, Hutchinson, and Glencoe are non-Metro MS4s located in the central and western portion of the watershed. All of the MS4s in the South Fork Crow River Watershed discharge to at least one impaired reach and/or impaired lake and therefore have TMDL-required load reductions. There are also 20 non-MS4 municipalities located throughout the watershed that discharge to various impaired and non-impaired reaches and lakes throughout the watershed, which could also voluntarily address their stormwater pollutant contributions.

In-Lake Management

There are 51 assessed lakes in the South Fork Crow River Watershed, 38 of which are considered shallow lakes by DNR definition (maximum depth of 15 feet or less, or greater than 80% littoral area). Shallow lakes are ecologically different from deep lakes in that they have a greater proportion of sediment area to lake volume, allowing potentially larger sediment contributions to nutrient loads and higher potential sediment resuspension that can decrease water clarity. Biological organisms also play a greater role in maintaining their water quality. Rough fish, especially carp, can uproot submerged aquatic vegetation and stir up sediment. Submerged aquatic vegetation stabilizes the sediment, reducing the amount that can be resuspended and cloud water clarity. Submerged aquatic vegetation also provides refuge for zooplankton, a group of small crustaceans that consumes algae.

All of these interactions in shallow lakes occur within a theoretical paradigm of two alternative stable states: a clear water macrophyte dominated state and a turbid water algae dominated state (Scheffer 2004). The clear water state is characterized by low algal biomass, an abundant and diverse submerged

aquatic vegetation community, a balanced fish community (if any), and large bodied zooplankton daphnia. Alternatively, the turbid water state is characterized by high phytoplankton biomass, little to no submerged aquatic vegetation, and has an imbalanced fish community often dominated by Common Carp and/or Fathead Minnow. Shallow lakes often exist in an area of hysteresis, with the lake flipping between the clear and turbid water states due to sudden changes in the fish community. The persistence of the clear water state is often the favored outcome of management activities, but can be difficult to maintain in many urban and agricultural landscapes. Understanding and identifying the potential mechanisms driving the state of water quality in a shallow lake is critical to successful and sustained management of shallow lakes.

Within the South Fork Crow River Watershed, 8 of the 12 deep lakes and 29 of the 38 shallow lakes have been assessed and are considered impaired by nutrients (phosphorus), suggesting they are currently in a turbid water state. To date, TMDL studies have been completed, or are currently being completed on 7 of the 8 impaired deep lakes and 26 of the 29 impaired shallow lakes. The TMDL studies indicate all 7 deep lakes and 21 of the 26 shallow lakes will need some level of internal load reductions in order to be flipped to a clear water state and meet state water quality standards. While the TMDL studies provide an estimate of the total internal phosphorus (mass) load reductions needed for each lake, they do not identify or quantify each potential internal source/driver. The DNR has performed biological assessments on many of the impaired lakes throughout the watershed through DNR fish surveys, fish IBIs, vegetation surveys, and vegetation Floristic Quality Indexes (FQIs). While these assessments are helpful, a more detailed analysis/study will be needed on each lake to identify specific biological (fish and vegetation), physical (hydrology), and/or chemical (sediment chemistry) factors driving internal load in each lake, and a list of management strategies (i.e., lake drawdown, rough fish removals/barriers, plant management, sediment P inactivation) to address these drivers.

Nutrients (Streams)

Monitoring data collected by the MPCA during the South Fork Crow Watershed Assessment indicate several tributary and main stem monitoring stations exceed the state's newly adopted river eutrophication standards, which includes targets for phosphorus concentration and several eutrophication response variables (Chl-*a*, biochemical oxygen demand (BOD), and DO flux). As a result, the SID Report identified eutrophication as a primary stressor in all seven of the HUC10 major subwatersheds. As discussed previously, phosphorus loading from the watershed is also a major concern for the impaired and non-impaired lakes throughout the watershed. Freshwater aquatic plants and animals need phosphorus to successfully grow; however, excess nutrients create overstimulated algal and plant growth, that degrades water quality. Large and rapid blooms can limit available oxygen, reduce water clarity, and create toxic conditions for both animals and humans (University of Missouri Extension 1999).

Of the 33 shallow and deep lakes with completed TMDL studies, 30 (91%) currently require watershed phosphorus load reductions. Nitrogen, primarily in the form of NO_3, is also high at several sites throughout the watershed and was identified as a biological stressor in two of the HUC10 major subwatersheds (JD 15 and JD 28A).

Stressors of Biologically-Impaired Stream Reaches

Pollutant sources affecting this watershed vary among its subwatersheds dependent upon land use, drainage systems, topography, demographic, soils, slopes, and other watershed conditions. Additionally, the availability of pollutants may vary through the course of the season because of changing vegetative conditions, precipitation events, and soil influences. Although differences are present, several pollutants and stressors were common, including: phosphorus, lack of habitat, and altered hydrology. In-channel modifications and excessive nutrients damage eco-system health and the ability for aquatic life to thrive.

Table 6: Primary stressors to aquatic life in biologically-impaired reaches in the South Fork Crow River Watershed

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor								
					Phosphorus	Total Suspended Solids	Dissolved Oxygen	Lack of Habitat	Chlorophyll-A	Biological Oxygen Demand	Altered Hydrology	Nitrogen	Conductivity
South Fork Crow	654	Pioneer Creek	T118 R24W S31, north line to T118 R24W S31, south line	Fish & Macroinvert.	●			●			●		
	624	Unnamed Creek	Unnamed cr to Lippert Lk	Fish & Macroinvert.	●			●			●		
	648	CD 9	Headwaters to -93.9053 44.9055	Fish & Macroinvert.	●			●			●		
	618	Unnamed Creek	Unnamed cr to Eagle Lk Outlet	Fish & Macroinvert.	●			●			●		
South Fork Crow	508	South Fork Crow River	Buffalo Cr to N Fk Crow R	Fish & Macroinvert	●		●		●	●			
City of Lester Prairie-South Fork Crow	617	Unnamed Creek	Headwaters to Otter Cr	Fish	●			●					
	572	JD 1	Unnamed ditch to Unnamed cr	Fish & Macroinvert	●			●					
	585	Unnamed Creek	CD 11 to Winsted Lk	Fish	●			●					
	611	CD 26/27	165th St to S Fk Crow R	Fish & Macroinvert	●			●					

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor								
					Phosphorus	Total Suspended Solids	Dissolved Oxygen	Lack of Habitat	Chlorophyll-A	Biological Oxygen Demand	Altered Hydrology	Nitrogen	Conductivity
	515	Bear Creek	Headwaters to S Fk Crow R	Fish & Macroinvert	●			●					
	622	Unnamed Creek	T116 R27W S5, west line to S Fk Crow R	Fish	●			●					
	641	Silver Creek (County Ditch 13)	Unnamed cr to S Fk Crow R	Fish & Macroinvert	●			●					
	642	Otter Creek	Headwaters to Cable Ave	Fish	●			●					
	643	Otter Creek	Cable Ave to S Fk Crow R	Fish	●			●					
	510 & 511	South Fork Crow River	Hutchinson Dam to Bear Cr	Fish & Macroinvert	●		●		●	●			
Buffalo Creek	645	CD 33	100th St to Buffalo Cr	Fish & Macroinvert	●			●			●		
	591	JD 8	Unnamed cr to Buffalo Cr	Fish & Macroinvert	●			●			●		
	614	Unnamed Creek	Lk Mary to RR crossing	Fish	●			●			●		

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor								
					Phosphorus	Total Suspended Solids	Dissolved Oxygen	Lack of Habitat	Chlorophyll-A	Biological Oxygen Demand	Altered Hydrology	Nitrogen	Conductivity
	615	Unnamed Creek	Unnamed cr to Buffalo Cr	Fish	●			●			●		
	638	Buffalo Creek	JD 15 to S Fk Crow R	Fish & Macroinvert	●		●	●	●				
JD 15	509	JD 15	Headwaters to T115 R32 WS31, east line	Fish & Macroinvert	●		●	●			●	●	●
	626	JD 15	Headwaters to JD15 main stem	Fish	●		●	●			●	●	
	627	JD 15	Headwaters to JD15 main stem	Fish	●		●	●			●	●	●
	628	JD 15	Headwaters to JD15 main stem	Fish & Macroinvert	●		●	●			●	●	●
JD 28A	631	CD 7A	Unnamed cr to Buffalo Cr	Fish & Macroinvert	●		●	●			●	●	
	630	Unnamed Ditch	Headwaters to Buffalo Cr	Fish & Macroinvert	●			●			●	●	●
	625	JD 9	Headwaters to Buffalo Cr	Fish & Macroinvert	●			●			●	●	●
	528	CD 4	Unnamed ditch to Buffalo Cr	Fish & Macroinvert	●			●			●	●	●

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor								
					Phosphorus	Total Suspended Solids	Dissolved Oxygen	Lack of Habitat	Chlorophyll-A	Biological Oxygen Demand	Altered Hydrology	Nitrogen	Conductivity
	504	JD 67	Headwaters to Buffalo Cr	Fish & Macroinvert	●			●			●	●	●
	502	Buffalo Creek	Headwaters to JD 15	Fish & Macroinvert	●		●	●			●		
City of Hutchinson-South Fork Crow	533	Unnamed Creek	Unnamed cr to Unnamed cr	Fish & Macroinvert	●			●			●		
	549	Belle Creek	Headwaters to JD 18	Fish & Macroinvert	●			●			●		
	550	JD 18	Belle Cr to S Fk Crow R	Fish	●			●			●		
	609	CD 18	Headwaters to S Fk Crow R	Fish & Macroinvert	●			●			●		
	613	King Creek	north line to S Fk Crow R	Fish	●			●			●		
	621	Unnamed Creek	Unnamed cr to S Fk Crow R	Macroinvert	●			●			●		
	623	Unnamed Creek	Unnamed cr to JD 18	Fish & Macroinvert	●			●			●		
	656	Unnamed Creek	140th St to Unnamed cr	Fish & Macroinvert	●			●			●		

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor								
					Phosphorus	Total Suspended Solids	Dissolved Oxygen	Lack of Habitat	Chlorophyll-A	Biological Oxygen Demand	Altered Hydrology	Nitrogen	Conductivity
	658	South Fork Crow River	Headwaters to 145th St	Fish	●	●	●	●		●			
City of Hutchinson - South Fork Crow	659	South Fork Crow River	145th Street to Hutchinson Dam	Fish & Macroinvert	●			●			●		
Headwaters- South Fork Crow	608	State Ditch Branch 2	Unnamed ditch to Unnamed ditch	Fish & Macroinvert	●	●	●	●		●			
	610	County Ditch No 24A	Unnamed ditch to Unnamed ditch	Fish	●	●	●	●		●			

Pollutant sources

Point and nonpoint sources of pollution were identified through previous TMDL processes, which are outlined in Tables 7 and 8. Although each subwatershed in the South Fork Crow River Watershed is unique, land use throughout the watershed is similar, which results in common pollutant sources in many of the lakes and streams. Section 2.3 provides more detail about individual pollutants, their sources, and their impacts.

Table 7: Point Sources in the South Fork Crow River Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Buffalo Creek	Brownton WWTP	MN0022951	Municipal wastewater	No	TMDL Allocations: DO, TSS, Bacteria
	Gascoyne Materials Handling & Recycling LLC	MN0069612	Industrial wastewater	No	TMDL Allocations: DO, TSS
	Glencoe WWTP	MN0022233	Municipal wastewater	No	TMDL Allocations: DO, TSS, Bacteria
	Seneca Foods Corp – Glencoe	MN0001236	Industrial wastewater	No	TMDL Allocations: DO, TSS
	Stewart WWTP	MNG580077	Municipal wastewater	No	TMDL Allocations: DO, TSS, Bacteria
City of Hutchinson - South Fork Crow River	Cedar Mills WWTP	MN0066605	Municipal wastewater	No	TMDL Allocations: TSS
	Cosmos WWTP	MNG580056	Municipal wastewater	No	TMDL Allocations: TSS
	Duininck Bros Inc - Aggregate	MNG490046	Industrial wastewater	No	TMDL Allocations: TSS
City of Lester Prairie - South Fork Crow River	Winsted WWTP	MN0021571	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
	AB Mauri Food Inc.	MNG250099	Industrial wastewater	No	TMDL Allocations: TSS
	Hutchinson WWTP	MN0055832	Municipal wastewater	No	TMDL Allocations: TSS
	Silver Lake WWTP	MNG580164	Municipal wastewater	No	TMDL Allocations: TSS
	Lester Prairie WWTP	MN0023957	Municipal wastewater	No	TMDL Allocations: TSS
Headwaters South Fork Crow River	Lake Lillian WWTP	MNG580225	Municipal wastewater	No	TMDL Allocations: TSS
Judical Ditch No 15	Buffalo Lake Advanced Biofuels LLC	MN0063151	Industrial wastewater	No	TMDL Allocations: DO, TSS
	Buffalo Lake WWTP	MN0050211	Municipal wastewater	No	TMDL Allocations: DO, TSS, Bacteria
	Hector WWTP	MN0025445	Municipal wastewater	No	TMDL Allocations: DO, TSS, Bacteria
South Fork Crow River	Delano WWTP	MN0051250	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
	Loretto WWTP	MN0023990	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria
	Mayer WWTP	MN0021202	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria
	New Germany WWTP	MN0024295	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria
	Watertown WWTP	MN0020940	Municipal wastewater	No	TMDL Allocations: TSS, Bacteria

Table 8: Nonpoint Sources in the South Fork Crow River Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources														
			Agricultural runoff (from cropland, pasture and/or feedlots)	Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion	Streambank/channel	Runoff from urban stormwater and/or near shore dev.	Wetlands	Internal Loading	Rough Fish	Atmosphere	Upstream Lakes
Buffalo Creek	Buffalo Creek (501/638)	DO	●	○	○	?	○	○	○		○	?	⊙			○
		TSS	●	○	○			○	●	●	⊙		⊙			○
		Bact.	●	●	⊙	?	○		⊙		⊙		?			
	Marion (43-0084-00)	TP	●	●	⊙	⊙			●				○	○	○	
City of Hutchinson-South Fork Crow River	South Fork Crow River (510)	TSS	●	○	○			○	●	●	⊙		⊙			○
	Belle (47-0049-01)	TP	●	●		⊙			●				●	⊙	○	
	Boon (65-0013-00)	TP	⊙	⊙		⊙			⊙				●	?	○	
	Cedar (43-0115-00)	TP	●	●		⊙			●				●	●	○	○
	Goose (47-0127-00)	TP	⊙	⊙		○			⊙				●	●	○	
	Greenleaf (47-0062-00)	TP	⊙	⊙		○			○				⊙	⊙	○	
	Hoff (47-0106-00)	TP	●	⊙		○			●				●	●	○	●
	Star (47-0129-00)	TP	●	⊙		?			●				●	?	○	○

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources													
			Agricultural runoff (from cropland, pasture and/or feedlots)	Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion	Streambank/channel	Runoff from urban stormwater and/or near shore dev.	Wetlands	Internal Loading	Rough Fish	Atmosphere	Upstream Lakes
	Willie (47-0061-00)	TP	●	⊙		⊙			●				⊙			⊙
City of Lester Prairie-South Fork Crow River	South Fork Crow River (511)	TSS	●	○	○			○	●	●	⊙		⊙			○
	Bear (43-0076-00)	TP	⊙	○		○			⊙				●	?	○	○
	Silver (43-0034-00)	TP	⊙	○		○			⊙		⊙		●	●	○	
	Winsted (43-0012-00)	TP	●	●	⊙	○			○		⊙		●	⊙	○	⊙
Headwaters South Fork Crow River	South Fork Crow River (540/658)	TSS	●	○	○			○	●	●	⊙		⊙			○
	Big Kandiyohi (34-0086-00)	TP	●	●	⊙	⊙			○				●	●	○	●
	Johnson (34-0012-00)	TP	●	⊙		○			●			?	●	?	○	○
	Kasota (34-0105-00)	TP	⊙	○	○	○			⊙				●	?	○	⊙
	Lillian (34-0072-00)	TP	○	○					○			?	○	○		●
	Little Kandiyohi (34-0096-00)	TP	⊙	○		○			⊙				●	?	○	●
	Minnetaga (34-0076-00)	TP	●	⊙		?			⊙				●	●	○	

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources													
			Agricultural runoff (from cropland, pasture and/or feedlots)	Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion	Streambank/channel	Runoff from urban stormwater and/or near shore dev.	Wetlands	Internal Loading	Rough Fish	Atmosphere	Upstream Lakes
	Thompson (47-0159-00)	TP	●	⊙		?			⊙				⊙	⊙	○	
	Wakanda (Main Basin) (34-0169-03)	TP	●	●	⊙	○			●		●		●	●	○	○
Judicial Ditch No 15	Judicial Ditch No 15 (513)	Bact.	●	●	⊙	?	○		⊙		⊙		?			
Judicial Ditch No 28A	Buffalo Creek (502)	Bact.	●	●	⊙	?	○		⊙		⊙		?			
	Preston (65-0002-00)	TP	●	⊙		○			○				○	⊙	○	●
South Fork Crow River	South Fork Crow River (508)	TSS	●	○	○			○	●	●	⊙		⊙			○
		Bact.	●	●	⊙	?	○		⊙		⊙		?			
	Mud (10-0094-00)	TP	●	●	⊙	?			⊙		○	?	⊙	?	○	⊙
	Oak (10-0093-00)	TP	⊙	⊙					⊙				●	●	○	
	Rice (86-0032-00)	TP	●	⊙	⊙	⊙			●		○	⊙	●	?	○	●
	Swede (10-0095-00)	TP	⊙	⊙		⊙			⊙				●	●	○	
	Ardmore (27-0153-00)	TP	These Impairments are addressed through the Pioneer-Sarah Creek TMDL/WRAPS Project:													

HUC-10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources													
			Agricultural runoff (from cropland, pasture and/or feedlots)	Fertilizer & manure run-off	Livestock overgrazing in riparian	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion	Streambank/channel	Runoff from urban stormwater and/or near shore dev.	Wetlands	Internal Loading	Rough Fish	Atmosphere	Upstream Lakes
	Half Moon (27-0152-00)	TP	https://www.pca.state.mn.us/water/tmdl/pioneer-sarah-creek-watershed-restoration-and-protection-strategy-tmdl-project													
	Irene (27-0189-00)	TP														
	North Whaletail (27-0184-01)	TP														
	Peter (North Bay) (27-0147-02)	TP														
	Robina (27-0188-00)	TP														
	South Whaletail (27-0184-02)	TP														
	Spurem (27-0149-00)	TP														
	Unnamed Creek (593)	Bact.														
	Pioneer Creek (653)	Bact.														
	Deer Creek (594)	Bact.														

Key: ● = High ⭘ = Moderate ○ = Low ? = present, but contribution to impairment unknown Blank = not a primary source

2.4 TMDL Summary

Completed TMDL Studies

Four TMDL studies have been conducted in the South Fork Crow River Watershed prior to the current study. The Buffalo Creek Bacteria TMDL (Wenck Associates 2013) covered two bacteria impaired reaches (07010205-502 and 501) of Buffalo Creek from its headwaters to its junction with the South Fork Crow River. The Lake Independence (27-0176) Phosphorus TMDL was completed in 2007 as a collaborative effort between the Pioneer-Sarah Creek Watershed Commission and the Three Rivers Park District. The South Fork Crow River Lakes Excess Nutrient TMDL (Carver County Land and Water Services 2010) addresses phosphorus impairments for Eagle (10-0121), Oak (10-0093), and Swede (10-0095) Lakes, which are located in the Carver County portion of the South Fork Crow River Watershed, and the Pioneer Sarah Creek Watershed TMDL, which contains three stream reaches located in the South Fork Crow River Watershed. The South Fork Crow River TMDL that is being developed concurrently with this WRAPS contains allocation load reductions for 8 stream and 35 lake impairments, which are summarized in Table 7 and Table 8 of this report. Additionally, Section 3 prioritizes sub watersheds into protection and restoration areas using pollutant loading analysis, which also outlines strategies for watershed loading reductions.

Additional TMDLs Developed Concurrently with this WRAPS

The South Fork Crow River TMDL study addressed five TSS impairments, one DO impairment, and two bacteria (fecal coliform and *E. coli*) impairments on several main stem and tributary reaches in the watershed. The TMDL also addressed nutrient (phosphorus) impairments for 23 lakes in the watershed. The TMDL report quantifies the pollutant reductions needed to meet state water quality standards for TSS, DO, bacteria, and phosphorus.

All impaired TSS reaches showed streambed and bank to be the primary sources of sediment, followed by cropland. Urban lands contributed 6% or less for all impaired reaches. It should be noted that bed/bank sediment can increase from practices that increase “flashiness” of the system such as tile drainage, runoff from impervious urban areas, and straightening of channels (ditches).

A bacteria accounting exercise was conducted to estimate the total amount of bacteria produced within the drainage area of each impaired reach. This exercise uses available information such as: livestock, human and pet populations, wildlife, and septic data. This information, with GIS and literature rates from studies, can estimate bacteria production in each area. Bacteria can occur from both permitted and non-permitted sources. Review of the area indicates that there are three active permitted wastewater dischargers in the JD15 reach and four wastewater dischargers in the South Fork Crow River reach. There are eight dischargers in the South Fork Crow River reach, which are located in Buffalo Creek Watershed that were addressed and allocated in the previous Buffalo Creek Bacteria TMDL (Wenck Associates 2013). There are nine MS4s that have a portion of their boundary within the impaired reaches. There are several small non-National Pollutant Discharge Elimination System (NPDES) registered feedlot operations in the South Fork Crow River Watershed. Currently, 15 NPDES permitted

feedlot operations are in the watershed that require the owner to apply for a feedlot permit when a new or expanding facility will have a capacity of 1,000 AUs or more.

All of this information estimated the total amount of bacteria produced within the direct drainage area of each impaired reach. The JD15 impaired reach had 93% of bacteria coming from surface applied manure and 5% coming from improperly managed pet waste. Less than 2% of bacteria is coming from wastewater treatment plant (WWTP) effluent, failing septic systems, and wildlife. The South Fork Crow River Subwatershed impaired area had 93.5% of bacteria sources coming from surface manure application and 6.3% from improperly managed pet waste. A total of .2% of bacteria comes from a combination of WWTP effluent, failing septic systems, and wildlife. Bacteria load reductions were developed for different flow regimes (Wenck 2016). Estimated reductions in *E. coli* were determined to fall between 32% to 47% depending on the flow regime.

DO is important to aquatic life. Low DO is primarily caused by excessive algae growth caused by phosphorus or nitrogen. As the algae die and decompose, the process consumes DO. Phosphorus loading from lakes can come from upstream sources, failing septic systems, atmospheric deposition, and internal loading. Internal phosphorus loading from lakes can be a major issue and cause sever algal growth. Out of the 23 lakes modeled, Marion Lake had a 6% load reduction while Goose Lake topped the load reduction at 92%. The majority of the lakes fall into the 50% to 85% phosphorus load reduction range.

The HSPF model was used to model daily DO in the impaired reach below 5.0 milligrams per liter (mg/L) of the open water months (April through November). The DO waste load allocation was divided into three categories: NPDES point source dischargers, permitted MS4s, and construction and industrial stormwater. In total, a 57% reduction has been estimated to meet water quality standards.

2.5 Protection Considerations

The previous sections identified and discussed several impaired water resources in the South Fork Crow River Watershed. There are currently several non-impaired water bodies in the watershed that are threatened by decreased water quality, urban stormwater, agricultural runoff, increased flooding impacts, and invasive species. The watershed is also home to several outstanding resources such as wildlife management areas and various state and county parks, forests, and preservation areas. The CROW, county SWCDs, Met Council, cities, counties, and state agencies have been working collaboratively to monitor and assess water quality, biodiversity, and ecology in a watershed-wide approach. Moving forward, protection efforts by these entities will become increasingly important to protect current water quality conditions from further degradation. Below is a short description of protection considerations for the South Fork Crow River Watershed.

Watershed-wide Protection

Working to protect surface and groundwater resources currently supporting beneficial uses, or close to the impairment threshold, through the implementation of best management practices (BMPs) is vital to the overall health of the South Fork Crow River Watershed and state.

Significant threats to water resources in the South Fork Crow River Watershed include:

- Declines in surficial groundwater resources threaten shallow water ecosystems such as wetlands, lakes, and streams. These ecosystems are vitally important to the watershed, the biological communities that rely on their existence, and for recreation.
- Climate change (or climate instability) poses a complex challenge to current water resource management practices. Recent climatological events such as drought, intense localized precipitation, and flooding have all been observed across the watershed. These changes can increase water quality degradation, flooding, and drought duration.
- Aquatic invasive species continue to threaten both the biodiversity and overall ecological health of high value resources within the watershed. The number of infested waterbodies continues to climb across the state of Minnesota.
- Rural and agricultural land uses that alter hydrology and move water off the landscape quickly can have a significant negative impact on flow regimes and water quality, especially if those lands are not well-managed or do not have downstream treatment.
- Improper management of manure from livestock operations, improperly-managed cropland drainage, inefficient fertilization practices, sediment loss from croplands, and onsite treatment of human waste cause water quality degradation and/or compromise the hydrologic integrity of streams and rivers where proper management practices are not in place.

Specific Streams Targeted for Protection

All streams supporting aquatic life in the watershed are considered waters to protect. There are currently six stream reaches in the watershed that fully support aquatic life based on the fish and macroinvertebrate IBI assessments, and should be considered protection streams. A full list of these reaches is presented in Table 9.

Table 9: Stream reaches that fully support aquatic life considered for protection

Reach AUID	Reach Name	HUC 12 Subwatershed
07010205-607	Big Kandiyohi Channel	Big Kandiyohi Lake
07010205-612	Unnamed ditch	Judicial Ditch No 1 West
07010205-506	Judicial Ditch 29	Judicial Ditch No 29
07010205-620	Judicial Ditch 1	Otter Lake-South Fork Crow River
07010205-616	McCuen Creek	McCuen Creek
07010205-571	Judicial Ditch 1	Judicial Ditch No 1 East

Specific Lakes Targeted for Protection

Priority lakes for protection throughout the state of Minnesota have been identified through a multi-agency approach led by the DNR and MPCA (MPCA 2017). Through this approach, 13 lakes in the South

Fork Crow River Watershed were identified based on criteria presented in Table 10. In addition to these lakes, the South Fork Crow River Watershed stakeholder group identified several other lakes throughout the watershed that should be targeted for protection. The stakeholder group's list of protection lakes is presented in Table 11 and was developed using the following criteria (note that some overlap exists between Tables 10 and 11):

- All lakes that fully support aquatic recreation and water quality standards should be considered protection lakes. There are currently four lakes (all deep lakes) in the watershed that meet this criteria.
- Lakes that have some water quality data, but results are inconclusive to fully assess their impairment status, should be considered for protection. There are currently 10 lakes in the watershed that meet this criteria, four of which (Swan, Eagle, Ella, Elizabeth) have been identified by the MPCA as being very close to the impairment threshold, and therefore should be considered high priority.
- Lakes on the DNR list of priority shallow lakes (DNR Shallow Lakes Program https://www.dnr.state.mn.us/wildlife/shallowlakes/index.html) should be considered protection lakes. The Shallow Lakes Program works to **protect and enhance wildlife habitat** on lakes dominated by this shallow water (or littoral) zone There are 45 lakes in the South Fork Crow River Watershed on the priority shallow lakes list, 18 of which are currently impaired, and therefore should be considered restoration lakes. There are 27 lakes on the list that have insufficient information to determine impairment or have not been assessed, and therefore should be considered protection lakes.
- There are three designated wildlife lakes within the watershed that should be considered high priority for protection: Tiger Lake, Patterson Lake, and Eagle Lake (McLeod County).
- Lakes that are currently managed by the United States Fish and Wildlife (USFW) should be considered protection lakes. There is one lake in the South Fork Crow River Watershed, Lewis Lake that is currently managed by USFW. This lake is also managed by the Buffalo Creek Watershed District (BCWD).
- Lakes that have been identified as lakes of biological significance by the DNR Ecological and Water Resources Division should be considered for protection. The Lakes of Biological Significance are lakes that exhibit the highest quality features of any of four categories, including aquatic plants, fish, birds, or amphibians. Lakes are rated either outstanding, high, or moderate for significance. There are currently 19 lakes of biological significance in the South Fork Crow River Watershed, nine of which do not have sufficient information to determine impairment or have not been assessed, and should be considered protection lakes.
- The DNR Wildlife group has identified nine lakes in the watershed that should be considered as high priority to protect, restore, and enhance. This priority list was based primarily on lakes shown on the priority shallow lakes GIS layer that also had lake management plans.

Importance of Groundwater/Drinking Water Protection

The South Fork Crow River Watershed provides drinking water for people within and outside of the watershed. There are 5,718 private wells within the watershed boundary, with the concentration of private wells increasing closer to the metro area. Groundwater protection is doubly important as not only is there a hydrologic connection between groundwater and surface water, but there is also a direct impact on human health if groundwater becomes contaminated. In the South Fork Crow River Watershed, NO_3 standards are exceeded by only a small subset of private wells. However, arsenic is a more significant issue, because exceedances area found in numerous wells at all depths (per Minnesota Department of Health staff).

In addition to supplying a significant quantity of drinking water to the residents of the watershed via groundwater, the runoff from the South Fork Crow Watershed all flows into the Mississippi River, which in turn supplies drinking water for the Twin Cities, as well as 50 other communities according to the EPA. Although the metro drinking water supply intakes are over eight hours from the mouth of the South Fork Crow River Watershed under most flow conditions for spill events, the watershed still contributes all of its surface runoff and associated contaminants to the river and therefore is important to consider when planning for human health protection.

Maps and data for groundwater in the South Fork Crow River Watershed can be found in Appendix C of this document.

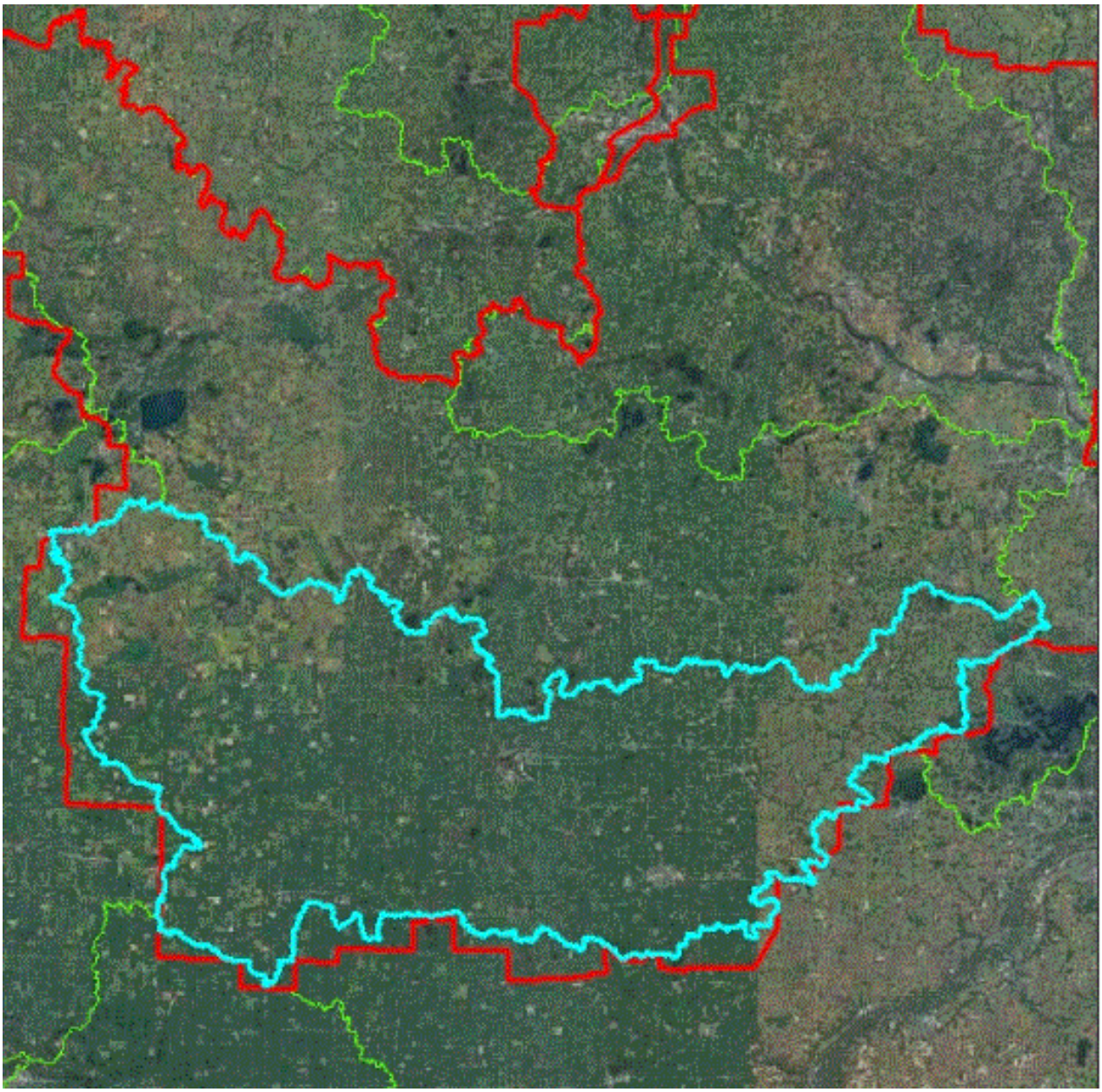


Figure 7: The South Fork Crow River Watershed is entirely within the Drinking Water Supply Area for the Twin Cities.

The South Fork Crow Watershed (inside of blue outline) is contained entirely within the drinking water supply area for the Twin Cities (red outline).

Table 10: Minnesota multi-agency lake prioritization: South Fork Crow River Watershed priority lakes for protection.

DNR ID	Lake Name	Depth Class	Area [acres]	Ecoregion	Disturbed Landuse [%]	Mean TP [µg/L]	Years TP	Mean Secchi [ft]	Presence of Trend	Trend slope description	Target TP [µg/L]	Load Reduction Target [%]	Priority
27-0179-01	North Little Long	Deep	52	NCHF	10%	15.5	11	4.94	Decreasing Trend	Evidence for long-term trend	13	5%	A
43-0104-00	Stahl's	Deep	141	NCHF	58%	34.0	7	1.29	Insufficient Data	NA	28	5%	A
340032-00	Carrie	Deep	89	WCBP	70%	18.3	5	1.36	Decreasing Trend	Evidence for a long-term trend	15	5%	B
43-0040-00	Swan	Shallow	352	WCBP	30%	45.4	4	0.50	Insufficient Data	NA	38	5%	B
34-0033-00	Ella	Shallow	153	WCBP	63%	61.3	3	0.67	Insufficient Data	NA	51	5%	B
34-0022-02	Elizabeth (Main Lake)	Shallow	1,023	WCBP	56%	73.4	3	0.78	Insufficient Data	NA	61	5%	B
27-0179-02	South Little Long	Deep	17	NCHF	10%	16.8	4	4.75	No Evidence of Trend	No evidence of trend	16	5%	C
43-0098-00	Eagle	Shallow	347	WCBP	79%	82.4	4	0.33	Insufficient Data	NA	69	5%	C
27-0187-00	Haughey	Deep	54	NCHF	83%	123.5	1	0.59	Insufficient Data	NA	103	5%	C

DNR ID	Lake Name	Depth Class	Area [acres]	Ecoregion	Disturbed Landuse [%]	Mean TP [µg/L]	Years TP	Mean Secchi [ft]	Presence of Trend	Trend slope description	Target TP [µg/L]	Load Reduction Target [%]	Priority
47-0060-00	Sioux	Shallow	399	NCHF	62%	142.5	2	0.38	Insufficient Data	NA	119	5%	C
34-0097-00	Eleanor	Shallow	167	WCBP	29%	151.5	2	0.30	Insufficient Data	NA	127	5%	C
72-0049-00	Schilling	Shallow	763	WCBP	34%	201.0	1	0.30	Insufficient Data	NA	168	5%	C
65-0006-00	Allie	Shallow	509	WCBP	73%	273.4	18	1.03	No Evidence of Trend	No evidence of trend	229	5%	C

Table 11: List of protection lakes in the South Fork Crow River Watershed identified by stakeholder group.

Lake Name	DNR ID	County	HUC12 Subwatershed	Fully Supporting WQ Standards	Close to Impairment	DNR Priority Shallow Lake	Designated Wildlife Lake	Managed by USFW and BCWD	Lake of Biological Significance	DNR High Priority	Multi-Agency Priority (Table 10)
Halva Marsh	43-0129-00	McLeod	Bear Creek			x					
Two Island	34-0439-00	Kandiyohi	Big Kandiyohi Lake			x					
Stahl's	43-0104-00	McLeod	Cedar Lake	x							A
Patterson	10-0086-00	Carver	City of Mayer-South Fork Crow River			x	x				
Tiger	10-0108-00	Carver	City of Mayer-South Fork Crow River			x	x		x		
Barber	43-0100-00	McLeod	County Ditch No 39			x					
Eagle	43-0098-00	McLeod	County Ditch No 39		x	x	x				C
Whitney	43-0097-00	McLeod	County Ditch No 39			x			x		
Harden	47-0112-00	Meeker	Hoff Lake			x				x	
Sioux	47-0060-00	Meeker	Hoff Lake			x			x	x	C
Willie	47-0261-00	Meeker	Hoff Lake			x					
Butternut	86-0253-00	Wright	Judicial Ditch No 1 East			x					
Grass	34-0170-00	Kandiyohi	Judicial Ditch No 1 East			x				x	
Dog	34-0003-00	Renville	Judicial Ditch No 1 West						x		
Middle	47-0168-00	Meeker	Judicial Ditch No 18			x					

Lake Name	DNR ID	County	HUC12 Subwatershed	Fully Supporting WQ Standards	Close to Impairment	DNR Priority Shallow Lake	Designated Wildlife Lake	Managed by USFW and BCWD	Lake of Biological Significance	DNR High Priority	Multi-Agency Priority (Table 10)
Rodewald	47-0169-00	Meeker	Judicial Ditch No 18			x					
Phare Lake	65-0012-00	Renville	Judicial Ditch No 28A			x					
King	47-0153-00	Meeker	King Creek						x		
Carrie	34-0032-00	Kandiyohi	Lake Elizabeth	x							B
Elizabeth	34-0022-02	Kandiyohi	Lake Elizabeth		x	x			x		B
Ella	34-0033-00	Kandiyohi	Lake Elizabeth		x	x					B
Mud	34-0021-00	Kandiyohi	Lake Elizabeth			x					
Wieker	47-0163-00	Kandiyohi	Lake Elizabeth							x	
Addie	43-0061-00	McLeod	Lake Marion-Buffalo Creek						x		
Lewis	43-0063-00	McLeod	Lake Marion-Buffalo Creek			x		x	x		
Marion	43-0084-01	McLeod	Lake Marion-Buffalo Creek			x			x		
Kasota	34-0105-00	Kandiyohi	Little Kandiyohi Lake			x				x	
Minnetaga	34-0076-00	Kandiyohi	Little Kandiyohi Lake			x				x	
Swan	43-0040-00	McLeod	Otter Creek		x	x				x	B
Allie	65-0006-00	Renville	Preston Lake			x					C

Lake Name	DNR ID	County	HUC12 Subwatershed	Fully Supporting WQ Standards	Close to Impairment	DNR Priority Shallow Lake	Designated Wildlife Lake	Managed by USFW and BCWD	Lake of Biological Significance	DNR High Priority	Multi-Agency Priority (Table 10)
North Little Long	27-0179-01	Hennepin	Rice Lake	x							A
Ox Yoke	27-0178-00	Hennepin	Rice Lake			x					
South Little Long	27-0179-02	Hennepin	Rice Lake	x							C
Schilling	72-0049-00	Sibley	Schilling Lake-Bufallo Creek			x					C
Rebecca	27-0192-00	Hennepin	South Fork Crow River							x	
Eleanor	34-0097-00	Kandiyohi	Wakanda Lake			x				x	C

3. Prioritizing and Implementing Restoration and Protection

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, and identify point sources and nonpoint sources of pollution with sufficient specificity to enable local water planners to be able to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users, and residents of the watershed, it is imperative to create social capital (trust, networks, and positive relationships) with those who will be needed to voluntarily implement BMPs. Thus, effective ongoing public participation is fully a part of these strategies moving forward. The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed modeling efforts and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on available local capacity and needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation, and course correction. It is important that as these actions are undertaken, all levels (federal, state, and local governments; non-profits; and landowners) continue to find ways to support local entities and individuals to ensure the waterbodies in the South Fork Crow River Watershed are restored and protected.

3.1 Targeting of Geographic Areas

Targeting has been used at several scales to help identify priority areas in the South Fork Crow River Watershed. The following discussion begins at the state and basin scale and moves to smaller more focused areas based on the specific tools and analyses used for this project.

State, Basin, and Regional Scale

Multiple agencies in Minnesota have developed strategies and basin approaches, which together with data analysis have been used to build a framework and help maximize and direct protection and restoration at a local-level priority scale. State databases were utilized with local knowledge to create a comprehensive base of information to help identify priority areas in the South Fork Crow River Watershed.

The Minnesota Nutrient Reduction Strategy was developed in response to concern about excessive nutrient levels that pose a substantial threat to Minnesota's lakes and rivers, as well as downstream waters including the Great Lakes, Lake Winnipeg, the Mississippi River, and the Gulf of Mexico. In recent decades, nutrient issues downstream of Minnesota have reached critical levels, including the effect of nutrients in the Gulf of Mexico, which resulted in a dead zone, eutrophication issues in Lake Winnipeg, and algal blooms in the Great Lakes. Several state-level initiatives and actions highlighted the need for a

statewide strategy that ties separate but related activities together to further progress in making nutrient reductions. Minnesota conducted both nitrogen and phosphorus assessments to identify nutrient source contributions. The main nutrient sources to the Mississippi River are phosphorus from agricultural cropland runoff, wastewater, and streambank erosion, and nitrogen from agricultural tile drainage and water leaving cropland via groundwater. The associated Nutrient Reduction Strategy Phase I milestones for the Mississippi River Basin N and P are 20% and 35% reduction from baseline by 2025 respectively. Additional milestones call for 30% (N) and 45% (P) by 2035 and 45% reduction from baseline in N by 2045. The primary tools the state will use to achieve these reductions are the 10-year cycle of watershed assessments and WRAPS studies to identify high-loading areas and critical management areas, and subsequent local water planning; enhanced phosphorus and nitrogen reduction strategies for wastewater effluent; facilitating implementation of agricultural BMPs targeted at increasing fertilizer use efficiency, reducing field erosion, and treating tile drainage water; and continued implementation of the stormwater discharge permitting system for MS4s.

The Nitrogen in Minnesota Surface Waters Study was developed in response to a concern for human health when elevated nitrogen levels reach drinking water supplies. The 10 mg/L NO_3-N drinking water standard established for surface and groundwater drinking water sources and for cold water streams is exceeded in numerous wells and streams. The purpose of this study was to provide an assessment of the science concerning N in Minnesota waters so that the results could be used for current and future planning efforts, thereby resulting in meaningful goals, priorities, and solutions.

More specifically, the purpose of this project was to characterize N loading to Minnesota's surface waters, and assess conditions, trends, sources, pathways, and potential BMPs to achieve nitrogen reductions in our waters. The nitrogen study contains a spreadsheet tool called the Nitrogen Best Management Practices (NBMP) tool (NBMP is described in more detail in the Nitrogen in Minnesota Surface Waters Report, Chapter F1 [Wall 2013]).

The Twin Cities Metropolitan Area Chloride Management Plan (CMP) was developed to address the increasing concentrations of chloride found in Minnesota's waters in urban areas in the Twin Cities, as well as across the state. The CMP provides the framework to assist local communities in reducing chloride concentrations in both the state's ground and surface waters through protection and restoration efforts. The draft CMP contains a variety of BMPs that reduce salt use while still maintaining safe conditions for the public. The chloride reduction strategy outlined in the draft plan uses a performance-based approach that does not have specific numerical requirements, but focuses on implementing BMPs and tracking trends in chloride concentrations. The primary recommended strategies for reducing chloride concentrations in the draft CMP include: 1) a shift to using more liquid deicing chemical products rather the granular ones, 2) improved physical snow and ice removal, 3) use of practices that prevent the formation of a bond between snow/ice and the pavement, 4) strategies that eliminate salt waste, 5) training for winter maintenance professionals, and 6) education for the public and elected officials.

South Fork Crow River Watershed Scale

Various reports, datasets, models, and GIS tools were developed through specific subwatershed assessments, management plans, MPCA's South Fork Crow River Watershed assessment process, and TMDL studies that can be used to identify degraded waterbodies and target areas to implement restoration and protection strategies. A summary of previous studies in the South Fork Crow River Watershed are presented in Tables 1 and 12, and a description of potential models and tools that can be used for future targeting and analysis are presented in Table 13. These resources were developed by various groups including MPCA, DNR, BWSR, and other agencies. More detailed information on each effort/tool can be obtained from the sources and links cited in each table. It is important to point out that the studies, models, and tools presented in these tables rely on a wide range of input datasets with different restoration and protection goals and initiatives in mind, ranging from urban stormwater management to geomorphic assessments and in-lake management.

HSPF

The HSPF model was selected as the primary watershed modeling tool to simulate hydrology and water quality for the South Fork Crow River Watershed TMDL Study. HSPF is a comprehensive watershed model that includes modeling land surface and subsurface hydrologic and water-quality processes, which are linked and closely integrated with corresponding stream, wetland, and reservoir processes. The HSPF model was used to quantify landscape and point source contributions of water, sediment, and nutrients to the impaired waterbodies in the South Fork Crow River Watershed. Landscape loads from the HSPF model were used as an input to other modeling tools (e.g., BATHTUB) to support the simulation of receiving water responses for impaired lakes in the South Fork Crow River Watershed. The HSPF model was also used to help identify major subwatersheds and stream reaches that have higher potential for exporting nutrients and sediment to downstream resources. Multiple memos are available which discuss modeling methodologies, data used, and calibration results in the South Fork Crow River Watershed in great detail [RESPEC, 2011a, 2011b, 2011c, 2011d, 2011e, 2011f, 2012, 2015].

Watershed Health Assessment Framework (WHAF)

The DNR has completed development of the Watershed Health Assessment Framework (WHAF), which provides a comprehensive overview of the ecological health of Minnesota's watersheds. The WHAF is based on a "whole-system" approach that explores how all parts of the system work together to provide a healthy watershed. The WHAF divides the watershed's ecological processes into five components: biology, connectivity, geomorphology, hydrology, and water quality. A suite of watershed health index scores have been calculated that represent many of the ecological relationships within and between the five components. These scores have been built into a statewide GIS database that is compared across Minnesota to provide a baseline health condition report for each of the 80 major watersheds in the state. The DNR has applied the condition report to larger (HUC-8) watersheds, and more recently has applied the framework at smaller (HUC-12) subwatershed levels. The WHAF may be a helpful resource in monitoring and assessing the health of the watershed as restoration and protection practices are implemented.

South Fork Crow Subwatershed Analysis

During the early stages of the development of this WRAPS, the South Fork Crow River Watershed stakeholder technical team expressed concern over the scale at which the restoration/protection strategies would be developed and targeted in the WRAPS report. The technical team concluded that in order to make the WRAPS report more useful to local stakeholders, it would need to prioritize geographical locations for restoration/protection strategies at smaller, more defined scales. As discussed previously (Tables 12 and 13), there are several studies, assessments, tools, and models that have been completed throughout various portions of the watershed. The stakeholder team wanted to use this WRAPS study as an opportunity to compile all current knowledge of the watershed and output from previous modeling efforts and studies into one centralized location/database. The hope was that this database could then be analyzed and presented in a way to help local resource managers identify the major issues/concerns in their particular subwatershed(s), along with targeted geographical areas for restoration/protection planning and implementation. This process, referred to as the South Fork Crow Subwatershed Analysis, is described below.

- **Define Scale for Analysis**

  WRAPS reports typically present restoration/protection strategies and geographical targeting at the HUC10 level, and occasionally the HUC12 level in smaller watersheds. It was decided that results of the South Fork Crow Subwatershed Analysis would be presented at the HUC12 subwatershed scale with the idea that finer scale GIS layers and models would be presented to identify specific "hot spot" areas within each HUC12 subwatershed to focus restoration and protection efforts.

- **Compile Information/Data**

  A complete list of the assessment data, GIS layers, and modeling tools used in the South Fork Crow Subwatershed Analysis are presented in Table A-1 of Appendix A. Nearly all of the data and information compiled for the subwatershed analysis was created by various agencies and therefore available through online sources.

- **Construct Database**

  The compiled data was organized in tabular format (Excel spreadsheet) and as a GIS geodatabase. Both of these databases are available for download (see links below).

- **Construct Map Books**

  Once the database was created, a series of maps were generated for each HUC12 subwatershed using key GIS layers:

  - Registered feedlots
  - High potential soil loss (RUSLE)
  - Potentially drained (tiled) areas
  - Restorable wetland areas

- Individual protection layers, including: sites of biodiversity significance, lakes of biological significance, wildlife habitat quality, publically managed lands, conservation easements

These layers were selected for the map book since they have the ability to show finer scale analysis (hot spots) for some of the priority concerns in the South Fork Crow River Watershed, including:

- Livestock and manure management (nutrients, DO, bacteria)
- Soil erosion (TSS, nutrients, bacteria)
- Altered hydrology (TSS, nutrients, DO, bacteria)
- Protection (all parameters)

- **Identifying Potential Restoration and Protection Focus Areas Using Multi-Layer GIS Approach**

  Example Restoration and Protection Focus Areas within each HUC12 subwatershed were identified by overlaying the key GIS map book layers described above (see final map in each map book for overlay). In general, areas that demonstrate high potential risk across multiple layers were identified as potential Restoration and Protection Focus Areas. Proximity to waterbodies, particularly impaired waterbodies, was also considered when identifying the potential Focus Areas. After the example restoration and protection focus Areas were identified, the map books were distributed to the technical team for review, at which time adjustments were made and additional Focus Areas were identified.

  It is important to point out that the primary purpose of this exercise was to develop a framework and general guidelines for identifying potential Restoration and Protection Focus areas through a multi-layer GIS approach. Thus, the restoration and protection focus areas presented in Appendix A should be considered "examples" at this time since they are strictly based on preliminary GIS layer analysis and have not been validated/assessed in the field. The hope is that local stakeholders and resource managers can use this information and process in future local water planning efforts, to develop new focus areas and refine and expand upon the example areas presented in Appendix A through field assessments, local knowledge, and by exploring/analyzing other layers and information in the tabular and GIS databases.

- **Final Products**

  The final output of the South Fork Crow Subwatershed Analysis includes the following components:

  - One-page summaries for each of the 40 HUC12 subwatersheds in the South Fork Crow River Watershed (Appendix A). Each summary includes a description of the subwatershed, a list of impairments/stressors/load reductions, example restoration and protection focus area map, and a to-do list highlighting restoration/protection objectives for the subwatershed
    - An eight-page map book for each of the 40 HUC 12 subwatersheds as described above (https://www.pca.state.mn.us/sites/default/files/wq-ws4-47c-1.pdf,

https://www.pca.state.mn.us/sites/default/files/wq-ws4-47c-2.pdf, https://www.pca.state.mn.us/sites/default/files/wq-ws4-47c-3.pdf)

- Excel spreadsheet tabular database summarizing all compiled data/information by HUC12 subwatershed (link to database)
- Geodatabase containing GIS layers compiled for analysis (contact CROW to obtain GIS files)

Future Subwatershed Assessments

The South Fork Crow HSPF model and Subwatershed Analysis are effective tools in identifying potential problem areas and subwatersheds and stream reaches contributing high levels of sediment, nutrients and other pollutant loads to downstream resources. These models and analyses, however, fall short in identifying exactly where on the landscape BMPs should be implemented. Moving forward, individual stakeholders and resource managers will undertake more detailed and systematic subwatershed assessments in their local water planning efforts that will provide field scale BMP planning and outreach for high-loading subwatersheds/critical areas. These subwatershed assessments can be performed in both urban and agricultural subwatersheds. Urban subwatershed assessments typically use urban water quality models such as P8 or WinSLAMM (see Table 13 for description) to identify high loading areas and analyze pollutant reductions and cost/benefit of specific BMP retrofit scenarios. The agricultural subwatershed assessments typically use fine-scale, LIDAR-based modeling tools such as PTMApp and ACPF to develop prioritized maps and an itemized list of potential BMPs with cost/benefit analysis, expected load reductions, and public outreach. Due to the concern of altered hydrology throughout the South Fork Crow River Watershed, a key component of these subwatershed assessments should be a channel assessment/survey to evaluate channel erosion, riparian vegetation, habitat, channel shape/pattern/slope, and overall hydraulic conditions. Examples of completed subwatershed assessments in the South Fork Crow River Watershed include the Kandi Creek Fluvial Geomorphology Field Report, the Kandi Creek Watershed Assessment, and the South Fork Crow River Watershed Hydrology, Connectivity, and Geomorphology Assessment Report (Table 12). The South Fork Crow River Watershed technical group has identified the following subwatersheds as priority areas for future subwatershed assessment projects:

- King Creek Subwatershed
- Lake Elizabeth Subwatershed
- Cedar Lake Subwatershed
- Big Kandiyohi Subwatershed
- South Fork Crow River Subwatershed
- Rice Lake Subwatershed
- Lake Wakanda Subwatershed
- Preston Lake Subwatershed
- Judicial Ditch No. 1 East Subwatershed

- Rice Lake Subwatershed
- Otter Lake-South Fork Crow River Subwatershed
- McCuen Creek Subwatershed
- City of Mayer - South Fork Crow River Subwatershed
- City of Watertown-South Fork Crow River Subwatershed
- Buffalo Creek Subwatershed

Table 12: Reports, assessments, studies, and management plans completed in the South Fork Crow River Watershed

Report/Study	Author	Description	Link
City of Willmar Watershed Management Plan	City of Willmar & Barr Engineering (2012)	Plan to guide the use, development, maintenance, and restoration of surface water resources within the City of Willmar and the surrounding watersheds. This plan includes portion of the City draining to Lake Wakanda Watershed.	*Report Link*
Rapid Watershed Assessment for the South Fork Crow River (MN) HUC: 07010205	USDA NRCS	Provides initial estimates of where conservation investments would best address the concerns of landowners, conservation districts, and other community organizations and stakeholders. Includes watershed-wide assessment of the following conditions: land ownership, water assessment, common resource areas, drainage classification, farmland classification, hydric soils, highly erodible land, land capability classification, threatened and endangered species, resource concerns, socioeconomic data, agricultural data	*Report Link*
South Fork Crow River Watershed: Watershed Plans	Water Resources Center MN State University (2014)	Report providing a comparison of management goals from each county, WMO and WD; and a summary of each water plan in the watershed including priority concerns, goals and objectives, and actions related to nutrient management.	*Report Link*
South Fork Crow River Watershed SID Report	MPCA (2017)	Summarizes SID work for 42 biological impairments in the South Fork Crow River Watershed. The impairments in this report are organized by 10-digit HUC	*Report Link*
South Fork Crow River Watershed	MPCA (2016)	Summarizes results of a two year, intensive watershed monitoring (IWM) project in the South Fork Crow River Watershed, which began in 2012. This project was	*Link*

Report/Study	Author	Description	Link
Monitoring and Assessment Report		designed to assess the quality of the lakes and streams in the watershed through both biological and water chemistry monitoring.	
Completed TMDL Studies and WRAPS in South Fork Crow Watershed	MPCA	List of completed TMDLs and WRAPS: • Lake Independence Phosphorus TMDL (2007) • South Fork Crow River Lakes Excess Nutrients TMDL Report (2010) • Buffalo Creek Bacteria TMDL (2013) • South Fork Crow River Watershed TMDL (2017) • Pioneer-Sarah Creek Watershed TMDL (2017) • Pioneer-Sarah Creek WRAPS (In Progress)	*Link to MPCA Watershed Page*
Comprehensive Water Quality Assessment of Select Metropolitan Area Streams: Crow River	Met Council (2014)	Report documenting results from assessments of flow and water quality at two sites in the Crow Watershed (Rockford and Mayer) and includes statistical assessments of trends of several parameters, conclusions about possible effects of landscape features, climatological changes, and human activities, and comparison with other streams within the metropolitan area.	*Report Link*
Cooperative Enhancement Plan for Lake Wakanda	Multiple Agencies (2014)	Plan to restore and improve water quality, fish, and wildlife habitat conditions in Lake Wakanda. Plan summarizes historical vegetation, fisheries, waterfowl, water quality, hydrology information/data and outlines a list of management objectives and actions for the lake.	*Report Link*
Kandi Creek Fluvial Geomorphology Field Report	DNR (2015)	Summary of DNR Ecological and Water Resources field work conducted along Kandi Creek in the Lake Wakanda Watershed. Analyzes the fluvial geomorphology components of Kandi Creek in order to help characterize the condition of the watershed and find relationships to help understand water quality and biological impairments throughout the watershed.	*Contact DNR for Report (not online)*

Report/Study	Author	Description	Link
Kandi Creek Watershed Assessment	USDA NRCS (2008)	Subwatershed assessment study of the Kandi Creek Watershed to review potential storage sites and assess the magnitude of stream bank erosion.	*Contact Kandiyohi NRCS*
Lake Wakanda (34-169), Kandiyohi County Cooperative Enhancement Plan	DNR (2014)	Joint plan with consideration given to fisheries and wildlife resources but to particularly focus on improving water quality, clarity and submersed and emergent vegetation levels in Lake Wakanda.	*Report Link*
HSPF Modeling of the Sauk River, Crow River, and South Fork Crow River	MPCA (2012)	Report documenting results from a successful calibration and validation of HSPF model applications for three watersheds.	*Report Link*

Table 13: Prioritization and targeting tools available for use in the South Fork Crow River Watershed

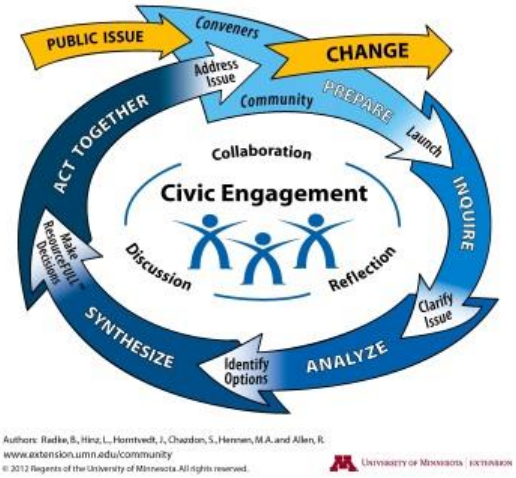
Tool	Description	How can the tool be used?	Notes	Link to information and data
HSPF Model	Simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land.	Incorporates watershed-scale and nonpoint source models into a basin-scale analysis framework. Addresses runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/ transformation of chemical constituents in stream reaches.	Local or other partners can work with MPCA HSPF modelers to evaluate at the watershed scale: 1) the efficacy of different kinds or adoption rates of BMPs, and 2) effects of proposed or hypothetical land use changes.	*USGS*
HSPF-SAM Tool	User-friendly desktop interface to HSPF model application to facilitate prioritization and placement of BMPs based on current conditions and under alternative future conditions as predicted by the calibrated HSPF model	Evaluate cost/benefit and pollutant reduction effectiveness of different BMP management scenarios. Tool can be used on small reaches/subwatersheds, or at large watershed-wide scales	The HSPF-SAM tool is funded by the MPCA through the Clean Water Fund and has been developed specifically for the South Fork Crow River Watershed	*CWF* *SAM*
Prioritize, Target, and Measure Application (PTMApp)	A GIS-based tool that builds on general strategy types in local water plans by identifying implantable on-the-ground Best Management and Conservation Practices	A GIS-based tool that builds on general strategy types in local water plans by identifying implantable on-the-ground Best Management and Conservation Practices	A GIS-based tool that builds on general strategy types in local water plans by identifying implantable on-the-ground Best Management and Conservation Practices	*PTMApp*
The Agricultural Conservation Planning Framework (ACPF)	GIS based tool that identifies locations where specific attributes are favorable for installation of agricultural BMP practices to control water flows and trap/treat nutrient losses in fields, at field edges, and in riparian zones. The tool provides an inventory of conservation alternatives that can be considered at the local and farm level. The input data required, including agricultural field boundaries, land	ACPF (along with PTMApp) can be used by local resource managers to identify and prioritize areas on the landscape where certain agricultural BMPs may work. BMPs available in this tool include: grassed waterways, contour buffer strips, nutrient removal wetlands, water and sediment control basins, and nitrogen bioreactors and other tile drainage BMPs. ACPF also includes a	Due to data requirements and processing times, ACPF works best when applied at the 12-digit HUC subwatershed scale.	*ACPF*

Tool	Description	How can the tool be used?	Notes	Link to information and data
	use, soil survey information, and detailed (LiDAR-based) elevation data, are broadly available across Minnesota and the Midwest.	riparian analysis tool to help identify riparian management alternatives.		
Watershed Nitrogen and Phosphorus Reduction Planning Tools (NBMP & PBMP)	NBMP and PBMP are Excel spreadsheet planning tools that can be used to develop a framework to compare and optimize selection of BMPs for reducing nitrogen and phosphorus loads from the highest contributing sources and pathways.	These tools are intended to compare the effectiveness and cost potential of various BMP options that could be implemented to reduce nutrient loading from cropland. The tool can be used by local resource managers to better understand the feasibility and cost of these BMPs.	Excel spreadsheet and information are available on the University of Minnesota website	*UMN*
Urban Water Quality Models (P8, WinSLAMM, PONDNET)	Urban water quality models such as P8, WinSLAMM and PONDNET, are able to model event based runoff, TSS, and TP through networks of detention ponds and other urban BMPs.	These models, once established within a municipality, can be used as part of a subwatershed assessment to evaluate the effectiveness of existing BMPs and identify high loading areas for potential BMP retrofit opportunities. Once a potential BMP is identified, the model can be used to estimate pollutant load reduction benefits.	Some municipalities within the watershed, such as the City of Hutchinson, already have existing water quality models developed for previous studies	*P8* *PONDNET* *WinSLAMM*
Revised Universal Soil Loss Equation (RUSLE) and Soil Erosion Risk Tool	RUSLE predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, land use and management practices.	The RUSLE model provides an assessment of existing soil loss from upland sources and the potential to assess sediment loading through the application of BMPs..	RUSLE results present maximum amount of soil loss that could be expected under existing conditions and do not represent sediment transport and loading to receiving waters.	*RUSLE*

Tool	Description	How can the tool be used?	Notes	Link to information and data
Restorable Wetland Prioritization Tool	A GIS-based tool developed by the University of Minnesota Duluth and other agencies that uses readily available GIS data consisting of 5 primary layers. The final product is a map showing potential locations for wetland restorations throughout the watershed.	This tool may be used to help identify and prioritize potential wetland restoration areas based on soil type and existing land use.		*UMD*
Zonation	A framework and software for large-scale spatial conservation prioritization; it is a decision support tool for conservation planning. This values-based model can be used to identify areas important for protection and restoration.	Zonation produces a hierarchical prioritization of the landscape based on the occurrence levels of features in sites (grid cells). It iteratively removes the least valuable remaining cell, accounting for connectivity and generalized complementarity in the process. The output of Zonation can be imported into GIS software for further analysis. Zonation can be run on very large data sets (with up to ~50 million grid cells).	The software allows balancing of alternative land uses, landscape condition and retention, and feature-specific connectivity responses. (Paul Radomski, DNR, has expertise with this tool.)	*CBIG*
Stream Fish and Invertebrate IBIs	The Index of Biotic Integrity (IBI) is a biological assessment tool developed in many regions for assessing health of streams, lakes and river systems. It incorporates a set of metrics that are combined to provide a community-level assessment of stream biological conditions.	IBI scores can be used to identify and determine impaired stream reaches for restoration, and non-impaired reaches for protection.		*MPCA*
Lake Fish IBI	Biological assessment tool comprised of multiple metrics that integrate aspects of species richness, community assemblage, and trophic composition. The combining of all individual metrics results in a single score that relates the relative health of the fish community with healthier systems having greater overall scores.	The Lake IBI scores can be used as a starting point to identify lakes that have imbalanced fish communities that need to be restored/managed. Similarly, lakes with high scores can be targeted for protection. The IBI scores also allow a means to evaluate the success of restoration and protection efforts.		*DNR*

Tool	Description	How can the tool be used?	Notes	Link to information and data
Lake Floristic Quality Index	Lake vegetation health assessment tool that is based on a metric of species richness and a Coefficient of Conservatism (C), which is a score (0 -10) that relates a species site fidelity and tolerance to disturbance.	FQI scores can be used to assess the general health of the plant community, and if restoration and protection efforts may be needed.		*MPCA*

3.2 Civic Engagement



A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. The MPCA has coordinated with the University of Minnesota Extension Service for years on developing and implementing civic engagement approaches and efforts for the watershed approach. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." Extension defines a resourceFULL decision as one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: http://www.extension.umn.edu/community/civic-engagement/

Accomplishments and Future Plans

Local stakeholders in the South Fork Crow River Watershed met to develop a civic engagement planning team, made up of CROW, SWCD staff, county staff, city staff, BCWD, and agricultural community representatives. The team developed a plan to create diverse ownership of the water resources of the South Fork Crow River Watershed. The team explored what we were doing well (This included numerous community based activities in the watershed, as well as technical work being accomplished by the CROW and other local organizations) and what to accomplish for diverse ownership. A civic engagement plan was developed that outlined deliverables for prioritized projects.

- Contact or Meet with Agricultural Community Groups, and look for ways to assist and work together
- Expand Recreational Opportunities
    - Paddle the Crow River Day
    - Paddle Patch Program
- Establish Local Media Partnerships
    - Participate in a call-in show for local radio
- Build Volunteer Programs
    - Volunteer monitors for every lake and stream stretch
    - Volunteer Recognition program
- Expand Youth Education Programs
    - Developing Community Education programs
- Citizen-led groups established

South Fork Paddle Patch

- Hutchinson Waters is a membership-based organization of individuals bound together by a common interest and goal to address water quality issues in the Hutchinson area. http://www.hutchinsonwaters.org/ https://www.facebook.com/Hutchinson-Waters-822456221159431/

- Planned Civic Engagement (CE) or public participation efforts moving forward
  - Additional facilitated paint events
- Other ongoing education/outreach/awareness efforts (other than CE) moving forward
- Need for commitment of resources to build local capacity
- Summary of all local involvement for all phases of the WRAPS process:
  - Attended Minnesota Garlic Festival
  - Increased citizen stream/lake monitoring and volunteers
  - Paint with CROW: In October 2015, CROW staff hosted a paint event at the Paint Factory in Hutchinson. Participants were led through a painting of the South Fork Crow River. Additionally, each individual was given a stack of watershed topic cards that were used to spur conservation.
  - Created portable photo booth for events.
  - Rain barrel distribution in Hutchinson and Glencoe
  - Support local lake associations and activities
  - Crow and CE Team meetings were held in: June 2012, July 2012, and August 2012

Paint with CROW at Paint Factory in Hutchinson

  - Conducted Stakeholder and Local Partner Team Advisory Meetings – Project staff held four stakeholder (technical advisors and WWTP operators), and public meetings on the following dates:
    - November 20, 2013 – Provided overview of the water quality model that has been created for the South Fork Crow River Watershed, ensured all available data had been identified, small group brainstorming and discussion to identify key resources and resource concerns, and discussed timeline and next steps.
    - December 10, 2014 – Overview of what has been completed in the project, discussion of Phase II and assistance from partners, updates from partners on projects and events in the South Fork Crow River Watershed, and upcoming meetings and steps in 2015.
    - December 15, 2015 – Reviewed TMDL findings with South Fork cities, wastewater treatment facilities (WWTF), and businesses.

        - September 13, 2016 – Presented information on the results from the South Fork TMDLs, and gathered insights for WRAPs plan.
        - January 31, 2017 – Presented information on the WRAP, and a one-on-one opportunity for local community groups to discuss their individual concerns.
        - Additionally, CROW staff hosted a public open house on the Lake Wakanda project and issues associated with the South Fork Crow River Headwaters in October 2014. Lake Wakanda workgroup met in January 2015 to review public comments and present to Kandiyohi County Board on February 17, 2015. Public hearing held on June 9, 2015, to discuss the drawdown for Lake Wakanda. CROW and Wenck staff met repeatedly to discuss project objectives and maintained frequent communication.
    - This project was also discussed at the CROW Joint Powers Board meetings which are open to the public:
        - **2012**: 02/02/2012, 04/05/2012, 09/06/2012, 11/08/2012, and 12/06/2012.
        - **2013**: 02/06/2013 and 11/06/2013.
        - **2014**: 11/05/2014.
        - **2015:** 02/04/2015, 04/14/2015, 06/03/2015, and 10/07/2015.
        - **2016**: 01/06/2016, 02/10/2016, 03/02/2016, 08/03/2016, 09/07/2016, and 11/02/2016.
- Consulting firm proposals were reviewed at the BCWD's Board meeting on December 19, 2012.

Public Notice for Comments

An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from April 16, 2018, through May 16, 2018.

3.3 Technical and Financial Assistance

State and local government units with primary implementation responsibility include:

- CROW
- BCWD
- SWCDs: Carver, McLeod, Sibley, Renville, and Kandiyohi
- Counties: Carver, McLeod, Sibley, Renville, and Kandiyohi
- MPCA
- DNR

Section 3.3 (Tables 14 through 20) provides the relevant governmental unit lead(s) for each proposed strategy.

A Technical Work Group will continue to assist in implementation and local water planning efforts. This work group is a subgroup of the TMDL and WRAPS stakeholder group, and includes representatives from state and local agencies along with interested stakeholders. The work group will provide technical oversight and identify opportunities for coordination and engagement with land managers, landowners, and water resource-focused groups. They will prioritize implementation activities, review monitoring data and prioritize ongoing monitoring needs, refine strategies and identify specific projects, and provide technical support for grant applications and planning initiatives.

In addition, this work group can support planning efforts expected to take place in the next 10 years. Watershed-based local planning efforts will further develop implementation strategies and recommend specific projects at the local scale. It is expected that CROW will lead and facilitate this work group. Additional local capacity will be needed to support this effort.

The proposed WRAPS will rely upon available funding sources to fund projects and programs as described in Section 3.4. Funding for the first ten years is significantly higher than existing efforts and will require additional sources of funding for local capacity and capital improvement projects.

Potential funding sources for the South Fork Crow River Watershed include:

- Clean Water Fund, part of the Clean Water, Land, and Legacy Amendment
- MPCA Clean Water Partnership Loan Program for Subsurface Sewage Treatment System (SSTS) upgrades and other BMPs
- Local government cost-share and loan programs
- Federal grants and technical assistance programs
- Conservation Reserve Program and Natural Resources Conservation Service (NRCS) cost-share programs
- Federal Section 319 program
- Outdoor Heritage Fund, part of the Clear Water, Land, and legacy Amendment
- Legislative-Citizen Commission on Minnesota Resources

3.4 Restoration and Protection Strategies

Specific strategies have been developed to restore the impaired waters within the watershed and for protecting waters within the watershed that are not impaired. The subwatershed-based implementation strategy tables that follow outline the strategies and possible actions that are capable of cumulatively achieving the needed pollution load reductions for point and nonpoint sources, as well as watershed and in-stream improvements to decrease stressors on biological communities throughout the watershed. The tables were developed by reviewing results of the TMDL studies, subwatershed analysis (Appendix A), HSPF modeling, and specific conditions affecting each subwatershed, as well as input and feedback from the South Fork Crow River Watershed technical group. The subwatershed analysis is sorted by HUC10 watershed (Figure 7). As this WRAPS Report includes waters that have been previously addressed by past TMDLs, specific implementation plans have already been developed for some of the waterbodies. In these cases, links to the past work are provided in the table. Some of the practices in the restoration and protection strategies tables may be credited as progress toward achieving TMDL WLAs. MS4s and other permitted entities may contact the MPCA to discuss which practices may be credited.

Figure 8: South Fork Crow River Watershed Subwatershed by 10HUC

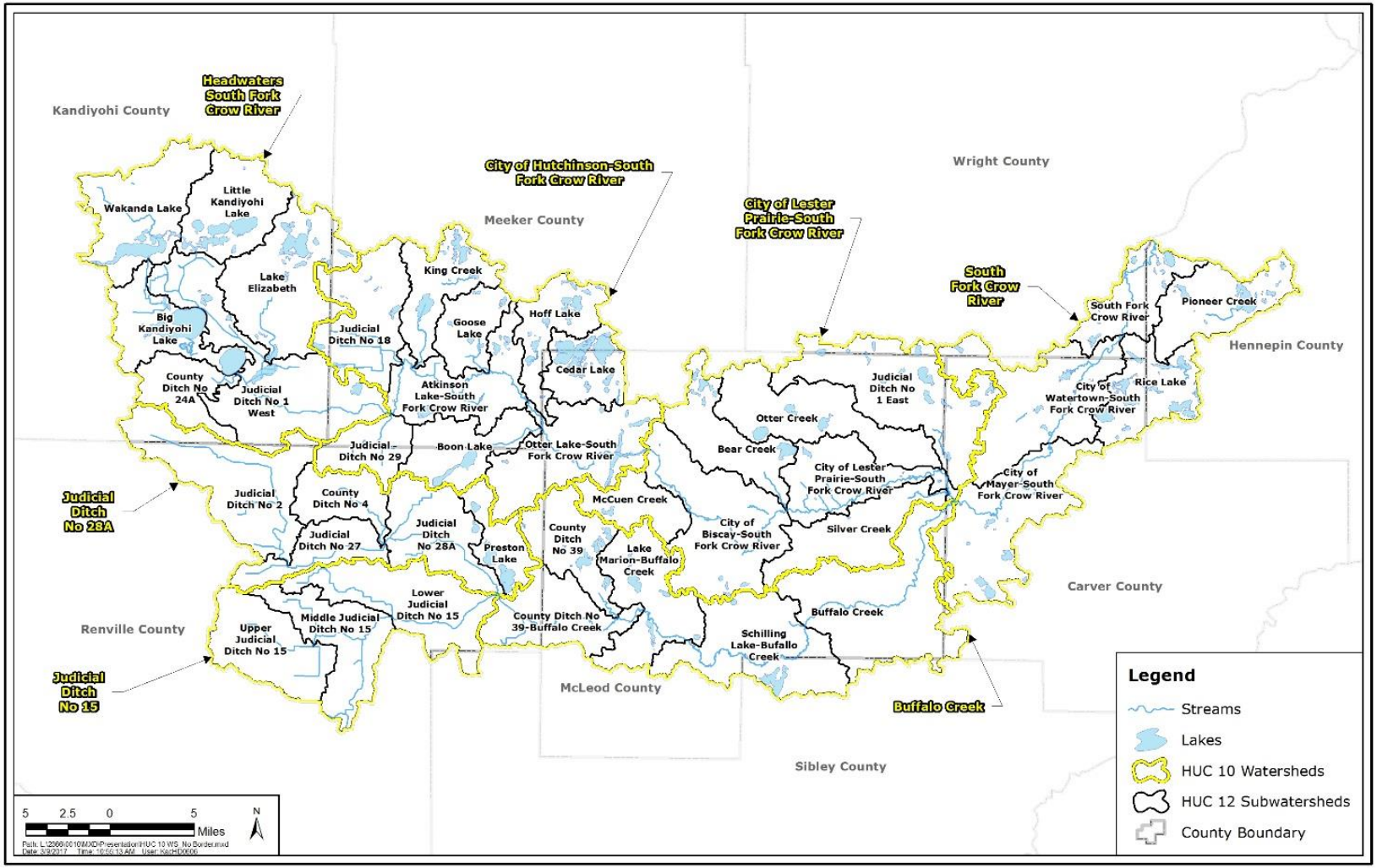


Table 14: Strategies and example actions proposed for the Headwaters South Fork Crow River HUC10 Subwatershed

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
Headwaters - South Fork Crow River	South Fork Crow River (07010205-558)	Kandiyohi Co., Meeker Co., Willmar City MS4	TSS	Loads vary by flow regime; 11% of samples currently exceed 65 mg/L	65 mg/L met 90% of time Apr-Sep; estimated 37% load reduction during very high flow conditions	Improve upland/field surface runoff controls (All impairments)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**TSS** Reach 558: 15% during very high flows **TP** Wakanda: 15% Kasota: 15% Little Kandiyohi: 15%	**TSS** Reach 558: 37% during very high flows **TP** Wakanda: 37% Kasota: 75% Little Kandiyohi: 53%	Percent Reduction (TSS, TP)	S	A	P			A	P	A		A	A	A		2047
							Implement soil & water conservation practices throughout watersheds draining to impaired lakes	Ongoing				S	A	P	A		A	P	A	A	A	A	A		
						Protect/stabilize banks/bluffs (All Impairments)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)				S	A	P	A		A	S		S	A				
							Implement livestock access control BMPs on feedlots near riparian corridors	Minimal				A	P	S				S	A	A	A	A			
	South Fork Crow River (558); County Ditch No 24A (610); State Ditch Branch 2 (608)	Kandiyohi Co.	Fish & Invert. IBI	Fish IBI Impairments (558, 610 and 608) and Invert. IBI Impairments (558 and 608)	Primary Stressors: stream P, eutrophication, lack of habitat, altered hydrology, TSS	Improve drainage management (All Impairments)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing					S	P				P			A	A	A		
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing					S	P				S		A	A	A			
						Improve fertilizer and manure application (Biotic Stressors,	Promote and implement manure and fertilizer spreading BMPs throughout	Ongoing				A	S	S				P	A		A	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
						Lake Nutrients)	watershed, target focus areas																		
	Lake Wakanda (34-0169)	Kandiyohi Co., Willmar City MS4	Lake Nutrients (TP)	16,012 lbs./yr.	Goal: 7,791 lbs./yr.; Reduction: 56%	Improve urban stormwater management (All Impairments)	ID and implement urban BMPs in City of Willmar MS4 and non-MS4 communities	Ongoing	Minnetaga: 15% Big Kandiyohi: 15% Thompson: 15% Johnson: 15%	Minnetaga: 60% Big Kandiyohi: 74% Thompson: 65% Johnson: 62%	Action Items and Percent Internal Load Reduction (TP)		A	A	P		S		A		A		A		
							ID and implement urban BMPs throughout City of Willmar MS4 to reduce P loading to Lake Wakanda	Ongoing					S	A	P								A		
	Kasota Lake (34-0105)	Kandiyohi Co.		13,750 lbs./yr.	Goal: 1,747 lbs./yr.; Reduction: 91%		ID and implement urban BMPs throughout Cities of Kandiyohi and Lake Lillian to reduce P loading to impaired lakes	Minimal				A	A	S			P		S				A		
						Reduce in-water loading (Lake Nutrients)	Assess vegetation community (Johnson, Thompson)	None	Complete surveys within 4 years	**TP** Wakanda: 37%		A		S					A	P				A	
	Little Kandiyohi Lake (34-0096)	Kandiyohi Co.		12,269 lbs./yr.	Goal: 2,589 lbs./yr.; Reduction: 79%		Develop plan to manage AIS (Big Kandiyohi), improve FQI scores and overall health of vegetation community (Kasota, Little Kandiyohi, Minnetaga)	None	Develop plan within 5 years			A	P							S				A	

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
	Minnetaga Lake (34-0076)	Kandiyohi Co.		10,241 lbs./yr.	Goal: 2,170 lbs./yr.; Reduction: 79%		Assess fish community (Johnson, Kasota, Little Kandiyohi)	None	Complete surveys within 4 years	Kasota: 97% Little Kandiyohi: 95% Minnetaga: 96% Big Kandiyohi: 64% Thompson: 65% Johnson: 90%			A						S	P				A	
	Big Kandiyohi Lake (34-0086)	Kandiyohi Co.		29,688 lbs./yr.	Goal: 9,902 lbs./yr.; Reduction: 67%		Assess rough fish populations and develop management strategies (Lillian, Minnetaga, Thompson, Wakanda)	None	Develop mgt. plan/strategies within 5 years				A						S	P				A	
	Lake Lillian (34-0072)	Kandiyohi Co.		8,114 lbs./yr.	Goal: 5,279 lbs./yr.; Reduction: 35%		Evaluate potential for outlet modification and partial and/or full lake drawdowns (Johnson, Kasota, Lillian, Little Kandiyohi, Minnetaga, Thompson, Wakanda)	None	Perform assessment or feasibility study within 5 years			A	S	S				A	P	S			A	
	Thompson Lake (47-0159)	Meeker Co.		1,797.2 lbs./yr.	Goal: 752.2 lbs./yr.; Reduction: 62%		Evaluate sediment chemistry and potential for phosphorus release from sediment if water level management is not feasible (Big Kandiyohi Lake, Johnson, Kasota, Little Kandiyohi,	None	Evalute sediment chemistry within 5 years			S		A				P	A					
	Johnson Lake (34-0012)	Kandiyohi Co.		494 lbs./yr.	Goal: 141 lbs./yr.; Reduction: 74%																				

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							Minnetaga, Thompson, Wakanda)																		
	Lake Elizabeth (34-0022)	Kandiyohi Co.	Phosphorus, biota	Mean TP currently 89 ug/L; FQI scores above threshold, Fish IBI scores below threshold	Mean TP Goal: 90 ug/L	Improve upland/field surface runoff controls	Implement soil & water conservation practices throughout lake watershed, target focus areas	Unknown	Identify focus areas and implement 1 project	Implement 3 projects	BMP projects	S	A	P			A	P	A		A	A	A	A	NA
						Protect	Protect in-lake vegetation community and enhance high priority habitat areas in and around Lake Elizabeth	Unknown	100%	100%	% of high priority habitat areas	A		S					A	P				A	
						Reduce in-water loading	Assess rough fish population, pursue removals and/or establish barriers as necessary	Unknown	Complete Assessment/Plan	Execute Plan	Assessment and Mgt. Plan	A	S	A					A	P				A	
							Assess AIS coverage and potential impact on native vegetation community and internal load	Unknown	Complete Assessment/Plan	Execute Plan	Assessment and Mgt. Plan	A	P							S				A	
	Grass Lake (Wetland to Wakanda Lake)	Kandiyohi Co., Willmar City MS4	--	--	--	Improve Drainage Mgt.	Continue to restore/enhance/protect Grass Lake wetland system to improve hydrology in Wakanda Watershed	In progress	Complete restoration	Complete Restoration	Wetland restoration project	A	P	S	S				A	S					
						Improve Urban Stormwater Mgt.	ID and implement urban BMPs throughout City of Willmar to reduce pollutant loading to Grass Lake	Unknown	10% reduction	37% reduction	% TSS and TP reduction	A	S	A	P				A				A		

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
						Monitor	Monitor Grass Lake inflow/outflow WQ and flow to monitor progress	None	2 years	5 years	years of monitoring	A	P	S					S	S				A	
	Priority Shallow Lakes for Protection	Kandiyohi Co. and Meeker Co.	--	--	--	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant communities, and other biological services of priority shallow lakes throughout watershed (Two Island Dog, Carrie, Ella, Mud, Wieker, Kasota, Minnetaga, Eleanor)	Ongoing	Develop protection plan	Implement plan	Plan	A		A					A	P	A			A	

Color Key:

		Key for Responsibilities:	
	Restoration	P	Primary Lead
	Protection	S	Secondary
	Point Sources	A	Assist as needed

Table 15: Strategies and example actions proposed for the City of Hutchinson – South Fork Crow River HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate				Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units														
City of Hutchinson - South Fork Crow River	South Fork Crow River (07010205-540)	Meeker Co., Renville Co., McLeod Co., City of Hutchinson MS4	TSS	Loads vary by flow regime; 11% of samples currently exceed 65 mg/L	65 mg/L met 90% of time Apr-Sep; estimated 37% load reduction during very high flow conditions	Improve upland/field surface runoff controls (TSS, Biotic Stressors, Lake Nutrients)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**TSS**	**TSS**	Percent Reduction (TSS, TP)	S		P		S	P	S			A				2047
							Implement soil & water conservation practices throughout watersheds draining to impaired lakes	Ongoing	Reach 540: 15% during very high flows	Reach 540: 37% during very high flows		S		P		S	P	S			A				
						Protect/stabilize banks/bluffs (TSS, Biotic Stressors, Lake Nutrients)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)	**Lake TP**	**Lake TP**			S	S		S		A	P						
							Implement livestock access control BMPs on feedlots near riparian corridors	Minimal	Boon: 15%	Boon: 38%		A	P	S		S	S	A	A	A	A				
						Improve urban stormwater management (TSS, Lake Nutrients)	ID and implement urban BMPs in City of Hutchinson MS4 and all non-MS4 communities	Ongoing	Star: 20%	Star: 71%		A	S	S	P	S		S							
							ID and implement urban BMPs throughout City of Hutchinson	Ongoing	Goose: 20%	Goose: 81%		A	S	S	P	S		S							

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							MS4 to reduce P loading to Otter Lake		Greenleaf: 15% Willie: 5% Hoff: 15% Cedar: 20% Belle: 20%	Greenleaf: 52% Willie: 5% Hoff: 40% Cedar: 67% Belle: 95%														
	South Fork Crow River (540); Bell Creek (549); JD18 (550); Unnamed Cr. (623); Unnamed Cr. (533); King Creek (613); Unnamed Cr. (621); CD18 (609); Unnamed Cr. (656)	Kandiyohi Co.	Fish & Invert. IBI	Fish IBI Impairments (540, 549, 550,623, 533, 613, 609, 656) and Invert. IBI Impairments (540, 549, 623, 533, 621, 609, 656)	Primary Stressors: Low DO, Stream P, TSS, Altered Hydrology	Improve drainage management (All Impairments)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing					P	S			S		A	A	A				
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing				P	S			S		A	A	A				
						Improve fertilizer and manure application (Biotic Stressors, Lake Nutrients)	Promote and implement manure and fertilizer spreading BMPs throughout watershed, target focus areas	Ongoing					P			S		A	A	A				
													P			S		A	A	A				
	Boon Lake (65-0013)	Meeker Co., Renville Co.	Lake Nutrients (TP)	6,358 lbs/yr	Goal: 1,892 lbs/yr; Reduction: 73%	Reduce in-water loading (Lake Nutrients)	Develop plan to manage/control AIS (Belle, Cedar, Greenleaf, Hoff, Otter, Star, Willie), improve FQI scores and overall health of vegetation community (Belle, Boon, Hoff)	None	Develop plan within 5 years		Action Items and Percent Internal Load Reduction (TP)	A	P	A						A			P	
	Star Lake (47-0129)	Meeker Co.		2,197 lbs/yr	Goal: 1,149 lbs/yr; Reduction: 49%																			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							Assess fish community (Boon)	None	Complete surveys within 4 years	-		A	P	A						A				P	
	Goose Lake (47-0127)	Meeker Co.		2,261 lbs/yr	Goal: 181 lbs/yr; Reduction: 93%		Assess rough fish populations and develop management strategies (Cedar, Goose, Hoff, Greenleaf, Star)	None	Develop mgt. plan/strategies within 5 years	**Lake TP** Boon: 88% Star: 34% Goose: 97% Greenleaf: 34% Cedar: 72% Belle: 42%		A	P	A						A				P	
	Greenleaf Lake (47-0062)	Meeker Co.		693 lbs/yr	Goal: 489 lbs/yr; Reduction: 37%		Evaluate potential for outlet modification and partial and/or full lake drawdowns (Boon, Cedar, Goose, Greenleaf, Hoff, Star)	None	Perform assessment or feasibility study within 5 years			A	P	A						A				P	
	Willie Lake (47-061)	Meeker Co.		2,629 lbs/yr	Goal: 2,564 lbs/yr; Reduction: 12%		Evaluate sediment chemistry and potential for phosphorus release from sediment if water level management is not feasible (Belle, Boon, Cedar, Goose, Greenleaf, Star)	None	Evaluate sediment chemistry within 5 years			A	P	A						A				P	
	Hoff Lake (47-0106)	Meeker Co.		7,916 lbs/yr	Goal: 5,890 lbs/yr; Reduction: 33%																				
	Cedar Lake (43-0115)	Meeker Co., McLeod Co.		5,966 lbs/yr	Goal: 2,482 lbs/yr; Reduction: 63%																				
	Belle Lake (47-0049)	Meeker Co., McLeod Co.		2,036 lbs/yr	Goal: 1,154 lbs/yr; Reduction: 49%																				
	Otter Lake (45-0085)	McLeod Co.		Mean TP currently 350 ug/L	Lake assessed to meet River Eutrophication TP Target: 150 ug/L																				
	Stahl Lake (43-0104)	Meeker Co.	Phosphorus, biota	Mean TP currently 31 ug/L; FQI score above threshold; Lake IBI not assessed	Mean TP Goal: 65 ug/L	Improve upland/field surface runoff controls	Implement soil & water conservation practices throughout lake watershed,	Unknown	Identify focus areas and implement 1 project	Implement 3 projects	BMP projects	S		P				P	S	A	S	A			NA

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							target focus areas																		
						Protect	Protect in-lake vegetation community and high priority habitat areas east of Stahl Lake	Unknown	100%	100%	% of high priority habitat areas	S		P				P	S	A	S	A			
						Monitor	Monitor inflows to lake to determine loading from watershed and input from surrounding wetlands	Unknown	Monitor for 2 years	Manage as needed	Monitor and Asses	S		P				P	S	A	S	A			
							Monitor and assess French Lake and potential loading to Stahl	Unknown	Monitor for 2 years	Manage as needed	Monitor and Asses	S		P				P	S	A	S	A			
	Wetland in JD29 Subwatershed	Meeker Co.	--	--	--	Protect	Work with land owners to protect and enhance wetland area identified as high biodiversity significance	Unknown	Assess and develop plan	Restore and manage as needed	Wetland restoration	S		P				P	S	A	S	A			
	Other priority shallow lakes for protection	Meeker Co., Renville Co., McLeod Co.	--	--	--	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant	Ongoing	Develop protection plan	Implement plan	Plan	S	S	S		S			A	P	A	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							communities, and other biological services of Harden, Sioux, Middle, Rodewald, and King Lakes																		

Color Key:

- Restoration
- Protection
- Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 16: Strategies and example actions proposed for the City of Lester Prairie – South Fork Crow River HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
Lester Prairie - South Fork Crow River	South Fork Crow River (07010205-510)	McLeod Co., City of Hutchinson MS4	TSS	Loads vary by flow regime; 11% of samples currently exceed 65 mg/L	65 mg/L met 90% of time Apr-Sep; estimated 42% load reduction during very high flow conditions	Improve upland/field surface runoff controls (TSS, Biotic Stressors, Lake Nutrients)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**TSS** Reach 510: 15% during very high flows	**TSS** Reach 510: 42% during very high flows	Percent Reduction (TSS, TP)	S		P		S	P	S			A			A	2047
							Implement soil & water conservation practices throughout watersheds draining to impaired lakes	Ongoing				S		P		S	P	S			A			A	
						Protect/stabilize banks/bluffs (TSS, Biotic Stressors, Lake Nutrients)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)	Reach 511: 15% during very high flows	Reach 511: 43% during very high flows			S	S		S		A	P						
							Implement livestock access control BMPs on feedlots near riparian corridors	Minimal	-	-		A	P	S		S	S	A	A	A	A			
	South Fork Crow River (07010205-511)	McLeod Co., City of Hutchinson MS4	TSS	Loads vary by flow regime; 19% of samples currently exceed 65 mg/L	65 mg/L met 81% of time Apr-Sep; estimated 43% load reduction during very high flow conditions	Improve urban stormwater management (TSS, Lake Nutrients)	ID and implement urban BMPs throughout City of Hutchinson MS4 and all non-MS4 communities	Ongoing	**Lake TP**	**Lake TP**		A	S	S	P	S		S							
							ID and implement urban BMPs	Ongoing	Bear: 20%	Bear: 67%		A	S	S	P	S		S							

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							throughout Cites of Silver Lake and Winsted to decrease P loading to Silver and Winsted Lakes																		
	South Fork Crow River (510, 511); Bear Cr. (515); CD26/27 (611); Unnamed Cr. (622, 617, 685); Silver Cr. (641); Otter Cr. (642, 643); JD1 (572)	McLeod Co.	Fish & Invert. IBI	Fish IBI Impairments (510, 511, 515, 611, 622, 641, 617, 642, 643, 572, 585) and Invert. IBI Impairments (510, 511, 515, 611, 641, 572)	Primary Stressors: Stream P, DO, Chlorophyll-a, BOD, Lack of Habitat	Improve drainage management (All Impairments)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing	Silver: 15% Winsted: 25%	Silver: 36% Winsted: 84%			P	S				S	A	A	A				
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing					P	S				S	A	A	A				
						Improve fertilizer and manure application (Biotic Stressors, Lake Nutrients)	Promote and implement manure and fertilizer spreading BMPs throughout watershed, target focus areas	Ongoing						P				S	A	A	A				
	Bear Lake (43-0076)	McLeod Co.	Lake Nutrients (TP)	1,622 lbs/yr	Goal: 245 lbs/yr; Reduction: 86%	Reduce in-water loading (Lake Nutrients)	Develop plan to manage/control AIS, improve FQI scores and overall health of vegetation community in Winsted Lake	None	Develop plan within 5 years		Action Items and Percent Load Reduction (TP)	A	P	A										A	

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
	Silver Lake (43-0034)	McLeod Co.		6,109 lbs/yr	Goal: 972 lbs/yr; Reduction: 86%		Assess vegetation community (Bear and Silver Lakes)	None	Complete surveys within 4 years	**Lake TP** Bear: 93% Silver: 92% Winsted: 99%		A	P	A						A				A	
							Assess fish community (Bear)	None	Complete surveys within 4 years			A	P	A						A				A	
							Assess rough fish populations and develop management strategies (Silver and Winsted)	None	Develop mgt. plan/strategies within 5 years			A	P	A						A				A	
							Evaluate potential for outlet modification and partial and/or full lake drawdowns (Bear, Silver, Winsted)	None	Perform assessment or feasibility study within 5 years			A	P	A						A				A	
	Winsted Lake (43-0012)	McLeod Co., Wright Co.		15,452 lbs/yr	Goal: 2,171 lbs/yr; Reduction: 86%		Evaluate sediment chemistry and potential for phosphorus release from sediment if water level management is not feasible (Bear, Silver, Winsted)	None	Evaluate sediment chemistry within 5 years			A	P	A						A				A	
	Swan Lake (43-0040)	McLeod Co.	Phosphorus and biota	Mean TP currently 45 ug/L; FQI above	Mean TP Goal: 65 ug/L;	Improve upland/field	Implement soil & water conservation	Unknown	Identify problem areas	Implement projects as necessary	Projects	S	P	S					P	S	A	S	A		NA

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
				threshold; Lake IBI below threshold	improve Lake IBI scores	surface runoff controls	practices throughout lake watershed, target focus areas																	
						Reduce in-water loading	Develop plan to improve IBI scores and overall health of fish community	Ongoing	Develop plan within 5 years	Implement Plan	Plan and implementation	S	P	S					P	S	A	S	A	
						Protect	Develop vegetation management plan to protect and maintain biodiversity and healthy vegetation community	Ongoing	Develop plan within 5 years	Implement Plan	Plan and implementation	S	P	S					P	S	A	S	A	
	McCuen Creek	McLeod Co.	Fish & Invert. IBI	Currently meets Fish & Invert. IBI	Maintain Fish and Invert. IBI Scores	Protect	Protect and restore headwater areas of McCuen Creek and in-channel conditions to continue to support biotic communities	Ongoing	Identify projects and problem areas	Implement projects as necessary	Projects	S	S	S					S	P				
	Other priority shallow lakes for protection	McLeod Co.	--	--	--	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant communities, and other	Ongoing	Develop protection plan	Implement plan	Plan	S	S	S					S	P				

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							biological services of Halva Marsh, Butternut and Grass Lakes																		

Color Key:

- Restoration
- Protection
- Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 17: Strategies and example actions proposed for the Judicial Ditch No 28A HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
				Strategy Type	Estimated Adoption Rate				Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
	Waterbody (ID)	Location and Upstream Influence Counties			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units														
Judicial Ditch No. 28A	Buffalo Creek (07010205-502)	Detailed allocations were developed for the Buffalo Creek Bacteria TMDL Report (2013). This document was approved by the EPA and available through the MPCA website: https://www.pca.state.mn.us/water/tmdl/buffalo-creek-south-fork-crow-river-bacteria-tmdl-project																				
	Buffalo Creek (07010205-502)	Renville Co., Kandiyohi Co.	Improve upland/field surface runoff controls (Biotic Stressor, Bacteria, Lake Nutrients)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**Bacteria** Reach 502: 20% for all flow conditions	**Bacteria** Reach 502: 49-61% depending on month	Percent Reduction (Bacteria, TP)	S	S	S		A	P	S			A				2047
			Protect/stabilize banks/bluffs (Biotic Stressors, Bacteria, Lake Nutrients)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)				S	S	S		A	P	S			A				
				Implement livestock access control BMPs on feedlots near riparian corridors	Minimal	**Lake TP**	**Lake TP**		A	P	S			P	S	A		A	A	A		
	Buffalo Creek (502); JD67 (504); CD4 (528); JD9 (625); Unnamed Ditch (630); CD7A (631)	Renville Co., Kandiyohi Co.	Improve drainage management (Biotic Stressors, Bacteria, Lake Nutrients)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing	Preston: 15%	Preston: 42%			S	S		S	P		A	A	A				
				Implement wetland restorations throughout subwatershed, target focus areas	Ongoing					P	S		S	S		A	A	A				
			Improve fertilizer and manure application (Bacteria, Biotic Stressors, Lake Nutrients)	Promote and implement manure and fertilizer spreading BMPs throughout watershed, target focus areas	Ongoing						P		S	S		A	A	A				
	Preston Lake (65-0002)	Renville Co.	Reduce in-water loading (Lake Nutrients)	Assess rough fish populations and develop management strategies to improve fish community in Preston Lake	None	Develop plan within 5 years	Implement plan	Plan and implementation	A	S	A											
				Develop plan to manage/control AIS and improve FQI scores and overall health of vegetation community in Preston Lake	None	Develop plan within 5 years	Implement plan	Plan and implementation	S	P	A											
	Allie Lake (65-0006)	Renville Co.	Improve upland/field surface runoff controls	Implement soil & water conservation practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in focus areas	practices	A	S	P		S		P	S	A	S	A		S	NA
			Improve drainage management	Implement drainage management practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in focus areas	practices	A	S	P		S		P	S	A	S	A		S	
				Implement wetland restorations throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in focus areas	practices	A	S	P		S		P	S	A	S	A		S	

Major Subwatershed	Waterbody and Location		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility													Estimated Year to Achieve Water Quality Target
					Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
			Improve fertilizer and manure application	Promote and implement manure and fertilizer spreading BMPs throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in focus areas	practices	A	S	P		S		P	S	A	S	A		S	
			Protect	Protect/promote/preserve publically managed land surrounding lake	Ongoing	Implement restoration projects	Implement restoration projects	Practices and projects	A	P	A		S			A	P	A	A	A	S	
			Reduce in-water loading	Assess rough fish populations and develop management strategies to improve fish community	None	Develop plan within 5 years	Implement plan	Plan and implementation		S			A			A	P				S	
				Develop plan to manage/control AIS and improve FQI scores and overall health of vegetation community	None	Develop plan within 5 years	Implement plan	Plan and implementation	A	P			A			A	P				S	
	Phare Lake (65-0012)	Renville Co.	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant communities, and other biological services	Ongoing	Develop protection plan	Implement plan	Plan	A	P	A		P		P	S	S	S	A			

Color Key:

- Restoration
- Protection
- Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 18: Strategies and example actions proposed for the Judicial Ditch No 15 HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
Judicial Ditch No. 15	Judicial Ditch 15 (07010205-513)	Renville Co.	Bacteria	Geometric means for June, July, Aug, Sep, and Oct currently exceed chronic *E. coli* standard	Estimated flow reduction by flow category: 57% Very High; 52% High; 66% Mid; 64% Low	Improve upland/field surface runoff controls (Bacteria, Biotic Stressors)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	-	-		S	S	S		A	P	S			A				2047
						Protect/stabilize banks/bluffs (Biotic Stressors. Bacteria)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)	**Bacteria** Reach 513: 20% for all flow conditions	**Bacteria** Reach 513: 52% - 66% depending on flow condition	Percent Reduction (Bacteria)	S	S	S		A	P	S			A				
							Implement livestock access control BMPs on feedlots near riparian corridors	Minimal				A	P	S			P	S	A		A	A	A		
						Improve urban stormwater management (Bacteria, Biotic Stressors)	ID and implement urban BMPs in non-MS4 communities (Buffalo Lake, Hector) throughout subwatershed	Ongoing				A	S	S		P	P		A		A				
	JD15 (509); JD15 Branches (626, 627, 628)	Renville Co.	Fish & Invert. IBI	Fish IBI Impairments (509, 626, 627, 628) and Invert. IBI Impairments (509, 628)	Primary Stressors: Phosphorus, Lack of Habitat, Nitrogen,	Improve drainage management (Bacteria, Biotic Stressors)	Implement drainage management practices throughout subwatershed,	Ongoing				A		S			P	S			A	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
					Conductivity, Altered Hydrology, DO		target focus areas																		
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing				A		S			P	S	A		A	A			
						Improve fertilizer and manure application (Bacteria, Biotic Stressors)	Promote and implement manure and fertilizer spreading BMPs throughout watershed, target focus areas	Ongoing				A		S			P	S				A	A		

Color Key:

	Restoration
	Protection
	Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 19: Strategies and example actions proposed for the Buffalo Creek HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
Buffalo Creek	Buffalo Creek (07010205-501)	Detailed allocations were developed for the Buffalo Creek Bacteria TMDL Report (2013). This document was approved by the EPA and available through the MPCA website: https://www.pca.state.mn.us/water/tmdl/buffalo-creek-south-fork-crow-river-bacteria-tmdl-project																						
	Buffalo Creek (07010205-501/638)	McLeod Co., Renville Co., Sibley Co., Glencoe City MS4	TSS	Loads vary by flow regime; 10% of samples currently exceed 65 mg/L	65 mg/L met 90% of time Apr-Sep; estimated 55% load reduction during very high flow conditions and 30% load reduction during high flow conditions	Improve upland/field surface runoff controls (All Impairments)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**TSS** Reach 501/638: 15% for all flow conditions	**TSS** Reach 501/638: 30% - 55% depending on flow condition	Percent Reduction (TSS, Oxygen Demand, Bacteria, TP)														2047
			Bacteria	Geometric means for May, June, July, Aug, Sep, and Oct currently exceed chronic *E. coli* standard	Bacteria reductions range from 55%-81% depending on month	Protect/stabilize banks/bluffs (TSS, Bacteria, Biotic Stressors, Lake Nutrients)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)	**Oxygen Demand** Reach 501/638:15%	**Oxygen Demand** Reach 501/638: 57%		S	A	P	A	A	P	S		S	A				
							Implement livestock access control BMPs on feedlots near riparian corridors	Minimal				A	P	S			S	S	A	A	A	A	A		
			DO	Current Oxygen Demand Load: 13,312 lbs/yr	Oxygen Demand Goal: 5,784 lbs/yr; Reduction: 57%	Improve urban stormwater management (TSS, DO, Bacteria, Biotic Stressors)	ID and implement urban BMPs throughout City of Glencoe MS4 to reduce sediment, oxygen demand, and bacteria loads to the South Fork Crow River	Ongoing	**Bacteria** Reach 501/638: 20% for all flow conditions	**Bacteria** Reach 501/638: 55% - 81% depending on month		S	A	P	A	A	P	S		S	A				
							Evaluate infrastructure, drainage, and storage in central and eastern portions of the City of Glencoe to reduce flooding and peak flows	Ongoing					S	A	P	P	S		S	S					
							ID and implement urban BMPs in non-MS4 communities (Stewart, Plato, Brownton) throughout subwatershed	Minimal	**Lake TP** Marion: 5%	**Lake TP** Marion: 15%		S	S	S	S	P	S		A					
	Buffalo Creek (501/638); JD8 (591); CD33 (645); Unnamed Creek (614, 615)	McLeod Co., Renville Co., Sibley Co.	Fish & Invert. IBI	Fish IBI Impairments (501/638, 591, 645, 614, 615) and Invert. IBI Impairments	Primary Stressors: Altered Hydrology, Phosphorus, DO, DO Flux, Chlorophyll-a,	Improve drainage management (All Impairments)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing					S	S		S	P		A	A	A			
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing					P	S		S	S		A	A	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																	
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
				(501/638, 591, 645)	pH, Lack of Habitat	Improve fertilizer and manure application (Bacteria, Biotic Stressors, Lake Nutrients)	Promote and implement manure and fertilizer spreading BMPs throughout watershed, target focus areas	Ongoing						P		S	S		A	A	A				
	Marion Lake (43-0084)	McLeod Co.	Lake Nutrients (TP)	3,251 lbs/yr	Goal: 3,069 lbs/yr; Reduction: 6%	Reduce in-water loading (Lake Nutrients)	Assess rough fish populations and develop management strategies to improve fish IBI scores and overall health of fish community (Marion)	None	Develop plan within 5 years	Implement plan	Plan and implementation	A	S	A					A	P				A	
	Eagle Lake (43-0098)	McLeod Co., Renville Co.	Phosphorus, biota	Mean TP currently 77 ug/L; FQI above threshold; Lake IBI not assessed	Mean TP Goal: 90 ug/L	Improve upland/field surface runoff controls	Implement soil & water conservation practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P			S		P	S	A	S	A		NA
						Improve drainage management	Implement drainage management practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P			P		P	S	A	S	A		
							Implement wetland restorations throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P			S		P	S	A	S	A		
						Improve fertilizer and manure application	Promote and implement manure and fertilizer spreading BMPs throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P			S		P	S	A	S	A		
						Protect	Protect/promote/preserve wetlands and high priority habitat areas in and surrounding lake	Ongoing	100%	100%	% of high priority habitat areas	A	P	A			S		P	S	S	S	A		
							Develop plan to monitor/manage AIS and protect vegetation community	Ongoing	Develop plan within 5 years	Implement plan	Plan and implementation	A	P				A			A	S				
						Monitor	Assess fish community	None	Complete surveys within 4 years	Manage as needed	Surveys/assessments	A	S				A			A	P				
							Continue to monitor in-lake water quality since lake is very close to impairment	Ongoing	Monitor for 4 years	Manage as needed	Monitor and Assess	P	A				A			S	S				
	Other priority shallow lakes for protection	McLeod Co., Renville Co., Sibley Co.	--	--	--	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant communities, and other biological services of Barber, Whitney, Addie, Lewis, Schilling Lakes	Ongoing	Develop protection plan	Implement plan	Plan	A	P	A			P		P	S	S	S	A		

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River Organization of Water	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	

Color Key:

- Restoration
- Protection
- Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 20: Strategies and example actions proposed for the South Fork Crow River HUC10 Subwatershed.

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
South Fork Crow River	Lake Independence (27-0176)	Detailed allocations and strategies have been developed for the Lake Independence Phosphorus TMDL (2007) and Implementation Plan (2007). These documents are approved by the EPA and available through the MPCA website: https://www.pca.state.mn.us/water/tmdl/lake-independence-excess-nutrients-tmdl-project																						
	All Waterbodies in the Pioneer-Sarah Creek Watershed District	Detailed allocations and strategies for all waterbodies in the Pioneer-Sarah Subwatershed and the Hennepin County portion of the Rice Lake Subwatershed have been developed for the Pioneer-Sarah Creek TMDL Study (2017) and WRAPS Report (2017). These documents are available through the MPCA website: https://www.pca.state.mn.us/water/tmdl/pioneer-sarah-creek-watershed-restoration-and-protection-strategy-tmdl-project																						
	Eagle Lake (10-0121); Oak Lake (10-0093); Swede Lake (10-0095)	Detailed allocations and implementation strategies for these three lakes have been developed for the South Fork Crow River Lakes TMDL Study (2010) and Implementation Plan (2010). This document is available through the MPCA website: https://www.pca.state.mn.us/sites/default/files/wq-iw8-23c.pdf																						
	South Fork Crow River (07010205-508)	Carver Co., McLeod Co., Wright Co., Hennepin Co, Corcoran City MS4, Independence City MS4, Loretto City MS4, Maple Plain City MS4, Medina City MS4, Minnetrista City MS4	TSS	Loads vary by flow regime; 13% of samples currently exceed 65 mg/L	65 mg/L met 90% of time Apr-Sep; estimated 49% load reduction during very high flow conditions and 9% load reduction during high flow conditions	Improve upland/field surface runoff controls (All Impairments)	Implement soil & water conservation practices throughout subwatershed, target focus areas	Variable	**TSS**	**TSS**	Percent Reduction (TSS, Bacteria, TP)	S		P		S	P	S			A			A	2047
							Implement soil & water conservation practices throughout watersheds draining to impaired lakes	Ongoing	Reach 508: 5% - 15% depending on flow condition	Reach 508: 9% - 49% depending on flow condition		S		P		S	P	S			A			A	
						Protect/stabilize banks/bluffs (TSS, Bacteria, Biotic Stressors, Lake Nutrients)	ID and implement streambank stabilization projects in high eroding areas	DNR Geomorphic Assessment Report (2015)	**Bacteria**	**Bacteria**		S	A	P	A		A	S		S	A				
			Bacteria	Geometric means for May, June, July, Aug, Sep, and Oct currently	Estimated flow reduction by flow category:		Implement livestock access control BMPs on feedlots near riparian corridors	Minimal	15% for all flow conditions	32% - 47% depending on flow condition		A	P	S				S	A	A	A	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
	South Fork Crow River (508); CD9 (648); Unnamed Cr (624, 618)	Carver Co., Wright Co., Hennepin Co.	Fish & Invert. IBI	exceed chronic *E. coli* standard	32% Very High; 33% High; 47% Mid; 36% Low	Improve urban stormwater management (TSS, Bacteria, Biotic Stressors)	ID and implement urban BMPs throughout City of Delano MS4 and all non-MS4 communities (Mayer, Norwood Young America, Watertown)	Ongoing	**Lake TP**	**Lake TP**		S	S	S	P		P		A						
							ID and implement urban BMPs in MS4 and non-MS4 communities to reduce bacteria loads to the South Fork Crow River	Ongoing	Mud: 20%	Mud: 72%		S	S	S	P		P		A						
				Fish IBI Impairments (508, 618, 624, 648) and Invert. IBI Impairments (508, 618, 624, 648)	Primary Stressors: Stream P, Low DO, DO flux, Chlorophyll-a, Lack of Habitat, Altered Hydrology	Improve drainage management (All Impairments)	Implement drainage management practices throughout subwatershed, target focus areas	Ongoing	Rice: 20%	Rice: 82%			P	S			S		A	A	A				
							Implement wetland restorations throughout subwatershed, target focus areas	Ongoing	Eagle: 35%	Eagle: 94%			P	P					S		S			
						Improve fertilizer and manure application (Bacteria, Biotic	Promote and implement manure and fertilizer spreading BMPs throughout	Ongoing	Oak: 35% Swede: 35%	Oak: 73% Swede: 96%				P		S			A	A	A				

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
						Stressors, Lake Nutrients)	watershed, target focus areas																		
	Mud Lake (10-0094)	Carver Co., Hennepin Co.	Lake Nutrients (TP)	2,674 lbs/yr	Goal: 739 lbs/yr; Reduction: 72%	Reduce in-water loading (Lake Nutrients)	Develop plan to manage/control AIS (Eagle, Oak, Swede), improve FQI scores and overall health of vegetation community (Eagle, Oak, Rice, Swede)	None	Develop plan within 5 years	**Lake TP** Mud: 96% Rice: 99% Eagle: 94% Oake: 73% Swede: 96%	Action Items and Percent Internal Load Reduction (TP)	A	P	A						A				P	
							Assess vegetation community (Mud)	None	Complete surveys within 4 years			A	P	A					A	S				A	
	Rice Lake (86-0032)	Wright Co., Hennepin Co., Carver Co.		3,740 lbs/yr	Goal: 543 lbs/yr; Reduction: 85%		Assess fish community (Mud, Rice)	None	Complete surveys within 4 years			A	P	A					A	S				A	
	Eagle Lake (10-0121)	Carver Co.		5,650 lbs/yr	Goal: 317 lbs/yr; Reduction: 94%		Assess rough fish populations and develop management strategies (Oak, Swede)	None	Develop mgt. plan/strategies within 5 years			A	P	A					A	S				A	
	Oak Lake (10-0093)	Carver Co.		952 lbs/yr	Goal: 256 lbs/yr; Reduction: 73%		Evaluate potential for outlet modification and partial and/or full lake drawdowns (Mud, Rice, Eagle, Oak, Swede)	None	Perform assessment or feasibility study within 5 years			A	S	A					A	P				A	
	Swede Lake (10-0095)	Carver Co.		11,127 lbs/yr	Goal: 443 lbs/yr; Reduction: 91%		Evaluate sediment chemistry and potential for phosphorus release from	None	Evaluate sediment chemistry within 5 years			S		A					P	A					

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							sediment if water level management is not feasible (Mud, Rice, Eagle, Oak, Swede)																		
	Tiger Lake (10-0108)	Carver Co.	Phosphorus, biota	Unknown	Unknown	Improve upland/field surface runoff controls	Implement soil & water conservation practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P				P	S	A	S	A			NA
						Improve drainage management	Implement drainage management practices throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P				P	S	A	S	A			
							Implement wetland restorations throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P				P	S	A	S	A			
						Improve fertilizer and manure application	Promote and implement manure and fertilizer spreading BMPs throughout lake watershed, target focus areas	Ongoing	Implement practices in critical areas	Implement practices in critical areas	practices	A	S	P				P	S	A	S	A			
						Protect	In-lake management/practices to protect wildlife, vegetation community and	Ongoing	100%	100%	% of high priority habitat areas	A	P	A				P	S	S	S	A			

Major Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility												Estimated Year to Achieve Water Quality Target
							Strategy Type	Estimated Adoption Rate																
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction			Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Crow River [illegible]	County Governments	SWCDs	MS4 Communities	Non-MS4 Cities	Buffalo Creek WD	NRCS	MPCA	DNR	BWSR	Department of Ag.	UMN Extension	Lake Associations	
							high priority habitat areas in and surrounding lake																	
						Monitor	Assess vegetation community	Unknown	Complete survey within 4 years	Manage as needed	Monitor and Asses	A	S						A	P				
							Monitor in-lake water quality	Unknown	Monitor for 2 years	Manage as needed	Monitor and Asses	S	P						S	S				
	Other priority shallow lakes for protection	Carver Co., Hennepin Co.	--	--	--	Protect	Perform watershed and in-lake practices to protect and enhance water quality, fisheries, plant communities, and other biological services of Patterson and Ox Yoke Lakes	Ongoing	Develop protection plan	Implement plan	Plan	A	P	A				P	S	S	S	A		

Color Key:

- Restoration
- Protection
- Point Sources

Key for Responsibilities:

P	Primary Lead
S	Secondary
A	Assist as needed

Table 21: Key for strategies column.

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
TSS	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Cover crops
		Water and sediment basins, terraces
		Rotations including perennials
		Conservation cover easements
		Grassed waterways
		Strategies to reduce flow- some of flow reduction strategies should be targeted to ravine subwatersheds
		Residue management - conservation tillage
		Forage and biomass planting
		Open tile inlet controls - riser pipes, french drains
		Contour farming
		Field edge buffers, borders, windbreaks and/or filter strips
		Stripcropping
	Protect/stabilize banks/bluffs: Reduce collapse of bluffs and erosion of streambank by reducing peak river flows and using vegetation to stabilize these areas.	Strategies for altered hydrology (reducing peak flow)
		Streambank stabilization
		Riparian forest buffer
		Livestock exclusion - controlled stream crossings
	Stabilize ravines: Reducing erosion of ravines by dispersing and infiltrating field runoff and increasing vegetative cover near ravines. Also, may include earthwork/regrading and revegetation of ravine.	Field edge buffers, borders, windbreaks and/or filter strips
		Contour farming and contour buffer strips
		Diversions
		Water and sediment control basin
		Terrace
		Conservation crop rotation
		Cover crop
		Residue management - conservation tillage
	Stream Channel Restoration	Addressing road crossings (direct erosion) and floodplain cut-offs
		Clear water discharge: urban areas, ag tiling etc. – direct energy dissipation
		Two-stage ditches
		Large-scale restoration – channel dimensions match current hydrology & sediment loads, connect the floodplain, stable pattern, (natural channel design principals)
		Stream channel restoration using vertical energy dissipation: step pool morphology
	Improve forestry management	Proper Water Crossings and road construction
		Forest Roads - Cross-Drainage
		Maintaining and aligning active Forest Roads
		Closure of Inactive Roads & Post-Harvest
		Location & Sizing of Landings
		Riparian Management Zone Widths and/or filter strips
	Improve urban stormwater management [to reduce sediment and flow]	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs

Nitrogen (TN) or Nitrate	Increase fertilizer and manure efficiency: Adding fertilizer and manure additions at rates and ways that maximize crop uptake while minimizing leaching losses to waters	Nitrogen rates at Maximum Return to Nitrogen (U of MN rec's)
		Timing of application closer to crop use (spring or split applications)
		Nitrification inhibitors
		Manure application based on nutrient testing, calibrated equipment, recommended rates, etc.
	Store and treat tile drainage waters: Managing tile drainage waters so that nitrate can be denitrified or so that water volumes and loads from tile drains are reduced	Saturated buffers
		Restored or constructed wetlands
		Controlled drainage
		Woodchip bioreactors
		Two-stage ditch
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and capturing of soil nitrate by roots during the spring, summer and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
		Crop conversion to low nutrient-demanding crops (e.g., hay).
Phosphorus (TP)	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Strategies to reduce sediment from fields (see above - upland field surface runoff)
		Constructed wetlands
		Pasture management
	Reduce bank/bluff/ravine erosion	Strategies to reduce TSS from banks/bluffs/ravines (see above for sediment)
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and minimize erosion and soil losses to waters, especially during the spring and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
	Preventing feedlot runoff: Using manure storage, water diversions, reduced lot sizes and vegetative filter strips to reduce open lot phosphorus losses	Open lot runoff management to meet 7020 rules
		Manure storage in ways that prevent runoff
	Improve fertilizer and manure application management: Applying phosphorus fertilizer and manure onto soils where it is most needed using techniques which limit exposure of phosphorus to rainfall and runoff.	Soil P testing and applying nutrients on fields needing phosphorus
		Incorporating/injecting nutrients below the soil
		Manure application meeting all 7020 rule setback requirements
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Sewering around lakes
		Eliminating straight pipes, surface seepages
	Reduce in-water loading: Minimizing the internal release of phosphorus within lakes	Rough fish management
		Curly-leaf pondweed management
		Alum treatment
		Lake drawdown
		Hypolimnetic withdrawal
	Improve forestry management	See forest strategies for sediment control
	Reduce Industrial/Municipal wastewater TP	Municipal and industrial treatment of wastewater P
		Upgrades/expansion. Address inflow/infiltration.

	Treat tile drainage waters: Treating tile drainage waters to reduce phosphorus entering water by running water through a medium which captures phosphorus	Phosphorus-removing treatment systems, including bioreactors
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
E. coli	Reducing livestock bacteria in surface runoff: Preventing manure from entering streams by keeping it in storage or below the soil surface and by limiting access of animals to waters.	Strategies to reduce field TSS (applied to manured fields, see above)
		Improved field manure (nutrient) management
		Adhere/increase application setbacks
		Improve feedlot runoff control
		Animal mortality facility
		Manure spreading setbacks and incorporation near wells and sinkholes
		Rotational grazing and livestock exclusion (pasture management)
	Reduce urban bacteria: Limiting exposure of pet or waterfowl waste to rainfall	Pet waste management
		Filter strips and buffers
		See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Replace failing septic (SSTS) systems
		Maintain septic (SSTS) systems
	Reduce Industrial/Municipal wastewater bacteria	Reduce straight pipe (untreated) residential discharges
		Reduce WWTP untreated (emergency) releases
Dissolved Oxygen	Reduce phosphorus	See strategies above for reducing phosphorus
	Increase river flow during low flow years	See strategies above for altered hydrology
	In-channel restoration: Actions to address altered portions of streams.	Goal of channel stability: transporting the water and sediment of a watershed without aggrading or degrading.
		Restore riffle substrate
Chloride	Road salt management	[Strategies currently under development within Twin Cities Metro Area CMP]

4. Monitoring Plan

Funding mechanisms for effectiveness monitoring are limited, however, there are a number of local entities that conduct monitoring in the South Fork Crow River Watershed, including but not limited to the CROW, BCWD, local SWCDs, cities, and counties. Local entities continue to pursue funding to assess and monitor water quality in the South Fork Crow River Watershed to fill identified data gaps, measure progress toward implementation goals for both protection and restoration and provide the basis for future planning and adaptive management. Some of the tools used by the local entities to measure implementation progress are:

- Annual local monitoring reports showing trends (if appropriate) and progress are produced, posted on websites, and distributed by the CROW, BCWD, and counties.
- Numbers of BMPs funded by state/federal funds are reported and tracked annually through the BWSR eLINK reporting system, which also calculates pollutant reductions.
- Annual reports and open houses highlight BMP protection and restoration projects.

Current Monitoring Efforts

Table 22 below depicts the ongoing monitoring by entity in the South Fork Crow River Watershed.

Table 22: South Fork Crow River Watershed monitoring by entity.

ENTITY	BASELINE	IMPLEMENTATION	FLOW	EFFECTIVENESS	TREND	VALIDATION
CROW	X					X
SWCD	X				X	X
DNR			X			
MPCA	X		X		X	
Volunteers	X				X	

CROW: The CROW will continue to seek funding to help on-going monitoring for baseline conditions and validation of TMDL allocations. CROW will collaborate with local partners and MPCA on large scale effectiveness monitoring.

Long-term streamflow and water quality monitoring is being conducted at two sites on the South Fork Crow River and one site on Buffalo Creek as part of the state's Watershed Pollutant Load Monitoring Network (WPLMN). The purpose of this monitoring is to maintain water quality data collection, build on local partnerships, and develop a better understanding of what impacts the rivers located in central Minnesota

and track water quality trends. WPLMN data will be used to assist with assessing impaired waters, watershed modeling, determining pollutant source contributions, developing watershed and water quality reports, and measuring the effectiveness of water quality restoration efforts.

DNR: The DNR completed a South Fork Crow River Watershed Characterization Report. The project results from six sites indicated systemic issues within the watershed. Systemic issues include: extensive channel modification and channelization throughout the watershed, impacts from improperly sized bridges and culverts on the river and streams, channel instability with accelerated streambank erosion and sediment transportation. South Fork Crow River Watershed has experienced significant man made alterations.

The DNR may continue to collect additional information at South Fork sites to document pattern and profile of the mainstem of the South Fork Crow and many of the major tributaries.

DNR Study in the South Fork Crow River Watershed

MPCA: Large scale effectiveness monitoring will be provided by the MPCA through on-going monitoring in the watershed including the major watershed outlet-monitoring program, the statewide WPLMN, and the Intensive Watershed Monitoring (IWM) associated with the Watershed Approach. As part of the 10-year cycle, IWM for the South Fork Crow River will begin again in 2022, which will allow another round of watershed-wide data collection of biology, hydrology, and chemistry that will be used for comparison with current conditions.

Volunteers: Citizen Volunteers from around the watershed collect transparency data using t-tubes. Volunteers continue to work with CROW and the MPCA on the large scale baseline monitoring.

Monitoring Needs

Following is a description of monitoring needs identified in the South Fork Crow River Watershed, contingent on availability and prioritization of resources.

Stream Monitoring

Routine stream monitoring in the South Fork Crow River Watershed is conducted by a number of agencies throughout the watershed. For example, the NFCRWD is currently targeting subwatersheds for intense monitoring to assess pollutant sources in the watershed. However, some special studies are needed to further understand the dynamics in the watershed. Following is a brief description of some of these studies.

Lake Monitoring

Inputs to lake response models for the TMDLs in the South Fork Crow River Watershed relied upon an HSPF model calibrated at a much broader scale than the lakesheds. These HSPF generated inputs for external nutrients were used in the lake models when monitoring data was insufficient, leading to increased uncertainty in the lake model results. Furthermore, internal loading for almost all of the lakes was based on lake response model residuals. Due to these modeling constraints, verification of model inputs should be the focus of the monitoring program moving forward. However, the majority of the lakes should have their primary inflow monitored for a minimum of one year and preferably three years. Internal loading should be monitored using laboratory sediment nutrient release assays to determine nutrient release rates. These data, combined with DO monitoring provide a more robust understanding of the role of external versus internal nutrient loading.

Inventory Updates

Updated Feedlot/animal number and SSTS inventories in the subwatersheds that have a high potential to contribute to bacteria impairments will be helpful to achieve reduction goals.

Volunteer Monitoring

Expanding both the citizen stream and lake monitoring programs (CSMP and CLMP) in the watershed would help to obtain data in areas that have not been assessable, due to either lack of access or staff time. Local resources could help to improve the monitoring dataset that would enable measuring improvements and developing trends.

HSPF Modeling

HSPF Modeling of the Sauk River, Crow River, and South Fork Crow River, (RESPEC 2012) has the following recommendations for future HSPF modeling that were created based on “lessons learned” in the process of formulating, calibrating, and executing the models. The Crow Watershed models are well calibrated and can be used for future evaluations and studies. Internal loading should be incorporated into lake modeling in the future. However, further refinement of internal loading approach is recommended to reduce the numerous runs required for its use and to potentially represent additional internal loading processes.

- The Crow and Sauk Watersheds have an abundance of flow and water-quality data. This level of data collection should be continued if possible. Additionally, sediment source apportionment data, tillage transects, septic tank studies, and other supplemental information cited in the HSPF report were very helpful for modeling and should be continued.
- To further improve the model calibration, particularly for sediment and water temperature, additional stream cross-sectional and lake outlet hydraulics information should be collected.

- Models combine the watershed loading from chemical and organic fertilizers. If required for specific management scenarios, the watershed loading should be split to represent manure specifically. Additional information and methodology would be required to implement this recommendation.

General Conclusions

- Lake TMDLs were completed for all nutrient impaired South Fork Crow lakes on the 2012 303(d) list
- Stream TMDLs were completed for South Fork Crow impaired stream reaches on the 2010 303(d) list
- Monitoring and modeling data gaps still exist to further understand the South Fork Crow Watershed dynamics
- The timeline for achieving all water quality standards in the South Fork Crow is coarsely estimated as 50 to 100 years due to the size of the watershed, and the number and magnitude of the impairments.

Additional South Fork Crow River Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the South Fork Crow River Watershed:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/rwa/?cid=nrcs142p2_023594

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the South Fork Crow Watershed:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb19.pdf

Minnesota Department of Natural Resources (DNR) State Water Trails for Crow River, South Fork:
http://www.dnr.state.mn.us/watertrails/southforkcrowriver/index.html

Minnesota Nutrient Planning Portal (MSU-M WRC) South Fork Crow River:
http://mrbdc.mnsu.edu/mnnutrients/watersheds/south-fork-crow-river-watershed

South Fork Crow River Watershed Health Assessment Scores:
http://mrbdc.mnsu.edu/mnnutrients/sites/mrbdc.mnsu.edu.mnnutrients/files/public/watershed/pm_what/southforkcrow.pdf

Upper Mississippi River Source Water Protection Project:

http://www.umrswpp.com/project.htm

5. References and Further Information

Metropolitan Council. 2014. Comprehensive Water Quality Assessment of Select Metropolitan Area Streams. Saint Paul: Metropolitan Council. https://metrocouncil.org/Wastewater-Water/Services/Water-Quality-Management/Stream-Monitoring-Assessment/Mississippi-River-Tributary-Streams-Assessment/Miss-River-Trib-Assessment-Reports/CROW-RIVER-SECTION.aspx

Minnesota Pollution Control Agency (MPCA). 2016. Draft South Fork Crow River Watershed TMDL Upper Mississippi Basin. https://www.pca.state.mn.us/sites/default/files/wq-iw8-52b.pdf

Minnesota Pollution Control Agency (MPCA). 2017. Incorporating Lake Protection Strategies into WRAPS Reports. https://www.pca.state.mn.us/sites/default/files/wq-ws4-03c.pdf

University of Missouri Extension. 1999. Agricultural Phosphorus and Water Quality. Pub. G9181. http://extension.missouri.edu/publications/DisplayPub.aspx?P=G9181

South Fork Crow River Watershed Reports

All South Fork Crow River Watershed reports referenced in this watershed report are available at the South Fork Crow River Watershed webpage: https://www.pca.state.mn.us/water/watersheds/south-fork-crow-river