Watershed

June 2022

Rainy River–Headwaters Watershed Total Maximum Daily Load Report

Blackduck River Total Maximum Daily Load

MINNESOTA POLLUTION CONTROL AGENCY

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Abbreviations

1W1P	One Watershed, One Plan
AMSL	above mean sea level
AUID	assessment unit identification
BANCS	Bank Assessment for Nonpoint Source Consequences of Sediment
BMP	best management practice
B org/day	billion organisms per day
BWSR	Board of Water and Soil Resources
cfs	cubic feet per second
CLMP	Citizen Lake Monitoring Program
CRP	Conservation Reserve Program
CREP	Conservation Reserve Enhancement Program
CSMP	Citizen Stream Monitoring Program
DNR	Minnesota Department of Natural Resources
E. coli	*Escherichia coli*
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
EQuIS	Environmental Quality Information System
HSPF	Hydrologic Simulation Program–Fortran
HUC	Hydrologic Unit Code
IBI	index of biotic integrity
ITPHS	imminent threat to public health and safety
IWM	intensive watershed monitoring
LA	load allocation
MAWQCP	Minnesota Agricultural Water Quality Certification Program
mg/L	milligrams per liter
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service

org/100 mL	organisms per 100 milliliters
PWP	Permanent Wetland Preserve
RIM	Reinvest in Minnesota
SAM	Scenario Application Manager
SDS	State Disposal System
SFIA	Sustainable Forest Incentive Act
SSTS	subsurface sewage treatment systems
SWCD	soil and water conservation district
TMDL	total maximum daily load
TSS	total suspended solids
USFS	United States Forest Service
WLA	wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy
WRP	Wetland Reserve Program

Executive summary

Section 303(d) of the federal Clean Water Act requires that total maximum daily loads (TMDLs) be developed for waters that do not support their designated uses. A TMDL study determines what is needed to attain and maintain water quality standards in waters that are not currently meeting them. A TMDL study identifies pollutant sources and allocates pollutant loads among those sources. This TMDL study addresses the Blackduck River Watershed in the Rainy River–Headwaters Watershed, located in St. Louis County, Minnesota. The causes of impairment are high levels of total suspended solids (TSS) and *Escherichia coli* (*E. coli*), affecting aquatic life and aquatic recreation designated uses, respectively.

Land cover in the Blackduck River Watershed is primarily mature forest, with areas of young forest, wetlands, and pasture. Forestry is an active industry in the watershed. Whereas pasture makes up only 5% of the Blackduck River Watershed, the pasture is concentrated along its stream corridors. High TSS concentrations were observed primarily under higher flows, and exceedances of the TSS standard occurred along a high slope reach that was identified as having high rates of erosion. *E. coli* concentrations were independent of stream discharge and were highest in pastured reaches.

Potential sources of pollutants include watershed runoff, septic systems, animal feeding operations and pastures, and near channel sources influenced by altered hydrology. There are currently no point source permitted sources of pollution in the watershed. Near channel sources account for the majority of the TSS load in the impaired reach, and pastured animals are the primary source of *E. coli*.

The pollutant loading capacities for the two impairments were determined through the use of load duration curves. These curves represent the allowable pollutant load at any given flow. Water quality data were compared to the standards to determine load reduction needs. A 10% explicit margin of safety (MOS) accounts for uncertainty. An estimated 64% TSS reduction and 71% *E. coli* reduction are needed to meet water quality standards.

Reasonable assurance that pollutant targets will be achieved is provided through permit compliance, nonpermitted source reduction programs, statewide initiatives, and local planning and implementation efforts. Implementation strategies are recommended to address the high priority sources and to help achieve the Blackduck River TMDLs. Implementation strategies include streambank stabilization and channel restoration, forest management, pasture and grazing management, roadway management, septic system inventory and upgrades, and education and outreach. Implementation will focus on an adaptive management approach, with continued monitoring and adjustment of the implementation approach. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the Blackduck River impairments. Public participation included meetings with watershed stakeholders and regional water resource professionals.

This TMDL report is supported by previous work, including the Rainy River–Headwaters Watershed monitoring and assessment report (MPCA 2017), the Rainy River–Headwaters Stressor Identification Report (MPCA 2019), and various watershed modeling memos (RESPEC 2014, 2015a, 2015b, 2016; MPCA 2020).

1. Project overview

1.1 Purpose

Section 303(d) of the federal Clean Water Act requires that TMDLs be developed for waters that do not support their designated uses. These waters are referred to as impaired and are listed in Minnesota's list of impaired water bodies. A TMDL study determines what is needed to attain and maintain water quality standards in waters that are not currently meeting them. A TMDL study identifies pollutant sources and allocates pollutant loads among those sources. The total of all allocations, including wasteload allocations (WLAs) for permitted sources, load allocations (LAs) for nonpermitted sources (including natural background), and the MOS, which is implicitly or explicitly defined, cannot exceed the maximum allowable pollutant load.

This TMDL study addresses the Blackduck River Watershed in the Rainy River–Headwaters Watershed (U.S. Geological Survey Hydrologic Unit Code (HUC)-8 09030001; Figure 1 and Figure 2), located in St. Louis County, Minnesota. Prior to 2008, the Blackduck River Watershed was considered by the State of Minnesota to be part of the Rainy River–Rainy Lake Watershed (09030003). In 2008, the International Joint Commission's Transboundary Hydrographic Data Harmonization Task Force was convened to improve the alignment of geospatial hydrographic datasets along the United States–Canada border. The results of the data harmonization placed the Blackduck River Watershed in the Rainy River–Headwaters Watershed (09030001). The MPCA uses the Natural Resources Conservation Service's (NRCS) Watershed Boundary Set, which reflects the data harmonization results. However, note that the HUC-8 boundary dataset used by the Minnesota Department of Natural Resources (DNR) does not reflect the data harmonization results, and therefore the DNR considers the Blackduck River Watershed to be part of the Rainy River–Rainy Lake Watershed (09030003).

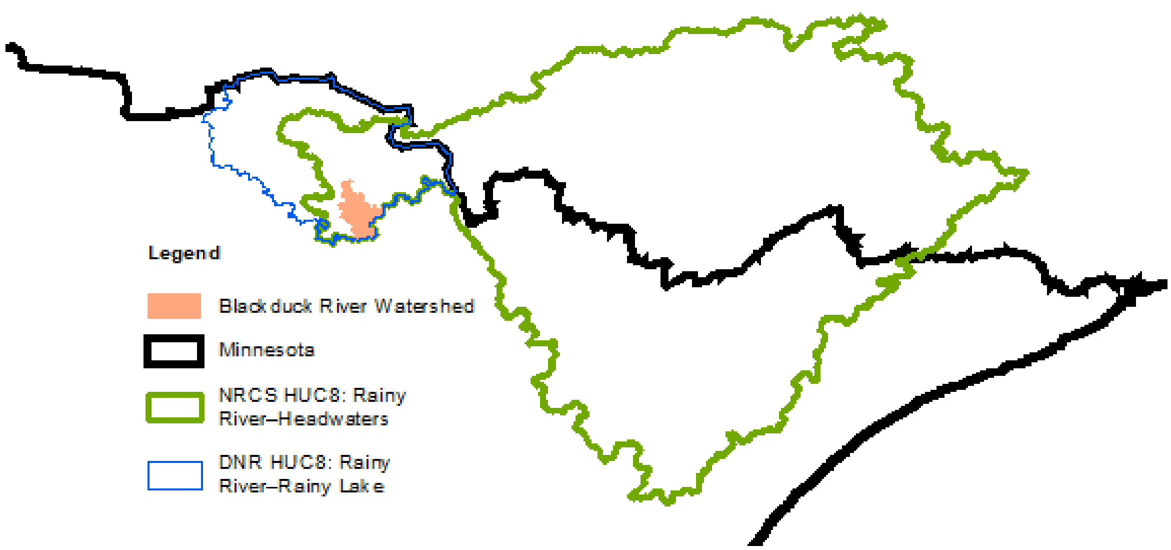

Figure 1. Location of Blackduck River Watershed in HUC-8 watershed boundaries

This TMDL report is a component of a larger effort to develop watershed restoration and protection strategies (WRAPS) for the Rainy River–Headwaters Watershed. Other components of the larger effort include the Rainy River–Headwaters Watershed Monitoring and Assessment Report (MPCA 2017), the Rainy River Headwaters Stressor Identification Report (MPCA 2019), the Lake of the Woods Watershed hydrology and water quality model (see RESPEC (2014) for information on model development and RESPEC (2016) for information on the model's land classification update and recalibration), and the Rainy River–Headwaters Watershed WRAPS (MPCA 2021).

1.2 Identification of water bodies

There are six stream reaches and one lake with aquatic life and/or aquatic recreation impairments in the Rainy River–Headwaters Watershed, for a total of nine impairments (Table 1). This TMDL report addresses two impairments on the Blackduck River—an aquatic life impairment due to elevated TSS and an aquatic recreation impairment due to elevated *E. coli*. Other aquatic life and aquatic recreation impairments in the Rainy River–Headwaters Watershed (Table 1, Figure 2) are further discussed in the WRAPS and include the following:

- Ash River, Blackduck River to Ash River Falls (09030001-818): The aquatic life impairment based on elevated TSS is being deferred because a use class change from 2A to 2B is being considered. After the use class decision is finalized, a TMDL will be completed if the water body is still considered impaired.
- Blueberry Lake (69-0054-00): The aquatic recreation impairment is due to high nutrients. The MPCA Assessment Consistency and Technical Team's Natural Background Review Committee concluded that the impairment is a result of natural conditions, and a TMDL does not need to be developed. Blueberry Lake is shallow with a maximum depth of six feet and a watershed to lake ratio of 44:1. There is little development, and wetlands dominate the watershed, contributing nutrients that support Blueberry Lake's high productivity.
- Five aquatic life impairments due to elevated aluminum and/or copper: These impairments were reviewed by the MPCA Assessment Consistency and Technical Team's Natural Background Review Committee. In September, 2017, the committee concluded that the impairments are due to naturally occurring elevated concentrations present in bedrock, and TMDLs do not need to be developed. USGS research demonstrated the influence of natural copper and nickel-bearing bedrock on water quality (Elliott et al. 2020). These watersheds were targeted for this research given their location in wilderness areas and surface exposure of metal-bearing mineralized bedrock.

In addition to the aquatic life and aquatic recreation impairments in this watershed, there are water bodies on Minnesota's 2018 list of impaired water bodies with aquatic consumption impairments based on mercury in fish tissue (212), mercury in the water column (1), or polychlorinated biphenyls (PCBs) in fish tissue (1). Of these impairments, 117 mercury TMDLs were approved as part of the 2018 Mercury TMDL Appendix A (Figure 3). Revisions to Appendix A of the Minnesota Statewide Mercury TMDL (MPCA 2007) are submitted to the U.S. Environmental Protection Agency (EPA) every two years with the impaired waters list. Water resources with mercury concentrations greater than 0.572 mg/kg are not part of Appendix A. These will undergo a separate process, which could include TMDL development, to meet the specific needs for greater reductions. This includes assessing the need to address sulfate and other pollutants and watershed processes in relation to their impact on mercury methylation. TMDLs for these 96 water bodies in the Rainy River–Headwaters Watershed are expected to be completed by 2033, where appropriate (according to Minnesota's draft 2020 list of impaired water bodies). A TMDL for the PCB impairment is expected to be completed by 2033.

The foci of the remainder of this TMDL report are the TSS and *E. coli* impairments located on the Blackduck River (AUID 09030001-820).

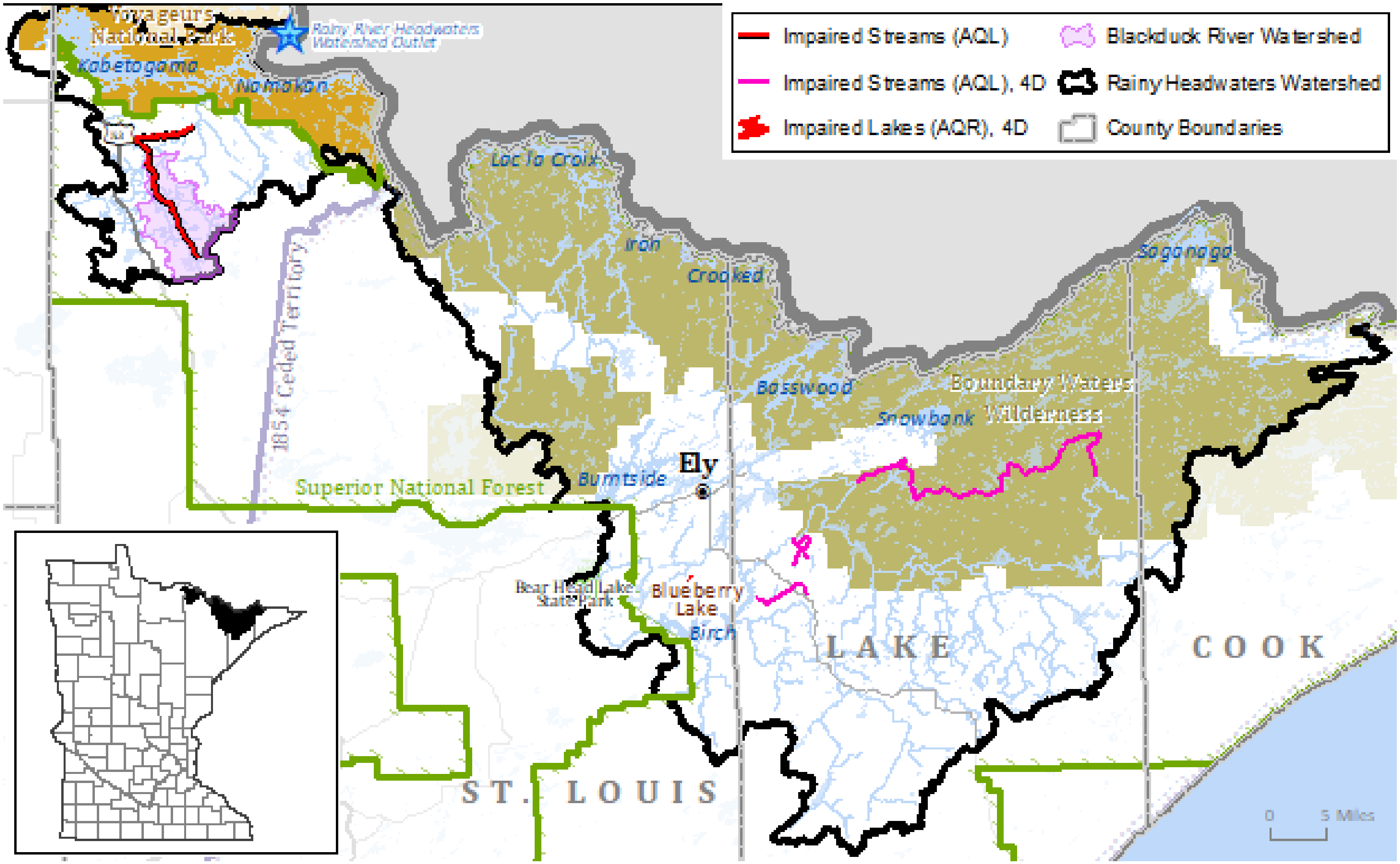

Figure 2. Rainy River–Headwaters Watershed and water bodies with aquatic life or aquatic recreation impairments.

The Blackduck River Watershed is highlighted to show the focus of this TMDL report. 4D: Impairment is due to natural conditions. See Table 1 for more information on the impaired water bodies.

Table 1. Water bodies in the Rainy River–Headwaters Watershed with aquatic life or aquatic recreation impairments

Impairments are ordered from west to east. The Blackduck River, which is the only water body for which TMDLs are developed in this report, is highlighted in grey. Impaired waters due to natural conditions with only insignificant anthropogenic influence are italicized and given an EPA Category 4D.

Water Body Name	Water Body Description	AUID [a]	Year Added to 303(d) List	TMDL Target Completion Year	Designated Use Class	Affected Designated Use	Pollutant or Stressor	EPA Category [b]	TMDL Developed in this Report
Blackduck River	Headwaters (Blackduck Lk 69-0842-00) to Ash R	09030001-820	2018	2021	1B, 2Ag	Aquatic Life	Total suspended solids	4A (proposed)	Y
Blackduck River	Headwaters (Blackduck Lk 69-0842-00) to Ash R	09030001-820	2018	2021	1B, 2Ag	Aquatic Recreation	*Escherichia coli*	4A (proposed)	Y
Ash River	Blackduck R to Ash River Falls	09030001-818	2018	2021 [c]	1B, 2Ag	Aquatic Life	Total suspended solids	5	N
Blueberry Lake	*Lake or Reservoir*	*69-0054-00*	*2018*		*2B*	*Aquatic Recreation*	*Nutrient/ eutrophication biological indicators*	*4D*	*N*
Keely Creek	*Headwaters (Heart Lk 38-0692-00) to Birch Lk*	*09030001-520*	*2018*		*2Bg*	*Aquatic Life*	*Aluminum*	*4D*	*N*
Unnamed creek	*Headwaters to Filson Creek*	*09030001-983*	*2018*		*2Bg*	*Aquatic Life*	*Aluminum*	*4D*	*N*
Filson Creek	*Omaday Lk to South Kawishiwi R*	*09030001-605*	*2018*		*2Bg*	*Aquatic Life*	*Aluminum*	*4D*	*N*
Filson Creek	*Omaday Lk to South Kawishiwi R*	*09030001-605*	*2018*		*2Bg*	*Aquatic Life*	*Copper*	*4D*	*N*
Kawishiwi River	*Lk Polly to South Kawishiwi R*	*09030001-992*	*2018*		*1B, 2Bdg*	*Aquatic Life*	*Aluminum*	*4D*	*N*

a. AUID = assessment unit identification

b. 4A: Impaired or threatened but a TMDL study has been approved by USEPA. 4A categories are proposed upon approval of this TMDL report.
4D: Impaired or threatened but doesn't require a TMDL because the impairment is due to natural conditions with only insignificant anthropogenic influence.
5: Use assessment indicates an impaired status and a TMDL plan has not been completed.

c. Although the target completion year is noted as 2021, the TMDL is being deferred until after the use class decision is finalized.

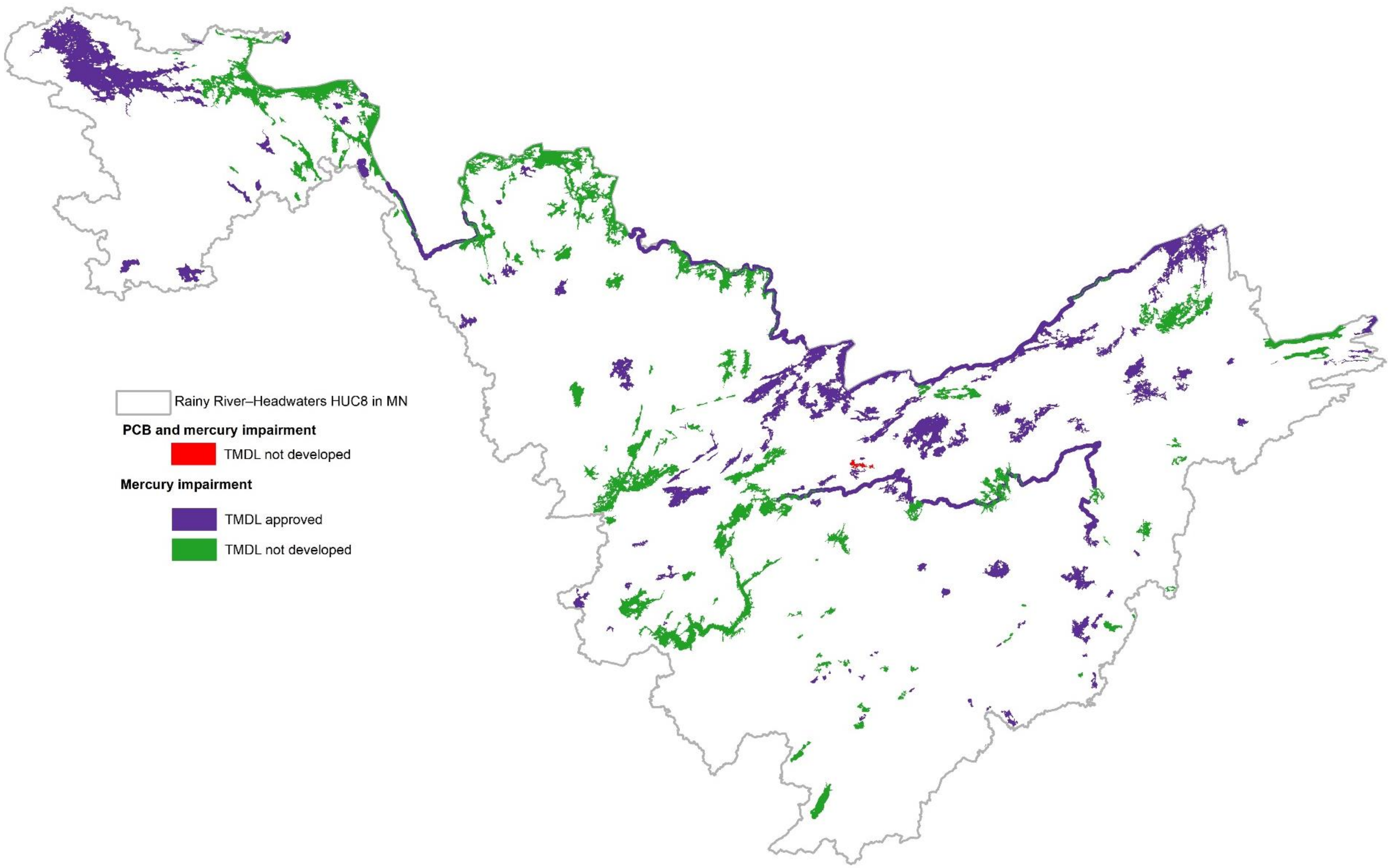

Figure 3. Water bodies with aquatic consumption impairments in the Rainy River–Headwaters Watershed

1.3 Priority ranking

The MPCA's schedule for TMDL completions, as indicated on Minnesota's Section 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL. The MPCA has aligned TMDL priorities with the watershed approach. The schedule for TMDL completion corresponds to the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan Minnesota's TMDL Priority Framework Report to meet the needs of EPA's national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the CWA Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments that will be addressed by TMDLs through the watershed approach.

2. Applicable water quality standards and numeric water quality targets

The federal Clean Water Act requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses—Identify how people, aquatic communities, and wildlife use our waters
- Numeric criteria—Amounts of specific pollutants allowed in a body of water that still protect it for the beneficial uses
- Narrative criteria—Statements of unacceptable conditions in and on the water
- Antidegradation protections—Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative criteria, and antidegradation protections provide the framework for achieving Clean Water Act goals. Minnesota's water quality standards are in Minn. R. chs. 7050 and 7052. All current state water rules administered by the MPCA are available on the Minnesota water rules webpage.

2.1 Beneficial uses

The beneficial uses for waters in Minnesota are grouped into one or more classes as defined in Minn. R. 7050.0140. The classes and associated beneficial uses are:

- Class 1 – domestic consumption
- Class 2 – aquatic life and recreation
- Class 3 – industrial consumption
- Class 4 – agriculture and wildlife
- Class 5 – aesthetic enjoyment and navigation
- Class 6 – other uses and protection of border waters
- Class 7 – limited resource value waters

The aquatic life use class includes a tiered aquatic life uses framework for rivers and streams. The framework contains three tiers—exceptional, general, and modified uses. All surface waters are protected for multiple beneficial uses.

2.2 Narrative and numeric criteria and state standards

Narrative and numeric water quality criteria for all uses are listed for four common categories of surface waters in Minn. R. 7050.0220. The four categories are:

- Cold water aquatic life and habitat, also protected for drinking water: classes 1B; 2A, 2Ae, or 2Ag; 3; 4A and 4B; and 5
- Cool and warm water aquatic life and habitat, also protected for drinking water: classes 1B or 1C; 2Bd, 2Bde, 2Bdg, or 2Bdm; 3; 4A and 4B; and 5

- Cool and warm water aquatic life and habitat and wetlands: classes 2B, 2Be, 2Bg, 2Bm, or 2D; 3; 4A and 4B; and 5
- Limited resource value waters: classes 3; 4A and 4B; 5; and 7

The narrative and numeric water quality criteria for the individual use classes are listed in Minn. R. 7050.0221 through 7050.0227. The procedures for evaluating the narrative criteria are presented in Minn. R. 7050.0150.

The MPCA assesses individual water bodies for impairment for Class 2 uses—aquatic life and recreation. Class 2A waters are protected for the propagation and maintenance of a healthy community of cold water aquatic life and their habitats. Class 2B waters are protected for the propagation and maintenance of a healthy community of cool or warm water aquatic life and their habitats. Protection of aquatic life entails the maintenance of a healthy aquatic community as measured by fish and macroinvertebrate indices of biotic integrity (IBIs). Fish and invertebrate IBI scores are evaluated against criteria established for individual monitoring sites by water body type and use subclass (exceptional, general, and modified).

Both class 2A and 2B waters are also protected for aquatic recreation activities including bathing and swimming, and the consumption of fish and other aquatic organisms. In streams, aquatic recreation is assessed by measuring the concentration of *E. coli* in the water, which is used as an indicator species of potential waterborne pathogens. To determine if a lake supports aquatic recreational activities, its trophic status is evaluated using total phosphorus, Secchi depth, and chlorophyll-*a* as indicators. The ecoregion standards for aquatic recreation protect lake users from nuisance algal bloom conditions fueled by elevated phosphorus concentrations that degrade recreational use potential.

2.3 Antidegradation policies and procedures

The purpose of the antidegradation provisions in Minn. R. ch. 7050.0250 through 7050.0335 is to achieve and maintain the highest possible quality in surface waters of the state. To accomplish this purpose:

- Existing uses and the level of water quality necessary to protect existing uses are maintained and protected.
- Degradation of high water quality is minimized and allowed only to the extent necessary to accommodate important economic or social development.
- Water quality necessary to preserve the exceptional characteristics of outstanding resource value waters is maintained and protected.
- Proposed activities with the potential for water quality impairments associated with thermal discharges are consistent with Section 316 of the Clean Water Act, United States Code, Title 33, Section 1326.

2.4 Blackduck River water quality standards

Water use classifications for the Blackduck River are provided in *Beneficial Use Designations for Stream Reaches: Rainy River–Headwaters Watershed (09030001)* (MPCA n.d.), which is incorporated by reference in Minn. R. 7050.0470. This TMDL report addresses the Blackduck River, which has the designated uses 1B, 2Ag, 3, 4A, 4B, 5, and 6. The Blackduck River does not meet the standards for class 2A waters.

The statewide TSS criterion for class 2A water bodies, which applies from April through September, is 10 mg/L TSS. There are two *E. coli* criteria for class 2 waters—one is applied to monthly *E. coli* geometric mean concentrations, and the other is applied to individual samples. Exceedances of either *E. coli* criterion in class 2 waters indicates that a water body does not meet the applicable designated use. The class 2 criteria for *E. coli* apply from April through October. The numeric water quality criteria for TSS and *E. coli* serve as targets for the Blackduck River TMDLs (Table 2).

Table 2. Water quality criteria for class 2A water bodies

Parameter	Water Quality Standard	Numeric Criteria
TSS	10 mg/L (milligrams per liter); TSS standards for class 2A may be exceeded for no more than 10% of the time. This standard applies April 1 through September 30.	≤ 10 mg/L
E. coli	Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 org/100 mL. The standard applies only between April 1 and October 31.	≤ 126 org/100 mL (monthly geometric mean) ≤ 1,260 org/100 mL (individual sample)

3. Watershed and water body characterization

The Blackduck River is 16.1 miles long, with a watershed area of 50.1 square miles. The watershed boundary is based on the DNR level 8 catchment dataset and is consistent with the subwatershed boundaries in the MPCA's Hydrologic Simulation Program–FORTRAN (HSPF) model (RESPEC 2016; see also Section 3.3.1.2 for a description of the model). The entire watershed is in the Superior National Forest, with a mix of ownership types (Table 3). Major tributaries to the Blackduck River are Ninemile Creek and Fawn Creek (Figure 4). The Blackduck River is the largest tributary of the Ash River, which flows north from its headwaters to the outlet at Lake Kabetogama in Voyageurs National Park (Figure 2).

No part of the Blackduck River Watershed is located within the boundary of a federally recognized Indian reservation.

Slopes in the watershed are highly variable, with higher gradient reaches located in the middle reaches of the river (see TSS source assessment in Section 3.3.1). The watershed is mostly covered with calcareous, silty-clay soils of the Des Moines Lobe. The soil has a high silt content and is highly erodible. For more information, see the *Rainy River Headwaters Stressor Identification Report* (MPCA 2019).

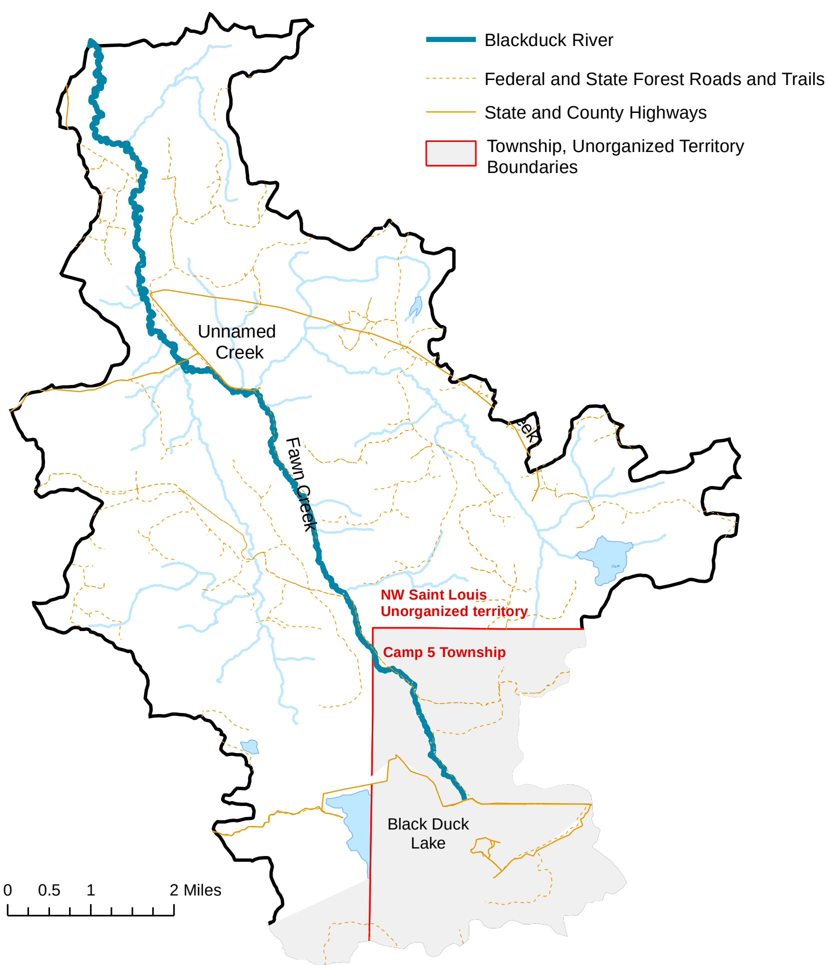

Figure 4. Blackduck River Watershed

Data source: Federal and State Forest Roads and Trails contains data from Roads and Trails, USFS; and Minnesota State Trails, DNR. City, Township, and Unorganized Territory Boundaries, MnGeo.

Table 3. Land ownership in the Blackduck River Watershed

Data source: USGS GAP (Gap Analysis Project) Stewardship 2008

Land Ownership	Percent Area
U.S. Forest Service	33%
DNR Division of Forestry	22%
County	13%
Private	24%
Private Industrial	8%

3.1 Land cover

Land cover in the Blackduck River Watershed is primarily mature forest, with areas of young forest, wetlands, and pasture (Table 4, Figure 5). Forestry is an active industry in the watershed; see the TSS source assessment (Section 3.3.1) for additional information on forest harvest. The *Rainy River Headwaters Stressor Identification Report* (Section 3.3 in MPCA 2019) includes a discussion of land cover in the Ash River Watershed, of which the Blackduck River Watershed is a part.

Whereas pasture makes up only 3.5% of the Blackduck River Watershed, the pasture is concentrated along its stream corridors. One of the largest pasture operations in the Rainy River–Headwaters Watershed is located in the Blackduck River Watershed. Since its establishment around the turn of the 20th century, the pasture has persisted and has since expanded in the 21st century. This pasture operation is referred to as "the ranch" or "the pasture" throughout this report and is discussed further in the source assessment (Section 3.3).

Pre-European settlement land cover was primarily mixed white pine and red pine forest (Figure 6). Aside from the open water of Blackduck Lake, the rest of the watershed was made up of other forest types. Much of the coniferous forest was cleared as the railroad pushed north, and the timber industry advanced in the late 1800s to early 1900s (Waters 1977). The pines that supported the great timber era were succeeded by mixed and deciduous species (Figure 5) such as aspen and birch. Remnants of the logging railroad found throughout the Blackduck River Watershed include abandoned in-stream pilings and the old grade. Abandoned railroad-stream crossings, only some of which include pilings, are identified in Figure 13 in the TSS source assessment (Section 3.3.1.1) and a map of the old railroad is provided in the Stressor Identification Report (MPCA 2019).

Table 4. Land cover in the Blackduck River Watershed

Data source: *Land Cover: Lake of the Woods 2010*[1]; updated to reflect recent forest clearing and conversion to pasture observed during fieldwork and quantified based on 2017 aerial photography.

Land Cover	Area (ac)	Area (%)
Wetlands	3,567	11.1%
Open water	1,494	4.7%
Mature forest	22,900	71.5%
Young forest	2,719	8.5%

[1] A 10-meter raster classification of ~2010 land cover for the Lake of the Woods/Rainy River Basin; developed by Department of Forest Resources, Remote Sensing and Geospatial Analysis Laboratory, University of Minnesota. Available from https://rs.umn.edu/datalayers.

Land Cover	Area (ac)	Area (%)
Pasture/grassland	1,140	3.5%
Urban/developed	224	0.7%
Total	32,044	100%

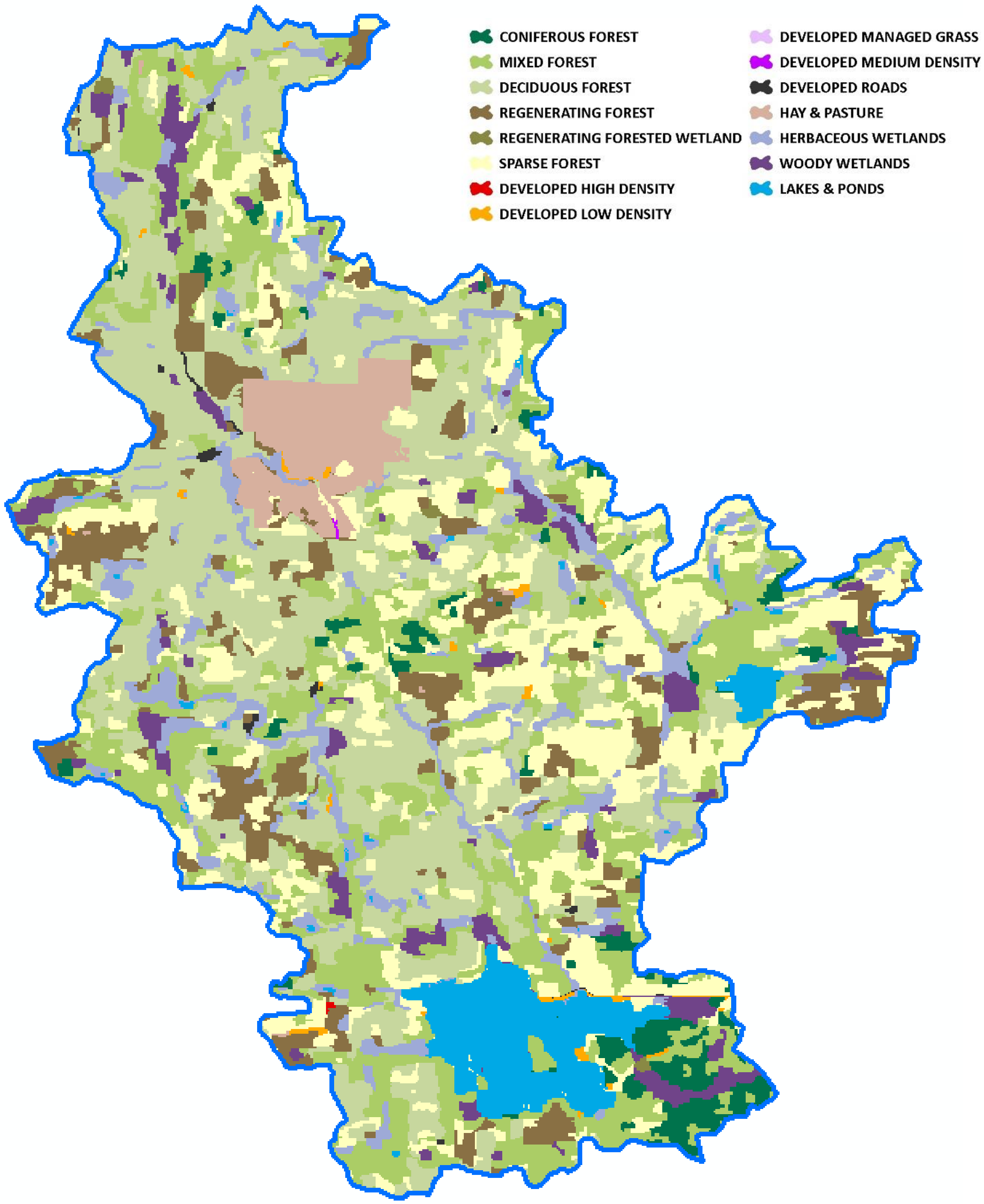

Figure 5. Land cover in the Blackduck River Watershed

Data source: *Land Cover: Lake of the Woods 2010*; updated to reflect recent forest clearing and conversion to pasture observed during fieldwork and quantified based on 2017 aerial photography.

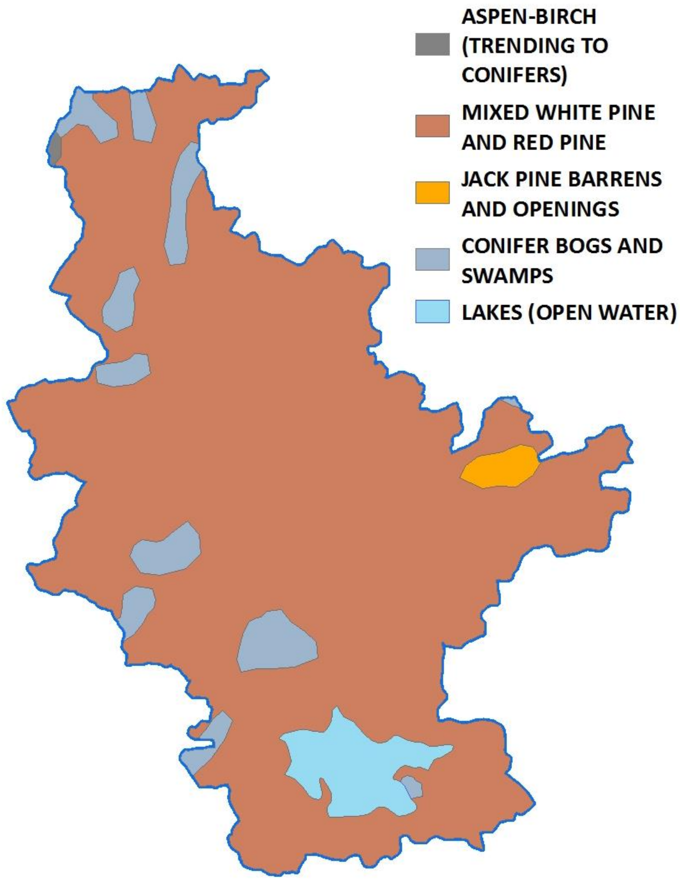

Figure 6. Pre-European settlement land cover in the Blackduck River Watershed
Data source: Marschner Presettlement Vegetation, DNR

3.2 Water quality summary

TSS and *E. coli* concentrations were analyzed at multiple sites along the Blackduck River and its tributaries. Data from the last 10 years (2009 through 2018) were downloaded from the MPCA's Environmental Quality Information System (EQuIS). Results from multiple samples from the same day were averaged.

Daily average flows along multiple reaches of the Blackduck River and its tributaries were simulated with the MPCA's HSPF model application of the Lake of the Woods Watershed (model version "RainyL_WQ_2019_Blackduck_NewPasture," run on 4/6/2020). The simulated flows from the HSPF model integrate flow monitoring data and provide long-term, continuous flow estimates; these simulated flows were used in developing the stream TMDLs. For additional information regarding HSPF modeling, see the summary in Section 3.3.1.2 or modeling documentation (RESPEC 2016, MPCA 2020).

TSS and *E. coli* data are available from 2014 to 2017. Data were summarized by year to evaluate annual trends in water quality and by month to evaluate seasonal variation. The summaries of data by year only consider data taken during the time period that the standard is in effect (April through September for TSS and April through October for *E. coli*). The frequency of exceedances represents the percentage of samples that exceed the water quality standard.

Water quality is often a function of stream flow, and water quality duration curves are used to evaluate the relationships between hydrology and water quality. For example, *E. coli* concentrations can increase with rising flows if watershed runoff from a feedlot is a substantial source. Other parameters may be more concentrated at low flows and diluted by increased water volumes at higher flows. Water quality duration curves include load duration curves and concentration duration curves, and they provide a visual display of the relationship between stream flow and water quality. Water quality duration curves were developed as follows.

Development of flow duration curves: Flow duration curves relate mean daily flow to the percent of time those values have been met or exceeded. For example, an average daily flow at the 50% exceedance value is the midpoint or median flow value; average daily flow in the reach equals or exceeds this value 50% of the time. The curve is divided into flow zones, including very high flows (0% to 10%), high flows (10% to 40%), mid flows (40% to 60%), low flows (60% to 90%), and very low flows (90% to 100%).

Flow duration curves were developed using average daily flow (1996 through 2018) from HSPF modeling. Simulated flows from all months (even those outside of the time period that the standard is in effect) were used to develop the flow duration curves.

Development of load and concentration duration curves: To develop load duration curves, all average daily flows were multiplied by the water quality standard (i.e., 10 mg/L TSS and 126 org/100 mL *E. coli*) and converted to a daily load to create curves that represent the load in the stream when the stream meets its water quality standard under all flow conditions. Loads calculated from water quality monitoring data are also plotted on the load duration curve. Loads are based on the concentration of the sample multiplied by the simulated daily average flow on the day that the sample was taken. Each calculated load that plots above the load duration curve represents an exceedance of the water quality standard whereas loads that plot below the load duration curve are less than the water quality standard.

Concentration duration curves are similar to load duration curves but instead plot concentration on the y-axis instead of load.

Water quality summary tables are presented in the sections below (3.2.1 and 3.2.2), and load duration curves are provided in Section 4.5.5 and 4.6.5.

3.2.1 Total suspended solids

The primary TSS water quality monitoring site on the impaired reach is S007-904, which is the Blackduck River at Sheep Ranch Road (Figure 7). The Blackduck River at Arrowhead Trail (site S009-130), approximately four miles upstream of S007-904, is also located on the impaired reach, and data from that site were also evaluated. Water quality data were not collected downstream of site S007-904 due to limited stream access. The assessed reach, which extends from Blackduck Lake to the Ash River, was assessed as impaired for aquatic life use based on high TSS concentrations observed between Blackduck Lake and site S007-904.

Exceedances of the TSS standard on the impaired reach were observed only at S007-904, with 24 to 64% of samples exceeding the criterion annually (Table 5) and a higher percentage of exceedances during the spring and early summer compared to the later summer months (Table 6).

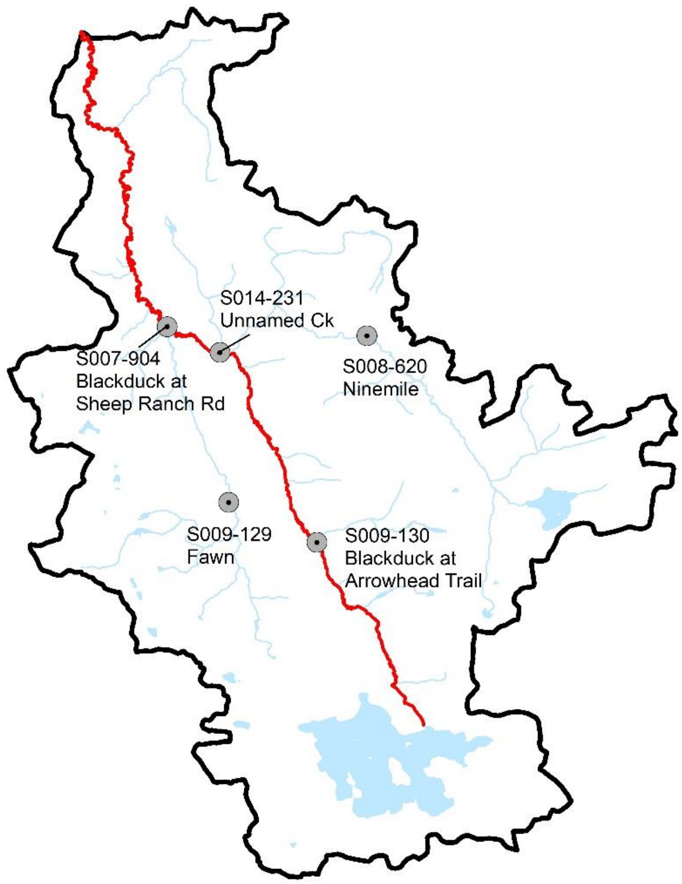

Figure 7. Monitoring sites used in TSS analyses

Table 5. Summary of TSS data for Blackduck River, by year (09030001-820; Apr–Sep)

Year	Sample Count	90th Percentile (mg/L)	Mean (mg/L)	Maximum (mg/L)	Number of Exceedances	Frequency of Exceedances
S009-130: Blackduck River at Arrowhead Trail						
2016	7	3	2	4	0	0%
S007-904: Blackduck River at Sheep Ranch Road						
2014	10	25	11	38	4	40%
2015	6	29	14	32	3	50%
2016	11	25	18	64	7	64%
2017	21	26	13	73	5	24%

Table 6. Summary of TSS data for Blackduck River, by month (09030001-820; 2014–2017)

Month	Sample Count	90th Percentile (mg/L)	Mean (mg/L)	Maximum (mg/L)	Number of Exceedances	Frequency of Exceedances
S009-130: Blackduck River at Arrowhead Trail						
Jun	1	NA	3	15	0	0%
Jul	2	1	1	2	0	0%
Aug	1	NA	4	4	0	0%
Sep	3	2	2	2	0	0%
S007-904: Blackduck River at Sheep Ranch Road						
Apr	2	25	23	26	2	100%
May	5	28	15	38	2	40%
Jun	10	31	19	73	6	60%
Jul	10	26	14	32	4	40%
Aug	10	7	4	12	1	10%
Sep	11	54	17	64	4	36%

At the Blackduck River at Sheep Ranch Road (S007-904), which is the site with observed TSS exceedances, exceedances occurred mostly under high and very high flows (Figure 8). Maximum observed concentrations during the summer (June through September) months were higher than April and May maxima. TSS concentration was dependent on stream discharge, and the data indicate that flows of 10 cubic feet per second (cfs) might be a threshold for the Blackduck River to suspend and transport material (MPCA 2019). Site S007-904 is located at the toe slope of a steepened reach (2% slopes) that extends for several miles through an area with erodible soils (see Figure 14 in the TSS source assessment, Section 3.3.1.1). During longitudinal sampling from a June 2017 rain event, TSS concentrations at this site were over twice as high as TSS concentrations at other Blackduck River Watershed sites (MPCA 2019). High TSS loading at this site primarily occurs during precipitation events. Additional details and data analysis are provided in the stressor identification report (MPCA 2019) and in the TSS source assessment (Section 3.3.1.1).

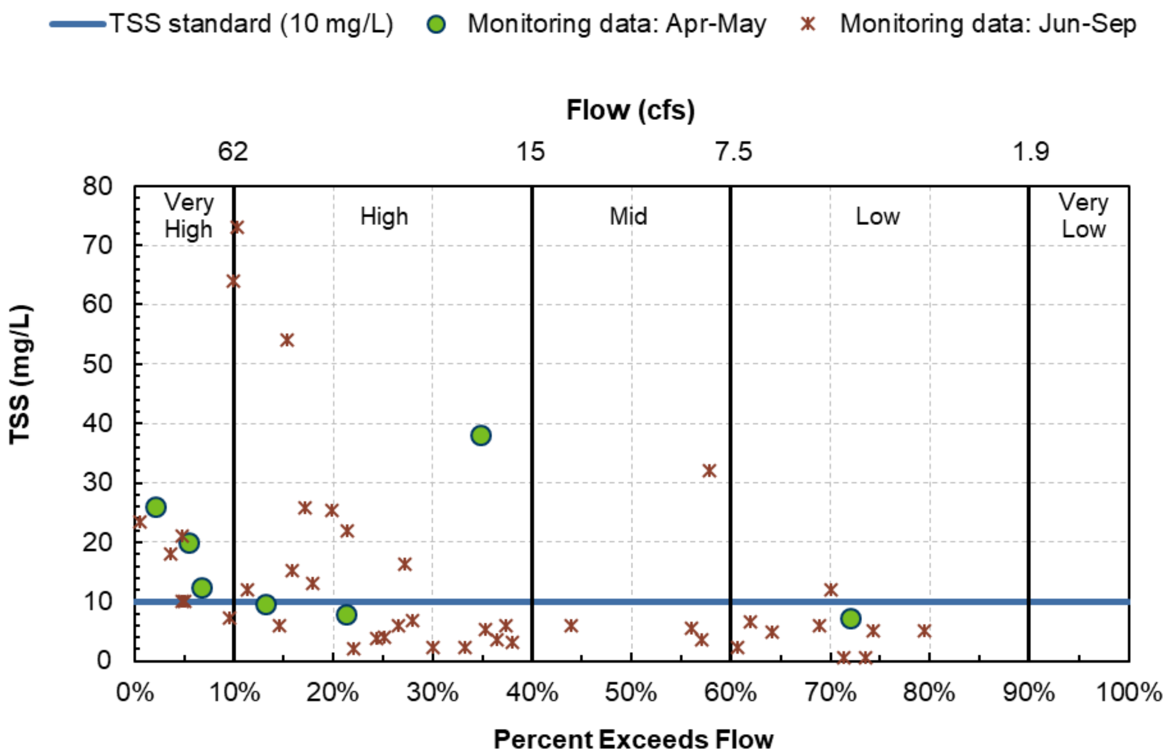

Figure 8. TSS concentration duration curve, Blackduck River site S007-904, Apr–Sep, 2014–2017

Note that the long-term simulated flows presented here are on average lower than the 2017 monitored flows in the stressor identification report (MPCA 2019). Higher than normal precipitation leading into the 2017 monitoring season may have filled wetland storage in the watershed, which could have led to higher than average stream flows in 2017.

3.2.2 *E. coli*

The primary *E. coli* water quality monitoring site is S007-904, which is the Blackduck River at Sheep Ranch Road (Figure 9). Data from upstream on the Blackduck River, as well as several tributaries, were also evaluated. Water quality data were not collected downstream of site S007-904 due to limited stream access. The assessed reach, which extends from Blackduck Lake to the Ash River, was assessed as impaired for aquatic recreation use based on high *E. coli* concentrations observed between Blackduck Lake and site S007-904.

All of the exceedances of the individual standard on the Blackduck River were observed at the Sheep Ranch Road site (S007-904), the most downstream site (Figure 9, Table 7). The monthly geometric mean standard was exceeded during all months with sufficient data (minimum of five samples), and the individual standard was exceeded in June through September (Table 8). *E. coli* concentrations were independent of stream discharge (Figure 10), exceeding the individual standard during low, middle, and high flows. High flow samples exceeded the individual standard during all summer months (June through August); however, low flow samples only exceeded the standard during late summer (August).

E. coli concentrations often exceeded the individual standard on tributaries Ninemile Creek and an unnamed creek (Figure 11). There were not enough samples collected on the tributaries to calculate a monthly geometric mean.

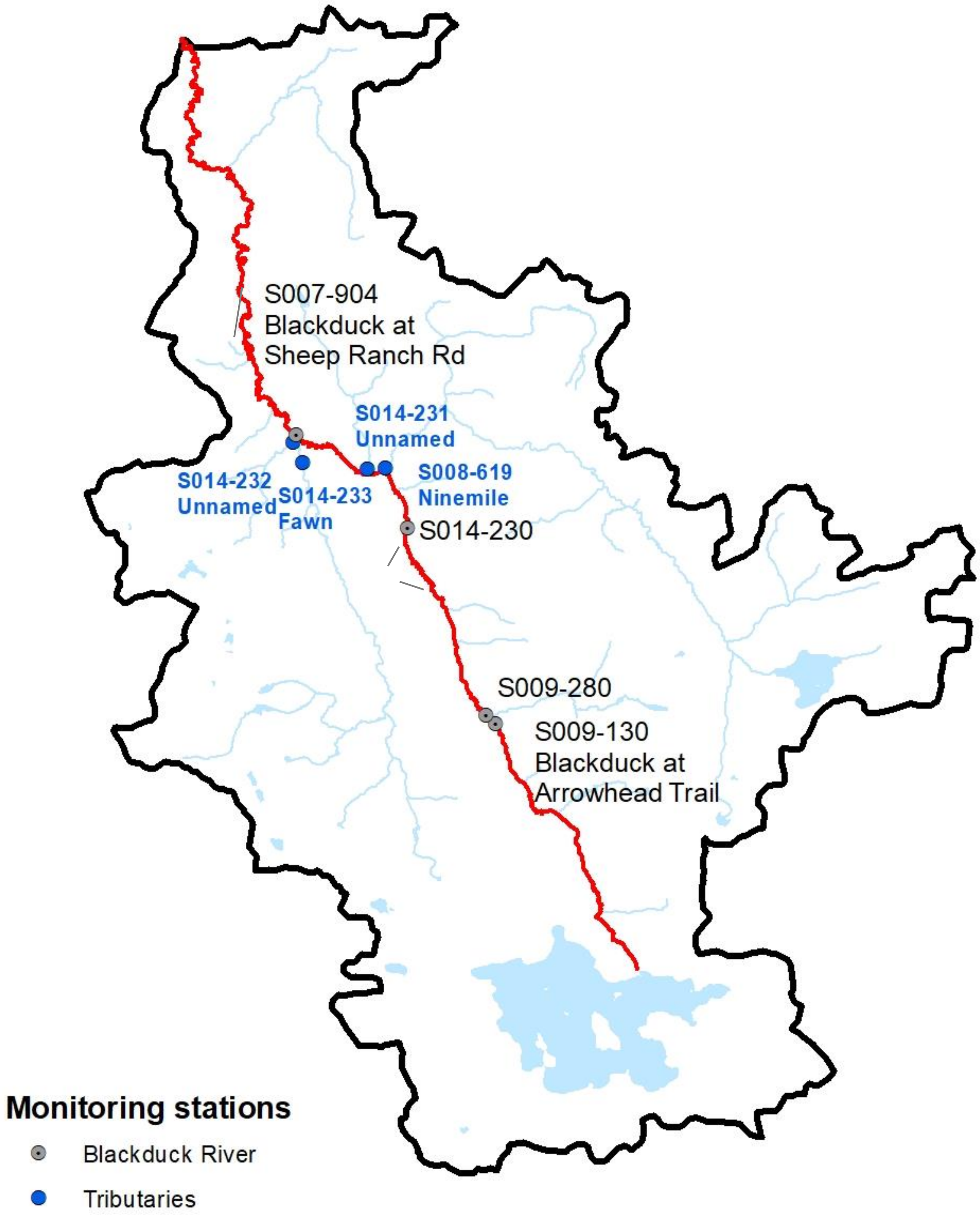

Figure 9. Monitoring sites used in *E. coli* analyses

Table 7. Summary of *E. coli* data for Blackduck River, by year (09030001-820; Apr–Oct)

The first summary aggregates data from all sites along the impaired reach; the second summary shows data from only S007-904, the most downstream site. All exceedances of the individual standard were observed at S007-904.

Year	Sample Count	Geometric Mean (MPN/100 mL)	Minimum (MPN/100 mL)	Maximum [a] (MPN/100 mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
All Blackduck River sites (S009-130, S009-280, S014-230, S007-904)						
2014	7	566	267	980	0	0%
2015	8	1297	238	2,420	6	75%
2016	25	362	56	2,420	3	12%
2017	28	303	36	2,420	5	18%
Site S007-904						
2014	7	566	267	980	0	0%
2015	8	1297	238	2,420	6	75%
2016	13	842	276	2,420	3	23%
2017	14	712	112	2,420	5	36%

a. 2,420 org/100mL is the method's maximum recordable value.

Table 8. Summary of *E. coli* data for Blackduck River, by month (09030001-820; 2014–2017)

Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual sample standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples.

Month	Sample Count	Geometric Mean (MPN/100 mL)	Minimum (MPN/100 mL)	Maximum [a] (MPN/100 mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
All Blackduck River sites (S009-130, S009-280, S014-230, S007-904)						
May	1 [b]	749	749	749	0	0%
Jun	21	392	40	2,420	5	24%
Jul	21	438	36	2,420	4	19%
Aug	21	440	46	2,420	4	19%
Sep	4 [b]	209	50	1,300	1	25%
Site S007-904						
May	1 [b]	749	749	749	0	0%
Jun	13	779	260	2,420	5	38%
Jul	13	818	238	2,420	4	31%
Aug	13	850	112	2,420	4	31%
Sep	2 [b]	731	411	1,300	1	50%

a. 2,420 org/100mL is the method's maximum recordable value.

b. Not enough samples to assess compliance with the monthly geometric mean standard.

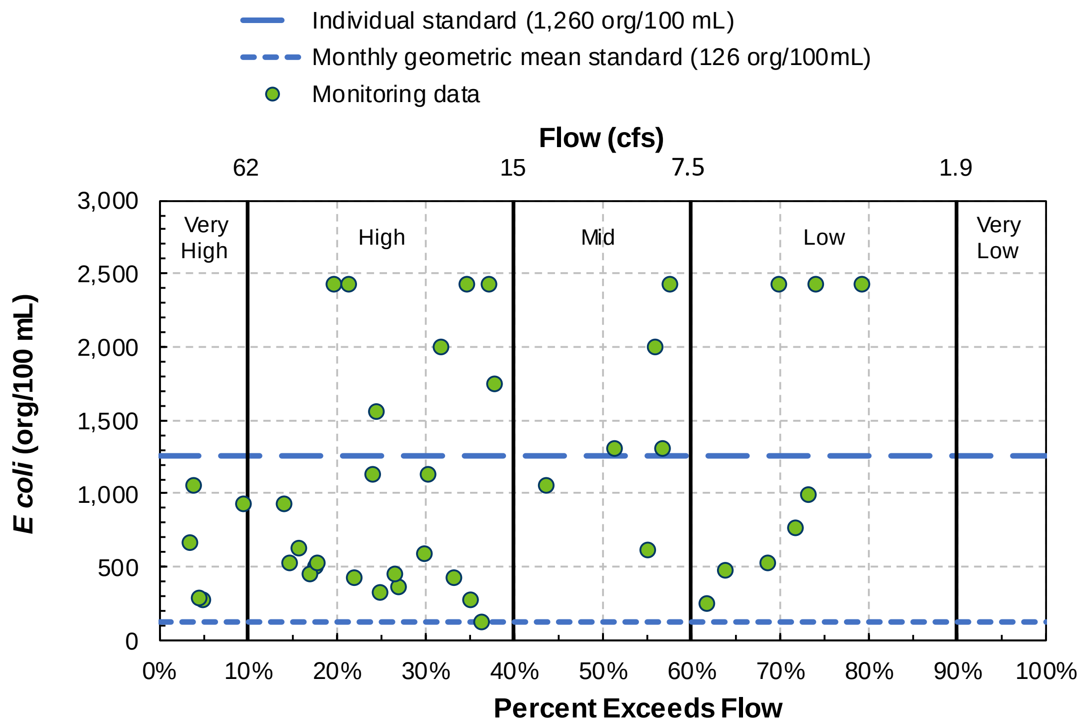

Figure 10. ***E. coli*** **concentration duration curve, Blackduck River site S007-904, May–Sep, 2014–2017**

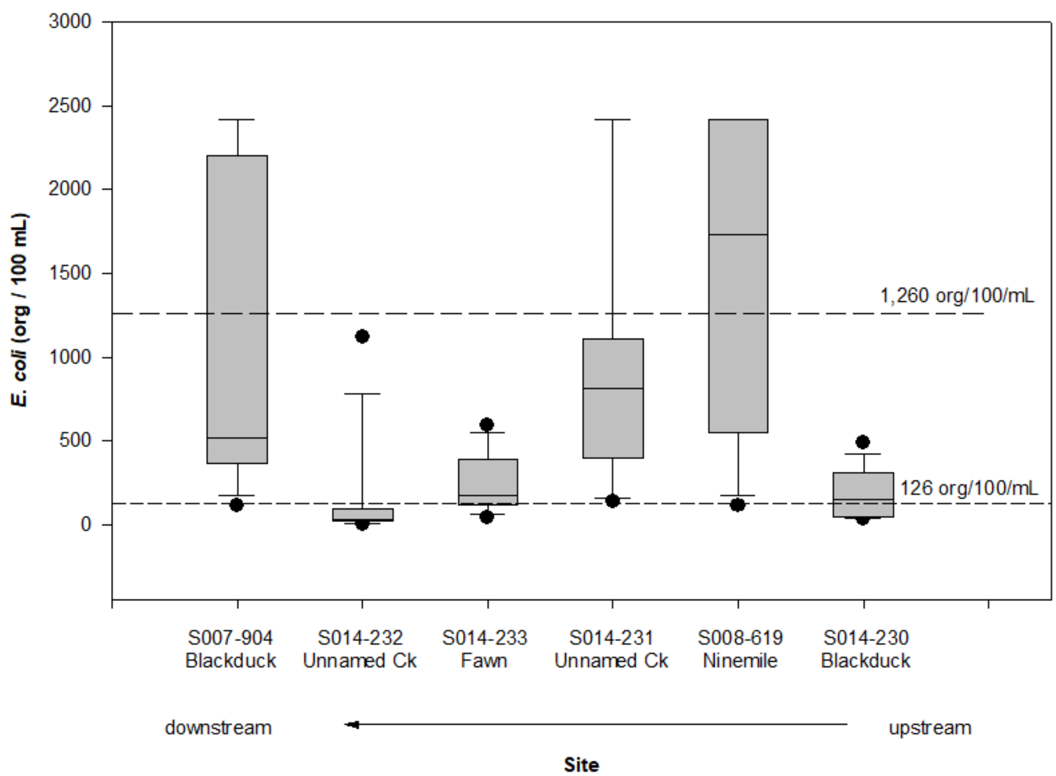

Figure 11. ***E. coli*** **box and whisker plots (2017), longitudinal analysis**

Data represent 13 days in 2017 (Jun–Sep) for which data are available at each site. See Figure 9 for locations of the monitoring stations. The 1,260 org/100 mL standard applies to individual samples, and the 126 org/100 mL applies to monthly geometric means.

3.3 Pollutant source summary

Source assessments evaluate the magnitude, timing, and location of pollutant loading to a water body. The purpose of this source assessment is to identify possible sources of *E. coli* and TSS in the Blackduck River Watershed.

The TSS and *E. coli* sources in the Blackduck River Watershed are all nonpermitted sources, which do not require a National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) permit. The phrase “nonpermitted” does not indicate that the pollutants are illegal, but rather that they do not require an NPDES/SDS permit. Some nonpermitted sources are unregulated, and some nonpermitted sources are regulated through nonNPDES programs and permits such as state and local regulations.

The pollutant sources include watershed runoff, septic systems, and pastures, and near-channel sources influenced by altered hydrology. Some pollutant loading is from natural background, which means that the source occurs outside of human influence. There are no known animal feeding operations, and there are no NPDES/SDS permitted sources such as wastewater treatment facilities, permitted animal feeding operations, or permitted stormwater.

3.3.1 Total suspended solids

The Blackduck River Watershed water quality analysis indicates that the reach between S009-130 and S007-904 (Figure 7) is a reach from Arrowhead trail to the Sheep Ranch Road where high TSS inputs occur on the Blackduck River (Figure 12). Tributaries Ninemile Creek, Fawn Creek, and Unnamed Creek enter the Blackduck River within this reach (Figure 7). Concentrations observed on Ninemile Creek and Fawn Creek are low compared to the Blackduck River (Figure 12). A description of sources of sediment is provided below, followed by the HSPF-simulated TSS loads for the Blackduck River Watershed.

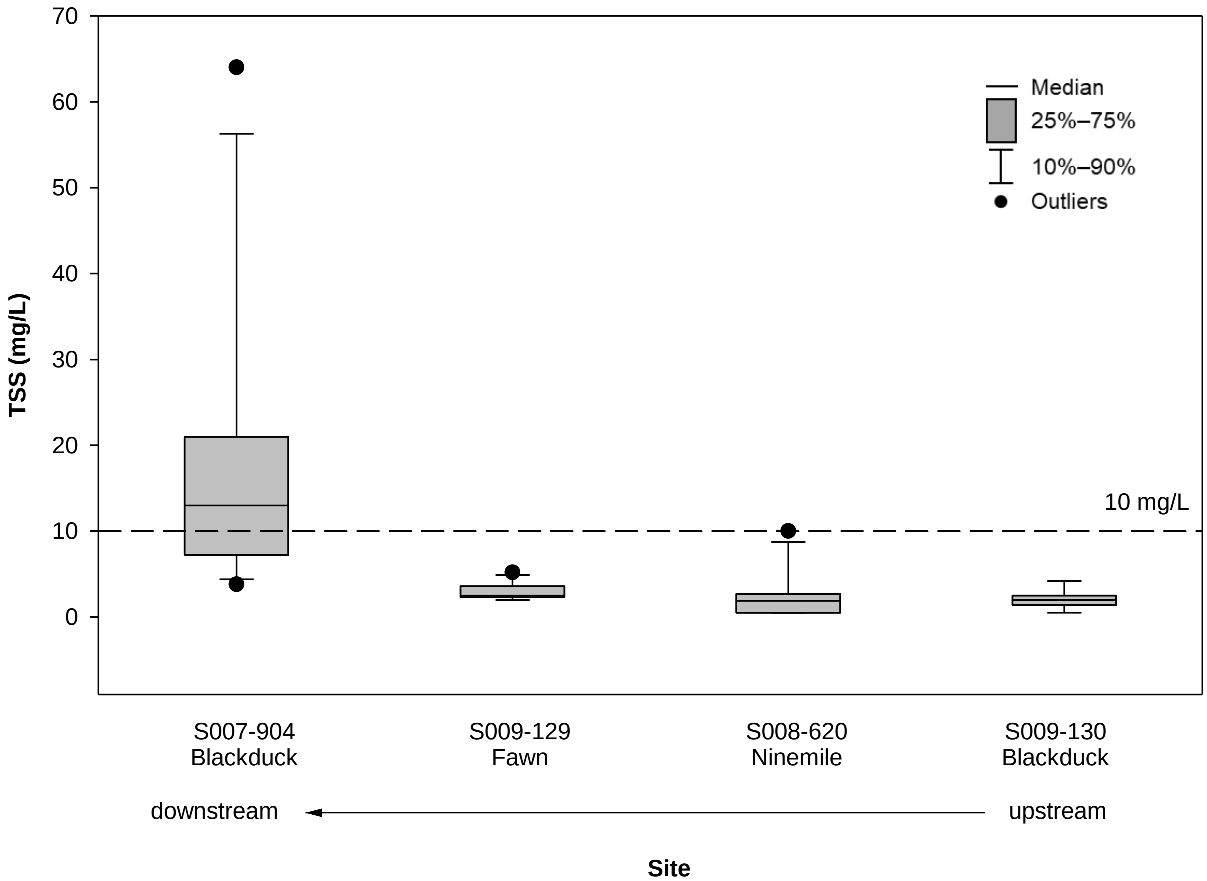

Figure 12. TSS box and whisker plots (2016), longitudinal analysis

For all sites except for the upstream Blackduck site (S009-130), data represent 11 days in 2016 (May–Sep) for which data are available at each site. For S009-130, the box plot represents 7 days. See (Figure 4) for locations of the monitoring stations.

3.3.1.1 TSS Sources

Stressor investigation on the Blackduck River identified the primary contributors of sediment in the watershed (MPCA 2019). Sediment sources and processes that lead to sedimentation include stream channelization, forest harvest, pasture runoff, cattle stream access, roads and culverts, an abandoned railroad grade, beaver dams, and natural background sources. All of these sources except for forest harvest and pasture runoff have a near-channel sediment component.

Several banks within the high TSS reach were identified as having comparatively high erosion rates for the watershed. A Bank Assessment for Nonpoint Source Consequences of Sediment (BANCS) assessment (DNR 2019) identified areas with a disproportionately high amount of erosion in the watershed. The highest erosion rates were associated with a 3.3-mile reach (“high erosion reach” in Figure 13 and Figure 14) that correlates with the location where elevated TSS inputs occur. A geomorphologic assessment concluded that the reach is unstable and incised. High flows cannot access the floodplain, resulting in excess sheer stress on the bed and banks and accelerating erosion rates.

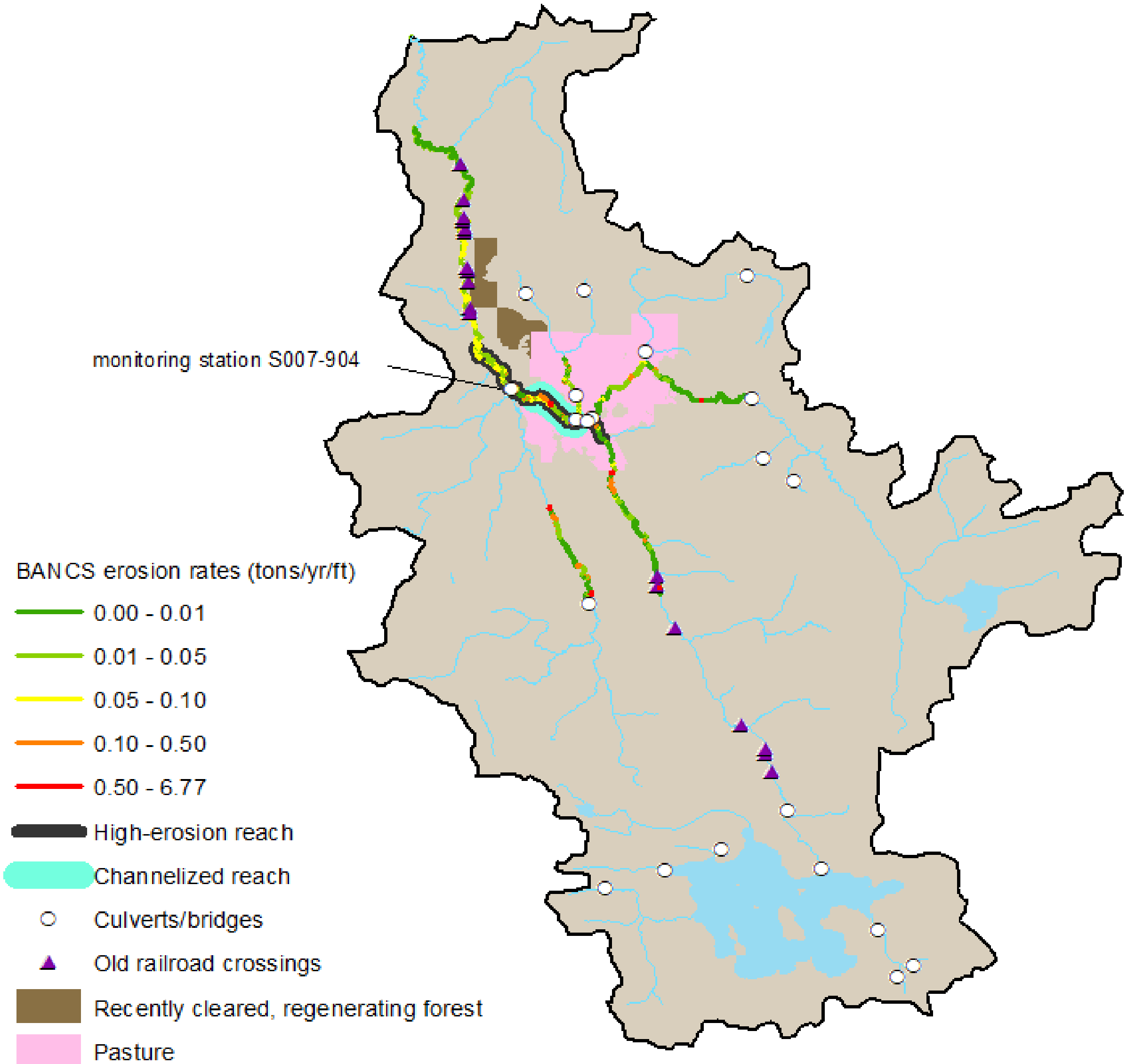

Figure 13. TSS sources in the Blackduck River Watershed

Data sources—*BANCS erosion rates, High-erosion reach, and Channelized reach*: DNR 2019; *Culverts/bridges* and *Old railroad crossings*: MPCA 2019; *Recently cleared, regenerating forest* and *Pasture*: observed during fieldwork and quantified based on 2017 aerial photography

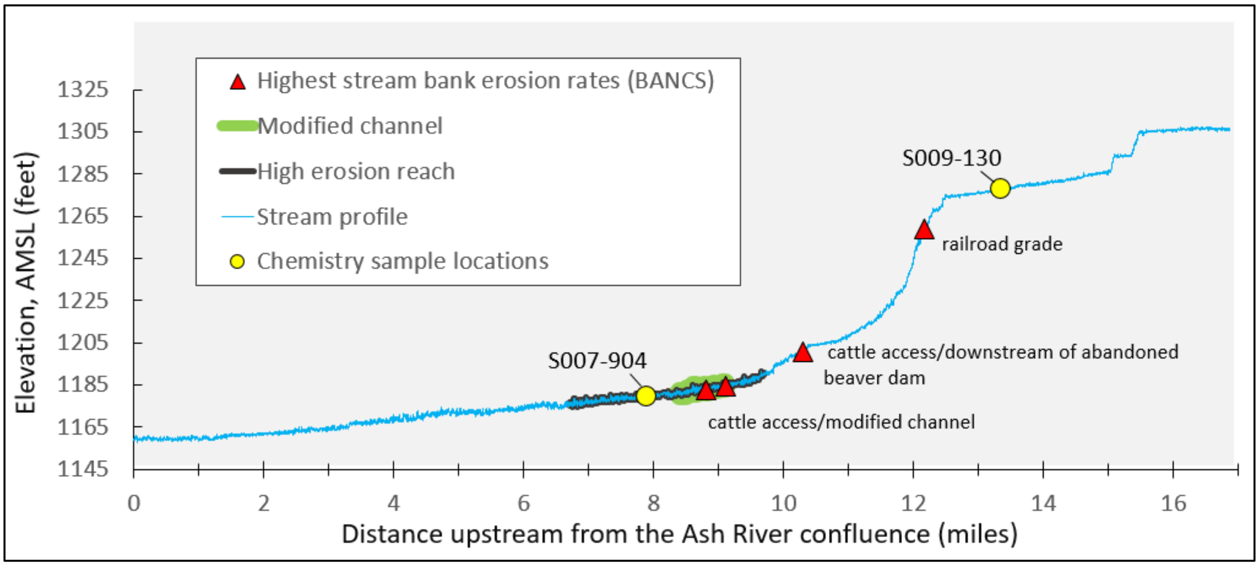

Figure 14. Blackduck River elevation profile derived from LiDAR data

Red triangles identify locations of highest stream bank erosion rates, and associated text indicates the likely cause based on observations noted in the BANCS assessment. AMSL = above mean sea level

Channelization

The primary cause of instability and resulting high TSS loading in this reach is likely the channelization of a 3,750-foot section that occurred prior to 1939 (Figure 13 and Figure 14). Local knowledge suggests that channelization was a means of reducing the number of stream crossings on the road leading into the pasture or ranch. Channel straightening moved the channel to the west side of the road and cut off several large stream meanders, restricting the stream corridor. This shortened the reach length by 34% and consequently increased the stream slope by 60%. Changes in stream function and form increased shear stress and initiated the acceleration of erosional processes. There is evidence of channel incision, excess fine sediments, and elevated TSS loading on the Blackduck River reach, likely consequences of an abrupt destabilization of the channel.

Forest harvest

Conversion of forest to a different forest species or to open land (i.e., that having no canopy or a young canopy) can negatively alter runoff and streamflow dynamics, as a result of less tree cover to intercept and evapotranspire precipitation inputs. Conversion from conifers such as pine to hardwood species such as aspen and birch can decrease forest evapotranspiration rates and increase water yields (Bernath et al. 1982). Increased peak flows and shifts in the timing of peak flows have been observed in northern Minnesota watersheds in which greater than 60% of the drainage area was converted to open land, including young forested areas of less than 16 years age (Verry 2001). These changes in runoff and streamflow can negatively affect sediment loading to receiving waters.

Century-old logging in the Blackduck River Watershed converted most of the coniferous forest to hardwoods, and likely resulted in increased water yields across the watershed. However, while an active forestry industry continues to exist in the watershed today, several lines of evidence suggest that near channel inputs such as gullying and bank erosion that result from riparian/near channel clearing are a larger source of sediment than runoff from harvested areas dispersed throughout the watershed. Riparian removal and disturbance has been well documented to reduce stream bank stability.

Estimates of open land (see *Land cover*, Section 3.1) in the Blackduck River Watershed and within each of its smaller subwatersheds are less than 40%, below the area-based threshold shown to alter streamflow dynamics identified in the Verry (2001) study. However, several large cuts for both timber production and pasture conversion that were recently completed adjacent to the Blackduck River correlate with moderate to high erosion and elevated TSS on the Blackduck River (Figure 13). More investigation would be needed to further confirm these correlations.

Pasture and cattle access to streams

Pastures are grazed areas where the concentration of animals allows a vegetative cover to be maintained during the growing season. Pastures are a common type of livestock operation in Minnesota and have less of an environmental impact than open feedlots when managed well. On a voluntary basis, pasture owners can implement best management practices (BMPs) to reduce erosion and runoff. Pastures are neither permitted nor registered with the state, and livestock on pastures are not restricted from accessing lakes, rivers, or other waters. However, perennial vegetative buffers of up to 50 feet along lakes, rivers, and streams are required by Minnesota's buffer law (see Section 6.2.2), and this applies to waters within pastures.

Grazing impacts to water quality include pasture runoff and near-channel disturbance, which can be intensified if livestock have unlimited access to the stream. Accelerated bank erosion and channel widening have been consistently documented in pastured streams, particularly where there is frequent animal traffic along the banks and in the stream channel (Riedel et al. 2006, Platts 1981). Cattle access to surface water bodies can result in a range of impacts on aquatic ecology, geomorphology, sediment transport, and the function of the riparian zone. High animal traffic can lead to soil compaction and loss of vegetative cover, reducing soil permeability and increasing runoff rates. In streams, faster runoff rates result in larger peak flows and total flows, increasing the shear stress on the bed and the banks. Trampled banks near high traffic access points can lead to bank instability, increased erosion, and excess deposition of fine sediment. Impacts can be mitigated through the use of vegetative buffers along waterways and barriers that limit or exclude the animals from entering surface water bodies.

One of the largest pasture operations in the Rainy Rivers–Headwaters Watershed is located in the Blackduck River Watershed. Conversion of forest to pasture at the cattle ranch has increased open land within and adjacent to the stream riparian area by over 500 acres in the past two decades. While major cuts expanding the pasture occurred in years 2003 and 2013, the continuation of forest harvest within the ranch was observed as recently as 2018. Harvest practices maintained trees within a 50-foot buffer along some reaches, but not others. Sections of Ninemile Creek and much of Unnamed Creek have been cleared of trees up to the streambanks. Grasses have replaced trees in much of the riparian area, meeting the requirements of Minnesota's buffer law (Minn. Stat. § 103F.48).

Within the pasture, streams are the primary source of water to cattle during the ice-free season. Cattle are allowed access to approximately 1.5 miles of the Blackduck River and several miles of its tributaries—Ninemile Creek, Fawn Creek, and Unnamed Creek. Stressor identification and BANCS survey efforts found evidence that heavily-used access points caused erosion and sedimentation. The stream banks in high animal traffic areas are trampled and devoid of vegetation, and in these same areas the channels are over-widened and embedded with fine streambed materials. Erosion rates were particularly high on pastured reaches of the Blackduck River, Ninemile Creek, and Unnamed Creek. BMP discussions have been initiated with the owner of the Blackduck River pasture operation.

Culverts and Roadways

Culverts and bridge crossings, when not properly sized and installed, can initiate stream instability and inhibit effective stream sediment transport. Poor alignment, setting, or sizing of a culvert can cause channel instability. Signs of instability include upstream deposition of sediment, downstream scour, lateral erosion, and road failures. To transport material and water effectively at a rate that is not too fast or too slow and to maintain overall stability, the ideal crossing span should equal bankfull width, the distance between the stream banks at bankfull stage, and should be set at an elevation to produce acceptable velocities that allow effective transport of sediment (DNR 2015).

A multi-agency effort surveyed 66 culverts in the Ash River Watershed including 16 culverts in the Blackduck River Watershed. Several culverts were not surveyed within the boundary of the cattle pasture. Based off of culverts that were surveyed, the percentage of culverts that are undersized (62%) and misaligned (25%) in the Blackduck River Watershed are proportionate to findings for the greater Ash River drainage, outlined in the stressor identification report (MPCA 2019). As a result, 25% of the surveyed culverts have visible signs of erosion and 31% are perched, meaning the outlet is elevated above the downstream water surface, in the Blackduck River Watershed.

The highest density of culverts are located near Blackduck Lake and within the cattle pasture (Figure 13). Near the lake, none of the culverts showed signs of erosion and one of seven was perched. Within the pasture, only two of seven culverts were surveyed, but based on the surveys and photographs of the culverts that were not surveyed, it is known that at least three culverts within the ranch have visible signs of erosion and two culverts are perched. The culvert at the outlet of Ninemile Creek is perched by several feet and is likely preventing a head-cut from migrating upstream. Overall, the number of stream crossings in the watershed is low compared to a more developed area; however, the highest density of problematic culverts is within or near the most unstable reach of the Blackduck River.

Roadways add to impervious surface and increased runoff and thereby contribute secondary effects such as destabilized channels, bank erosion, and increased pollutant transport (EPA 2011). The road network within the Blackduck River Watershed had moderate road densities compared to adjacent watersheds (MPCA 2019). The network of mostly gravel and silt forest roads used to access forest plots and remote residences is most prominent between the water monitoring station S007-904 and Blackduck Lake, and in the Ninemile Creek Subwatershed. Roadside erosion into streams or road ditches with stream connections has been observed in the Blackduck River Watershed, particularly during snowmelt.

Historic railroad and crossings

An abandoned railroad is located contiguous to much of the full length of the Blackduck River, crossing the stream at eighteen locations. The stressor identification report identified the railroad as a source of erosion to the Blackduck River (MPCA 2019). Evidence is outlined in the BANCS study (DNR 2019), which found that the abandoned railroad initiates erosion through two processes. First, the old railroad grade itself is undermined where the stream abuts against the grade, accelerating the detachment and transport of grade and bank materials in streamflow. Second, in-channel pilings at former crossings create log jams spanning the width of the channel, causing excess stress on the banks. Additionally, there is visual evidence that very high flows initiate a rapid release of the log jams, which cause large bank scours where the log jams had formed.

There are two high density rail crossing reaches of the Blackduck River (Figure 13), including a reach upstream of the pasture and another downstream of S007-904. Moderate erosion rates for the watershed were associated with the rail and nine of its crossings in the downstream reach. The BANCS survey did not extend far enough upstream to include most of the upstream rail crossings. Where bank erosion data exist in the headwater reach, high erosion rates correlate with the abandoned railroad.

Sections of the railroad grade upstream of the pasture are part of the David Dill/Arrowhead State Trail system, used primarily for snowmobiling in the winter. A proposed change to allow all-terrain vehicle use on this section of the trail is currently under review by the DNR.

Beaver dams

Beaver dams are comparatively a minor source of erosion in the Blackduck River Watershed (MPCA 2019). The majority of the beaver dams causing erosion do so under high flow conditions and are located against valley walls, where flow is directed around the dams and into the banks. Beaver dams are abundant (approximately 350 identified using aerial imagery) in the Blackduck River Watershed. Those associated with highly eroding banks are isolated on reaches of the Blackduck River, Fawn Creek, and Ninemile Creek (DNR 2019). Beaver dams likely also serve as a sediment sink at lower flows.

Beaver dams are commonly categorized as a "natural background" pollutant source. However, this TMDL report recognizes that not all beaver dams in the Blackduck River Watershed are completely "natural" based on documentation of human influence on beaver densities, both directly and indirectly, in northeast Minnesota for more than a century. Beavers themselves have been managed throughout northern Minnesota over the past century, as have some of their natural predators, such as the gray wolf. Since pre-settlement, much of the watershed has been converted from a coniferous forest to tree species more preferable to beaver, including aspen and birch. Aspen is arguably one of the most felled for food and building material by the beaver (Hall 1960).

Natural background sources

"Natural background" is defined in both Minnesota rule and statute. The Clean Water Legacy Act (Minn. Stat. § 114D.15, subd. 10) defines natural background as "characteristics of the water body resulting from the multiplicity of factors in nature, including climate and ecosystem dynamics, that affect the physical, chemical, or biological conditions in a water body, but does not include measurable and distinguishable pollution that is attributable to human activity or influence." Minn. R. 7050.0150, subp. 4 states, "'Natural causes' means the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a water body in the absence of measurable impacts from human activity or influence."

Natural background sources are inputs that would be expected under natural, undisturbed conditions. Natural background sources of TSS can include inputs from natural geologic processes such as soil loss from upland erosion and stream development, and loading from forested land, wildlife, etc. For the Blackduck River impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment, and therefore natural background is accounted for and addressed through the MPCA's water body assessment process.

Natural background conditions were evaluated within the source assessment portion of this study. Soils in the watershed are susceptible to erosion in areas, including the reaches where TSS is elevated (MPCA 2019). However, TSS load estimates (see *Summary of TSS sources*, Section 3.3.1.2) indicate that natural background inputs are generally low compared to near channel inputs and runoff from pasture and young forests. Evidence such as side channel oxbows indicates that the channel was historically active; however, stressor identification and the geomorphic assessment of the channel suggest that near channel sources of sediment cannot be considered natural background.

Based on the MPCA's water body assessment process and the TMDL source assessment exercises, there is no evidence at this time to suggest that natural background sources are a major driver of the impairment and/or affect the Blackduck River's ability to meet state water quality standards.

3.3.1.2 Summary of TSS sources

Sources of TSS to the Blackduck River were quantified with the Lake of the Woods Watershed HSPF model (model version "RainyL_WQ_2019_Blackduck_NewPasture," run on 4/6/2020). HSPF is a comprehensive model of watershed hydrology and water quality that allows the integrated simulation of point sources, land and soil contaminant runoff processes, and in-stream hydraulic and sediment-chemical interactions. The results provide hourly runoff flow rates, sediment concentrations, and nutrient concentrations, along with other water quality constituents, at the outlet of any modeled subwatershed. Within each subwatershed, the upland areas are separated into multiple land use categories, and loads generated from these land cover categories were tabulated from the HSPF model.

The original model (RESPEC 2016) was later revised by MPCA staff (MPCA 2020). In addition to updated meteorological data and calibration to more recent data, the model revisions include an update of the land cover in the Blackduck River Watershed to reflect recent forest clearing and conversion to pasture observed during fieldwork and quantified based on 2017 aerial photography. Model documentation contains additional details about the model development and calibration (RESPEC 2016, MPCA 2020).

Table 9. TSS source loads in the Blackduck River Watershed

Loads were estimated with the HSPF model.

TSS Source	Mean Annual TSS Load (tons)	Percent of Mean Annual Load
Wetlands	<1	<1%
Mature forest	60	11%
Young forest	30	6%
Pasture/grassland	17	3%
Urban	3	<1%
Near channel	437	80%
Total	547	100%

The watershed HSPF model indicates that near channel sources account for the majority of the TSS load in the Blackduck River. Natural background loads (i.e., mature forests and wetlands) are comparatively low. Mature forest contributes 11% of the TSS load, but is also the primary land cover in this watershed (i.e., 71% of the watershed is forested). Wetlands have a negligible load contribution to the Blackduck River. Human-influenced sources such as young forest and pasture/grassland contribute TSS loads that are proportionate to their percent land cover (i.e., 6% of the TSS load originates in young forest that account for 9% of the watershed area, and 3% of the TSS load originates in pasture/grasslands that account for 3.5% of the watershed area).

This source assessment applies to the Blackduck River Watershed as a whole. However, the TSS sources are not distributed evenly throughout the watershed. Whereas 80% of the total load is estimated to be from near channel sources, this load originates primarily in the high erosion reach indicated in Figure 13.

This source assessment is confirmed by the monitoring data—the majority of TSS exceedances occur during higher flows, indicating that runoff-driven sources such as near channel erosion and surface runoff are the primary sources of concern (Figure 8). Stressor identification and BANCS analysis identified channel erosion associated with an unstable and historically altered reach of the Blackduck River as a primary source of sediment. Other TSS sources in the watershed that increase near channel contributions of sediment include cattle stream access, beaver dams that are above natural background levels, an old railroad, and gullying associated with tree clearing of the stream corridor.

3.3.2 E. coli

The water quality analysis indicates that the reach between S014-230 and S007-904 is a reach where high *E. coli* inputs occur (Figure 9, Figure 11) on the Blackduck River. This reach of the Blackduck River and two of its tributaries, Ninemile and Unnamed Creek, have elevated *E. coli* levels that at times exceed the individual standard (Figure 11). The reaches with high *E. coli* partially or completely flow through the pasture operation.

Monitoring sites located outside the influence of the pasture (S014-232 and S014-230 of Figure 11) provide a reference for less impacted conditions in this area. The *E. coli* concentrations at these sites were slightly elevated compared to the monthly geometric mean standard; however, sample counts were generally small.

3.3.2.1 *E. coli* sources

Stressor investigation on the Blackduck River identified pasture runoff and direct fecal deposition as the primary contributors of *E. coli* in the watershed (MPCA 2019). Other sources that can contribute to elevated *E. coli* include wildlife, beaver dams, and septic systems. All of the sources are nonpermitted; there are currently no *E. coli* pollutant sources that are regulated through NPDES/SDS permits in the Blackduck River Watershed.

Pasture/cattle access

Runoff mechanisms that transport *E. coli* from pastures to surface water bodies are similar to the sediment pasture runoff mechanisms described above in Section 3.3.1.1. In addition to runoff, direct fecal deposits from cattle provide a significant source of *E. coli* to streams (Soupir et al. 2010, Bragina et al. 2017). Reductions in direct fecal deposits are often the leading change in management practices necessary to meet water quality standards in agricultural watersheds. When alternative off-stream water is provided, the amount of time cattle spend in the streams can be greatly reduced. If off-stream water is combined with other good grazing management practices (appropriate stocking rate, even grazing distribution, and avoiding grazing in sensitive areas during vulnerable periods), levels of *E. coli* can also be significantly reduced (Wagner et al. 2013).

Pasture runoff and direct fecal deposition are considered primary sources of *E. coli* to the Blackduck River, based on data that show that *E. coli* concentrations are elevated at sites located within the ranch relative to concentrations upstream or disconnected from the ranch (Figure 11). The three streams with *E. coli* levels that exceed the individual standard are the primary source of water for cattle during the growing season. Fawn Creek, also located within the ranch, did not exceed the individual standard. While Fawn Creek has a small nonfenced portion of the stream available to cattle, stressor identification (MPCA 2019) speculated that limited access combined with undesirable wading conditions likely discourage extensive watering in this stream, particularly when easier access is available within the same fenced area on the Blackduck River. Water quality samples on reaches with no cattle access (Blackduck River upstream of the ranch and a downstream tributary) did not exceed the individual standard.

E. coli concentrations in the Blackduck River were elevated during all sampled months (Table 8) and under low, middle, and high flow conditions (Figure 10), which indicates that both pasture runoff and direct fecal deposition contribute to the impairment. Under low flow conditions, concentrations only exceeded the individual standard in August, which indicates that direct fecal deposition is most problematic in late summer. Conversely, the sample data indicate that precipitation-driven runoff (i.e., high flow conditions) elevates *E. coli* levels in the Blackduck River during all sampled months (June through September).

Wildlife and beaver dams

E. coli can enter surface water by wildlife (e.g., ducks, geese) from dwelling and congregating in wetlands, streams, and lakes. Fecal bacteria fate and transport mechanisms differ between wildlife that live in surface water such as waterfowl and semi-aquatic mammals (e.g., beaver), where there is a daily source of bacteria input directly to waters, and wildlife that dwell in upland areas such as deer, where input of bacteria to water bodies is primarily precipitation-driven.

Wetlands, forests, Blackduck Lake, and in-stream wildlife such as beaver are potential sources of wildlife-driven *E. coli* in the impaired reach. Beaver dams are abundant and widespread throughout the watershed outside of the boundary of the ranch; Fawn Creek is the only pastured stream where active beaver dams were present during the monitoring timeframe. Beavers share stream and riparian habitat with an abundance of other wildlife as the streams and wetlands are closely connected in the Blackduck River Watershed; therefore, beaver influence on *E. coli* concentrations in the Blackduck River could not be discerned from other wildlife. Beavers can be considered as both a natural background source and a source that is exacerbated by human activity (see *Beaver dams* in Section 3.3.1.1).

Sites monitored for *E. coli* within the watershed that are not impacted by pasture (e.g. S014-230 and S014-232) provide a reference for wildlife and other contributions such as septic systems. The *E. coli* geometric mean for combined nonpastured reaches (79 organisms per 100 mL) was nearly an order of magnitude lower than the geometric mean for combined pasture-influenced reaches (650 organisms per 100 mL).

Septic systems

Subsurface sewage treatment systems (SSTS) that are an imminent threat to public health and safety (ITPHS) can contribute *E. coli* to nearby surface waters. ITPHS septic systems have either a sewage discharge to surface water, a sewage discharge to the ground surface, a sewage backup, or any other situation with the potential to immediately and adversely affect or threaten public health or safety (e.g., unsafe tank lids or electrical hazards). Therefore, not all of the ITPHS septic systems discharge *E. coli* directly to surface waters. On average, 2% of the SSTS in St. Louis County were ITPHS in 2018. There are approximately 50–70 SSTS in the Blackduck River Watershed, the majority of which are seasonal. There have been a low number of instances of SSTS discharging at the surface reported in the watershed. The exact extent of ITPHS currently is unknown; however, an estimate of 2% was determined to be appropriate for this watershed, based on inspection records both for the watershed and St. Louis County as a whole. Whereas there may be *E. coli* loading from ITPHS, it is likely a relatively minor source compared to the *E. coli* that is derived from pasture and cattle access.

Natural background

"Natural background" sources are defined in the TSS source assessment (Section 3.3.1.1) and are inputs that would be expected under natural, undisturbed conditions. Natural background sources of *E. coli* can include inputs from forested land, wetlands, and wildlife. However, for the Blackduck River impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment, and therefore natural background is accounted for and addressed through the MPCA's water body assessment process. Natural background conditions were evaluated, where possible, within the source assessment portion of this study. These source assessment exercises indicate that natural background inputs are generally low compared to inputs from livestock on pasture, including cattle access to surface waters.

Based on the MPCA's water body assessment process and the TMDL source assessment exercises, there is no evidence at this time to suggest that natural background sources are a major driver of any of the impairments and/or affect the water bodies' ability to meet state water quality standards.

Naturalized *E. coli*

The relationship between *E. coli* sources and *E. coli* concentrations found in streams is complex, involving precipitation and flow, temperature, sunlight and shading, livestock management practices, wildlife contributions, *E. coli* survival rates, land use practices, and other environmental factors. Research in the last 15 years has found the persistence of *E. coli* in soil, beach sand, and sediments throughout the year in the north central United States without the continuous presence of sewage or mammalian sources. This *E. coli* that persists in the environment outside of a warm-blooded host is referred to as naturalized *E. coli* (Jang et al. 2017). Naturalized *E. coli* can originate from different types of *E. coli* sources, including natural background sources such as wildlife and human-attributed sources such as pets, livestock, and human wastewater. Therefore, whereas naturalized *E. coli* can be related to natural background sources, naturalized *E. coli* is not always from a natural background source.

An Alaskan study (Adhikari et al. 2007) found that total coliform bacteria in soil were able to survive for six months in subfreezing conditions. Two studies near Duluth, Minnesota found that *E. coli* were able to grow in agricultural field soil (Ishii et al. 2010) and temperate soils (Ishii et al. 2006). A study by Chandrasekaran et al. (2015) of ditch sediment in the Seven Mile Creek Watershed in southern Minnesota found that strains of *E. coli* had become naturalized to the water−sediment ecosystem. Survival and growth of fecal coliform has been documented in storm sewer sediment in Michigan (Marino and Gannon 1991), and *E. coli* regrowth was documented on concrete and stone habitat within an urban Minnesota watershed (Burns & McDonnell Engineering Company, Inc. 2017). This ability of *E. coli* to survive and persist naturally in watercourse sediment can increase *E. coli* counts in the water column, especially after resuspension of sediment (e.g., Jamieson et al. 2005).

The MPCA does not currently use methods as standard practice to estimate (using an equation or model) or measure (using a laboratory analysis) what proportion of *E. coli* is naturalized. While a measurement would be preferable over an estimate, it is also more expensive, because it involves a laboratory component. The adaptation and evolution of naturalized *E. coli* that allows it to survive and reproduce in the environment makes it physically and genetically distinct from *E. coli* that cannot survive outside of a warm-blooded host. Laboratory methods target those physical and genetic differences and quantify their presence to provide a measurement. The MPCA is developing a protocol for the use of laboratory analyses to track *E. coli* to their source(s) (i.e., microbial source tracking); these approaches may in the future shed light on naturalized *E. coli*.

3.3.2.2 Summary of *E. coli* sources

Sources throughout the entire Blackduck River Watershed were considered as contributors to the *E.coli* impairment. Water quality data indicate that the pasture is a primary source of *E. coli* to the Blackduck River. *E. coli* levels were highest in three pastured streams, including the Blackduck River where levels immediately downstream of the pasture were an order of magnitude higher than upstream of the pasture. *E. coli* exceedances of the individual standard occurred during low, moderate, and high flows, indicating that a mixture of sources, including both runoff and direct fecal deposition, are sources of concern (Figure 10).

E. coli loading from wildlife, septic systems, and natural background is likely minor compared to that derived from pasture and cattle access. *E. coli* sampling confirmed that levels at water monitoring stations outside of the influence of the pasture were an order of magnitude lower than pasture-influenced reaches.

4. TMDL development

A water body's TMDL represents the loading capacity, or the amount of pollutant that a water body can assimilate while still meeting water quality standards. The loading capacity is allocated to the water body's pollutant sources. The allocations include WLAs for NPDES-permitted sources, LAs for nonpermitted sources (including natural background), and an MOS, which is implicitly or explicitly defined. The sum of the allocations and MOS cannot exceed the loading capacity, or TMDL. This section describes the general approach used to derive the TMDLs and allocations and includes the TMDL tables for the TSS and *E. coli* Blackduck River impairments.

4.1 Overall approach

The loading capacities for TSS and *E. coli* were developed using load duration curves for the Blackduck River. See Section 3.2 for a description of load duration curve development. The load duration curves provide loading capacities along all flows observed in the stream, along with observed loads calculated from monitoring data and simulated flow. For any given flow in the load duration curve, the loading capacity is determined by selecting the point on the load duration curve that corresponds to the flow exceedance (along the x-axis).

The load duration curve method is based on an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes, virtually the full spectrum of allowable loading capacities is represented by the resulting curve. In the TMDL equation tables in this report, only five points on the entire load duration curve are depicted (the midpoints of the designated flow zones). However, the entire curve represents the TMDL and is what the EPA ultimately approves.

4.2 Margin of safety

The MOS accounts for uncertainty concerning the relationship between load and WLAs and water quality. The MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as a load set aside). An explicit MOS of 10% was included in the Blackduck River TSS and *E. coli* TMDLs to account for these uncertainties. The use of an explicit MOS accounts for uncertainty in water quality monitoring, calibration and validation of the HSPF watershed model, and environmental variability in flow and sediment loading. This MOS is considered to be sufficient given the robust dataset and the calibration results of the HSPF model. The Lake of the Woods Watershed model was calibrated and validated using 32 stream flow gaging stations (RESPEC 2015a) and 33 stations with TSS monitoring data (RESPEC 2015b). In addition, the Blackduck segment of the HSPF model was calibrated to flow data from two stream gages, one on the Blackduck River and one downstream on the Ash River, and to TSS data from seven monitoring stations throughout the Blackduck/Ash stream network.

Calibration results indicate that the HSPF model is a valid representation of hydrology and water quality in the watershed. Simulated flows from the model were used to develop the load duration curves for both impairments, and the simulated TSS loads were used to estimate TSS loads to the Blackduck River. (The HSPF model does not simulate *E. coli* loads.)

4.3 Seasonal variation and critical conditions

The application of load duration curves in the Blackduck River TSS and *E. coli* TMDLs addresses seasonal variation and critical conditions. Load duration curves evaluate pollutant loading across all flow regimes including high flow, which is when pollutant loading from watershed runoff is typically the greatest, and low flow, which is when loading from direct sources to the stream typically has the most impact. Because flow varies seasonally, load duration curves address seasonality through their application across all flow conditions in the impaired water body.

Seasonal variation and critical conditions are addressed by the water quality standards. The TSS standard for aquatic life applies from April through September, when aquatic organisms are most active and when high stream TSS concentrations generally occur. The *E. coli* standard for aquatic recreation applies from April through October, which is when aquatic recreation is more likely to occur in Minnesota waters and when high *E. coli* concentrations generally occur.

4.4 Baseline year

The monitoring data used to calculate the percent reductions are from 2014 through 2017. The baseline year for implementation is 2015, the midpoint of the time period. BMPs present on the landscape during the model simulation time period are implicitly accounted for in the model.

4.5 Total suspended solids

4.5.1 Loading capacity methodology

The loading capacity was calculated as simulated flow at the downstream end of the impaired reach multiplied by the TSS standard (10 mg/L). Loading capacities were calculated across the entire spectrum of flows in the stream through the use of a load duration curve.

4.5.2 Wasteload allocation methodology

The WLA is allocated to existing or future NPDES-permitted pollutant sources. Whereas currently there are no permitted TSS sources in the watershed, WLAs are assigned to permitted construction and industrial stormwater to account for potential future sources in those sectors. This is based on the assumption that small, short-term construction and industrial stormwater permits might be required at a future date.

Construction stormwater is regulated through an NPDES/SDS permit (MNR100001). Untreated stormwater that runs off of a construction site often carries sediment to surface water bodies. Phase II of the stormwater rules adopted by the EPA requires an NPDES/SDS permit for a construction activity that disturbs one acre or more of soil; a permit is needed for smaller sites if the activity is either part of a larger development or if the MPCA determines that the activity poses a risk to water resources. Coverage under the construction stormwater general permit requires sediment and erosion control measures that reduce stormwater pollution during and after construction activities. The annual average area under construction in the Minnesota portion of the Rainy River–Headwaters Watershed is 0.02% (2015 through 2019 average). To allow for future permitted construction stormwater activities, the WLA for construction stormwater was calculated as 0.02% multiplied by the TMDL minus the MOS.

Industrial stormwater is regulated through an NPDES/SDS permit (MNR050000) when stormwater discharges have the potential to come into contact with materials and activities associated with the industrial activity. To allow for future permitted industrial stormwater activities, the WLA for industrial stormwater was calculated as equal to the construction stormwater WLA: 0.02% multiplied by the TMDL minus the MOS.

4.5.3 Load allocation methodology

The LA is allocated to existing or future nonpermitted pollutant sources. The LA was calculated as the TMDL minus the MOS minus the construction and industrial stormwater WLAs.

Natural background conditions were also evaluated, where possible, within the modeling and source assessment portion of this study (Section 3.3.1.1). Natural background sources are implicitly included in the LA portion of the TMDL table, and reductions should focus on the major human-attributed sources identified in the source assessment.

4.5.4 Percent reduction

The estimated percent reduction provides a rough approximation of the overall reduction needed for the water body to meet the water quality standard. The percent reduction is a means to capture the level of effort needed to reduce TSS concentrations in the watershed. The percent reduction should not be construed to mean that each of the separate sources listed in the TMDL table needs to be reduced by that amount.

The existing concentration was calculated as the 90^{th} percentile of observed TSS concentrations. The 90^{th} percentile was used because the TSS standard states that the numeric criterion (10 mg/L) may be exceeded for no more than 10% of the time. The percent reduction needed to meet the TSS standard was calculated as the 90^{th} percentile concentration minus the TSS standard (10 mg/L) divided by the 90^{th} percentile concentration. The calculation approximates the reduction in *concentration* (as opposed to load) needed to meet the standard overall, aggregated across all flow conditions.

4.5.5 TMDL summary

The TSS standard was exceeded primarily under middle to very high flows (Figure 15). To meet the standard, the TSS concentrations in the Blackduck River need to be reduced by approximately 64% (Table 10).

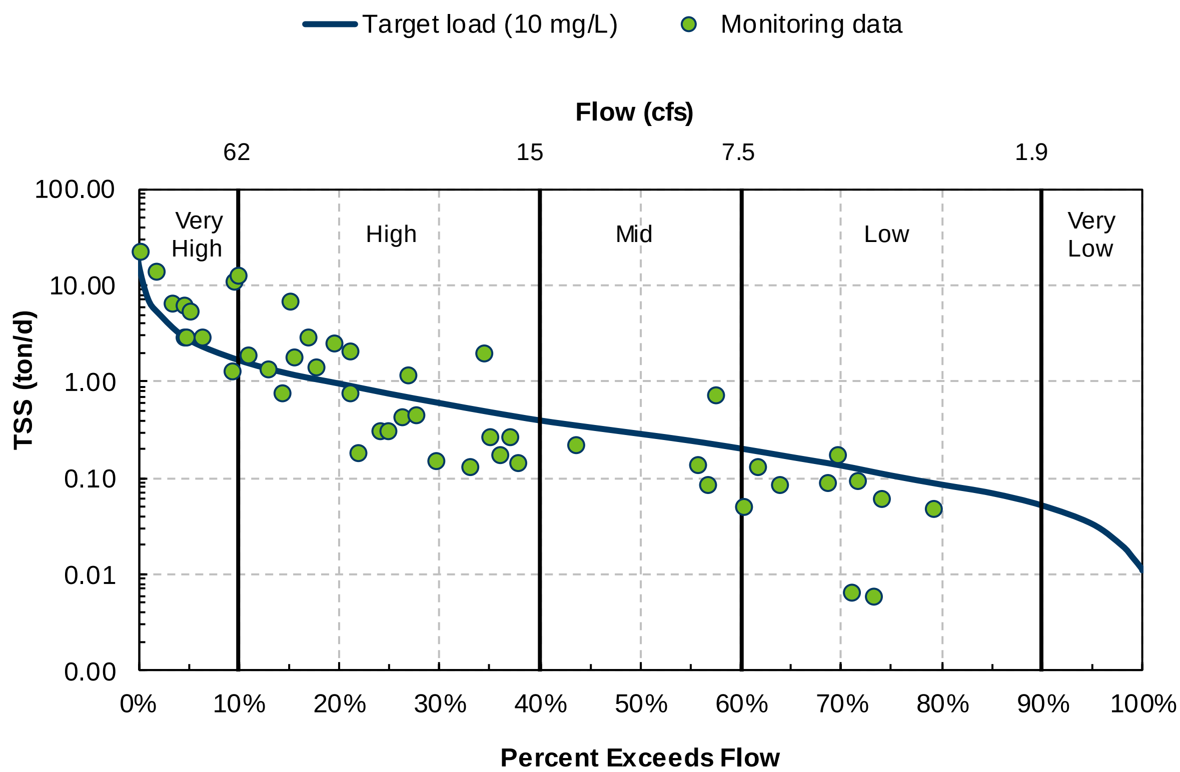

Figure 15. TSS load duration curve, Blackduck River (09030001-820)

Table 10. TSS TMDL summary, Blackduck River (09030001-820)

- Listing year: 2018
- Baseline year(s): 2015
- Numeric standard used to calculate TMDL: 10 mg/L TSS
- TMDL and allocations apply April-September

		TSS load (tons/day)				
TMDL parameter		**Very High (62-1,008 cfs)**	**High (15-62 cfs)**	**Mid (7.5-15 cfs)**	**Low (1.9-7.5 cfs)**	**Very Low (0.4-1.9 cfs)**
WLA	Construction stormwater	0.00048	0.00013	0.000050	0.000019	0.0000058
	Industrial stormwater	0.00048	0.00013	0.000050	0.000019	0.0000058
	Total WLA	0.00096	0.00026	0.00010	0.000038	0.000012
LA	**Total LA**	2.4	0.67	0.25	0.099	0.030
MOS		0.27	0.074	0.028	0.011	0.0033
Total load		2.7	0.74	0.28	0.11	0.033
Existing 90th percentile concentration (mg/L)		28				
Overall estimated percent reduction		64%				

Loads are rounded to two significant digits.

4.6 E. coli

4.6.1 Wasteload allocation methodology

There are no existing or known future NPDES-permitted *E. coli* sources in the Blackduck River Watershed, and therefore WLAs were not assigned in the *E. coli* TMDL.

WLAs for regulated construction stormwater (MNR100001) are not developed in Minnesota because *E. coli* is not a typical pollutant from construction sites. Industrial stormwater receives a WLA only if the pollutant is part of benchmark monitoring for an industrial site in the watershed of an impaired water body. There are currently no NPDES-permitted industrial stormwater sites in the Blackduck River Watershed. There are no fecal bacteria or *E. coli* benchmarks associated with the industrial stormwater general permit (MNR050000), and therefore industrial stormwater *E. coli* WLAs were not assigned for future permitted sources.

4.6.2 Loading capacity methodology

The loading capacity was calculated as simulated flow at the downstream end of the impaired reach multiplied by the *E. coli* monthly geometric mean standard (126 org / 100 mL). Loading capacities were calculated across the entire spectrum of flows in the stream through the use of a load duration curve.

4.6.3 Load allocation methodology

The LA is allocated to existing or future nonpermitted pollutant sources. The LA was calculated as the TMDL minus the MOS.

Natural background conditions were also evaluated, where possible, within the modeling and source assessment portion of this study (Section 3.3.2.1). Natural background sources are implicitly included in the LA portion of the TMDL tables, and reductions should focus on the major human-attributed sources identified in the source assessment.

4.6.4 Percent reduction

The estimated percent reduction provides a rough approximation of the overall reduction needed for the water body to meet the water quality standard. The percent reduction is a means to capture the level of effort needed to reduce *E. coli* concentrations in the watershed. The percent reduction should not be construed to mean that each of the separate sources listed in the TMDL table needs to be reduced by that amount.

The existing concentration was calculated as the maximum monthly observed geometric mean *E. coli* concentration. The percent reduction needed to meet the standard was calculated as the maximum monthly observed geometric mean concentration minus the geometric mean standard (126 org/100 mL) divided by the maximum monthly observed geometric mean concentration. By using the highest observed monthly geometric mean, the percent reduction calculation approximates the reduction in *concentration* (as opposed to load) needed to meet the monthly geometric mean standard overall, aggregated across all flow conditions.

4.6.5 TMDL summary

E. coli concentrations are high across all flow regimes that were monitored (Figure 16). To meet the standard, the *E. coli* concentrations in the Blackduck River need to be reduced by approximately 71% (Table 11). All reductions need to be made by nonpermitted sources as there are no known permitted sources of *E. coli* within the watershed.

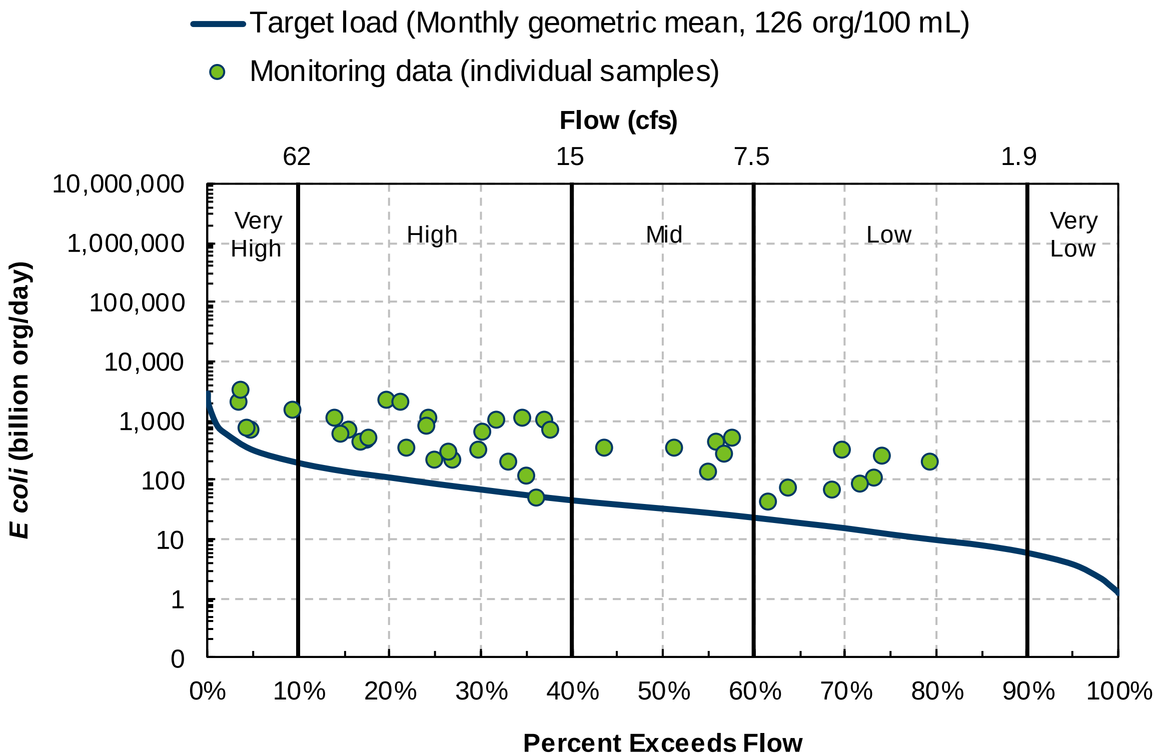

Figure 16. *E. coli* load duration curve, Blackduck River (09030001-820)

Table 11. *E. coli* TMDL summary, Blackduck River (09030001-820)

- Listing year: 2018
- Baseline year(s): 2015
- Numeric standard used to calculate TMDL: 126 org *E. coli* / 100 mL
- TMDL and allocations apply April-October

	***E. coli* load (B org/day [a])**				
TMDL parameter	**Very High (62-1,008 cfs)**	**High (15-62 cfs)**	**Mid (7.5-15 cfs)**	**Low (1.9-7.5 cfs)**	**Very Low (0.4-1.9 cfs)**
Total LA	279	76	30	11	3.4
MOS	31	8.5	3.3	1.2	0.38
Total load	310	85	33	12	3.8
Maximum observed monthly geometric mean (org / 100 mL)	440				
Overall estimated percent reduction	71%				

a. B org/day = billion organisms per day

Loads are rounded to two significant digits, except in the case of values greater than 100, which are rounded to the nearest whole number.

5. Future growth considerations

Land use in the watershed is predominantly forested, with private residences and small resorts dispersed throughout. St. Louis County is projected to decrease in population by 2.5% by year 2050 (Minnesota State Demographic Center 2017), and a substantial increase in population in the Blackduck River Watershed is not expected. While development has slowed and is projected to decrease on average, the St. Louis County, Minnesota 2010 through 2020 Water Plan reports that development near lakes, rivers, and streams in the county increased during the last decade. The Water Plan projects that shoreland areas, especially on large popular lakes, will continue to be in demand for development.

5.1 New or expanding permitted MS4 WLA transfer process

Future transfer of watershed runoff loads in this TMDL may be necessary if any of the following scenarios occur within the project watershed boundaries.

1. One or more nonregulated municipal separate storm sewer systems (MS4s) become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.
2. Expansion of a U.S. Census Bureau Urbanized Area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an urban area at the time the TMDL was completed, but are now inside a newly expanded urban area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
3. A new MS4 or other stormwater-related point source is identified and is covered under an NPDES/SDS permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL. Loads will be transferred on a simple land-area basis. In cases where an allocation is transferred to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

5.2 New or expanding wastewater

The MPCA, in coordination with the EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to water bodies with an EPA approved TMDL for TSS or *E. coli* (described in MPCA 2012). This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target and will ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA to comment on the permit changes based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that the new or expanded wastewater discharge is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

6. Reasonable assurance

A TMDL requires reasonable assurance that pollutant reduction targets will be achieved. Pollutant reduction needs in the Blackduck River Watershed are primarily from nonpermitted sources. There is "reasonable assurance" that elements are in place, for both permitted and nonpermitted sources, that are making (or will make) progress toward needed pollutant reductions. Restoration of the Blackduck River will occur as part of local, regional, state, and federal efforts and will be led as appropriate by St. Louis County, North St. Louis Soil and Water Conservation District (SWCD), state and federal agencies, nonprofit organizations, and residents.

6.1 Reduction of permitted sources

TMDL implementation from permitted sources will consist of permit compliance as explained below. Although there are currently no active construction or industrial stormwater permits in the Blackduck River Watershed, the permits for these sources provide reasonable assurances for the TSS TMDL in the event that sites are permitted in the future.

6.1.1 Permitted construction stormwater

Regulated construction stormwater was given a categorical WLA is this study. Construction activities disturbing one acre or more are required to obtain NPDES/SDS permit coverage through the MPCA. Compliance with TMDL requirements are assumed when a construction site owner/operator meets the conditions of the Construction General Permit and properly selects, installs, and maintains all BMPs required under the permit, including any applicable additional BMPs required in Section 23 of the Construction General Permit for discharges to impaired waters, or compliance with local construction stormwater requirements if they are more restrictive than those in the State General Permit.

6.1.2 Permitted industrial stormwater

Industrial stormwater was given a categorical WLA in this study. Industrial activities require permit coverage under the state's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or NPDES/SDS Nonmetallic Mining/Associated Activities General Permit (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS permit and properly selects, installs, and maintains BMPs sufficient to meet the benchmark values in the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL report.

6.2 Reduction of nonpermitted sources

Several nonpermitted reduction programs exist to support implementation of nonpoint source reduction BMPs in the Blackduck River Watershed. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or dedicated funding. The following examples describe large-scale programs that have proven to be effective and/or will reduce pollutant loads going forward.

6.2.1 SSTS program

SSTSs are regulated through Minn. Stat. §§ 115.55 and 115.56. SSTS specific rule requirements can be found in Minn. R. 7080 through 7083. Regulations include the following:

- Minimum technical standards for design and installation of individual and mid-size SSTS
- A framework for local units of government to administer SSTS programs
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee
- Various ordinances for SSTS installation, maintenance, and inspection

Each county maintains an SSTS ordinance, in accordance with Minn. Stat. and Minn. R., establishing minimum requirements for regulation of SSTS, for the treatment and dispersal of sewage within the applicable jurisdiction of the county, to protect public health and safety, to protect groundwater quality, and to prevent or eliminate the development of public nuisances. Ordinances serve the best interests of the county's citizens by protecting health, safety, general welfare, and natural resources. In addition, each county zoning ordinance prescribes the technical standards that on-site septic systems are required to meet for compliance and outlines the requirements for the upgrade of systems found not to be in compliance. This includes systems subject to inspection at transfer of property, upon the addition of living space that includes a bedroom and/or a bathroom, and at discovery of the failure of an existing system. Since 2002, St. Louis County has, on average, replaced over 350 systems per year (Figure 17).

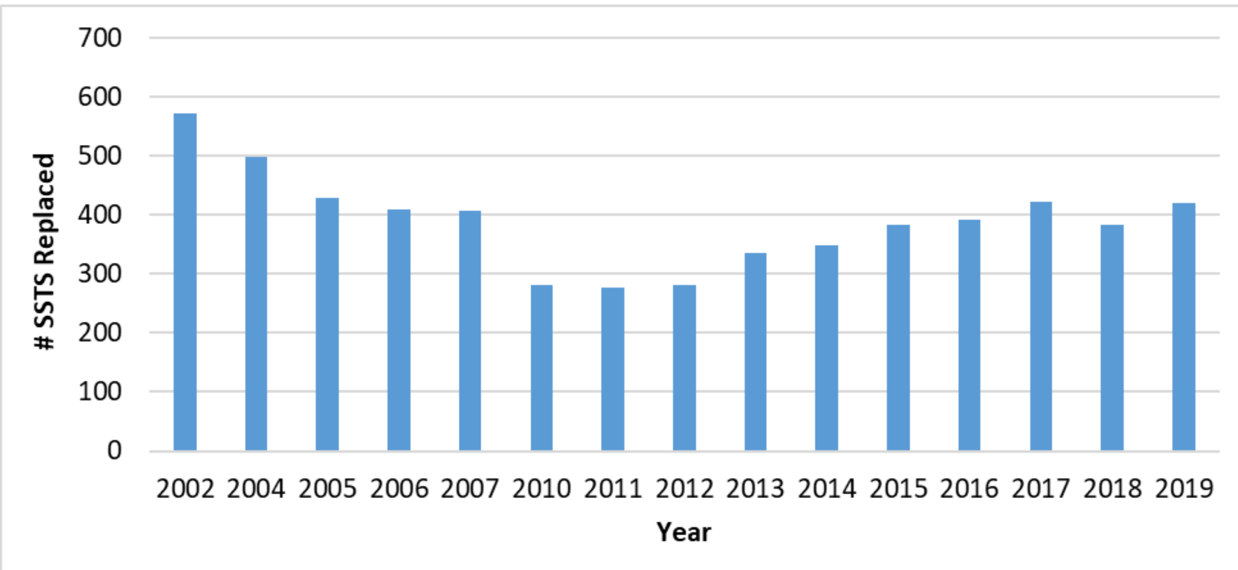

Figure 17. SSTS replacements in St. Louis County by year

Data not reported on replacements in 2003, 2008, and 2009

All known ITPHS septic systems are recorded in a statewide database by the MPCA. From 2006 to 2019, 797 alleged straight pipes were tracked by the MPCA statewide, 765 of which were abandoned, fixed, or were found not to be a straight pipe system. The remaining known, unfixed, straight pipe systems have received a notice of noncompliance and are currently within the 10-month deadline to be fixed, have been issued Administrative Penalty Orders, or are docketed in court. The MPCA, through the Clean Water Partnership Loan Program, has awarded over $157,400 to St. Louis County to provide low interest loans for SSTS upgrades since 1998. More information on SSTS financial assistance can be found at the MPCA's SSTS financial assistance webpage: https://www.pca.state.mn.us/water/ssts-financial-assistance.

6.2.2 Minnesota buffer law

Minnesota's buffer law (Minn. Stat. § 103F.48) requires perennial vegetative buffers of up to 50 feet along lakes, rivers, and streams and buffers of 16.5 feet along ditches. These buffers help filter out phosphorus, nitrogen, and sediment. Alternative practices are allowed in place of a perennial buffer in some cases. Amendments enacted in 2017 clarify the application of the buffer requirement to public waters, provide additional statutory authority for alternative practices, address concerns over the potential spread of invasive species through buffer establishment, establish a riparian protection aid program to fund local government buffer law enforcement and implementation, and allowed landowners to be granted a compliance waiver until July 1, 2018, when they filed a compliance plan with the appropriate SWCD.

The Board of Water and Soil Resources (BWSR) provides oversight of the buffer program, which is primarily administered at the local level. Compliance with the buffer law ranges from 94% to 100% in St. Louis County as of March 2021 (data available on BWSR website under Buffer Program Update). Review of stream corridors using aerial imagery indicates near 100% compliance with the buffer law in the Blackduck River Watershed.

6.2.3 St. Louis County shore setback and shore impact zone requirements

The Zoning Ordinance of St. Louis County, Minnesota (2016) restricts development within a set distance from the shoreline of rivers, streams, and lakes and restricts vegetative removal within set shore and bluff impact zones. The requirements apply to protected rivers, streams, and lakes or waters designated through county adopted land use plans. Setback and shore impact zone distances are specific to the classification of the water body as outlined in the ordinance.

6.2.4 Minnesota Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. Those who implement and maintain approved farm management practices will be certified and, in turn, obtain regulatory certainty for a period of 10 years.

Through this program, certified producers receive:

- Regulatory certainty: certified producers are deemed to be in compliance with any new water quality rules or laws during the period of certification
- Recognition: certified producers may use their status to promote their business as protective of water quality
- Priority for technical assistance: producers seeking certification can obtain specially designated technical and financial assistance to implement practices that promote water quality

6.2.5 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion and sedimentation, improved or created wildlife habitat, and mitigation against increasing weather volatility. Through EQIP, the NRCS provides agricultural producers with financial resources and one-on-one help to plan and implement conservation practices. This program could help support implementation efforts to address nonpoint sources of sediment and *E. coli* suggested in Section 8.2.

6.2.6 Sustainable Forest Incentive Act

The Sustainable Forest Incentive Act (SFIA) is a voluntary program that provides incentive payments to encourage sustainable use of forest lands to property owners with qualifying lands. Property owners can receive a payment for each acre of qualifying forest land they enroll. In return, the land cannot be developed and must have a forest management plan. All enrolled land must remain in SFIA for at least 8, 20, or 50 years depending on the agreement. Descriptions of qualifying properties can be found at the following address: https://www.revenue.state.mn.us/sustainable-forest-incentive-act.

6.2.7 Minnesota Nutrient Reduction Strategy

Suspended solids in streams are carriers of nutrients, especially phosphorus; therefore, many nutrient reduction strategies also reduce suspended solids. The Minnesota Nutrient Reduction Strategy (MPCA 2014) guides activities that support nitrogen and phosphorus reductions in Minnesota water bodies and those water bodies downstream of the state (e.g., Lake Winnipeg, Lake Superior, and the Gulf of Mexico). The Nutrient Reduction Strategy was developed by an interagency coordination team with help from public input. Fundamental elements of the Nutrient Reduction Strategy include:

- Defining progress with clear goals
- Building on current strategies and success
- Prioritizing problems and solutions
- Supporting local planning and implementation
- Improving tracking and accountability

Included within the strategy discussion are alternatives and tools for consideration by drainage authorities, information on available tools and approaches for identifying areas of phosphorus and nitrogen loading and tracking efforts within a watershed, and additional research priorities. The Nutrient Reduction Strategy is focused on incremental progress and provides meaningful and achievable nutrient load reduction milestones that allow for better understanding of incremental and adaptive progress toward final goals. The strategy has set a reduction of 10% for phosphorus and 13% for nitrogen in the Lake Winnipeg basin (relative to 2003 conditions).

Successful implementation of the Nutrient Reduction Strategy will require broad support, coordination, and collaboration among agencies, academia, local government, and private industry. The MPCA is implementing a framework to integrate its water quality management programs on a major watershed scale, a process that includes:

- IWM
- Assessment of watershed health
- Development of WRAPS reports

- Management of NPDES and other regulatory and assistance programs

This framework will result in nutrient reduction for the basin as a whole and the major watersheds within the basin.

6.2.8 Conservation easements

Conservation easements are a critical component of the state's efforts to improve water quality by reducing soil erosion, reducing phosphorus and nitrogen loading, and improving wildlife habitat and flood attenuation on private lands. Easements protect the state's water and soil resources by permanently restoring wetlands, adjacent native grassland wildlife habitat complexes, and permanent riparian buffers. In cooperation with county SWCDs, BWSR's programs compensate landowners for granting conservation easements and establishing native vegetation habitat on economically marginal, flood-prone, environmentally sensitive, or highly erodible lands. These easements vary in length of time from 10 years to permanent/perpetual easements. Types of conservation easements in Minnesota include Conservation Reserve Program (CRP), Reinvest in Minnesota (RIM), and the Wetland Reserve Program (WRP) or Permanent Wetland Preserve (PWP).

6.3 Summary of local plans

Minnesota has a long history of water management by local government, which included developing water management plans along county boundaries since the 1980s. The BWSR-led One Watershed, One Plan (1W1P) program is rooted in work initiated by the Local Government Water Roundtable (Association of Minnesota Counties, Minnesota Association of Watershed Districts, and Minnesota Association of SWCDs). The Roundtable recommended that local governments organize to develop focused implementation plans based on watershed boundaries. That recommendation was followed by the legislation (Minn. Stat. § 103B.801) that established the 1W1P program, which provides policy, guidance, and support for developing comprehensive watershed management plans:

- Align local water planning purposes and procedures on watershed boundaries to create a systematic, watershed-wide, science-based approach to watershed management.
- Acknowledge and build off of existing local government structure, water plan services, and local capacity.
- Incorporate and make use of data and information, including WRAPS.
- Solicit input and engage experts from agencies, citizens, and stakeholder groups; focus on implementation of prioritized and targeted actions capable of achieving measurable progress.
- Serve as a substitute for a comprehensive plan, local water management plan, or watershed management plan developed or amended, approved, and adopted.

St. Louis County has decided to participate in the 1W1P process and intends to begin planning within the next several years. The Blackduck River Watershed will be incorporated into the 1W1P for the combined Vermilion River and Rainy River–Rainy Lake HUC-8 watersheds. The 1W1P process considers the Blackduck River Watershed to be part of the Rainy River–Rainy Lake Watershed; see Section 1.1 and Figure 1. The 1W1P planning boundaries are found at the following link:

https://bwsr.state.mn.us/one-watershed-one-plan-participating-watersheds.

Until the completion of a comprehensive watershed management plan that incorporates the Blackduck River Watershed, the St. Louis County Water Plan (2010 through 2020) remains in effect per the Comprehensive Local Water Management Act (Minn. Stat. § 103B.301). The plan expiration date may be extended pending future participation in the 1W1P program. Restoring waters in the county listed as "impaired" on the state's 303(d) list of impaired waters is a priority concern addressed in the current water plan. Action items to address impaired waters include developing protection and restoration strategies, and implementing projects and actions directed at reducing sources of nonpoint pollution. Reduction of nonpoint pollution is also addressed in the St. Louis County Comprehensive Land Use Plan, which includes actionable language that addresses wastewater issues related to failing septic systems and the protection of lakes and watercourses through setbacks/buffering.

6.4 Examples of pollution reduction efforts

Agencies, organizations, and landowners in the Blackduck River Watershed have been collaborating in water quality improvement planning. Several water quality and stream habitat projects have been implemented to directly or indirectly reduce pollutant loading in the watershed, and similar efforts are expected to continue into the future.

- In 2007, the United States Forest Service (USFS) led a road washout remediation project on a tributary to Fawn Creek. Downstream sediment deposited by the washout was removed, and the new crossing was designed to restore channel and riverine corridor hydraulics, which supports natural sediment transport.
- Between 2016 and 2020, there has been an on-going effort to communicate water quality and stream restoration and protection efforts in the Rainy River–Headwaters Watershed, including the Blackduck River Watershed. These include no less than two public meetings and eight watershed project team meetings consisting of regional natural resource professionals at the local, county, state, and federal government levels.
- Between 2017 and 2018, North St. Louis SWCD and Vermilion Community College of Ely surveyed culverts in the Blackduck River Watershed, identifying potential impacts on streambank erosion, stream stability, and sediment transport.
- In 2017 to present, North St. Louis SWCD has been in regular communication with the landowner of the ranch, providing information on stream water quality and technical assistance programs such as MAWQCP, SFIA, and EQIP and establishing the foundational relationship necessary for successful implementation of such programs
- In 2019, North St. Louis SWCD led a tree-planting effort that resulted in over 1,000 additional trees, all conifer species, in the riparian corridor of Fawn Creek, funded through the Conservation Partners Legacy Grant Program.

6.5 Funding

Funding sources to implement TMDLs can come from local, state, federal, and/or private sources. Examples include BWSR's Watershed-based Implementation Funding, Clean Water Fund Competitive Grants (e.g., Projects and Practices), USFS, and conservation funds from NRCS (e.g., EQIP and Conservation Stewardship Program).

Watershed-based implementation funding is a noncompetitive process to fund water quality improvement and protection projects for lakes, rivers/streams, and groundwater. This funding allows collaborating local governments to pursue timely solutions based on a watershed's highest priority needs. The approach depends on the completion of a comprehensive watershed management plan developed under the 1W1P program or the Metropolitan Surface Water framework to provide assurance that actions are prioritized, targeted, and measurable.

BWSR has begun the transition of moving toward watershed-based implementation funding to accelerate water management outcomes, enhance accountability, and improve consistency and efficiency across the state. This approach allows more clean water projects to be implemented and helps local governments spend limited resources where they are most needed.

Watershed-based implementation funding assurance measures are based on fiscal integrity and accountability for achieving measurable progress towards water quality elements of comprehensive watershed management plans. Assurance measures will be used as a means to help grantees meaningfully assess, track, and describe use of these grant funds to achieve clean water goals through prioritized, targeted, and measurable implementation. The following assurance measures are supplemental to existing reporting and on-going grant monitoring efforts:

- Understand contributions of prioritized, targeted, and measurable work in achieving clean water goals.
- Review progress of programs, projects, and practices implemented in identified priority areas.
- Complete Clean Water Fund grant work on-schedule and on-budget.
- Leverage funds beyond the state grant.

6.6 Other partners and organizations

The Natural Resource and Water Management program at Vermilion Community College of Ely, Minnesota has been engaged in water quality and watershed data collection efforts in the Blackduck River Watershed since 2016. Their efforts were a key contributor to the data presented in this TMDL.

6.7 Reasonable assurance conclusion

In summary, significant time and resources have been devoted to identifying pollutant sources and the best BMPs, providing means of focusing them in the Blackduck River Watershed, and supporting their implementation via state initiatives and dedicated funding. The Rainy River–Headwaters Watershed WRAPS and TMDL process engaged partners to arrive at reasonable examples of BMP combinations that attain pollutant reduction goals in the Blackduck River Watershed. Minnesota is a leader in watershed planning as well as monitoring and tracking progress toward water quality goals and pollutant load reductions.

7. Monitoring

Monitoring in the Blackduck River Watershed is expected to occur through the following programs:

- **Monitoring approach**: IWM at the HUC-8 watershed scale is part of the MPCA's watershed approach to restoring and protecting water quality. Monitoring occurs in each HUC-8 watershed approximately every 10 years and consists of a 2-year intensive monitoring program of lakes and streams in which the MPCA determines their overall health and identifies impaired waters. The next round of IWM in the Rainy River–Headwaters Watershed is expected to begin in approximately 2024–2025.
- **Citizen water monitoring**: The MPCA coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Blackduck Lake is currently monitored through the CLMP, and the CSMP has identified a site on the Blackduck River as a high priority site in need of a citizen monitor. Having citizen volunteers monitor a given lake or stream station monthly and from year to year can provide long-term data needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years.
- **Other monitoring**: Other monitoring is important to determine the effectiveness of implementation activities and to delist waters that are no longer impaired in the Blackduck River Watershed. Continued monitoring is also important to determine when a change in management is needed. If BMPs are failing to make improvements in TSS and/or *E. coli* loading, additional monitoring of sources (e.g., naturalized *E. coli* sourcing) that are not currently well understood may be needed. This additional monitoring is not mandatory and will be dependent on availability of resources and local monitoring priorities.

8. Implementation strategy summary

This section summarizes implementation strategies that could be used to help achieve the Blackduck River TMDL.

8.1 Permitted sources

8.1.1 Construction stormwater

The WLA for stormwater discharges from sites where there is construction activity reflects the potential number of construction sites greater than one acre expected to be active in the watershed at any one time, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at construction sites are defined in Minnesota's NPDES/SDS General Stormwater Permit for Construction Activity (MNR100001). If a construction site owner/operator obtains coverage under the NPDES/SDS General Stormwater Permit and properly selects, installs, and maintains all BMPs required under the permit, including those related to impaired waters discharges and any applicable additional requirements found in Appendix A of the Construction General Permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Construction activity must also meet all local government construction stormwater requirements.

8.1.2 Industrial stormwater

The WLA for stormwater discharges from sites where there is industrial activity reflects the potential number of sites in the watershed for which NPDES/SDS Industrial Stormwater Permit coverage is required, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at the industrial sites are defined in Minnesota's NPDES/SDS Industrial Stormwater Multi- Sector General Permit (MNR050000) or NPDES/SDS General Permit for Construction Sand and Gravel, Rock Quarrying and Hot Mix Asphalt Production facilities (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS Permit and properly selects, installs, and maintains all BMPs required under the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Industrial activity must also meet all local government construction stormwater requirements.

8.2 Nonpermitted sources

WRAPS for the Blackduck River Watershed, a subwatershed of the Rainy River–Headwaters Watershed, were developed as part of the MPCA's watershed approach to restoring and protecting water quality (MPCA 2021). A core team of regional resource professionals guided the selection of appropriate strategies that will steer future implementation planning to protect high quality waters and restore impaired waters. Nonpermitted sources of sediment and *E. coli* in the Blackduck River Watershed are identified in the source assessments for TSS (Section 3.3.1.1) and *E. coli* (Section 3.3.2.1) of this report. The assessment unit used by the MPCA extends the entire length of the Blackduck River, from Blackduck Lake to the Ash River, and therefore the entire Blackduck River is identified as impaired. However, high concentrations of TSS and *E. coli* were observed only in portions of the reach, and the recommended implementation strategies address the sources that lead to impairment in these focus areas.

The following list of activities are recommended to address nonpoint sources of sediment in the watershed:

- **Streambank stabilization and channel restoration (TSS strategy)**

  Implement restoration activities to address stream bank erosion and stream instability. Consider remeandering the stream channel and reconnecting it to the floodplain in the unstable channelized reach. Ensure restoration activities take a comprehensive approach to addressing stream function and form, are protective of existing infrastructure, produce minimal disturbance to existing vegetation, and are designed by a certified engineer.

- **Pasture and grazing management guidance (TSS and *E. coli* strategy)**

  Work with the landowner of the ranch to promote and develop a pasture and grazing management plan that benefits the pasture environment and stream ecosystem and reduces pollutant sources to the Blackduck River and its tributaries. Encourage the use of barriers that limit or exclude the animals from entering surface water bodies, and encourage vegetative buffers along waterways that include un-grazed native grasses, forbs, trees, and shrubs. Connect the landowner of the ranch with NRCS programs such as EQIP to provide funding for BMP implementation including installation of an alternative water source for livestock. Coordinate with other state and local experts such as the Sustainable Farming Association of Minnesota to maximize environmental and landowner benefits.

- **Forest management guidance (TSS strategy)**

  Encourage adherence to State Forest Management Guidelines and forestry practices that are protective of the stream riparian and water quality. Work with private land owners to develop Forest Stewardship Plans. Emphasize long-lived conifers in critical riparian locations of the watershed and climate change resiliency in species selection. Encourage private and public (intra-agency) communications and collaboration to reduce, or at a minimum prevent an increase in, open lands in the watershed.

- **Culvert guidance (TSS strategy)**

  A culvert inventory was completed for the watershed through a multi-agency effort administered by the DNR. These data have been imported into the DNR's culvert inventory database. Several culverts were identified as being barriers for fish passage and/or contributing to stream bank and channel erosion. Review the inventory data and work with road management entities, both public and private, to prioritize and upgrade culverts with consideration of climate change resiliency in infrastructure design.

- **Roadway, motorized trail, and ditch maintenance guidance (TSS strategy)**

  Assess and prioritize roadways and motorized trails within the watershed for gullying, erosion, and pollutant runoff. Assess the state of existing roadside ditches and identify priority locations for ditch management (e.g., re-vegetation, armoring). Encourage roadway and motorized trail design and management practices that are protective of water quality including low maintenance roads. Develop and implement guidance for public and private road ditch maintenance to minimize un-vegetated channels and associated erosion.

- **Remnant railroad piling removal and rail grade/bank stabilization (TSS strategy)**

  Inventory in-stream railroad pilings and sections of the old railroad grade that abut the stream channel. Prioritize areas for restoration that negatively impact aquatic life and/or water quality and/or show signs of streambank erosion, sedimentation, and channel instability. Research piling removal methods and removal process impacts on stream stability. Ensure all historic preservation requirements are met ahead of implementation. Develop recommendations and communicate findings to public and private landowners. Upon future approval of all-terrain vehicle use proposed for sections of the David Dill/Arrowhead Trail, former railroad-stream crossings within the state trail section should be designed to meet permit standards and be protective of stream health and stability.

- **Septic system inventory and upgrades (*E. coli* strategy)**

  Conduct an inventory of SSTS in the Blackduck River Watershed for systems with unknown status, identifying total number of systems and compliance status. Prioritize SSTS according to compliance status; identify all ITPHS systems as high priority for maintenance and replacement. Work with private landowners to achieve compliance.

- **Education and outreach (TSS and *E. coli* strategy)**

  Provide education and outreach for pollutant-reduction activities. Assist private landowners in forest management, pasture management, and grazing planning. Provide information or hands-on workshops to landowners on forest and pasture management activities as well as stream crossing, road, ditch, beaver dam, and stream habitat management.

8.3 Cost

TMDLs are required to include an overall approximation of implementation costs (Minn. Stat. 114D.25). The costs to implement the activities outlined in the strategy are approximately $900,000 to $2,200,000 over the next 10 years and address nonpermitted sources. The cost estimate is based on historical project costs, estimated costs in the Scenario Application Manager (SAM) v2.0 BMP database, and best professional judgement. The cost estimate includes pasture and livestock management BMPs, streambank/in-channel restoration, piling removal, and increasing local capacity to oversee implementation in the watershed and the voluntary actions needed to achieve necessary TMDL reductions.

Incentive payments for Forest Stewardship programs are not included in the cost estimate, nor are road/trail construction, culvert upgrades, and SSTS maintenance and upgrades. Upgrading roadways and culverts is assumed to be part of regular road construction activities. Replacement of ITPHS systems and SSTS maintenance were not considered in the overall cost calculation because their costs are already accounted for in existing programs. In-channel piling removal cost estimates assume that 60% of the old railroad crossings may not be contributing to TSS loading to the stream or impacting natural channel function. The amount of lands in the Blackduck River Watershed that are eligible to enroll in Forest stewardship programs and the level of landowner interest in enrollment are currently unknown. This can be addressed by increasing local capacity, as also can culvert and road inventory and prioritization, ditch maintenance guidance, and education and outreach.

8.4 Adaptive management

This list of implementation elements and the more detailed WRAPS report (MPCA 2021) focuses on adaptive management (Figure 18). Continued monitoring and “course corrections” responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the Blackduck River impairments.

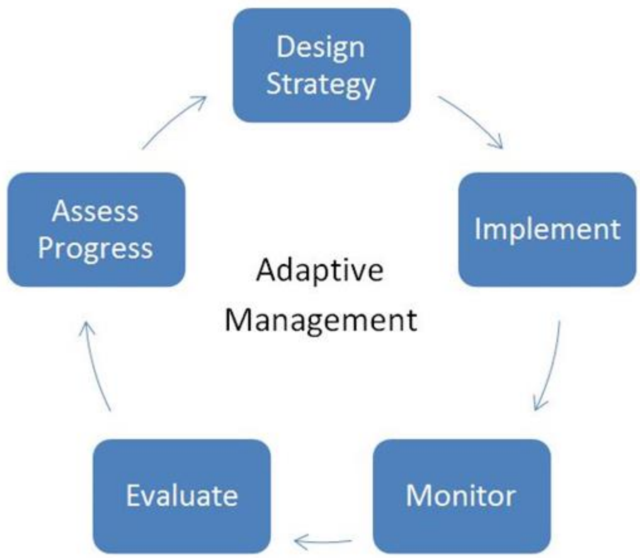

Figure 18. Adaptive management

9. Public participation

Two public stakeholder meetings were held as part of the Rainy River–Headwaters WRAPS process. The meetings were offered in two different locations, Orr and Ely, to provide access to the communities nearest to the impaired waters and to the largest population center in the Rainy River–Headwaters Watershed.

The meetings provided an overview of the MPCA's watershed approach, details on exceptional use waters and impairments within the Rainy River–Headwaters Watershed, and an introduction to WRAPS. After a presentation, participants asked questions about the process and shared concerns about protecting the Rainy River–Headwaters Watershed. The Blackduck River impairment was discussed at these meetings alongside the water quality in the rest of the Rainy River–Headwaters Watershed. Concern was expressed by some anglers on the impact of elevated suspended sediment to trout within the Blackduck River system with a focus on Fawn Creek, which is stocked with trout.

Meetings were held on the following dates:

- Orr, Minnesota: November 13, 2017
- Ely, Minnesota: November 16, 2017

In addition to the public meetings, a presentation on the Blackduck and Ash River system impairments and problem investigation was made to Rainy Basin resource professionals at the 2018 International Rainy–Lake of the Woods Watershed Forum in International Falls.

A core team of regional resource professionals met 10 times between 2014 and 2020 to provide their professional judgement on water quality issues within the watershed and provide guidance to WRAPS and TMDL development. This core team included representatives from various entities:

- North Saint Louis SWCD
- Lake County SWCD Cook County SWCD
- Minnesota DNR
- 1854 Treaty Authority
- MPCA
- Minnesota BWSR
- Minnesota Department of Health
- USFS
- National Park Service

Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from August 30, 2021 through October 29, 2021. The TMDL Report was noticed alongside a corresponding WRAPS Report. Three comment letters, which referenced both the WRAPS and TMDL were received and responded to as a result of the public comment period. Most concerns were based on protection and were addressed in the WRAPS Report. Each comment was responded to individually.

Responses to comments identified changes made to the two reports, based on that comment. Comments focused on non-ferrous metallic mining issues including discussion of conductivity impacts to aquatic life and mercury methylation by sulfate. Additional text was added to the TMDL Report to provide more context on how the MPCA is approaching mercury methylation within aquatic consumption TMDLs.

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