Fecal Coliform TMDL Assessment for High Island Creek and Rush River

Submitted by:

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Minnesota State University, Mankato
&
Sibley County

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		Page #:
Waterbody ID	**High Island Creek Watershed** Buffalo Creek: Unnamed Cr to High Island Cr — Fecal coliform — 07020012-578 Buffalo Creek/County Ditch 59: High Island Ditch 5 to Unnamed Stream — Fecal coliform — 07020012-598 High Island Creek: JD 15 to Unnamed Cr — Fecal coliform — 07020012-535 High Island Creek: Unnamed Cr to Minnesota R — Fecal coliform — 07020012-589 High Island Creek Ditch 2: Unnamed Cr to High Island Cr — Fecal coliform — 07020012-588 **Rush River Watershed** Rush River, South Branch: Unnamed Ditch to Rush R — Fecal coliform — 07020012-553 Rush River: S Br Rush R to Minnesota R — Fecal coliform — 07020012-521	2
Location	The High Island Creek and Rush River watersheds are located in the Lower Minnesota watershed in south central Minnesota. The watersheds are located across 410,000 acres in portions of McLeod, Nicollet, Renville and Sibley Counties. High Island Creek and the Rush River outlet into the Minnesota River near Henderson, Minnesota.	1,2
303(d) Listing Information	The MPCA's projected schedule for TMDL completions, as indicated on Minnesota's 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL. Reaches addressed by this project were scheduled to begin between 2002 and 2006 and completed between 2008 and 2009. The impaired reach watersheds include all of High Island Creek and Rush River Watersheds covering a total of 410,997 acres (642 square mile) across portions of Renville, McLeod, Sibley and Nicollet Counties. Four upstream reaches of High Island Creek are also listed as impaired for pathogens. JD 15 to Unnamed Creek is an 83,121 acre watershed located across portions of Renville, Sibley and McLeod Counties (listed in 2002). High Island Ditch 2: Unnamed Cr to High Island Cr drains 10,517 acres in Sibley County (listed in 2008). Buffalo Creek: Unnamed Creek to High Island Creek is an 18,003 acre watershed in Sibley County (listed in 2006). Buffalo Creek/County Ditch 59: High Island Ditch 5 to Unnamed Stream drains 12,350 acres in Sibley County (listed in 2006). One upstream reach of the Rush River is listed as impaired for pathogens. Rush River, South Branch: Unnamed Ditch to Rush River is a 117,918 acre watershed across Sibley and Nicollet Counties (listed in 2008).	2,4
Impairment / TMDL Pollutant(s) of Concern	Fecal coliform bacteria	4
Impaired Beneficial Use(s)	The applicable water body classifications and water quality standards are specified in Minnesota Rules Chapter 7050. Minnesota Rules Chapter 7050.0407 lists water body classifications and Chapter 7050.2222 subp. 5 list applicable water quality standards for the impaired reaches for Aquatic Recreation.	3,4
Applicable Water Quality Standards/ Numeric Targets	Minnesota Rules Chapter 7050 provides the water quality standards for Minnesota waters. The rules are as follows for Class 2B surface waters for fecal coliform bacteria: The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. Fecal coliform organisms not to exceed 200 organisms per 100 milliliters as a geometric mean of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 2000 organisms per 100 milliliters. The standard applies only between April 1 and October 31.	4,11,12

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Loading Capacity (expressed as daily load)	Flow regimes were determined for high, moist, mid-range, dry and low flow conditions. The mid-range flow value for each flow regime was then used to calculate the total monthly loading capacity (TMLC). Thus, for the "high flow" regime, the loading capacity is based on the monthly flow value at the 5th percentile. The flow used to determine loading capacity for each flow regime was multiplied by a conversion factor of 146,776,126,400. Fecal coliform TMDLs are expressed in both monthly and maximum daily terms. This is to ensure that both the monthly geometric mean and upper tenth percentile portions of the water quality standard are addressed. All maximum daily loading capacity and allocation values are set at a third the monthly loading capacity. In conceptual terms, three days of bacteria loads that approach the maximum daily capacities will "use up" most of the monthly capacity. A greater percentage of days would be considered dry; however the majority of bacterial loading to streams occurs during wet conditions.			**Page#** 21-29
Wasteload Allocation Fecal Coliform High Island Creek: Unnamed Creek to Minnesota River	**Source**		**Individual Daily WLA**	**Page #** 30-32
	CAFOs			
	Brad Baumgardt Farm Sec 2	129-103300	0	
	Tesch Farms	143-50002	0	
	Five Star Dairy LLC	143-60460	0	
	Daniel Thoele Farm	143-89168	0	
	Larry Baumgardt Farm	143-89746	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	Arlington	MN0020834	0.05	
		TOTAL	0.05	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	
Wasteload Allocation Fecal Coliform High Island Creek: JD 15 to Unnamed Creek	**Source**	**Permit #**	**Individual Daily WLA**	**Page #** 33-35
	CAFOs			
	Brad Baumgardt Farm Sec 2	129-103300	0	
	Larry Baumgardt Farm	143-89746	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	None	NA	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	

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	Source	Permit #	Individual Daily WLA	Page #
Wasteload Allocation Fecal Coliform Buffalo Creek: Unnamed Creek to High Island Creek	**CAFOs**			36-38
	Tesch Farms	143-50002	0	
	Five Star Dairy LLC	143-60460	0	
	Daniel Thoele Farm	143-89168	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	None	NA	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	
Wasteload Allocation Fecal Coliform High Island Creek: High Island Ditch 2 – Unnamed Creek to High Island Creek	**Source**	**Permit #**	**Individual Daily WLA**	**Page #**
	CAFOs			50-52
	None	NA	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	None	NA	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	
Wasteload Allocation Fecal Coliform Buffalo Creek: High Island Ditch 5 to Unnamed Stream	**Source**	**Permit #**	**Individual Daily WLA**	**Page #**
	CAFOs			39-41
	Five Star Dairy LLC	143-60460	0	
	Daniel Thoele Farm	143-89168	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	None	NA	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	
Wasteload Allocation Fecal Coliform Rush River: South Branch Rush River to Minnesota River	**Source**	**Permit #**	**Individual Daily WLA**	**Page #**
	CAFOs			42-45
	Warren Krohn Farm	103-50002	0	
	Waibel Pork Inc	103-50003	0	
	Corey Hotovec Farm	103-50007	0	
	Christensen Farms Site C016	103-50008	0	
	Josie's Pork Farm Inc - Gaylord	103-50017	0	
	Bruce & Laurie Platz Farm – Sec 10	103-97452	0	
	Duane & David Gran Farm – Sec 19B	103-97625	0	
	Adam Gleisner Farm Sec 2	103-97632	0	
	Pinpoint Research – Sec 29	103-97780	0	
	Paul and Donita Platz Farm	143-50001	0	
	MG Waldbaum – Golden Egg Farm	143-50004	0	
	Minnesota Pullets	143-50005	0	
		TOTAL	0	

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	Source	Permit #	Individual Daily WLA	Page #
Wasteload Allocation Fecal Coliform Rush River: South Branch Rush River to Minnesota River (cont)	**WWTF**			42-45
	Altona	MN0067610	0.004	
	Gaylord	MN0051209	0.167	
	Gibbon	MNG580020	0.019	
	Lafayette	MN0023876	0.007	
	Starland	MN0067334	0.002	
	Waldbaums	MN0060798	0.03	
	Winthrop	MN0051098	0.079	
		TOTAL	0.31	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
		TOTAL	0	
Wasteload Allocation Fecal Coliform Rush River: South Branch Unnamed Ditch to Rush River	**Source**	**Permit #**	**Individual Daily WLA**	**Page #**
	CAFOs			46-49
	Warren Krohn Farm	103-50002	0	
	Waibel Pork Inc	103-50003	0	
	Corey Hotovec Farm	103-50007	0	
	Christensen Farms Site CO16	103-50008	0	
	Josie’s Pork Farm Inc - Gaylord	103-50017	0	
	Bruce & Laurie Platz Farm – Sec 10	103-97452	0	
	Duane & David Gran Farm – Sec 19B	103-97625	0	
	Adam Gleisner Farm Sec 2	103-97632	0	
	Pinpoint Research – Sec 29	103-97780	0	
	Paul and Donita Platz Farm	143-50001	0	
		TOTAL	0	
	Source	**Permit #**	**Individual Daily WLA**	
	WWTF			
	Gibbon	MNG580020	0.019	
	Lafayette	MN0023876	0.007	
		TOTAL	0.026	
	Source	**Permit #**	**Individual Daily WLA**	
	Straight-Pipe Septics			
	Illegal Discharges	NA	0	
Margin of Safety	Because the allocations are a direct function of monthly flow, accounting for potential flow variability is the appropriate way to address the MOS explicitly for the fecal coliform impairments. This is done within each of five flow zones. The MOS was determined as the difference between the median flow and minimum flow in each zone.			**Page #** 53
Seasonal Variation	Monitoring data show an apparent relationship between season and fecal coliform bacteria concentration. Typically the highest bacterial concentrations are found in the summer and early fall. In the spring, concentrations are typically lower, despite the fact that significant manure application occurs during this time and that fields have little crop canopy to protect against water erosion.			18
Reasonable Assurance	The source reduction strategies detailed in the implementation plan section have been shown to be effective in reducing pathogen transport/survival. Many of the goals outlined in this TMDL study run parallel to objectives outlined in the local Water Plans. Various program and funding sources will be used to implement measures that will be detailed in an implementation plan to be completed. Through existing permit programs fecal coliform impairments are being addressed and monitored. In the future, it can be assumed that this will continue.			78

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Monitoring	A detailed monitoring plan will be included in the Implementation Plan to be completed. Currently, there are monitoring efforts in the watershed.		53
Implementation	A summary of potential management measures was included. More detail will be provided in the implementation plan.		75-77
Public Participation	Public participation opportunities were provided during the project in the form of public open houses, news releases and a project newsletter. The project worked closely with a broad array of county, state and individual stakeholders.		80
	Public Comment period:	July 21-August 20, 2008	
	Meeting location:	Gaylord, MN; Buffalo Lake, MN; Henderson, MN; Stewart, MN	
	Comments received?	Yes	

Executive Summary

The High Island Creek and Rush River Watersheds are located in the Lower Minnesota Watershed, in south central Minnesota. The watersheds are located across 410,000 acres in portions of McLeod, Nicollet, Renville and Sibley counties. High Island Creek and Rush River outlet into the Minnesota River near Henderson, Minnesota. According to the State of the Minnesota River annual reports, these rivers rank among the highest for fecal coliform bacteria concentrations in the entire Minnesota River Basin.

This document contains the TMDLs for five impaired stream reaches in the High Island Creek Watershed and two in the Rush River Watershed. These stream reaches are listed as impaired for failure to meet their swimming designated uses due to excessive fecal coliform concentrations.

Water quality data collected in both watersheds show elevated fecal coliform concentrations at all monitored stream sites. Monitoring data indicate an 80%-90% reduction in fecal coliform levels will be needed to meet surface water quality standards. The data indicate fecal coliform bacteria levels are typically the highest in the summer months of June and July, particularly during storm runoff events. The document describes the likely major contributors of fecal coliform contamination separated into two major categories - dry conditions and wet conditions. Under dry conditions, when there is limited dilution in the streams, direct or continuously discharging bacteria sources might be dominant. Under wet conditions, runoff-related sources are more important.

Applied manure and inadequately functioning septic systems appear to be the important sources of fecal coliform contamination based on source inventory assessments and water quality testing. While there is considerable uncertainty about the actual magnitude of these sources, these are the areas where increased focus would seem to have the most potential for water quality improvements. While there is existing state and local regulatory authority related to both septic systems, and land application of manure, research, education, and the promotion of voluntary BMPs will be the primary means to address the water quality impairments.

While pollutant runoff from urban landscapes can be as great or greater than that from agricultural areas, only about two percent of the land area of the Rush and High Island watersheds are in commercial, industrial and residential use. As such, the overall contribution of bacteria from other land use is believed to be relatively small. In addition, the sewage treatment for the cities and towns in the watersheds includes disinfection which results in the discharge of treated wastewater with very low bacteria levels. Livestock manure represents nearly 99% of the fecal matter produced in each watershed. The vast majority of this manure is contained in pits, basins or barns; or stockpiled on lots or pads, until it can be used as a fertilizer. The manure is either incorporated into or surface applied, on farm fields. As such, the majority of fecal material that is produced in the basin is land applied manure. Land application of this manure has three potential pathways to reach surface waters; 1) overland runoff, 2) open tile intakes and 3) macropores/preferential flow. The majority of livestock producers in the watersheds are probably handling their manure and conducting land application consistent with current rules, guidelines, and University recommendations. These practices, however, do not typically result in total containment of manure under all conditions. Even if less than 1% of the land applied manure enters surface waters through one or more of the pathways mentioned, it could account for violations of the bacterial water quality standard. It should be noted that agricultural field runoff generally contains at least some fecal bacteria even in the absence of recent manure application or grazing. There are several explanations for this including the presence of wildlife, the survival of bacteria in soils for long periods of time, and the possible colonization in the soil by "indigenous" coliform bacteria that have no direct link to humans, wildlife or livestock. These factors should reinforce the value of controlling soil erosion and sediment runoff as a "multi-benefit" water quality improvement strategy.

It is important to note that livestock and livestock manure have environmental and economic benefits that must be taken into account and weighed against potential bacterial water quality impacts. Livestock manure reduces commercial fertilizer demand, while adding organic matter to the soil. Soil rich in organic matter is less prone to erosion. There are also significant numbers of beef and dairy cattle in the watersheds. The pasture and hay land supported by these ruminants may result in further soil erosion reduction, particularly if it is located on steeper lands.

Primary sources of fecal coliform contamination during low flows appear to be "straight pipe" septic systems, systems that discharge untreated sewage directly or through tile drainage to surface waters. There are estimated to be over 500 of these systems in High Island Creek watershed, and nearly 900 in Rush River Watershed. Direct discharge of these systems to surface waters during low flow periods can be a major contributor of fecal coliform contamination.

A third significant source during both wet and dry periods appears to be the stream channel itself. A portion of fecal coliform contamination from human and animal sources may stay in the stream channel sediments and act as a reservoir. Increases in flow during storm runoff can cause resuspension of sediments that contain fecal coliform bacteria. In some situations, exceedances of water quality standards during low flow periods may also partially be attributed to release of fecal coliform bacteria from streambed sediments.

The document also describes conditions when bacterial concentrations are highest in High Island Creek and Rush River. Monitoring data show bacterial concentrations appear to increase as air and water temperature increases. The data also show a strong correlation between suspended sediment and bacterial concentrations, with high bacterial concentrations found with high sediment concentrations.

This document describes the above sources and dynamics in more detail. The document also describes applicable water quality standards for fecal coliform bacteria, population source inventories, TMDL allocations and suggested implementation strategies.

During the time this TMDL is on public notice, it is anticipated that Minnesota’s bacterial water quality standard will change from fecal coliform to E. coli. E. coli is a sub-group of fecal coliform. Because the E. coli standard was developed to be “equivalent” to the fecal coliform standard in terms of protectiveness, the loading capacity, allocations, reduction estimates, and general implementation activities developed to attain the fecal coliform water quality standards should also result in attainment of the new E. coli standard.

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Section 5.0 – TMDL Allocations for Individual Impaired Reaches

Section 5 contains the following tables for each impaired reach

a. Human and Animal Population Inventory
b. Wastewater Treatment Facilities

Section 8.0 – Bacteria Source Assessment and Implementation Activities

Appendices

Acronyms

AU – Animal Unit
CFU – Colony Forming Units
CFS – Cubic Feet Per Second
CWP – Clean Water Partnership
DNR – Department of Natural Resources
FC – Fecal Coliform
HICW – High Island Creek Watershed
ISTS – Individual Sewage Treatment System
IWMI – Interagency Watershed Monitoring Initiative
LA – Load Allocation
MOS – Margin of Safety
MPCA – Minnesota Pollution Control Agency
MS4 – Municipal Separate Storm Sewer Permit
NPDES – National Pollutant Discharge Elimination System
NRCS – Natural Resources Conservation Service

QAQC – Quality Assurance Quality Control
RRW – Rush River Watershed
TMDL – Total Maximum Daily Load
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
WLA – Waste Load Allocation
WTF – Wastewater Treatment Facility

Section 1.0 – Introduction

1.1 Overview

High Island Creek Watershed (HICW) is a 153,222 acre watershed located across three southern Minnesota counties; Sibley (66% area), McLeod (23%) and Renville (11%). High Island Creek is part of the Lower Minnesota Watershed, a major sub-basin of the Minnesota River Basin.

The watershed topography is flat to gently rolling in the western two-thirds and steeply sloped terrain in the eastern one-third. The watershed receives an average of 29 to 30 inches of annual precipitation. Soils range from poorly drained to well drained loamy soils. Approximately 85% of the landuse is agricultural, primarily corn and soybeans. As of the 2002 feedlot inventory, there were 194 feedlots containing 27,612 animal units in the watershed. Livestock includes dairy, beef, swine and poultry.

The population of HICW is estimated at 5,351, with three small cities: Arlington, New Auburn and a portion of Stewart. Forty-seven percent of the population lives in rural areas. An estimated 2,517 watershed residents utilize individual septic systems for their waste treatment, equating to roughly 1,013 rural septic systems.

The RRW is a rural watershed that drains 257,775 acres in Sibley, Nicollet and McLeod counties. Rush River has three tributaries, the north, middle and south branches of the Rush River. RRW is part of the Lower Minnesota River Watershed a major sub-basin of the Minnesota River Basin. As the largest of the Lower Minnesota River subwatersheds, the RRW comprises 22% of the total land area. The combined stream length of the north, middle, south and mainstem is 50 miles, with an additional 500 miles of public open ditches. Artificial drainage has increased stream length by 400 to 500 % of the original stream. In addition, there are several thousand miles of public and private tile and an estimated 7000 open tile intakes.

The western ¾ of the Rush River Watershed is flat to gently rolling. The three branches of Rush River converge in the eastern ¼ of the watershed, where the watershed becomes steeply sloped. An estimated 90% of the landscape is in an agricultural landuse. There are 429 feedlots with 86,329 animal units in the watershed.

Four cities are located in the watershed; Gaylord, Winthrop and Gibbon in Sibley County and Lafayette in Nicollet County. The population of the watershed is estimated at approximately 9,010 (44.7% rural). Fifty-five percent or an estimated 4,027 residents utilize an individual septic treatment system (ISTS).

Fecal coliform bacteria levels in High Island Creek and Rush River are among the highest of all monitored streams in Minnesota. As of fall 2007 there were five stream reaches in High Island Creek Watershed and two in Rush River Watershed listed on the 303d list of impaired streams. Table 1.1 presents the impaired stream reaches for fecal coliform bacteria in the watersheds.

Table 1.1 - Fecal Coliform Bacteria Impaired Stream Reaches

Stream Name	Description	Year Listed	Target Completion	MPCA River Assessment Unit ID
High Island Creek Watershed				
Buffalo Creek	Unnamed Cr to High Island Cr	2006	2009	07020012-578
Buffalo Creek / County Ditch 59	High Island Ditch 5 to Unnamed Stream	2006	2009	07020012-598
High Island Creek	JD 15 to Unnamed Cr	2002	2008	07020012-535
High Island Creek	Unnamed Cr to Minnesota R	2006	2009	07020012-589
High Island Creek Ditch 2	Unnamed Cr to High Island Cr	2008		07020012-588
Rush River Watershed				
Rush River, South Branch	Unnamed Ditch to Rush R	2008		07020012-553
Rush River	S Br Rush R to Minnesota R	2002	2008	07020012-521

Figure 1.1 displays the location of the seven impaired stream reaches. The mainstem High Island Creek is divided into two impaired reach segments, splitting at High Island Lake outlet. Buffalo Creek also has two impaired reach segments which split at the confluence of county ditches 5 and 59.

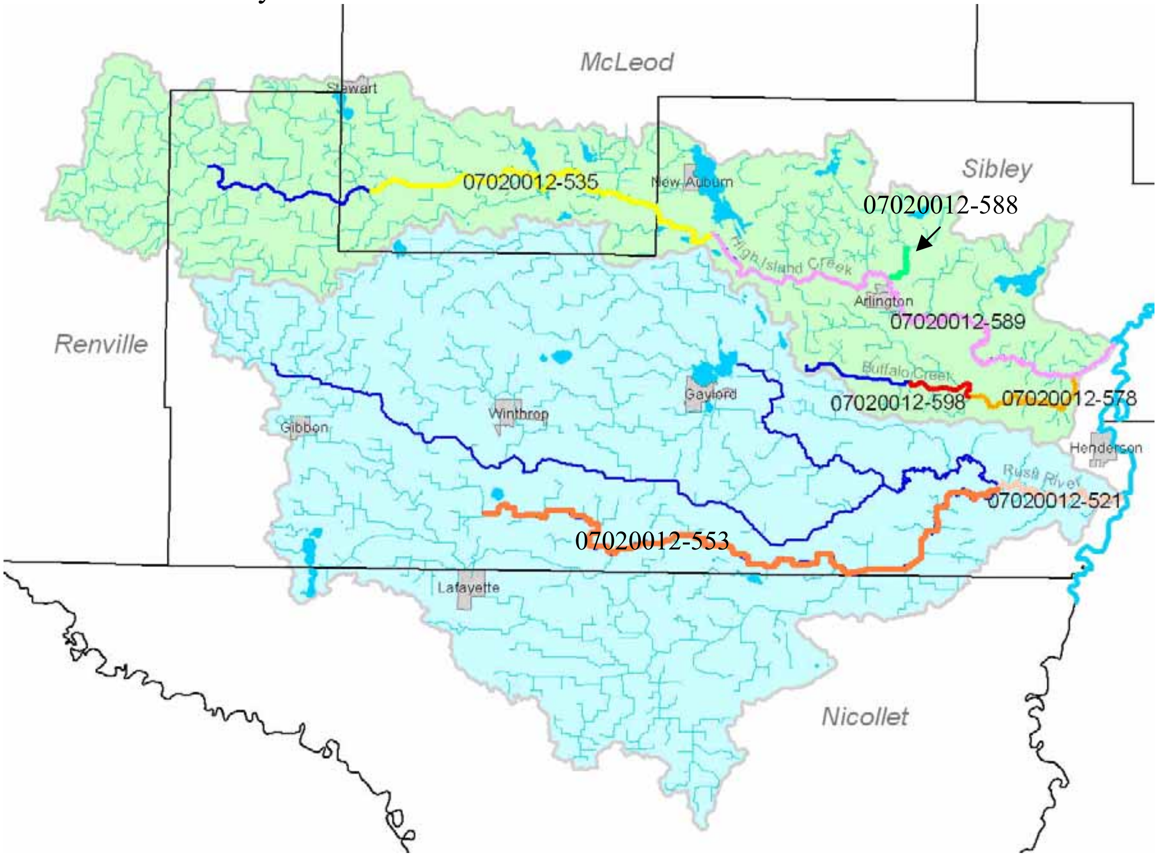


Figure 1.1 – Impaired Reach Locations and River Assessment ID's

1.2 Purpose

Section 303(d) of the federal Clean Water Act and US Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies which are violating water quality standards.

A TMDL represents the maximum amount of pollutant a waterbody can receive and still meet water quality standards and designated uses. The TMDL process establishes the allowable loading of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions.

The EPA specifies that in order for a TMDL to be considered complete and approvable, it must include the following eight elements:

1. It must be designed to meet applicable water quality standards;
2. It must include a total allowable load as well as individual waste load allocations and load allocations;
3. It must consider the impacts of background pollutant contributions, such as wildlife;
4. It must consider critical environmental conditions, such as stream flow, precipitation, temperature, etc;
5. It must consider seasonal environmental variations;
6. It must include an implicit or explicit margin of safety to account for uncertainties inherent to the TMDL development process;
7. It must provide opportunity for public participation; and
8. It should consider reasonable assurance in the attainment of allocations.

In general, the TMDL is developed according to the following relationship:

TMDL = WLA + LA + MOS

Where (for fecal coliform TMDLs):

WLA = Waste Load Allocation, which is the sum of all point sources, including:
    Permitted Wastewater Treatment Facilities
    Communities Subject to MS4 NPDES Requirements
    Livestock Facilities Requiring NPDES Permits
    "Straight Pipe" Septic Systems
LA = Load Allocation, which is the sum of all nonpoint sources, including;
    Runoff from fields receiving manure application
    Runoff from feedlots without runoff controls
    Overgrazed pastures near streams and waterways
    Urban Stormwater
    Wildlife
MOS = Margin of Safety (may be implicit and factored into conservative WLA or LA, or explicit.)

This document provides the information used to develop TMDLs for five impaired reaches in HICW and two impaired reach in RRW. These stream reaches are listed as impaired for failure to meet their swimming designated beneficial uses due to excessive fecal coliform concentrations.

The criteria used for determining stream reach impairments is outlined in the Minnesota Pollution Control Agency (MPCA) document, Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment – 305(b) Report and 303(d) List), January 2003. The applicable water body classifications and water quality standards are specified in Minnesota Rules Chapter 7050. Minnesota Rules Chapter 7050.0407 lists water body classifications and Chapter 7050.2222 subp. 5 lists applicable water quality standards for the impaired reaches.

The assessment protocol includes pooling of data by month over a 10-year period. A geometric mean is then calculated for each month, April through October, with a minimum of five samples used for each monthly calculation.

There are two scenarios when a stream reach will qualify to be listed as impaired. If any monthly geometric mean value exceeds 200 organisms per 100 ml the stream qualifies to be listed as impaired. The other scenario involves combining the entire ten year data set and assessing the percent of samples that exceed 2000 organisms per 100 ml. If more than 10% of the samples exceed 2000 org/100ml, the stream qualifies as listing as impaired.

Table 3.3 represents the analysis of 336 fecal coliform bacteria samples collected from five monitoring sites in the High Island Creek watershed and 370 samples from five sites in Rush River Watershed (1997 though 2005). These samples were collected as part of the High Island Creek Assessment Project Clean Water Partnership (CWP) and the Rush River Assessment Project CWP.

The CWP projects used MPCA standard quality assurance quality control (QAQC) procedures in collection of samples, which includes collection of samples in sterilized bottles, shipping samples at 4 degrees C and delivery of samples to a certified laboratory within the 24 hour holding period. Fecal coliform samples were analyzed at Minnesota Valley Testing Laboratory in New Ulm.

Monitoring data from the CWP projects indicate frequent violations of the monthly fecal coliform standard. The magnitude of these violations, especially during the summer months, suggest serious water quality impairments that will require substantial bacterial reductions in waterbodies.

Section 2.0 - Background Information

2.1 Study Area Overview

Fecal Coliform bacteria contamination is a significant water quality concern in High Island Creek Watershed (HICW), with five stream reaches listed on the US EPA 303 (d) impaired waters list. Since monitoring began in the late-1990's, the HICW has ranked near the highest for fecal coliform bacteria levels among Minnesota River Basin tributaries. Fecal Coliform bacteria counts frequently exceeded the surface water standard of 200 colony forming units per 100 ml at all monitored sites in the watershed. Runoff from feedlots, manure applied lands and noncompliant septic systems were indicated as significant sources of bacterial contamination in the HICW CWP Final Report.

Elevated fecal coliform bacteria concentrations are also a concern in the RRW with the mainstem Rush River being listed on the 303(d) list. The Rush River CWP Final Report indicated the primary sources for FC contamination to be applied manure, runoff from noncompliant feedlots and sewage discharges from noncompliant septic systems.

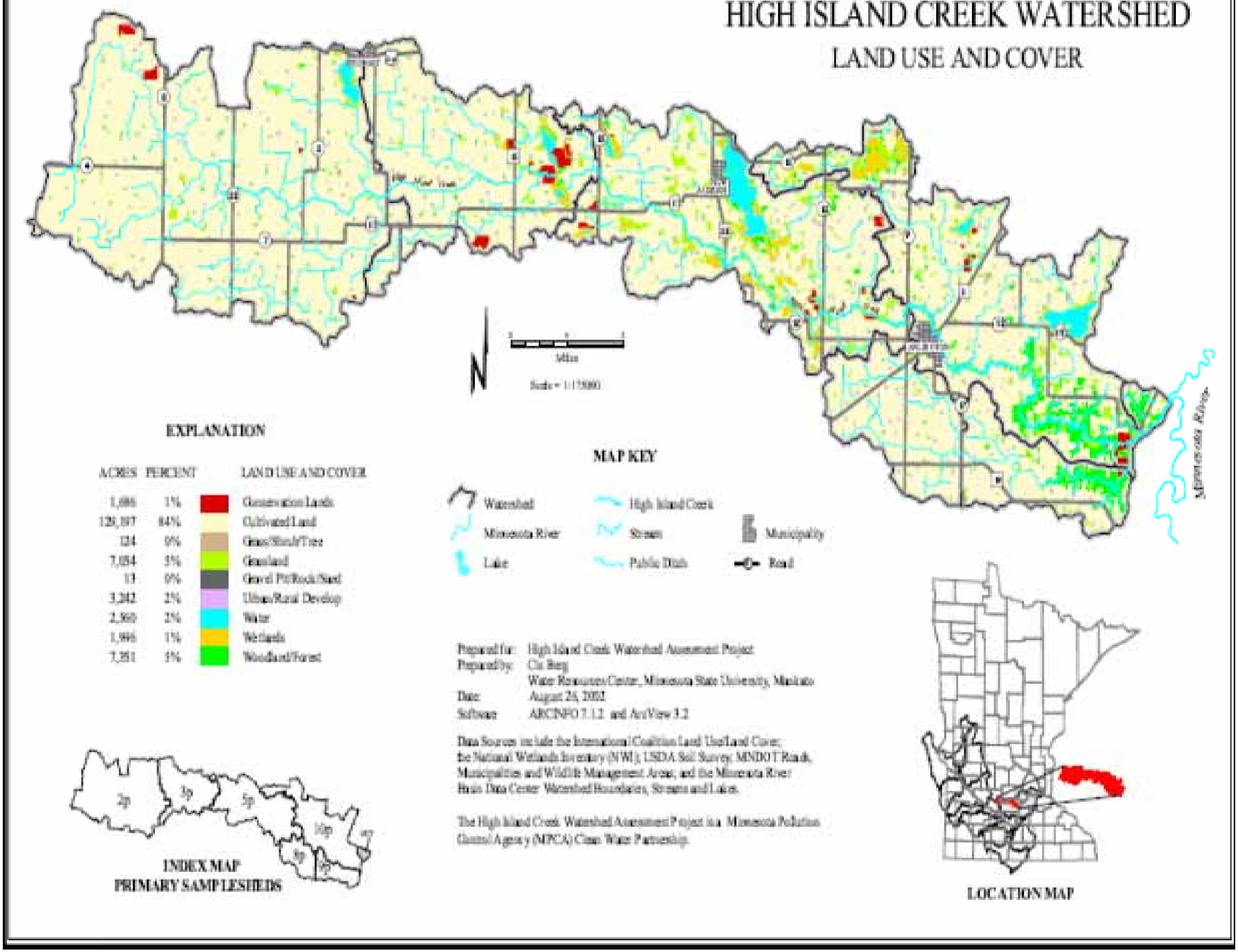
2.2 Land Use and Cover (1990)

HICW and RRW's are dominated by cultivated land at 84.3% and 90.1% respectively. In HICW the other significant land use categories are woodland (4.8%), grassland (4.6%) and urban/rural development (2.1%). In RRW, the other major land use categories include woodland (3.6%), urban/rural development (2.3%) and grassland (1.6%).

Table 2.2 – High Island Creek and Rush River Watersheds Land Use and Cover (1990)

	High Island Creek Watershed		Rush River Watershed	
Land Use and Cover	**Acres**	**Percent**	**Acres**	**Percent**
Conservation	1,686	1.1%	1,821	0.7%
Cultivated Land	129,197	84.3%	232,337	90.1%
Grassland	7,178	4.7%	4,050	1.6%
Gravel/Pit/Rock/Sand	13	0.0%	32	0.0%
Urban/Rural Development	3,242	2.1%	5,804	2.3%
Water	2,560	1.7%	1,899	0.7%
Wetlands	1,996	1.3%	2,561	1.0%
Woodland	7,351	4.8%	9,272	3.6%
Total Acres	**153,223**	**100.0%**	**257,776**	**100.0%**

Figures 2.2a and 2.2b present land use and cover for both watersheds based on 1990 landuse statistics.

# HIGH ISLAND CREEK WATERSHED

LAND USE AND COVER

EXPLANATION

ACRES	PERCENT		LAND USE AND COVER
1,686	1%	🟥	Conservation Lands
128,397	84%	▢	Cultivated Land
124	0%	▨	Grass/Shrub/Tree
7,054	5%	🟩	Grassland
13	0%	■	Gravel Pit/Rock/Sand
3,242	2%	🟪	Urban/Rural Develop
2,360	2%	🟦	Water
1,946	1%	🟧	Wetlands
7,281	5%	🟩	Woodland/Forest

MAP KEY

Watershed
Minnesota River
Lake
High Island Creek
Stream
Public Ditch
Municipality
Road

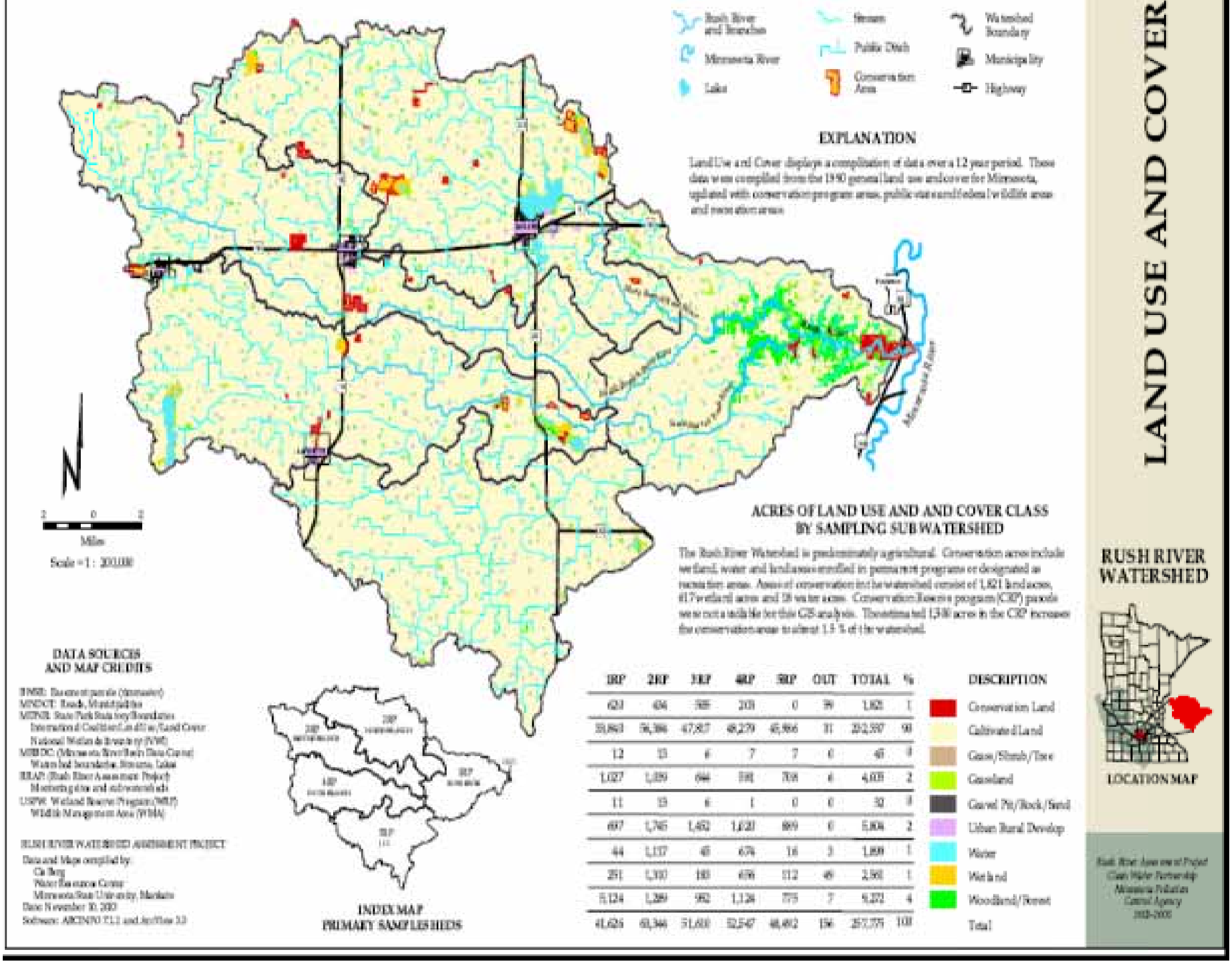
Prepared for: High Island Creek Watershed Assessment Project
Prepared by: Chi Berg
Water Resources Center, Minnesota State University, Mankato
Date: August 26, 2002
Software: ARCINFO 7.1.2 and ArcView 3.2

Data Sources include the International Coalition Land Use/Land Cover; the National Wetlands Inventory (NWI); USDA Soil Survey; MNDOT Roads, Municipalities and Wildlife Management Areas; and the Minnesota River Basin Data Center Watershed Boundaries, Streams and Lakes.

The High Island Creek Watershed Assessment Project is a Minnesota Pollution Control Agency (MPCA) Clean Water Partnership.

LAND USE AND COVER

RUSH RIVER WATERSHED



EXPLANATION

Land Use and Cover displays a compilation of data over a 12 year period. These data were compiled from the 1990 general land use and cover for Minnesota, updated with conservation program areas, public state and federal wildlife areas and recreation areas.

ACRES OF LAND USE AND AND COVER CLASS BY SAMPLING SUBWATERSHED

The Rush River Watershed is predominately agricultural. Conservation acres include wetland, water and land areas enrolled in permanent programs or designated as recreation areas. Areas of conservation in the watershed consist of 1,821 land acres, 417 wetland acres and 18 water acres. Conservation Reserve program (CRP) parcels were not available for this GIS analysis. The estimated 1,308 acres in the CRP increases the conservation areas to almost 1.5 % of the watershed.

1RP	2RP	3RP	4RP	5RP	OUT	TOTAL	%		DESCRIPTION
623	434	505	203	0	39	1,821	1	🟥	Conservation Land
33,863	56,386	47,827	49,279	45,866	31	232,597	90	▨	Cultivated Land
12	13	6	7	7	0	45	0	▨	Grass/Shrub/Tree
1,027	1,059	644	591	708	4	4,033	2	🟩	Grassland
11	13	6	1	0	0	32	0	■	Gravel Pit/Rock/Sand
697	1,765	1,462	1,620	869	0	5,806	2	🟪	Urban Rural Develop
44	1,137	45	674	16	3	1,899	1	🟦	Water
251	1,310	180	656	112	45	2,561	1	🟧	Wetland
5,124	1,289	992	1,126	775	7	9,272	4	🟩	Woodland/Forest
41,626	63,346	51,600	52,547	48,492	156	257,775	100		Total

DATA SOURCES AND MAP CREDITS

BWSR: Easement parcels (Minnesota)
MNDOT: Roads, Municipalities
MDNR: State Park Statutory Boundaries
International Coalition Land Use/Land Cover
National Wetlands Inventory (NWI)
MRBDC: (Minnesota River Basin Data Center)
Watershed boundaries, Streams, Lakes
RRAP: (Rush River Assessment Project)
Monitoring sites and subwatersheds
USFW: Wetland Reserve Program (WRP)
Wildlife Management Area (WMA)

RUSH RIVER WATERSHED ASSESSMENT PROJECT
Data and Maps compiled by:
Cis Berg
Water Resources Center
Minnesota State University, Mankato
Date: November 10, 2003
Software: ARC/INFO 7.1.1 and ArcView 3.3

INDEX MAP
PRIMARY SAMPLESHEDS

Rush River Assessment Project
Clean Water Partnership
Minnesota Pollution
Control Agency
2002-2005

2.3 Temperature

Figure 2.3 presents the average monthly temperatures at Gaylord, Minnesota (located in RRW) during the monitoring season months of April through October. Ice out conditions in the watersheds typically occur between the end of March and early April. Temperatures reach peak levels during July/August and then gradually decline. Monitoring data indicate that temperature does have an association with bacterial concentrations in surface waters. Monitoring data indicate that very cold stream water during early spring often is below surface water standards for fecal coliform bacteria.

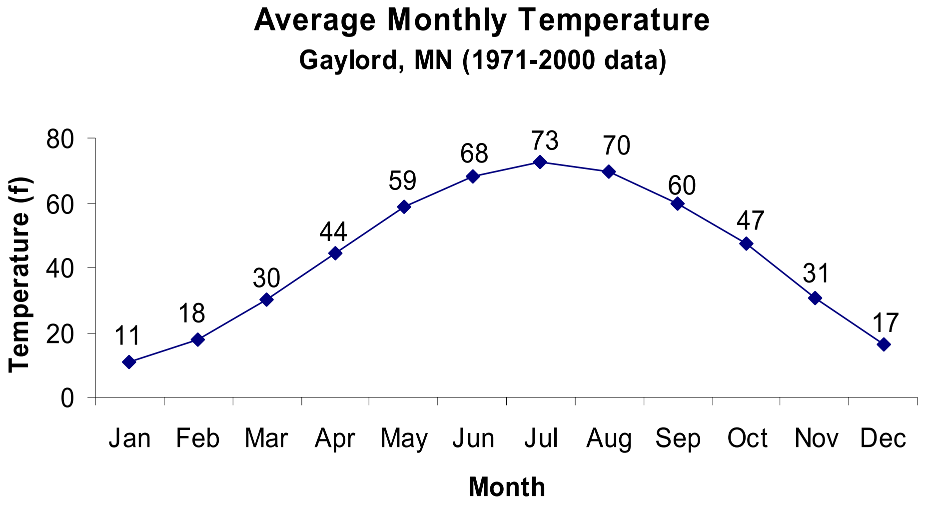
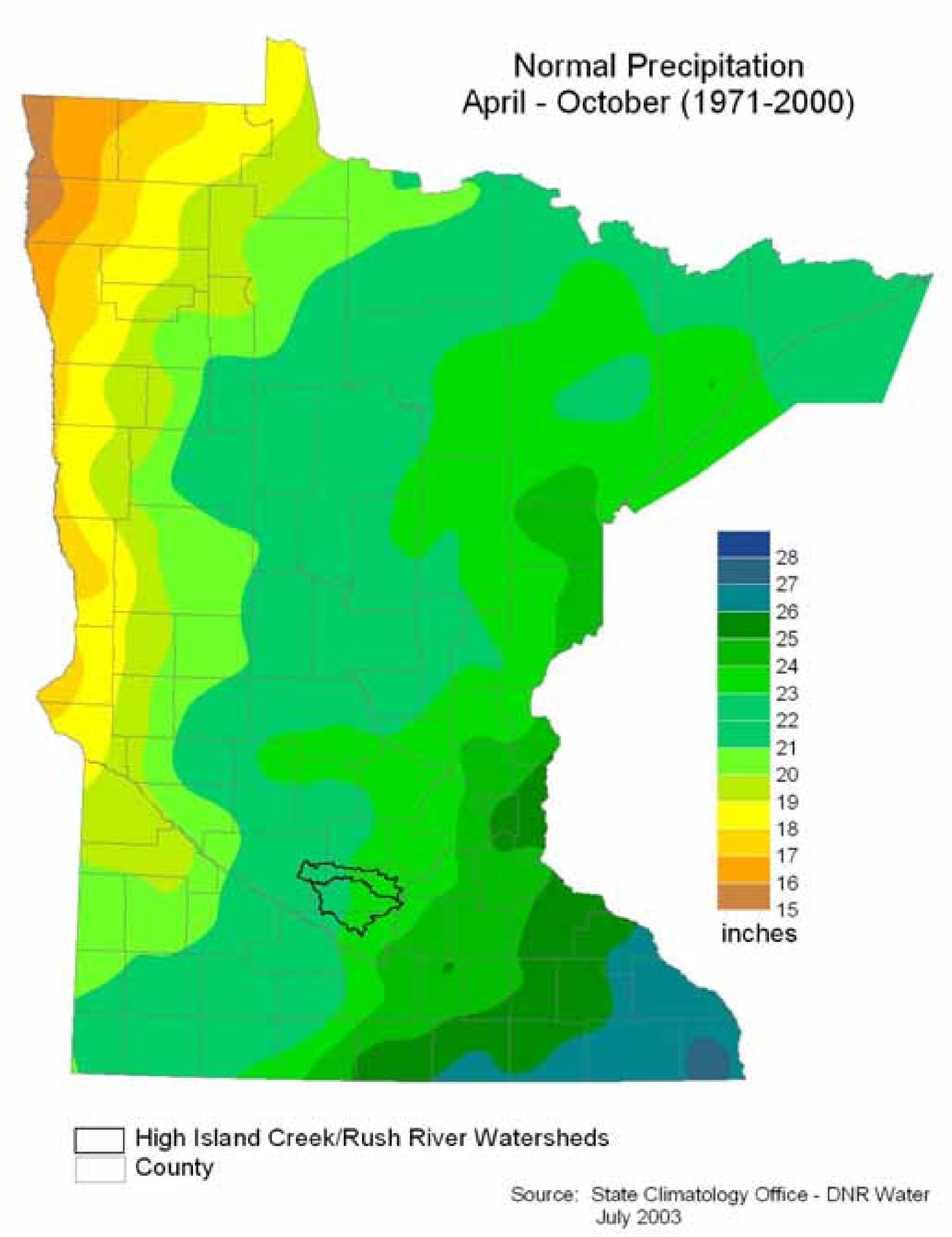


Figure 2.3 – Average Monthly Temperature by Month

2.4 Precipitation

The watersheds average 29 to 30 inches of precipitation annually. The monitoring season months of April through October represent 80% of the annual average precipitation with totals of 23 to 24 inches. In a typical year, the western portions of the watersheds receive less precipitation than the east. Table 2.4 presents the average monthly precipitation values for three locations in or near HICW and RRW.



Source: State Climatology Office - DNR Water
July 2003

Figure 2.4 – Map of Average Precipitation for Minnesota

Table 2.4 – Precipitation Data for Cities in HIRR Watersheds

Site	Average Monthly Precipitation (inches)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Gaylord (Rush River Watershed)	0.76	0.72	1.60	2.54	3.43	4.66	3.87	4.16	3.14	2.03	1.92	0.86	29.69
Stewart (High Island Creek Watershed)	0.89	0.73	1.67	2.51	3.16	4.26	4.10	4.06	2.83	1.94	1.90	0.91	28.95
St. Peter (near Rush River Watershed)	0.93	0.69	1.76	2.42	3.51	4.95	4.09	4.26	2.82	2.18	1.62	1.03	30.25

Source: 1971-2000 National Climatic Data Center

2.5 Stream Flow Characteristics

The surface water standard for fecal coliform bacteria applies to the months of April through October. On average, the month with the highest flow volume is April, due to the combination of snowmelt runoff and runoff from precipitation. June, the month with the greatest precipitation totals has the second highest mean monthly flow.

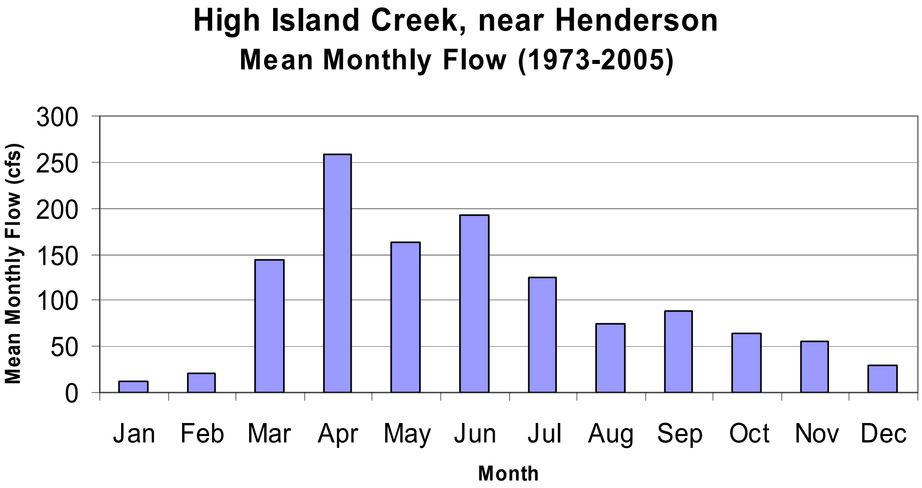


Figure 2.5 – Mean Monthly Flow for High Island Creek near Henderson (1973-2005)

Section 3.0 – Applicable Water Quality Standards and Description of Factors Affecting Impairments

3.1 Description of Fecal Coliform Bacteria

Fecal coliform bacteria are a bacteria group that are found in the intestines of warm blooded animals. While usually not harmful themselves, fecal coliforms are considered an indicator of the presence of other disease causing bacteria, viruses, and/or protozoans.

Fecal coliform bacteria are passed through the fecal excrement of humans, livestock and wildlife. These bacteria can enter streams and ditches through direct discharge of waste from mammals and birds, from agricultural and urban stormwater runoff and from poorly or untreated human sewage. Agricultural practices such as spreading manure during wet periods and allowing livestock uncontrolled access to streams can contribute to high levels of fecal coliform bacteria (Edwards et al.,1997; McMurry et al. 1998). Wildlife can also be a contributor of fecal coliform bacteria, especially during low flow conditions (Sherer et al., 1988; LaWare and Rifai, 2006).

In addition to bacteria and other pathogens, human and animal wastes contain high levels of other pollutants such as phosphorus, nitrogen, and oxygen demanding organic material. Additionally, some of the same soil erosion processes and delivery pathways that lead to sediment pollution of streams and rivers also contribute to human and animal waste entering the water. As such, efforts to contain sewage and animal waste, and to control soil erosion and sedimentation, result in better overall water quality.

3.2 Applicable Minnesota Water Quality Standards

Minnesota Rules Chapter 7050 provides the water quality standards for bacterial concentrations in Minnesota waters. The rules are as follows for class 2B surface waters, which include all of the impaired reaches covered in this report.

3.2.1 Class 2B waters

The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable.

Fecal coliform organisms not to exceed 200 organisms per 100 milliliters as a geometric mean of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 2000 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Table 3.2.1 summarizes the fecal coliform bacteria standards for all classes of water in Minnesota.

Table 3.2.1 – Minnesota Surface Water Standards for Fecal Coliform Bacteria

Use Class	Standard No. of Organisms Per 100 mL of Water		Applicable Season	Use
	Monthly Geometric Mean*	10% of Samples Maximum**		Body Contact
2A, trout streams and lakes	200	400	April 1 - October 31	Primary
2Bd, 2B, 2C, non-trout (warm) waters	200	2000	April 1 - October 31	Primary
2D, wetlands	200	2000	April 1 - October 31	Primary, if the use is suitable
7, limited resource value waters	1000	2000	May 1 - October 31	Secondary

* Not to be exceeded as the geometric mean of not less than 5 samples in a calendar month.

** Not to be exceeded by 10% of all samples taken in a calendar month, individually.

Source: Guidance Manual for Assessing the Quality of Minnesota Surface Waters: For the Determination of Impairment. 305(b) Report and 303(d) List

3.3 Impairment Assessment: Fecal Coliform Impairments

Preliminary monitoring of fecal coliform bacteria was conducted in the late 1990's by the MPCA and Sibley County to determine levels of contamination in the both watersheds. The monitoring data revealed elevated fecal coliform concentrations across the watersheds and the need for thorough diagnostic watershed studies. This led to the High Island Assessment Project (2000-2003) and Rush River Assessment Project (2003-2004) CWPs. These studies involved the monitoring at several stream locations for sediment, nutrients and fecal coliform bacteria. Bacterial monitoring of these watersheds continued in 2005 as part of the HIRR Fecal Coliform TMDL. As of fall 2005, 720 samples had been collected at the ten HICR/RRW monitoring sites. Prior to these projects little water quality data exists for these watersheds. Figure 3.3 displays the location of diagnostic study monitoring sites.

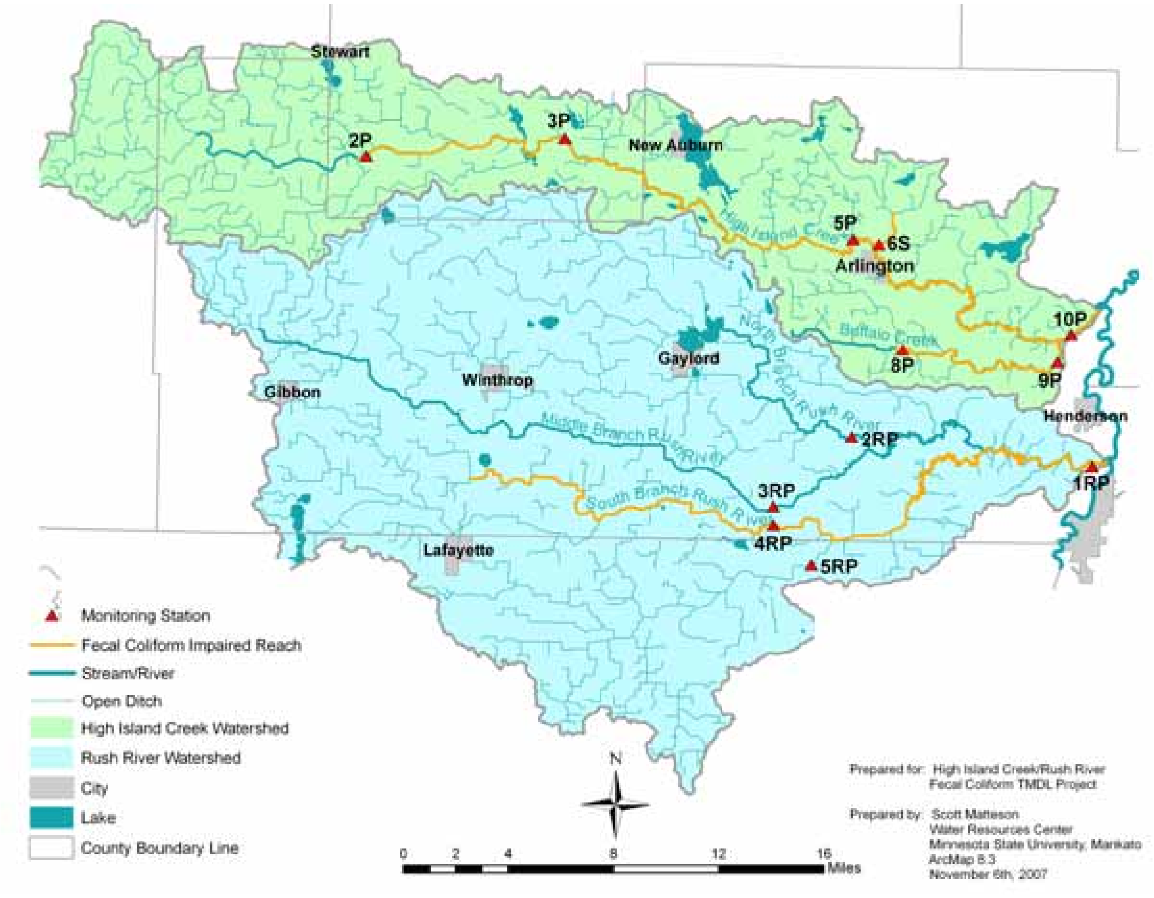


Figure 3.3a – Fecal Coliform Bacteria Monitoring Sites in HICW and RRW

Table 3.3 presents a summary of fecal coliform data collected between 1998 through 2005. The data show elevated fecal coliform concentrations across both watersheds. As of fall 2007, High Island Creek (sites 2P, 3P, 5P and 10P), Buffalo Creek (8P and 9P) and the Rush River (sites 1RP and 4RP) all have segments listed as impaired on the 303(d) list.

Table 3.3 – Stream Monitoring Sites and Impairment Assessment Data (1998-2005 data)

Monitoring Site	Drainage (acres)	Total Smpls	# Smpls >2000	Smpls >2000	Apr. GM	May GM	Jun. GM	Jul. GM	Aug. GM	Sep. GM	Years of Data
Site 1RP - RR Outlet	257,619	95	20	21.1%	216	438	855	937	428	1,018	98,99,03,04,05
Site 2RP - North Branch RR	63,344	72	19	26.4%	230	984	849	689	1,415	2,145	99,03,04,05
Site 3RP - Middle Branch RR	51,610	71	19	26.8%	455	1,315	1,357	1,176	803	2,003	99,03,04,05
Site 4RP - South Branch RR	52,547	72	15	20.8%	231	558	758	716	1,130	3,584	99,03,04,05
Site 5RP - JD1	48,292	60	19	31.7%	161	951	1,519	2,659	448	1,496	03,04,05
Site 2P - Upstream Bakers Lk.	49,823	34	4	11.8%		223	913	963			00,01,02
Site 3P - Outlet Bakers Lake	71,498	31	4	12.9%		85	560	381			00,01,02
Site 5P - HI near Arlington	102,776	80	24	30.0%	146	466	1,213	707	446	7,552	00,01,02,04,05
Ste 6S - CD 2 near Arlington	10,487	25	5	20.0%			957	885	692		99,00,01
Site 8P - Upper Buffalo Creek	9,755	31	9	29.0%		243	2,347	1,034			00,01,02
Site 9P - Lower Buffalo Creek	17,754	79	20	25.3%	100	354	1,938	1,461	263	1,060	00,01,02,04,05
Site 10P - HI Outlet	152,150	126	43	34.1%	218	549	1,996	1,273	180	2,563	98,99,00,01,02,03,04,05

🟧 Qualifies for Listing as Impaired Waterbody 🟩 Does not Qualify for Listing as Impaired Waterbody

Figures 3.3b and 3.3c present monthly geometric mean values for each HIRR monitoring site based on data collected between 1998 through 2005.

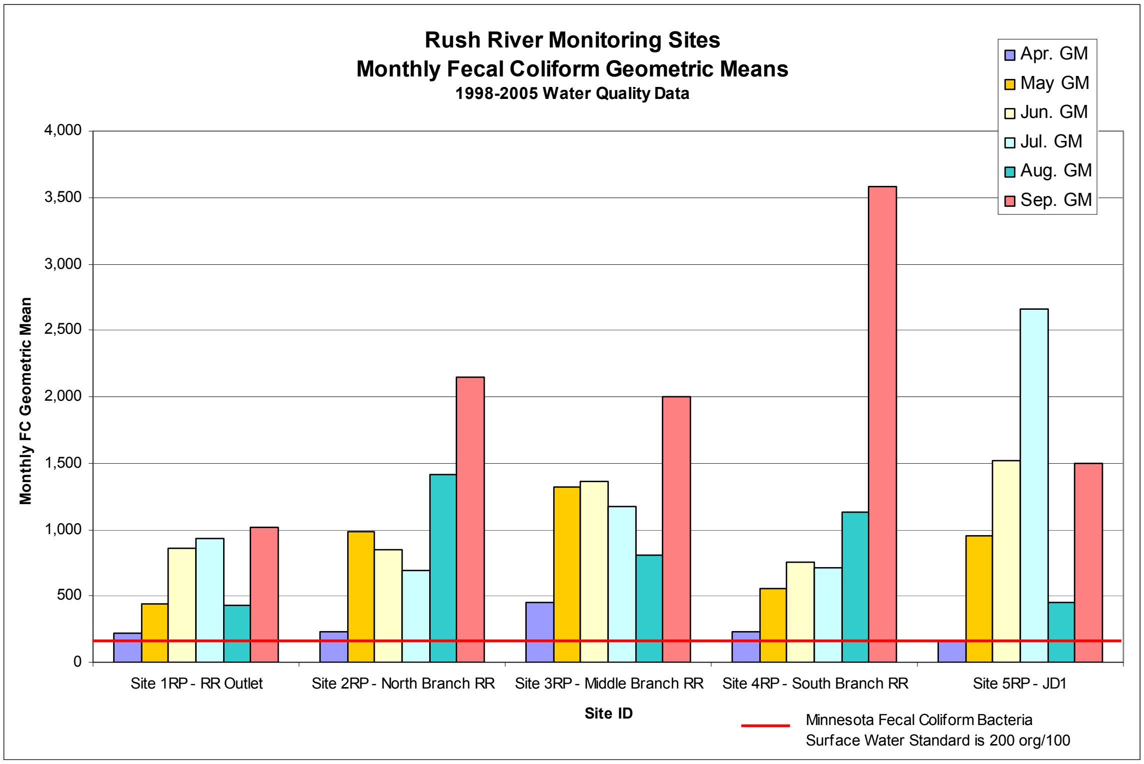


Figure 3.3b – Rush River Monthly Fecal Coliform GMs (1998-2005 data)

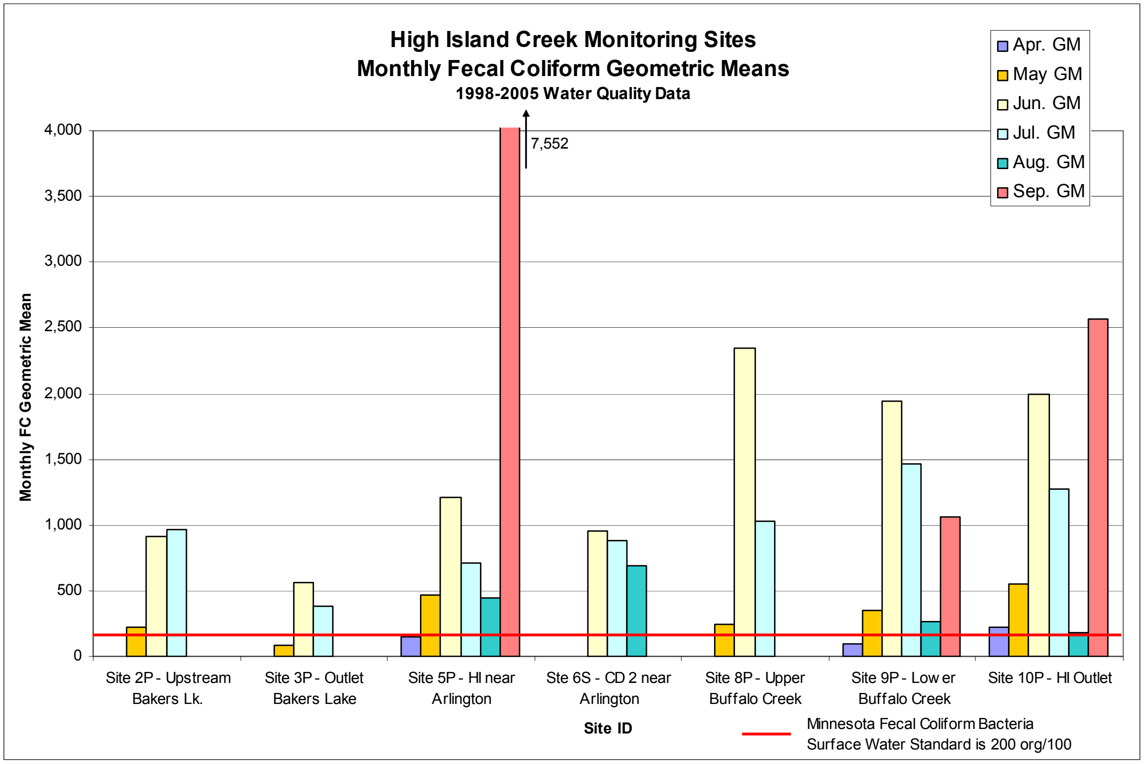


Figure 3.3c – High Island Creek Monthly Fecal Coliform GMs (1998-2005 data)

3.4 Fecal Coliform and Flow

There is a significant relationship between flow and fecal coliform concentration in both watersheds. On average, as flows increase fecal coliform bacteria concentration also increase. This relationship is evident by charting flow and bacterial concentrations using a method called the duration curve. The duration curve method involves obtaining average daily flow values for a stream monitoring site over its entire record. For High Island Creek this period extends from 1973 through 2005 for a total of over 10,700 data points. Next, the daily flow values are sorted from maximum to minimum flow and plotted on a chart. Figure 3.4a displays the flow duration curve for the High Island Creek outlet monitoring site. The chart depicts the percentage of time any particular flow is exceeded. For example, 330 CFS has only been exceeded by 10% of daily flow values, and thus is considered the beginning of the “high flow” category. A value of 2 CFS was exceeded by 90% of daily flow values and represents “low flow” conditions.

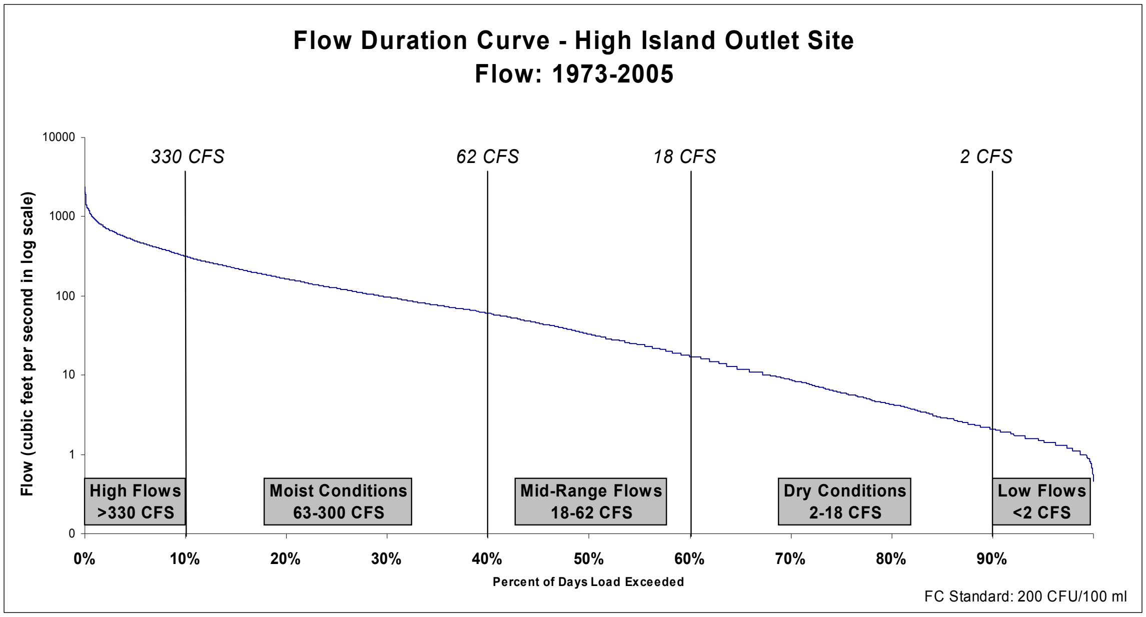


Figure 3.4a – Flow Duration Curve for High Island Creek, near Henderson

Next, samples that have been collected over the flow record are plotted on the flow duration curve. Daily flow values are multiplied by the surface water quality standard of 200 cfu/100 ml for fecal coliform bacteria. Samples are plotted by multiplying the daily mean flow of the sample date by the sample concentration. The 123 samples collected from High Island Creek (Site 10P) from 1998 through 2005 are plotted on the chart, resulting in a “Load Duration Curve”. This method is useful for determining the frequency and severity of surface water quality standard exceedances during varying flow conditions.

Chart 3.4b shows that 90% of samples (36 of 40) collected from High Island Creek at flows above 280 CFS exceeded 200 cfu/100 ml. The geometric mean of these high flow samples was 1,889 cfu/100 ml. In contrast, only 50% of samples collected during “dry conditions exceeded 200 cfu/100 ml, with a much lower geometric mean of 160 cfu/100 ml.

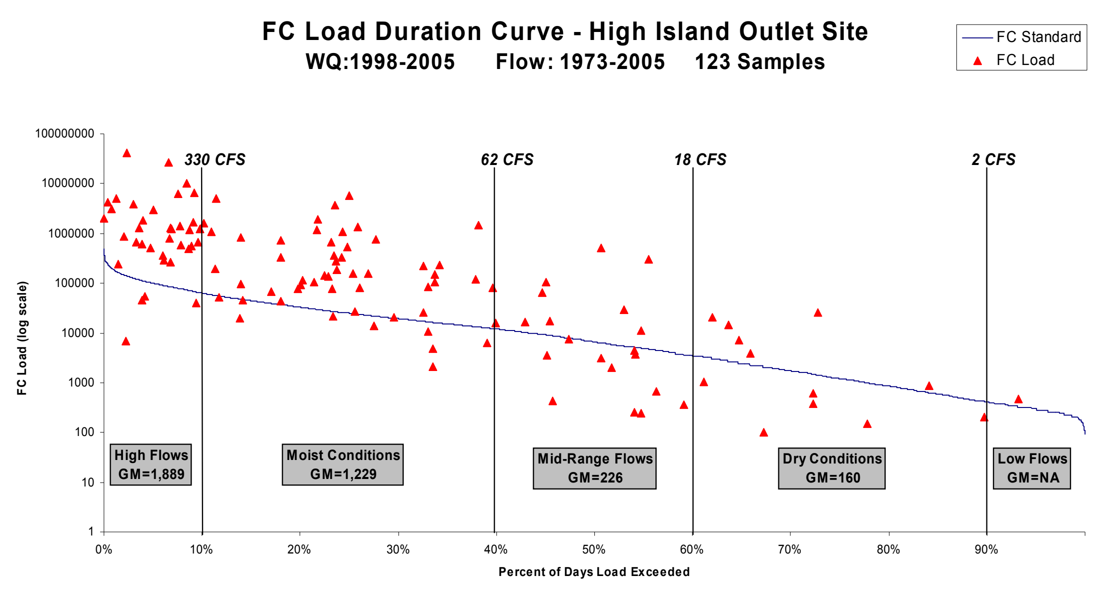


Figure 3.4b – Load Duration Curve for High Island Creek, near Henderson

Table 3.4 provides statistics relating fecal coliform concentration and flow conditions. The data indicate the majority of bacterial load that moves through these systems occurs during high flow conditions.

Table 3.4 – Fecal Coliform Statistics by Flow Condition

Flow Condition	Flow Range (cfs)	% of Time Flow Exceeded	# Samples	Fecal Coliform GM	% Samples >200 FC	% Samples >2000 FC
Low	0 - 2	91-100%	1	na	na	na
Dry	3 - 18	61-90%	12	160	50.0%	8.3%
Mid-Range	19 - 62	41-60%	19	226	42.1%	15.8%
Moist	63 - 330	11-40%	54	1,229	83.3%	37.0%
Wet	>330	1-10%	36	1,889	88.9%	50.0%

3.5 Fecal Coliform and Total Suspended Solids

A second significant relationship is between fecal coliform concentrations and total suspended solid concentrations. Figure 3.5 displays the High Island Creek outlet load duration curve with samples above 100 mg/L TSS drawn out. The value of 100 mg/L was chosen as water samples testing above this threshold are usually deriving much of the flow from stormwater. At concentrations above 100 mg/L, significant erosion is occurring from overland, streambank and gully erosion.

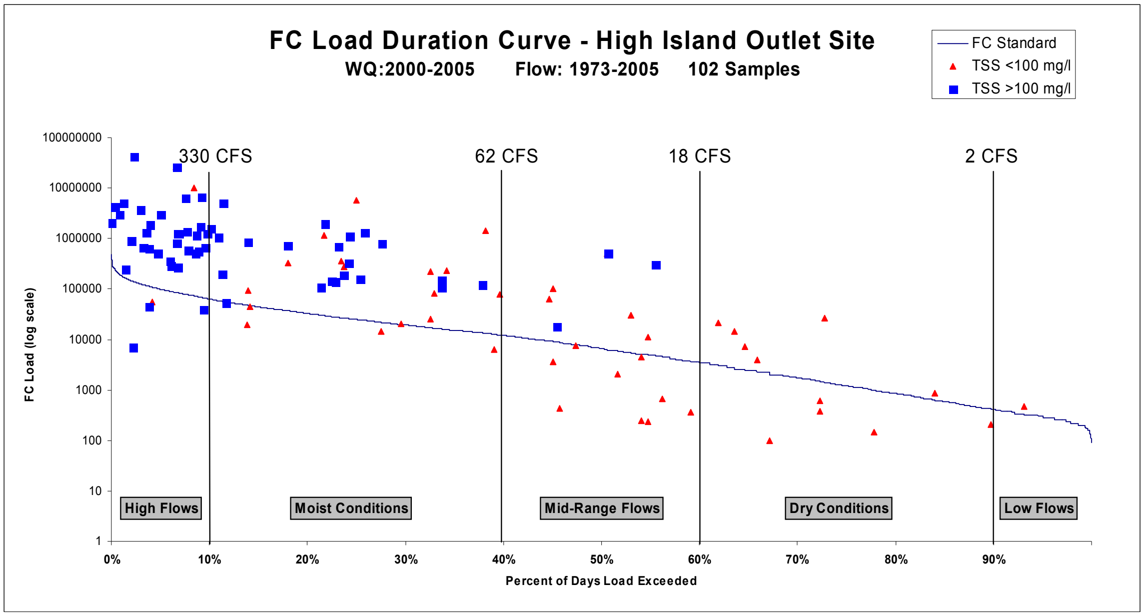


Figure 3.5 – TSS Load Duration Curve for High Island Creek, near Henderson

Tables 3.5a and 3.5b present statistics relating fecal coliform bacteria and TSS for the High Island Creek and Rush River outlet sites. As total suspended solids increase bacterial concentrations also increase.

This data show there is a strong correlation of bacterial levels and TSS concentrations. While this might not be a causative relationship, best management practices that reduce soil erosion might reduce bacterial transport to streams. The data may also indicate in channel resuspension of streambed sediments that are laden with fecal coliform bacteria as a potential source (as discussed in section 2.6).

Table 3.5a – High Island Creek Outlet – FC vs. TSS Statistics

Total Suspended Solids (mg/L)	# Samples	Fecal Coliform GM	% Samples >200 FC	% Samples >2000 FC
<56	26	172	46.2%	7.7%
56-175	26	804	73.1%	34.6%
176-400	25	2,158	92.0%	40.0%
>400	25	3,909	100.0%	76.0%

Table 3.5b – Rush River Outlet – FC vs. TSS Statistics

Total Suspended Solids (mg/L)	# Samples	Fecal Coliform GM	% Samples >200 FC	% Samples >2000 FC
<56	28	169	46.4%	0.0%
56-175	20	647	70.0%	25.0%
176-400	13	1,289	92.3%	23.1%
>400	18	3,755	100.0%	77.8%

3.6 Geographic Scope of Impairment

Every stream reach in the HICW and RRW with adequate monitoring data qualifies to be listed as impaired for fecal coliform bacteria. Furthermore, these sites greatly exceed recommended water quality standards during the summer and fall months.

3.7 Seasonality

Tables 3.7a and 3.7b provide monthly fecal coliform bacteria statistics for High Island Creek and Rush River outlets monitoring sites. Monitoring data show a clear relationship between season and fecal coliform bacteria concentration. Typically the highest bacterial concentrations are found in June through September. April is usually the monitoring month with the lowest bacteria concentrations, despite the fact that significant manure application occurs during this time and that fields have little crop canopy to protect against water erosion. The lower FC concentrations in August are explained by lack of flow, as both HIC and RR are usually at nearly no flow condition. During these dry periods, groundwater is often the only source of flow and fecal coliform concentrations are much lower.

Table 3.7a – High Island Creek Outlet FC Statistics by Month

Month	# Samples	Fecal Coliform GM	% Samples >200 FC	% Samples >2000 FC
March	2	na	na	na
April	16	218	56.3%	12.5%
May	31	483	58.1%	25.8%
June	37	2,010	94.6%	45.9%
July	19	1,273	89.5%	36.8%
August	8	180	37.5%	0.0%
September	9	2,563	88.9%	77.8%

Table 3.7b - Rush River Outlet FC Statistics by Month

Month	# Samples	Fecal Coliform GM	% Samples >200 FC	% Samples >2000 FC
March	3	na	na	na
April	13	150	46.2%	15.4%
May	24	396	54.2%	20.8%
June	31	1,036	90.3%	32.3%
July	15	937	86.7%	20.0%
August	9	428	44.4%	11.1%
September	9	1,018	88.9%	33.3%

The apparent seasonality of fecal coliform bacteria concentrations appears to be associated strongly with stream water temperature. Seasonal changes in landuse, such as timing of manure application, appear to have little correlation with seasonality of bacterial concentrations. Fecal coliform bacteria are the most productive at temperatures similar to their origination environment in animal intestines. Therefore fecal coliform bacteria are at their highest concentrations during warmer temperatures, possibly due to reproduction in numbers. However, at lower temperatures it is probable the metabolism of organisms slow, therefore prolonging their existence (Chapelle, 2001; Cullimore, 1993). Thus, while bacterial concentrations may be lower during colder periods, survival rates are increased.

As part of the HICW and RRW CWP diagnostic studies, stream water temperature monitoring was not conducted. However, monitoring projects conducted by the WRC near these watersheds have shown the relationship of bacteria and stream temperature. Figure 3.7 provides an example of this association at the Beauford Creek Watershed (10 miles south of Mankato, Minnesota). The figure displays the percentage of baseflow samples that exceeded the surface water standard of 200 cfu/100 ml based on stream temperature classification. The data set included 76 samples collected during the 2000, 2004, and 2005 monitoring seasons and excluded all samples collected within 48 hours of greater than 0.5 inches of precipitation. The data show a significant association between stream temperature and fecal coliform bacteria concentration. The higher bacterial concentrations during the warm summer/fall months may also be associated with greater nutrient and algae concentrations at that time of year. Nutrients and algae may support bacterial growth and therefore temperature may be a secondary factor.

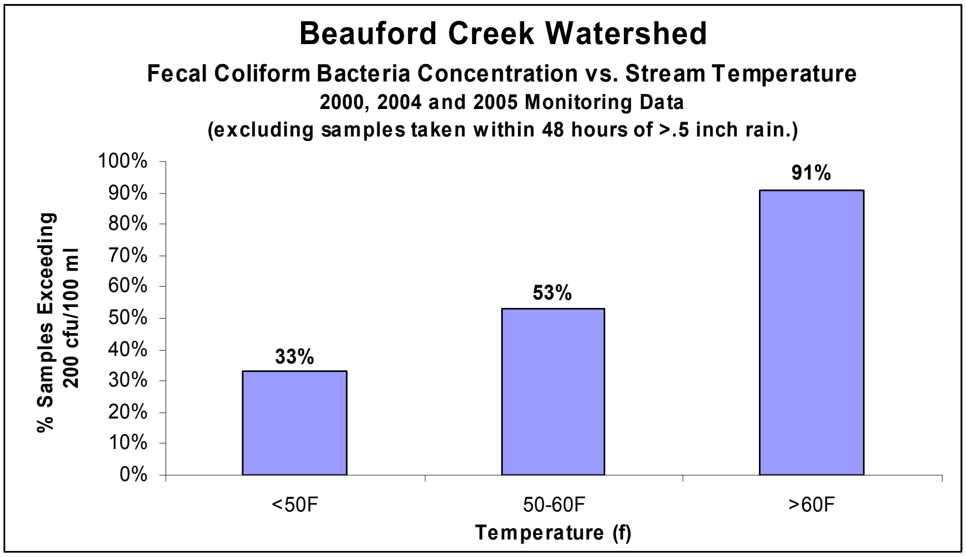


Figure 3.7 – Beauford Creek – Fecal Coliform vs. Stream Temperature

Data presented in Sections 3.3 – 3.7 illustrate the effects of precipitation, runoff, flow, season and water temperature on the presence and/or population of fecal coliform bacteria at the outlet sites of the Rush River and High Island Creek. No single factor appears to fully explain the temporal variability of fecal coliform concentrations observed in the watersheds. A multivariate statistical analysis would be required to identify the factor or combination of factors that is most likely to result in elevated levels of coliform bacteria. For the purposes of this study, it is sufficient to say that a combination of environmental factors as described above accounts for the delivery, proliferation and longevity of fecal coliform bacteria in the Rush River and High Island Creek watersheds.

3.8 Trends in Fecal Coliform Surface Water Quality

It is not possible to assess trends in bacterial concentrations as monitoring data only exists since the late 1990’s.

3.9 TMDL Endpoints

TMDL endpoints will meet the 200 organism/100 ml “chronic” standard and 2000 “acute” standard for fecal coliform bacteria. Section 4.0 outlines the process used to determine monthly and daily TMDL allocations for each of the impaired streams. This process involved using long term flow data from three USGS flow gauging stations and incorporating the two numeric water quality standards for fecal coliform bacteria.

The first numerical standard is that streams will have a monthly geometric mean below 200 org/100 ml. This standard was incorporated to calculate the monthly loading capacity and allocations. The second numerical standard is that no more than 10% of samples may exceed 2000 org/100 ml and was used to calculate the daily loading capacity and allocations. Daily loading capacity and allocations were determined as 1/3rd the monthly loading capacity and allocations. This relates to the 2000 numerical standard being a factor of 10 times the 200 numerical standard. Neither the monthly or daily loading capacities (nor individual allocations) may be exceeded.

Section 4.0 – Explanation of Load Allocations (LA) Wasteload Allocations (WLA) and Margin of Safety (MOS)

The following section provides background information, water quality data and load/wasteload allocations for the seven impaired stream reaches. The TMDL assessment process was modeled after the approach used in the Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairment in the Lower Mississippi River Basin in Minnesota, (MPCA, 2006).

The TMDLs consist of three components; WLA, LA and MOS as defined in section 1.2 on page 2. The WLA includes three subcategories: permitted wastewater treatment facilities; livestock facilities requiring NPDES permits, and “straight pipe” septic systems. The LA, reported as a single category includes manure runoff from farm fields, pastures, and smaller non-NPDES-permitted feedlots, runoff from non-MS4 communities, and fecal coliform bacteria contributions from wildlife. The LA includes land-applied manure from livestock facilities requiring NPDES permits, provided the manure is applied in accordance with a permit. The third component, MOS, is the part of the allocation that accounts for uncertainty that the allocations will result in attainment of water quality standards.

The three components were calculated as monthly loads of fecal coliform organisms. The fecal coliform load limits were calculated for five flow regimes, from near drought to flood condition. This method is referred to as the duration curve approach. By adjusting the WLA, LA and MOS to a range of five discrete flow intervals at each reach, a closer correspondence is obtained between the flow-specific loading capacity and the TMDL components at the range of flow conditions experienced historically at each site.

The duration curve approach involved using long term (1973-2005) flow monitoring data from the High Island Creek outlet USGS gaging site. Monthly mean flow values were obtained for April through October, from 1973 through 2005. The April through October period was selected as this corresponds with the fecal coliform standard. Table 4.0a presents the USGS monthly flow values for High Island gaging site.

Table 4.0a – High Island Creek, Monthly Mean Flow Values, CFS (1973-2005)

	Monthly Mean Flow						
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
1973							5
1974	144	88	143	7	2	1	2
1975	245	206	125	78	3	2	9
1976	22	3	2	1	1	1	2
1977	11	7	6	40	8	11	25
1978	159	94	90	22	17	36	21
1979	564	205	112	77	342	299	81
1980	86	26	88	7	4	7	4
1981	13	7	23	36	245	157	99
1982	511	234	153	12	4	23	79
1983	593	189	122	205	61	61	74
1984	555	327	362	187	82	10	188
1985	302	220	144	61	22	68	298
1986	572	381	370	333	101	303	203
1987	37	13	40	59	14	6	4
1988	33	22	6	1	1	2	2
1989	39	13	4	6	4	3	2
1990	7	47	247	124	86	8	3
1991	154	261	232	64	66	592	190
1992	193	119	197	155	92	235	159
1993	420	478	646	783	353	196	60
1994	260	235	185	159	130	483	264
1995	340	261	213	95	51	26	105
1996	260	180	162	31	4	2	4
1997	585	90	100	575	380	88	57
1998	406	99	268	175	29	7	20
1999	295	346	157	103	16	5	3
2000	7	14	77	47	5	2	2
2001	1,104	390	239	23	4	3	2
2002	26	43	393	150	225	64	98
2003	74	251	116	53	3	2	2
2004	11	163	746	233	16	36	30
2005	236	194	366	75	7	78	

The resulting 224 monthly flow values were then sorted by flow volume, from highest to lowest to develop a flow duration curve (similar to the “daily” flow duration curve described in section 3.4). Figure 4.0a displays the flow duration curve for the High Island Creek outlet monitoring site. The chart depicts the percentage of time any particular flow is exceeded. For example, during the flow record 366 CFS was exceeded by 10% of monthly flow values, and thus represents “high flow” conditions. A value of 3 CFS was exceeded by 90% of monthly flow values and represents “low flow” conditions.

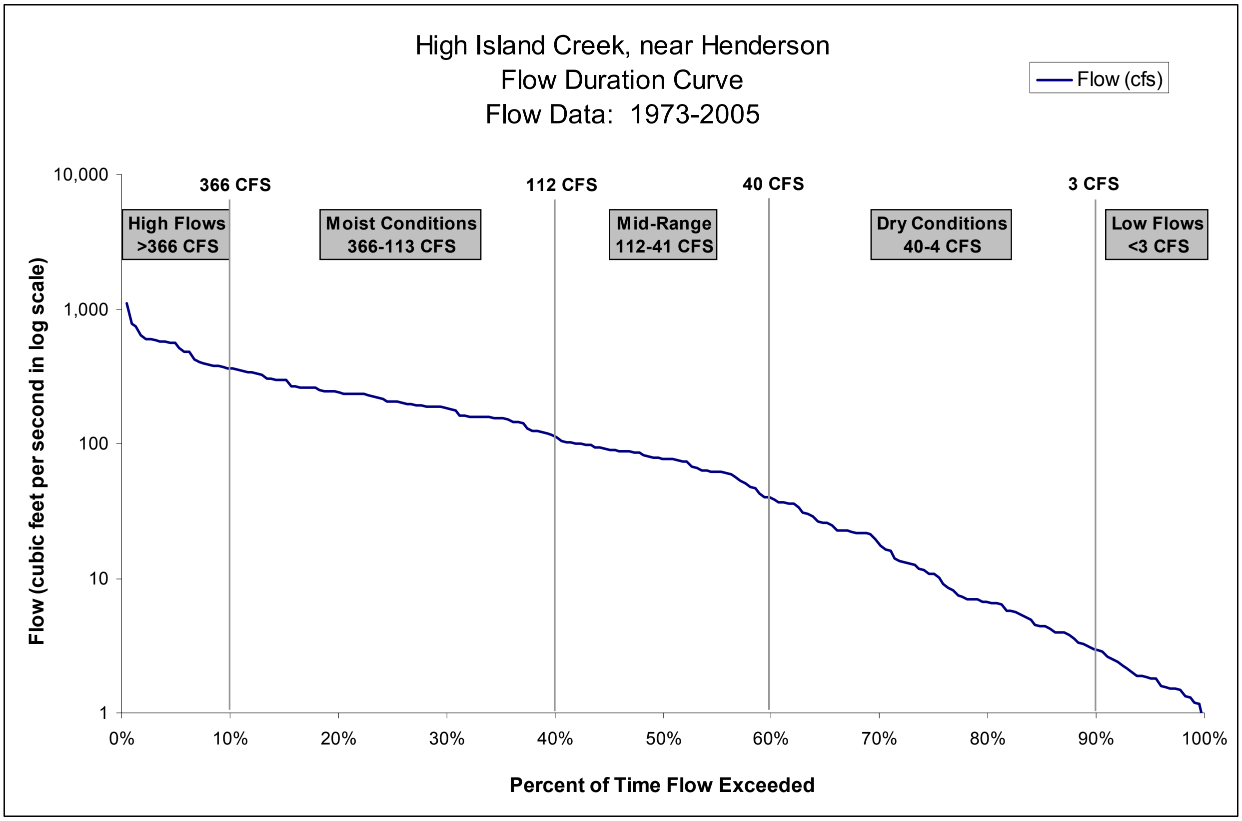


Figure 4.0a – High Island Creek Flow Duration Curve (based on mean monthly flows)

Flow regimes were determined for high flow, moist, mid-range, dry, and low flow conditions. The mid-range flow value for each flow regime was then used to calculate the total monthly loading capacity (TMLC). Thus, for the "high flow" regime, the loading capacity is based on the monthly flow value at the 5th percentile. At this flow value, the mean monthly flow would be exceeded by 5% of all flow values in the dataset. Table 4.0b presents the flow regimes that were determined for the High Island Creek gaging site, along with the flow value used to calculate the TMLC.

Table 4.0b – Flow Regimes and Values Used to Calculate Total Monthly Loading Capacity

Flow Condition	Percent of Time Flow Exceeded	Flow Range	Flow Used to Calculate Total Monthly Loading Capacity
High	0-10%	>366	555
Moist	10-40%	113-366	205
Mid	40-60%	41-112	78
Dry	60-90%	4-40	11
Low	90-100%	<3	2

The flow used to determine loading capacity for each flow regime was multiplied by a conversion factor of 146,776,126,400. This conversion factor is defined by the following equation:

Load Capacity (org/month) = Concentration (org/100mL) *X* Flow (cfs) *X* (200 cfu/100ml)
Multiply by 3,785.2 to convert mL per gallon to cfu/100 gallons
Divide by 100 to convert to cfu/gallon
Multiply by 7.48 to convert gallon per ft^3 to org/ft^3
Multiply by 86,400 to convert seconds per day to ft$^{3/}$day
Multiply by 30 to convert day per month to ft$^{3/}$month
Multiply by the water quality standard of 200 cfu/100 ml
Load Capacity (cfu/month) = 733,880,632 *X* Flow

Next, a Margin of Safety was determined for each flow regime. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. Because the allocations are a direct function of monthly flow, accounting for potential flow variability is the appropriate way to address the MOS. This is done within each of 5 flow zones. The MOS was determined as the difference between the median flow and minimum flow in each zone. For example, the MOS for the high flow zone is the 95th percentile flow value subtracted from the 100th percentile flow value. The resulting value was converted to a load and used as the MOS. The values that were used to calculate the TMLC and MOS are presented in figure 4.0b.

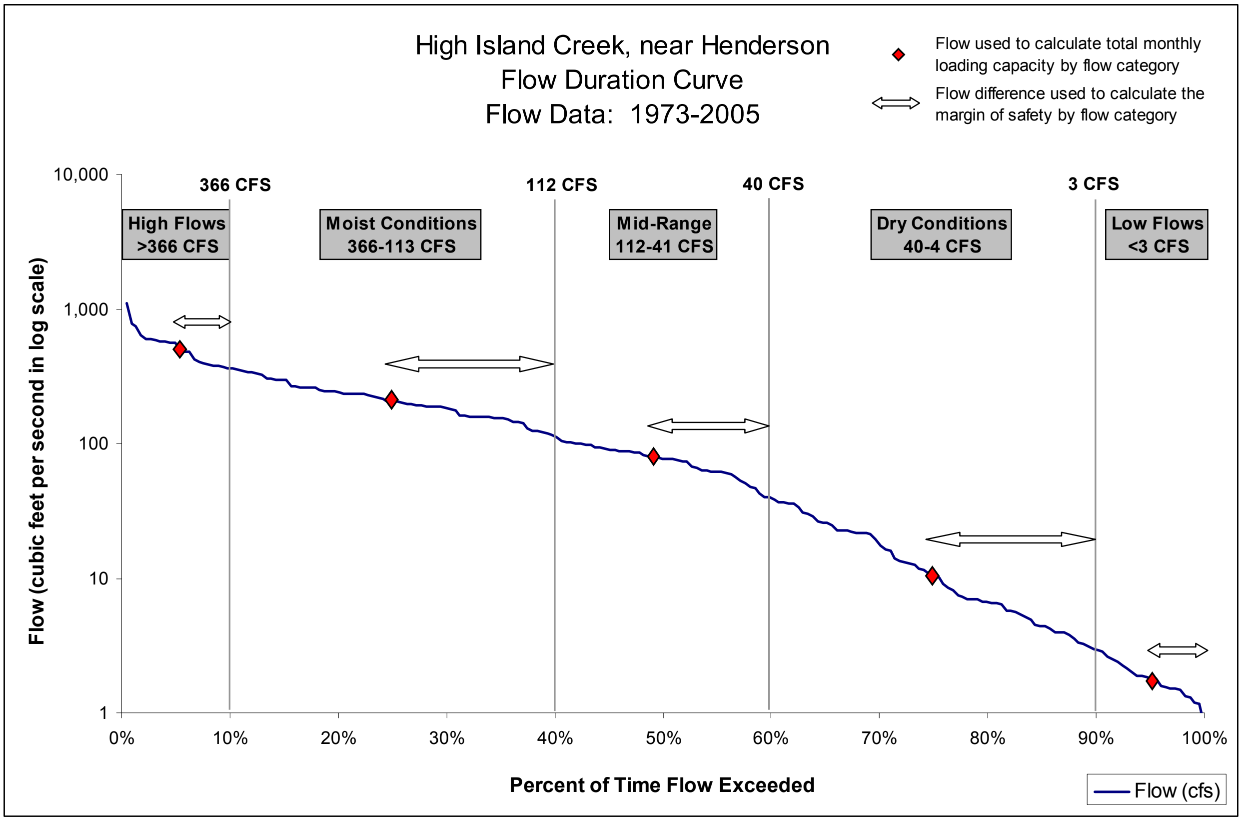


Figure 4.0b – High Island Creek Flow Duration Curve with TMLC and MOS

Table 4.0c presents the resulting TMDL Allocation (WLA+LA) and MOS for the High Island Creek outlet impaired reach based on the five flow regimes. The values expressed are in total organisms per month. For each of the five flow regimes, the monthly flow volume was multiplied by the water quality standard of 200 organisms/100 ml. This usually produces loading capacities in the trillions of organisms per month (T-org/month).

Table 4.0c – TMDL and MOS for High Island Creek

Flow Zone	TMLC	MOS	Allocation
High	81.46	27.87	53.59
Moist	30.09	13.72	16.37
Mid	11.45	5.59	5.86
Dry	1.61	1.14	0.47
Low	0.29	0.15	0.15

* Values expressed as trillion organisms per month

The remaining four HICW impaired stream reaches lack long term flow monitoring data. Flow values for these impaired watersheds were calculated by normalizing data from the High Island Creek USGS gage station. For example, the Buffalo Creek impaired stream reach is approximately 11% of the watershed area monitored by the High Island Creek gaging station. To determine flow zones for the Buffalo Creek site, mean monthly flows were assumed to be 11% of the flow volumes at the High Island Creek outlet gaging station. These values were then checked against available flow data for Buffalo Creek (which had flow data for 2001, 2002, 2004 and 2005). Table 4.0d presents available mean monthly flow data for the High Island USGS gage station and Buffalo Creek outlet station. Based on available data, Buffalo Creek had an average mean flow that was 10% of the High Island USGS gage. Generally, normalized monthly flow values based the USGS sites were very close to actual monitored flows. The method was also used to estimate monthly mean values for the Rush River Watershed, which only had flow data for 2003-2005.

Table 4.0d – Mean Monthly Flow Values (CFS, 2001-2005) for High Island Creek and Buffalo Creek Outlet Monitoring Sites

	Mean Monthly Flow (CFS)		
Month/Year	**Buffalo Creek Outlet Site**	**High Island Creek Outlet Site**	**% Difference**
Apr-01*	115.9	1345.9	9%
May-01	17.2	390.0	4%
Jun-01	18.1	239.0	8%
Jul-01	1.4	23.0	6%
Aug-01	0.03	3.6	1%
Sep-01	0.2	2.5	7%
Apr-02	3.8	26.1	15%
May-02	7.2	43.0	17%
Jun-02	88.7	392.7	23%
Jul-02*	7.5	218.1	3%
Mar-04	6.8	38.0	18%
Apr-04	1.8	11.4	16%
May-04	21.0	163.2	13%
Jun-04	60.3	745.8	8%
Jul-04	20.1	233.1	9%
Aug-04	0.4	15.9	2%
Sep-04	6.7	35.2	19%
Apr-05	26.2	235.9	11%
May-05	30.4	193.5	16%
Jun-05	26.2	365.5	7%
Jul-05	8.2	75.1	11%
Aug-05	0.2	6.7	2%
Sep-05	2.0	77.7	3%
Oct-05*	20.6	214.2	10%
Mean Flow	**20.5**	**212.3**	**10%**

* Data missing, mean value based on days when both sites had flow data.

The TMDL is divided into WLA and LA components. A description of the process used to determine the WLA and LA is provided below. The process is taken directly from the Regional Lower Mississippi TMDL report:

WASTELOAD ALLOCATION

- *Wastewater treatment facility (WWTF) allocations were calculated by multiplying wet-weather design flows for all facilities in an impaired reach watershed by the permitted discharge limit (200 organisms per 100ml) that applies to all WWTFs. As long as WWTFs discharge at or below this permit limit, they will not cause violations of the fecal coliform water quality standard regardless of their fecal coliform load.*
- *A number of smaller NPDES-permitted WWTF's are stabilization ponds systems. Unlike the larger (and some smaller) mechanical treatment systems which have continuous discharges, pond systems typically discharge over a 1-2 week period in the spring and in the fall. Because the discharge volumes from these pond systems are small, and to provide an extra margin of safety in the event they need*

to discharge outside of the spring or fall window, the WWTF wasteload allocation assumed that these facilities could discharge for an entire month under any flow conditions.

- *Straight-pipe septic systems are illegal and un-permitted, and as such are assigned a zero wasteload allocation.*
- *Since wet-weather design flows represent a "maximum" flow for a facility, the WWTF allocations are conservative in that they are substantially greater than what is actually required.*
- *For the Rush River and High Island outlet impaired stream reaches WWTF design flow exceeded minimum stream flow for the low flow zone. Of course, actual WWTF flow can never exceed stream flow as it is a component of stream flow. To account for this unique situation, the wasteload and load allocations are expressed as an equation rather than an absolute number. That equation is simply:*

  Allocation = (flow contribution from a given source) X (200 orgs./100ml.)

  In essence, this amounts to assigning a concentration-based limit to the nonpoint source load allocation sources. While this might be seen as overly stringent, these sources tend not to be significant contributors under dry and low flow conditions. The contribution of fecal coliform from straight-pipe septic systems could be substantial under these conditions; however these systems are still assigned a zero allocation, as are livestock facilities with NPDES permits.
- *Livestock facilities that have been issued NPDES permits are assigned a zero wasteload allocation. This is consistent with the conditions of the permits, which allow no pollutant discharge from the livestock housing facilities and associated site. Discharge of fecal coliform from fields where manure has been land applied may occur at times. Such discharges are covered under the load allocation portion of the TMDLs, provided the manure is applied in accordance with the permit.*

LOAD ALLOCATION

- *Once the WLA and MOS were determined for a given reach and flow zone, the remaining loading capacity was considered load allocation. The load allocation includes nonpoint pollution sources that are not subject to NPDES permit requirements, as well as "natural background" sources such as wildlife. The nonpoint pollution sources are largely related to livestock production, inadequate human wastewater treatment, and municipal stormwater systems. Straight-pipe septic systems and communities covered by MS4 NPDES permits, are included in the wasteload allocation.*

Daily Loading Capacity and Allocations

The TMDLs are expressed in both monthly and maximum daily terms. This is to ensure that both the monthly geometric mean and upper 10th percentile portions of the water quality standard are addressed. All maximum daily loading capacity and allocation values are set at 1/3 rd of the monthly loading capacity and allocation values based on the following rationale:

The upper 10th percentile criterion is 10 times the geometric mean criterion (2000 org ./ 100ml = upper 10th percentile; 200 org./100ml = geometric mean). Thus, assuming average daily loading capacities and allocations are 1/30th of the monthly values, 10 times the average daily values could be allocated as maximum daily loading capacities and allocations under the upper 10th percentile standard. In mathematical terms the maximum daily value = 10 x 1/30th of the monthly value = 10/30th or 1/3 rd of the monthly value.

It is important to note that neither the daily or monthly loading capacities should be violated. In conceptual terms, 3 days of bacteria loads that approach the maximum daily capacities will "use up" most of the monthly capacity.

Impacts of Growth on Allocations and Need for Reserve Capacity

As a result of population growth and movement, changes in the agricultural sector, and other land use changes in the HICW and RRW, sources and pathways of bacteria to surface waters will not remain constant over time. The potential impact of these changes on specific bacteria sources are discussed below.

Straight-Pipe Septic Systems

As a result of state and local rules, ordinances, and programs, the number of straight pipe septic systems will decrease over time. Because these systems constitute illegal discharges, they are not provided a load allocation for any of the impaired reaches covered in this report. As such, other elements of the TMDL allocation will not change as these systems are eliminated.

Wastewater Treatment Facilities

Flows at some wastewater treatment facilities are likely to increase over time with increases in the populations they serve. As long as current fecal coliform discharge limits are met at these facilities, however, such increases will not impact the allocation provided to other sources. This is because increased flows from wastewater treatment facilities add to the overall loading capacity by increasing river flows.

Potential Industrial Facilities

In the event that an industrial facility within the watershed receives a NPDES permit and discharges stormwater with a bacterial component, a portion of the Load Allocation, proportional to the land area occupied by the facility, will be transferred to the WLA to accommodate this load.

Livestock

Along with humans, the other major source of fecal coliform in the watersheds are livestock. While there have been changes in the sizes and types of facilities, there do not appear to be clear trends in overall livestock numbers. With changes in facility size and type, a continuing shift in focus from the facilities themselves to land application practices may be warranted in the future. If growth in livestock numbers does occur, newer regulations for facility location and construction, manure storage design, and land application practices should help mitigate potential increases in fecal coliform loading to the streams and rivers of the basin.

For the reasons discussed above, no explicit adjustments were made to the waste load or load allocations, and no reserve capacity was added, to account for human or livestock population growth. The MPCA will monitor population growth, urban expansion, and changes in agriculture, and reopen the TMDLs covered in this report if and when adjustments to allocations may be required.

Section 5.0 - TMDL Allocations for Individual Impaired Reaches

5.1 High Island Creek; Unnamed Creek to Minnesota River

This 28.9 mile reach of High Island Creek extends from the outlet of High Island Creek at the Minnesota River to upstream at the confluence with High Island Lake outlet. The stream reach was placed on the impaired waters list in 2006. The majority of monitoring conducted on this portion of the river was from 2000 through 2006 by the High Island Creek Clean Water Partnership. Figure 5.1 displays the impaired stream reach, the watershed, and location of the monitoring site where water quality data were collected.

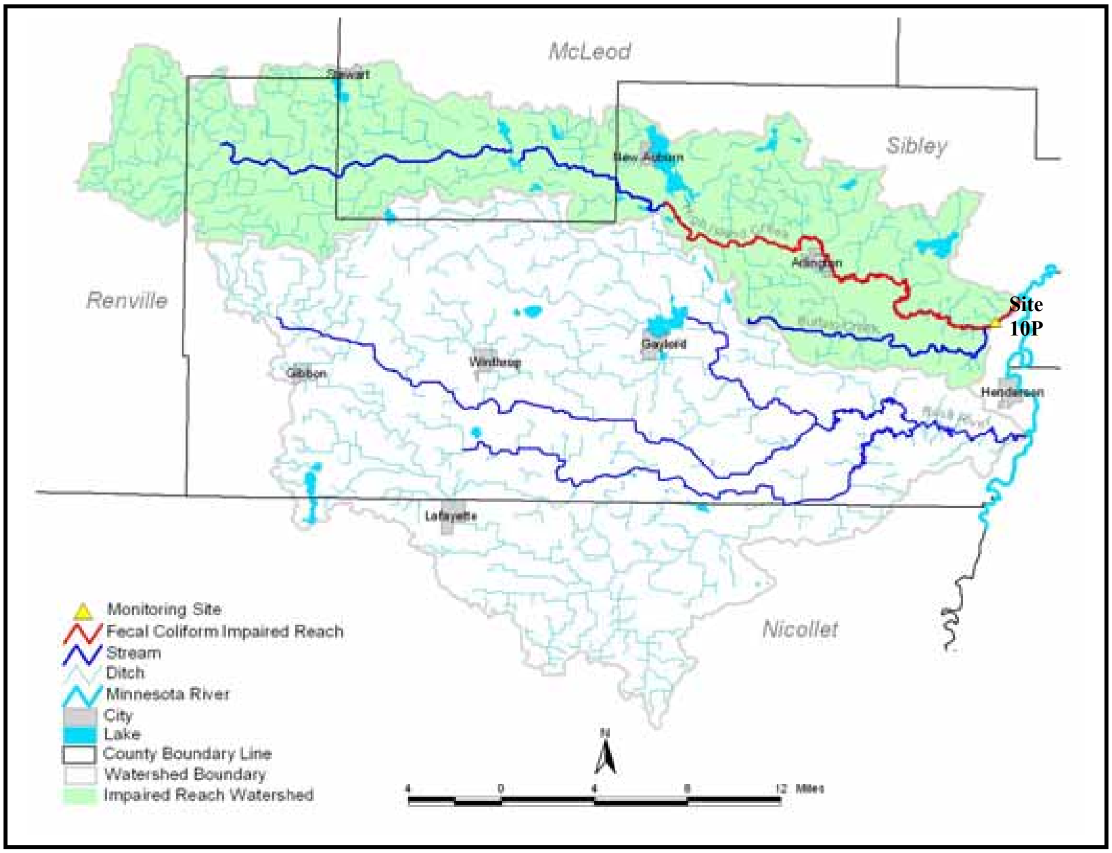


Figure 5.1 – High Island Creek; Unnamed Creek to Minnesota River

The impaired reach watershed includes all of High Island Creek Watershed. The watershed is 153,222 acres (239 square miles) in size and includes the communities of Arlington, New Auburn and a portion of Stewart. Wastewater from Arlington discharges into High Island Creek, ½ mile southeast of town (table 5.1a). New Auburn does not discharge treated wastewater as they utilize a spray irrigation system. The community of Stewart discharges wastewater outside the watershed. The watershed also includes five livestock facilities that have been issued NPDES permits (table 5.1b).

Table 5.1a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
Arlington	MN0020834	0.670	0.152
Totals		0.670	0.152

Table 5.1b - Livestock Facilities with NPDES Permits

Facility	ID Number
Brad Baumgardt Farm Sec 2	129-103300
Tesch Farms	143-50002
Five Star Dairy LLC	143-60460
Daniel Thoele Farm	143-89168
Larry Baumgardt Farm	143-89746

Table 5.1c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this reach of High Island Creek.

Table 5.1c - Monthly Fecal Coliform Loading Capacities and Allocations – High Island Creek; Unnamed Creek to Minnesota River

Drainage Area (square miles): 239										
Total WWTF Design Flow (mgd): 0.67	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	81.46	27.15	30.09	10.03	11.45	3.82	1.61	0.54	*	*
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.15	0.05	0.15	0.05	0.15	0.05	0.15	0.05	*	*
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	53.44	17.81	16.21	5.40	5.70	1.90	0.32	0.11	*	*
Margin of Safety	27.87	9.29	13.72	4.57	5.59	1.86	1.14	0.38	na	na
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		*	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.2%		0.5%		1.3%		9.4%		*	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.6%		53.9%		49.8%		19.7%		*	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		na	

*Note - WWTF design/discharge flow exceeded low flow

alllocation = (flow contribution from a given source) X (200 orgs./100ml.), see section 5.0 for details

5.1.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.1.1 – Required Fecal Coliform Reductions; Site 10P – High Island Creek Outlet

Month	Monthly GM (cfu/100ml)	Required Reduction
April	218	8.3%
May	549	63.6%
June	1,996	90.0%
July	1,273	64.3%
August	180	None Required
September	2,563	92.2%

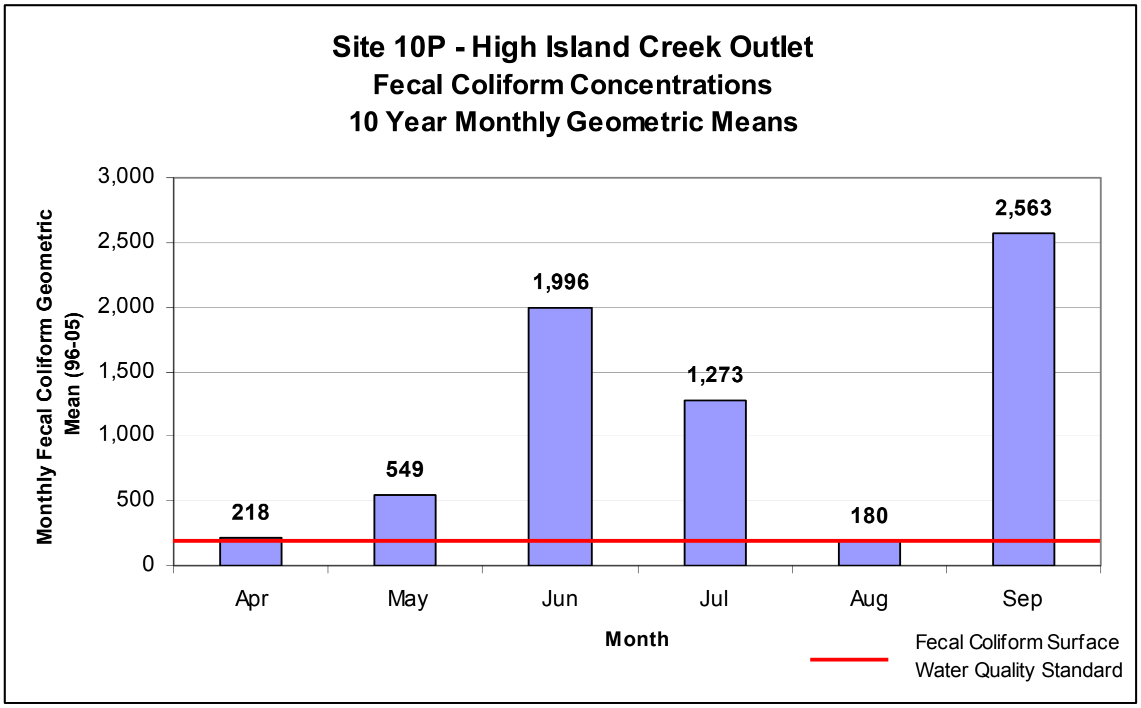


Figure 5.1.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.2 High Island Creek; JD 15 to Unnamed Creek

This 17.6 mile reach of High Island Creek extends from confluence of High Island Lake outlet and High Island Creek upstream to the headwaters of High Island Creek. The stream reach was placed on the impaired waters list in 2002. The majority of monitoring conducted on this portion of the river was from 2000 through 2002 by the High Island Creek Clean Water Partnership. Monitoring during this period was conducted at two sites along the impaired reach. Figure 5.2 displays the impaired stream reach, the watershed, and location of monitoring sites where water quality data were collected.

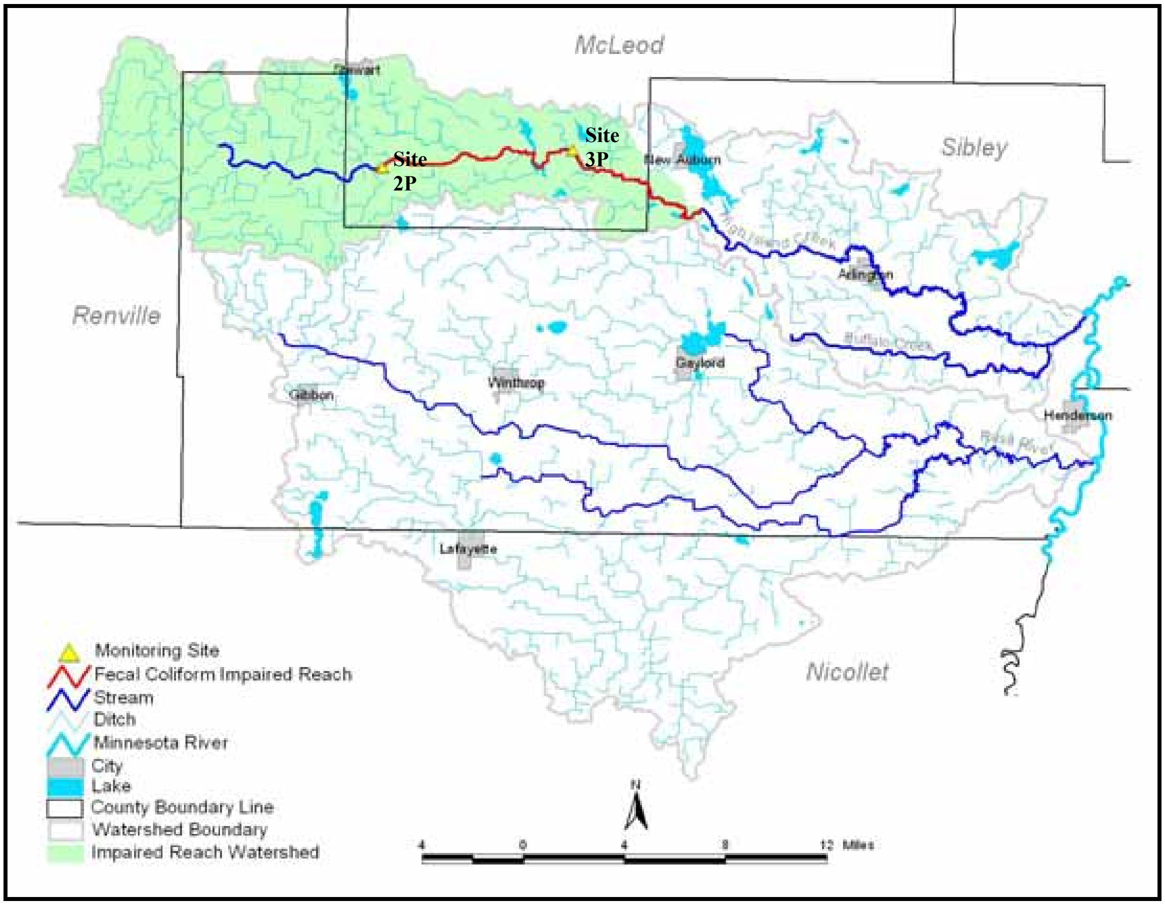


Figure 5.2 - High Island Creek; JD 15 to Unnamed Creek

The impaired reach watershed includes the upper portion of High Island Creek watershed. The impaired watershed is 83,121 acres (130 square miles) and includes the south portion of the City of Stewart. Stewart discharges wastewater outside the watershed, thus no wasteload allocation is included in this TMDL. The watershed also includes two livestock facilities that have been issued NPDES permits (table 5.2b).

Table 5.2a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
None			
Totals		0.000	0.000

Table 5.2b - Livestock Facilities with NPDES Permits

Facility	ID Number
Brad Baumgardt Farm Sec 2	129-103300
Larry Baumgardt Farm	143-89746

Table 5.2c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for the impaired reach of High Island Creek.

Table 5.2c - Monthly Fecal Coliform Loading Capacities and Allocations – High Island Creek; JD 15 to Unnamed Creek

Drainage Area (square miles): 130										
Total WWTF Design Flow (mgd): 0.00	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	44.21	14.74	16.33	5.44	6.21	2.07	0.88	0.29	0.88	0.29
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	29.08	9.69	8.88	2.96	3.18	1.06	0.25	0.08	0.16	0.05
Margin of Safety	15.13	5.04	7.45	2.48	3.04	1.01	0.62	0.21	0.08	0.03
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		100%	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.0%		0.0%		0.0%		0.0%		0.0%	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.8%		54.4%		51.2%		29.1%		66.7%	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		33.3%	

5.2.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.2.1a - Required Fecal Coliform Reductions; Site 2P – Upstream Bakers Lake

Month	Monthly GM (cfu/100ml)	Required Reduction
April	Inadequate Data	Inadequate Data
May	223	10.3%
June	943	78.1%
July	963	79.2%
August	Inadequate Data	Inadequate Data
September	Inadequate Data	Inadequate Data

Table 5.2.1b - Required Fecal Coliform Reductions; Site 3P – Downstream Bakers Lake

Month	Monthly GM (cfu/100ml)	Required Reduction
April	Inadequate Data	Inadequate Data
May	85	None Required
June	560	64.3%
July	381	47.5%
August	Inadequate Data	Inadequate Data
September	Inadequate Data	Inadequate Data

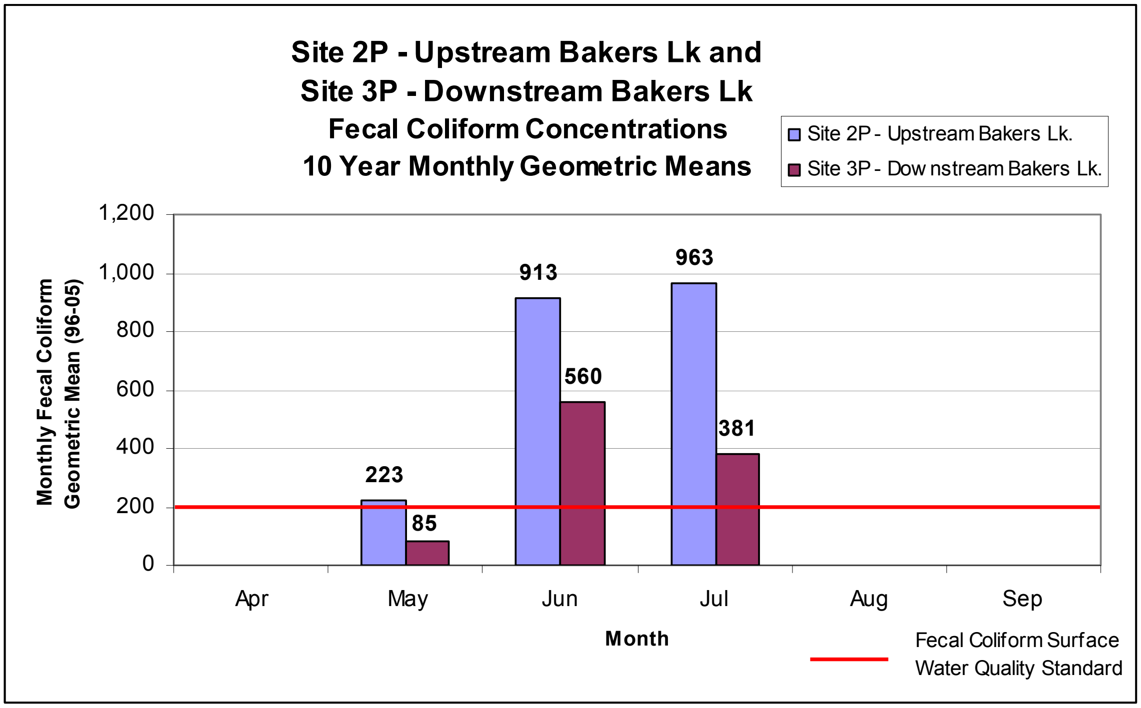


Figure 5.2.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.3 Buffalo Creek; Unnamed Creek to High Island Creek

This 6.8 mile reach of Buffalo Creek extends from the outlet at High Island Creek, upstream to the confluence of county ditch 59. The stream reach was placed on the impaired waters list in 2006. Water quality monitoring of this reach was conducted from 2000 through 2006 by the High Island Creek Clean Water Partnership. Figure 5.3 displays the impaired stream reach, the watershed, and location of the monitoring site where water quality data were collected.

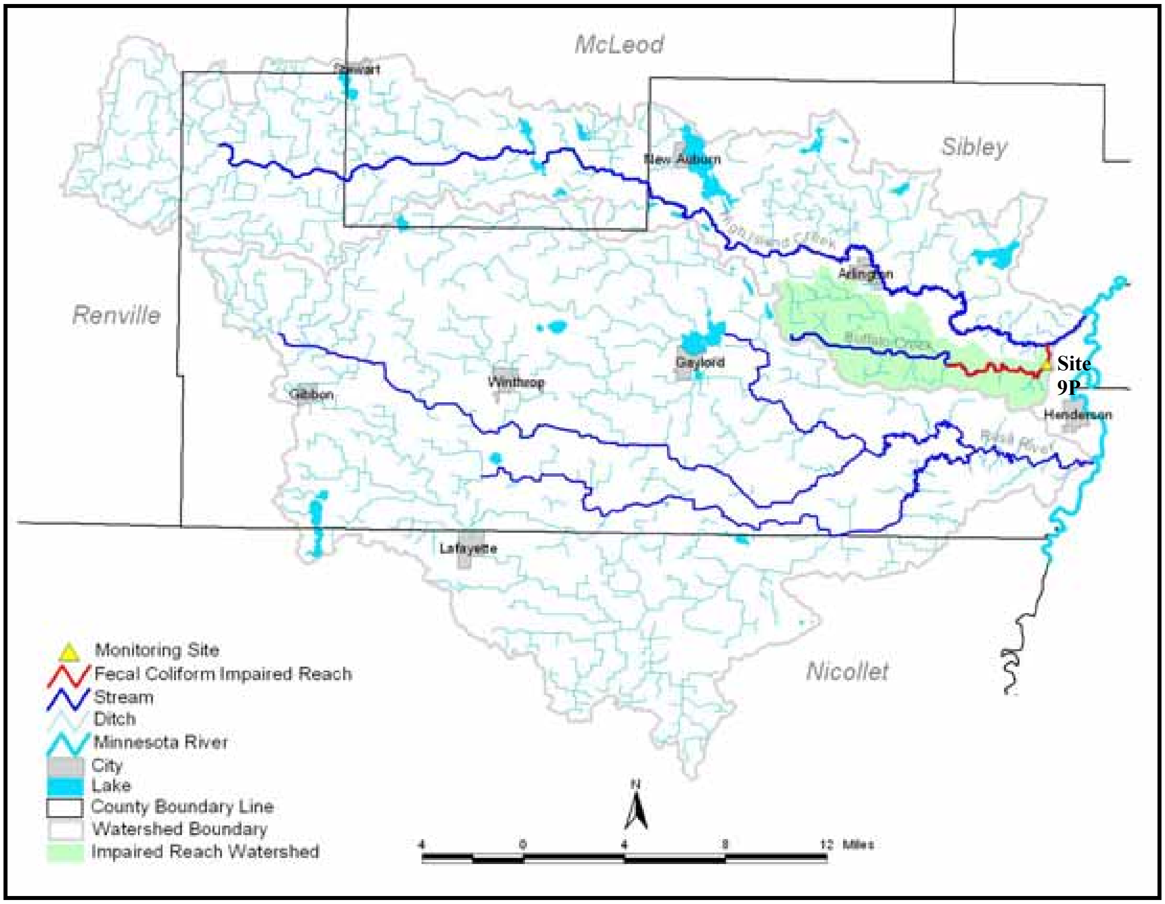


Figure 5.3 - Buffalo Creek; Unnamed Creek to High Island Creek

The impaired reach includes the entire Buffalo Creek watershed. The impaired watershed is 18,003 acres (28 square miles). The watershed contains no cities and thus no wasteload allocation is included in the TMDL. The watershed also includes three livestock facilities that have been issued NPDES permits (table 5.3b).

Table 5.3a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
None			
Totals		0.000	0.000

Table 5.3b - Livestock Facilities with NPDES Permits

Facility	ID Number
Tesch Farms	143-50002
Five Star Dairy LLC	143-60460
Daniel Thoele Farm	143-89168

Table 5.3c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this reach of Buffalo Creek.

Table 5.3c - Monthly Fecal Coliform Loading Capacities and Allocations – Buffalo Creek; Unnamed Creek to High Island Creek

Drainage Area (square miles): 28										
Total WWTF Design Flow (mgd): 0.00	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	9.58	3.19	3.54	1.18	1.35	0.45	0.19	0.06	0.03	0.01
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	6.30	2.10	1.92	0.64	0.69	0.23	0.06	0.02	0.03	0.01
Margin of Safety	3.28	1.09	1.61	0.54	0.66	0.22	0.13	0.04	0.02	0.01
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		100%	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.0%		0.0%		0.0%		0.0%		0.0%	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.8%		54.4%		51.2%		29.1%		66.7%	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		33.3%	

5.3.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.3.1 – Required Fecal Coliform Reductions; Site 9P – Buffalo Creek Outlet

Month	Monthly GM (cfu/100ml)	Required Reduction
April	100	None Required
May	354	43.5%
June	1,938	89.7%
July	1,461	86.3%
August	263	24.0%
September	1,060	81.1%

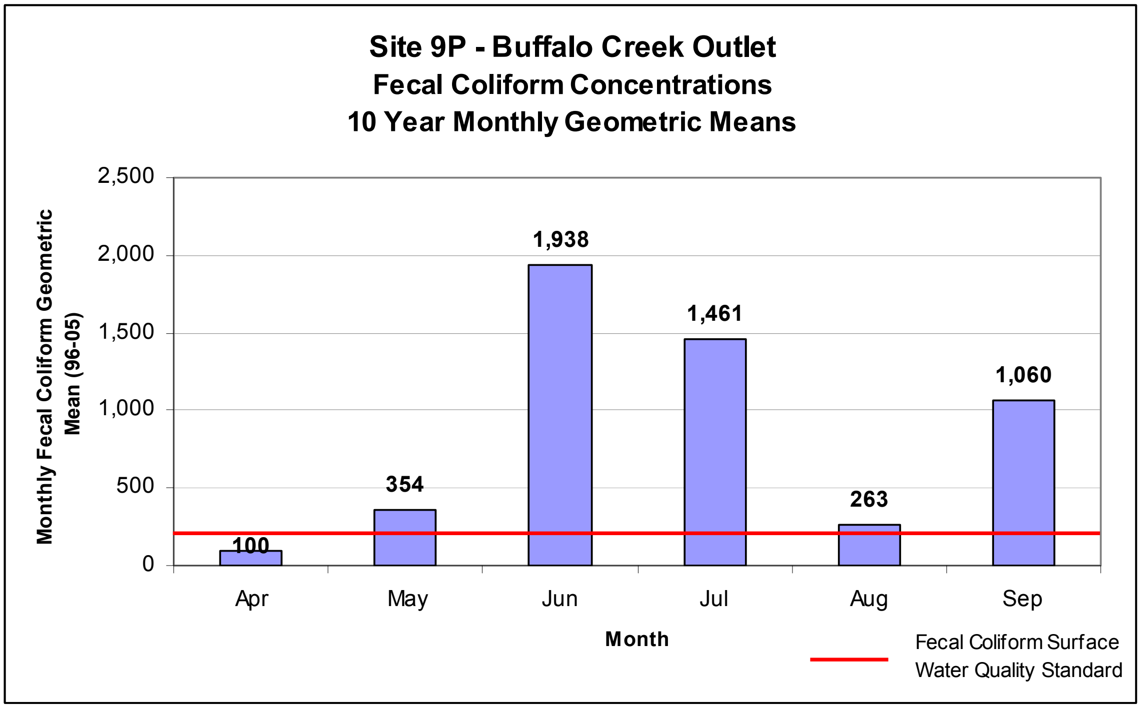


Figure 5.3.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.4 Buffalo Creek; High Island Ditch 5 to Unnamed Stream

This 3.2 mile reach of Buffalo Creek extends from county ditch 59 upstream to the confluence with High Island Ditch 5. The stream reach was placed on the impaired waters list in 2006. Monitoring was conducted on this impaired reach in 2001 and 2002 by the High Island Creek Clean Water Partnership. Figure 5.4 displays the impaired stream reach, the watershed, and location of the monitoring site where the water quality data were collected.

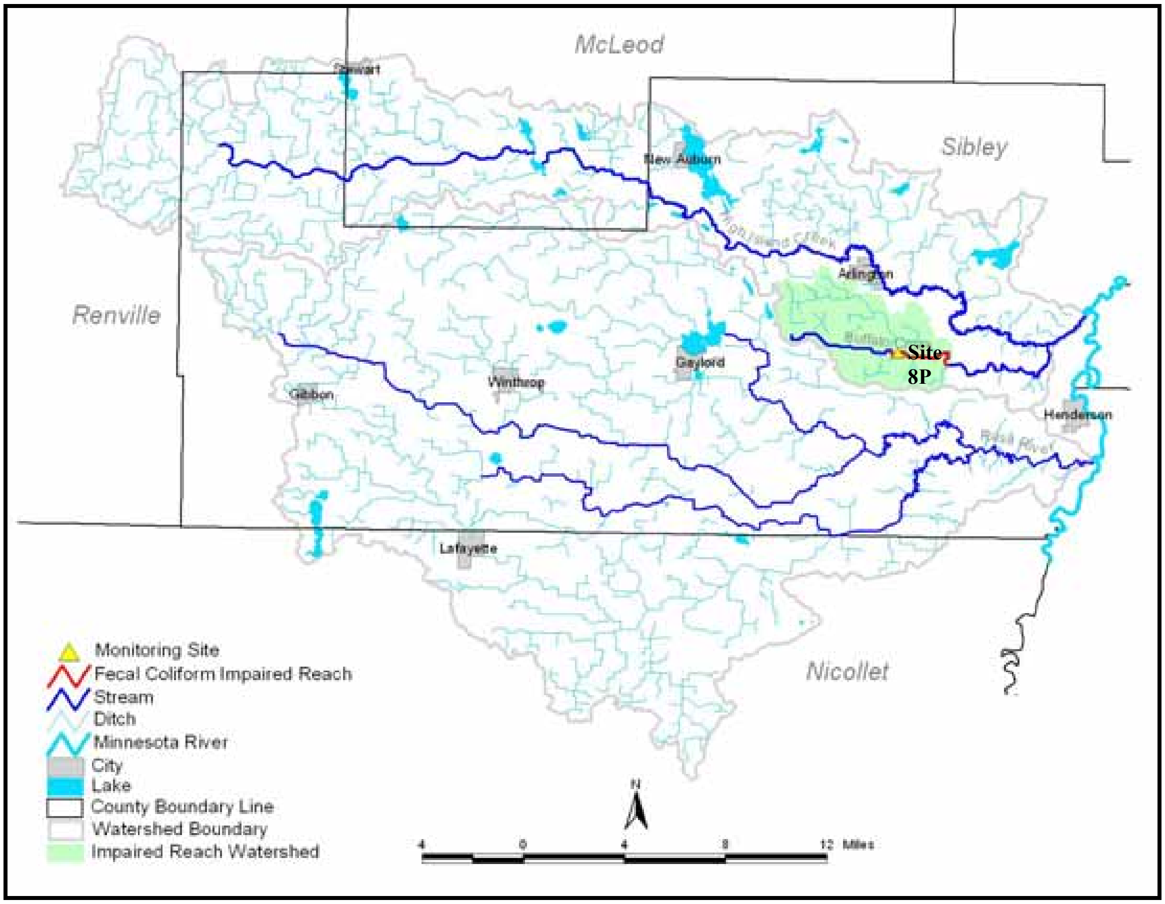


Figure 5.4 - Buffalo Creek; High Island Ditch 5 to Unnamed Stream

The impaired reach encompasses the upper portion Buffalo Creek watershed. The impaired reach watershed is estimated to be 12,350 acres (19 square miles). The watershed contains no cities and thus no wasteload allocation is included in the TMDL. The watershed also includes two livestock facilities that have been issued NPDES permits (table 5.4b).

Table 5.4a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
None			
Totals		0.000	0.000

Table 5.4b - Livestock Facilities with NPDES Permits

Facility	ID Number
Five Star Dairy LLC	143-60460
Daniel Thoele Farm	143-89168

Table 5.4c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this reach of Buffalo Creek.

Table 5.4c - Monthly Fecal Coliform Loading Capacities and Allocations – Buffalo Creek; High Island Ditch 5 to Unnamed Stream

Drainage Area (square miles): 19										
Total WWTF Design Flow (mgd): 0.00	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	6.57	2.19	2.43	0.81	0.92	0.31	0.13	0.04	0.02	0.01
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	4.32	1.44	1.32	0.44	0.47	0.16	0.04	0.01	0.01	0.00
Margin of Safety	2.25	0.75	1.11	0.37	0.45	0.15	0.09	0.03	0.01	0.00
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		100%	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.0%		0.0%		0.0%		0.0%		0.0%	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.8%		54.4%		51.2%		29.1%		50.0%	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		50.0%	

5.4.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.4.1 – Required Fecal Coliform Reductions; County Ditch 59 (Upper Buffalo Creek)

Month	Monthly GM (cfu/100ml)	Required Reduction
April	Inadequate Data	Inadequate Data
May	243	17.7%
June	2,369	91.6%
July	1,299	84.6%
August	Inadequate Data	Inadequate Data
September	Inadequate Data	Inadequate Data

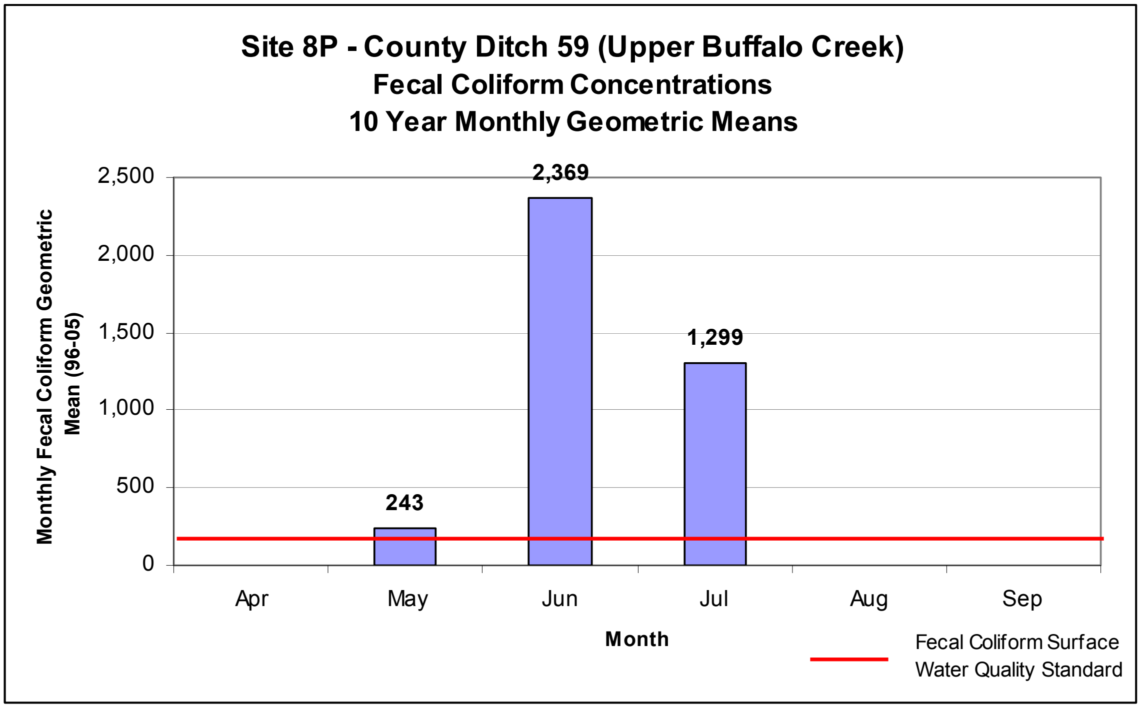


Figure 5.4.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.5 Rush River; South Branch Rush River to Minnesota River

This 8.1 mile reach of Rush River extends from the Minnesota River upstream to the rivers confluence with the South Branch Rush River. The stream reach was placed on the impaired waters list in 2002. Monitoring of this portion of the river was conducted in 1998 and 1999 by the MPCA and 2003 through 2006 by the Rush River Clean Water Partnership. Figure 5.5 displays the impaired stream reach, the watershed, and location of the monitoring site where the water quality data were collected.

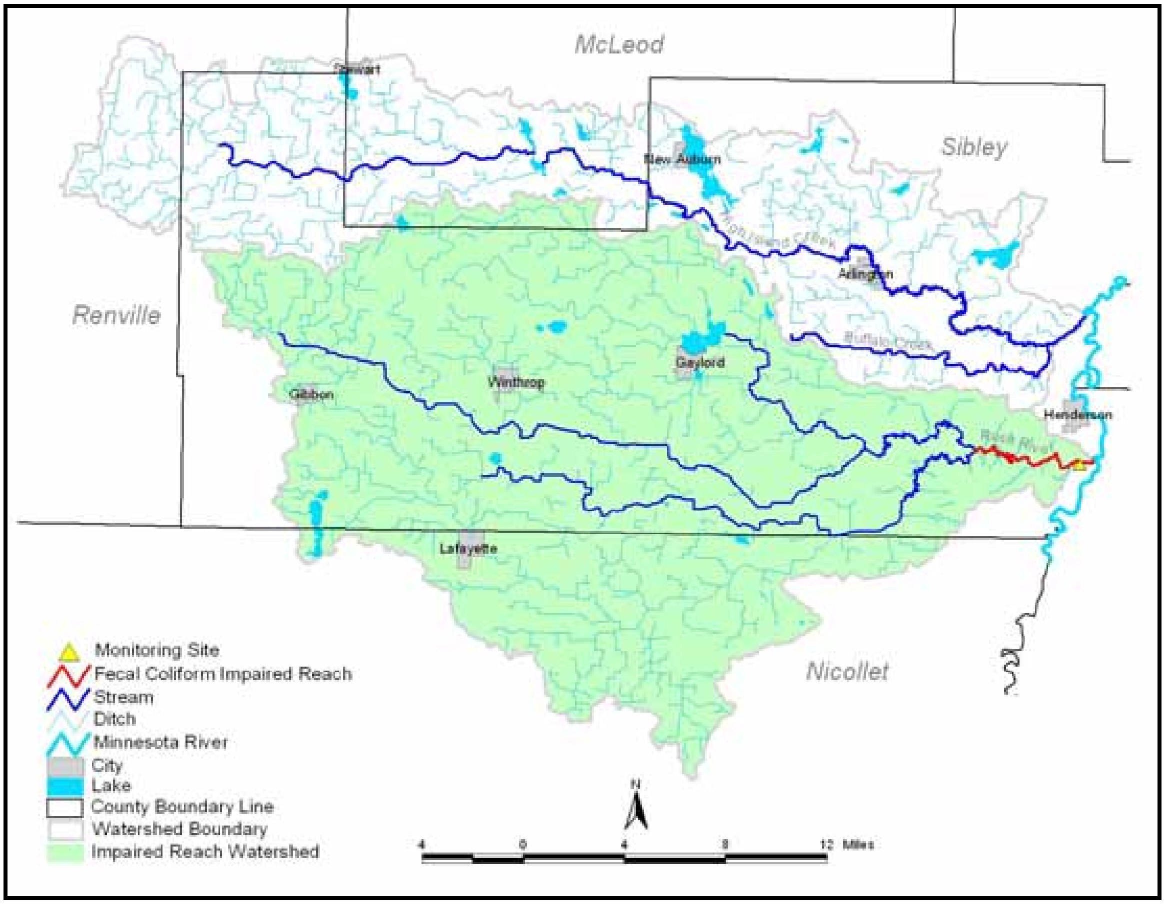


Figure 5.5 - Rush River; South Branch Rush River to Minnesota River

The impaired reach includes the entire Rush River Watershed, which is 257,775 acres (403 square miles). The watershed contains communities of Gaylord, Gibbon, Lafayette and Winthrop (table 5.5a), all of which discharge treated wastewater within the impaired watershed. The watershed also contains two unincorporated Hutterian Colonies, Starland and Altona, that have permitted waste water treatment facilities that discharge within the watershed. Lastly, MG Waldbaums, a large poultry processing plant located near Gaylord also has their own WWTP that discharges to the north Branch Rush River. The watershed includes 12 livestock facilities that have been issued NPDES permits (table 5.5b).

Table 5.5a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
Altona	MN0067610	0.106	0.012
Gaylord	MN0051209	4.401	0.500
Gibbon	MNG580020	0.505	0.057
Lafayette	MN0023876	0.095	0.022
Starland	MN0067334	0.066	0.007
Waldbaums	MN0060798	0.400	0.091
Winthrop	MN0051098	2.086	0.237
Totals		7.659	0.926

Table 5.5b - Livestock Facilities with NPDES Permits

Facility	ID Number
Warren Krohn Farm	103-50002
Waibel Pork Inc	103-50003
Corey Hotovec Farm	103-50007
Christensen Farms Site C016	103-50008
Josie's Pork Farm Inc - Gaylord	103-50017
Bruce & Laurie Platz Farm - Sec 10	103-97452
Duane & David Gran Farm - Sec 19B	103-97625
Adam Gleisner Farm Sec 2	103-97632
Pinpoint Research - Sec 29	103-97780
Paul & Donita Platz Farm	143-50001
MG Waldbaum - Golden Egg Farm	143-50004
Minnesota Pullets	143-50005

Table 5.5c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this reach of Rush River.

Table 5.5c - Monthly Fecal Coliform Loading Capacities and Allocations – Rush River; South Branch Rush River to Minnesota River

Drainage Area (square miles): 403 Total WWTF Design Flow (mgd): 7.66	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	137.11	45.70	50.64	16.88	19.27	6.42	2.72	0.91	*	*
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.93	0.31	0.93	0.31	0.93	0.31	0.93	0.31	*	*
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	89.27	29.76	26.62	8.87	8.93	2.98	0.00	0.00	*	*
Margin of Safety	46.91	15.64	23.10	7.70	9.41	3.14	1.79	0.60	na	na
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		*	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.7%		1.8%		4.8%		34.2%		*	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.1%		52.6%		46.3%		0.0%		*	
Margin of Safety	34.2%		45.6%		48.8%		65.8%		na	

*Note - WWTF design/discharge flow exceeded low flow

alllocation = (flow contribution from a given source) X (200 orgs./100ml.), see section 5.0 for details

5.5.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.5.1 – Required Fecal Coliform Reductions; Site 1RP – Rush River Outlet

Month	Monthly GM (cfu/100ml)	Required Reduction
April	216	7.4%
May	438	54.3%
June	855	76.6%
July	937	78.7%
August	428	53.3%
September	1,018	80.4%

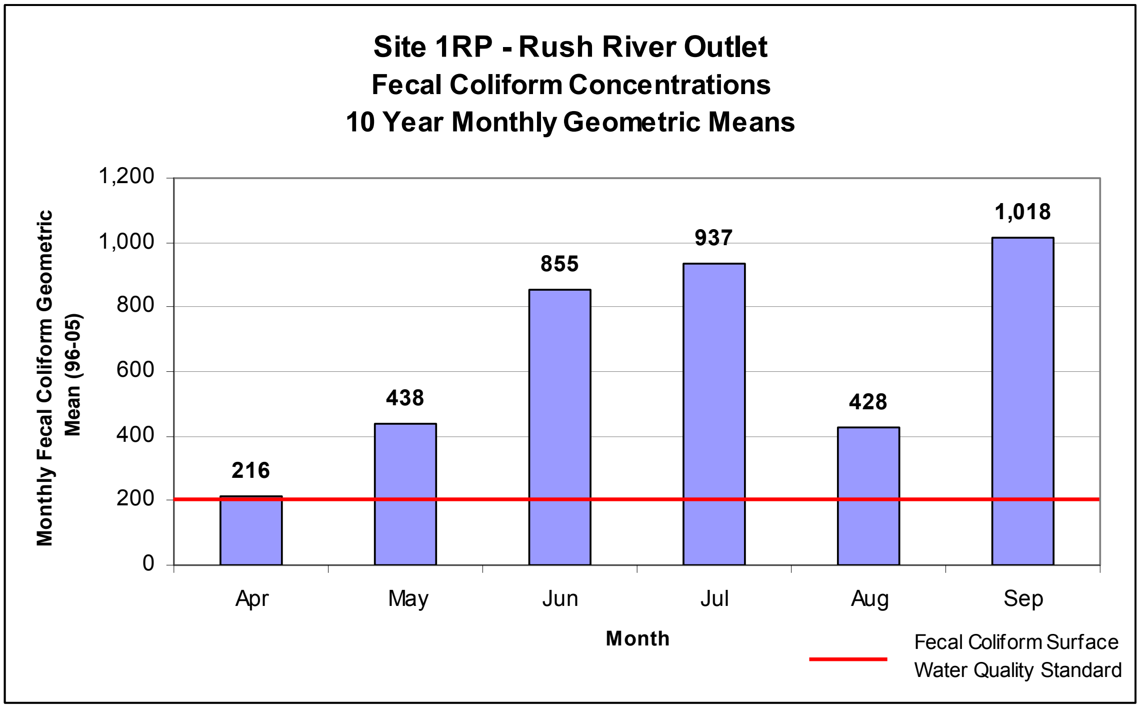
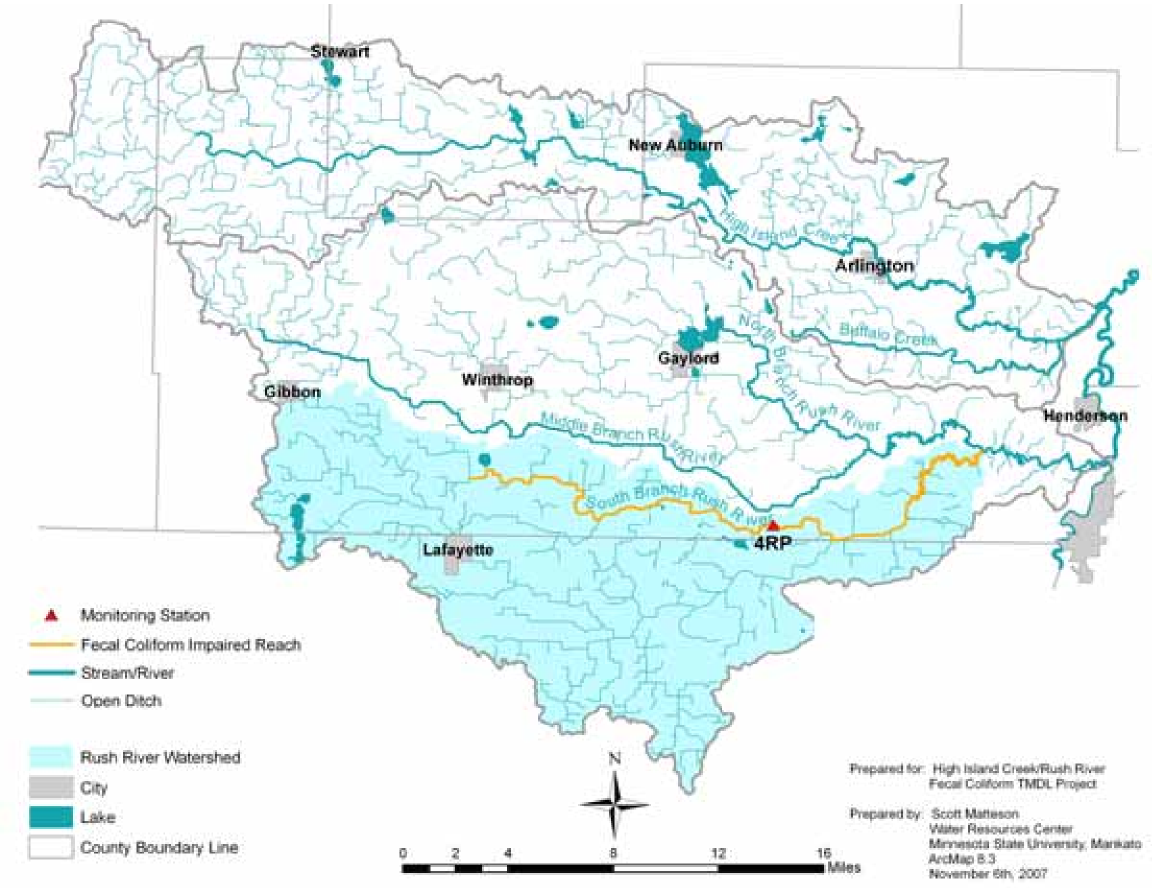


Figure 5.5.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.6 Rush River, South Branch; Unnamed Ditch to Rush River

This 32.6 mile reach of Rush River extends from the confluence of the mainstem and South Branch Rush River to the headwaters of the South Branch Rush River. The stream reach was placed on the impaired waters list in 2008. Monitoring of this portion of the river was conducted in 1998 by the MPCA and 2003 through 2006 by the Rush River Clean Water Partnership. Figure 5.6 displays the impaired stream reach, the watershed, and location of the monitoring site where the water quality data were collected.



Prepared for: High Island Creek/Rush River Fecal Coliform TMDL Project

Prepared by: Scott Matteson
Water Resources Center
Minnesota State University, Mankato
ArcMap 8.3
November 6th, 2007

Figure 5.6 - Rush River, South Branch; Unnamed Ditch to Rush River

The impaired reach watershed includes 117,918 acres (184 square miles) in the southern Sibley and northern Nicollet counties. The watershed contains communities of Lafayette and southern portion of Gibbon (table 5.6a), both of which discharge treated wastewater within the impaired watershed. The watershed includes 10 livestock facilities that have been issued NPDES permits (table 5.6b).

Table 5.6a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
Gibbon	MNG580020	0.505	0.057
Lafayette	MN0023876	0.095	0.022
Totals		0.600	0.079

Table 5.6b - Livestock Facilities with NPDES Permits

Facility	ID Number
Warren Krohn Farm	103-50002
Waibel Pork Inc	103-50003
Corey Hotovec Farm	103-50007
Christensen Farms Site C016	103-50008
Josie's Pork Farm Inc - Gaylord	103-50017
Bruce & Laurie Platz Farm - Sec 10	103-97452
Duane & David Gran Farm - Sec 19B	103-97625
Adam Gleisner Farm Sec 2	103-97632
Pinpoint Research - Sec 29	103-97780
Paul & Donita Platz Farm	143-50001

Table 5.6c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this reach of Rush River.

Table 5.6c - Monthly Fecal Coliform Loading Capacities and Allocations – Rush River, South Branch; Unnamed Ditch to Rush River

Drainage Area (square miles): 184										
Total WWTF Design Flow (mgd): 0.35	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	62.72	20.91	23.17	7.72	8.81	2.94	1.24	0.41	0.23	0.08
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.03
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	41.18	13.73	12.52	4.17	4.43	1.48	0.28	0.09	0.01	0.00
Margin of Safety	21.46	7.15	10.57	3.52	4.31	1.44	0.88	0.29	0.11	0.04
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		100%	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.1%		0.3%		0.9%		6.4%		0.0%	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.7%		54.0%		50.3%		22.7%		50.0%	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		50.0%	

5.6.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.6.1 – Required Fecal Coliform Reductions; Site 4RP – South Branch Rush River

Month	Monthly GM (cfu/100ml)	Required Reduction
April	231	13.4%
May	558	64.2%
June	758	73.6%
July	716	71.1%
August	1,130	82.3%
September	3,584	94.4%

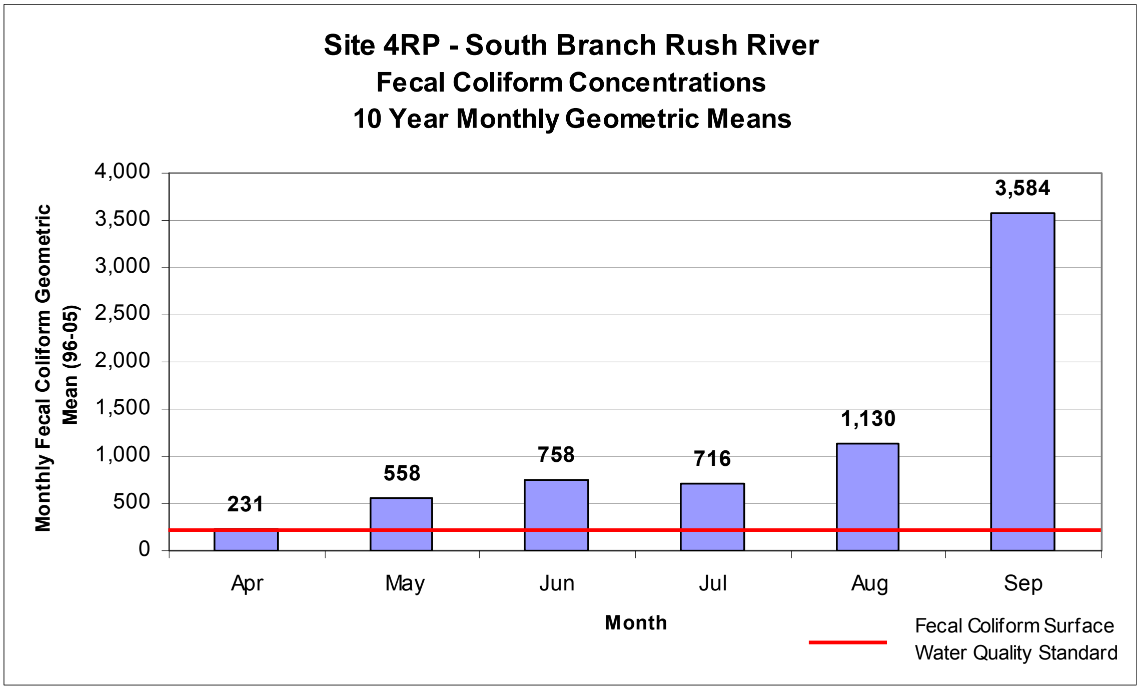


Figure 5.6.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

5.7 High Island Ditch 2, Unnamed Creek to High Island Creek

This 1.9 mile impaired reach is a watershed district ditch system that outlets into High Island Creek, ½ mile north of Arlington. The stream reach was placed on the impaired waters list in 2008. Monitoring of this portion of the river was conducted in 1999 by the MPCA and 2000 and 2001 by the High Island Creek Clean Water Partnership. Figure 5.7 displays the impaired stream reach, the watershed, and location of the monitoring site where the water quality data were collected.

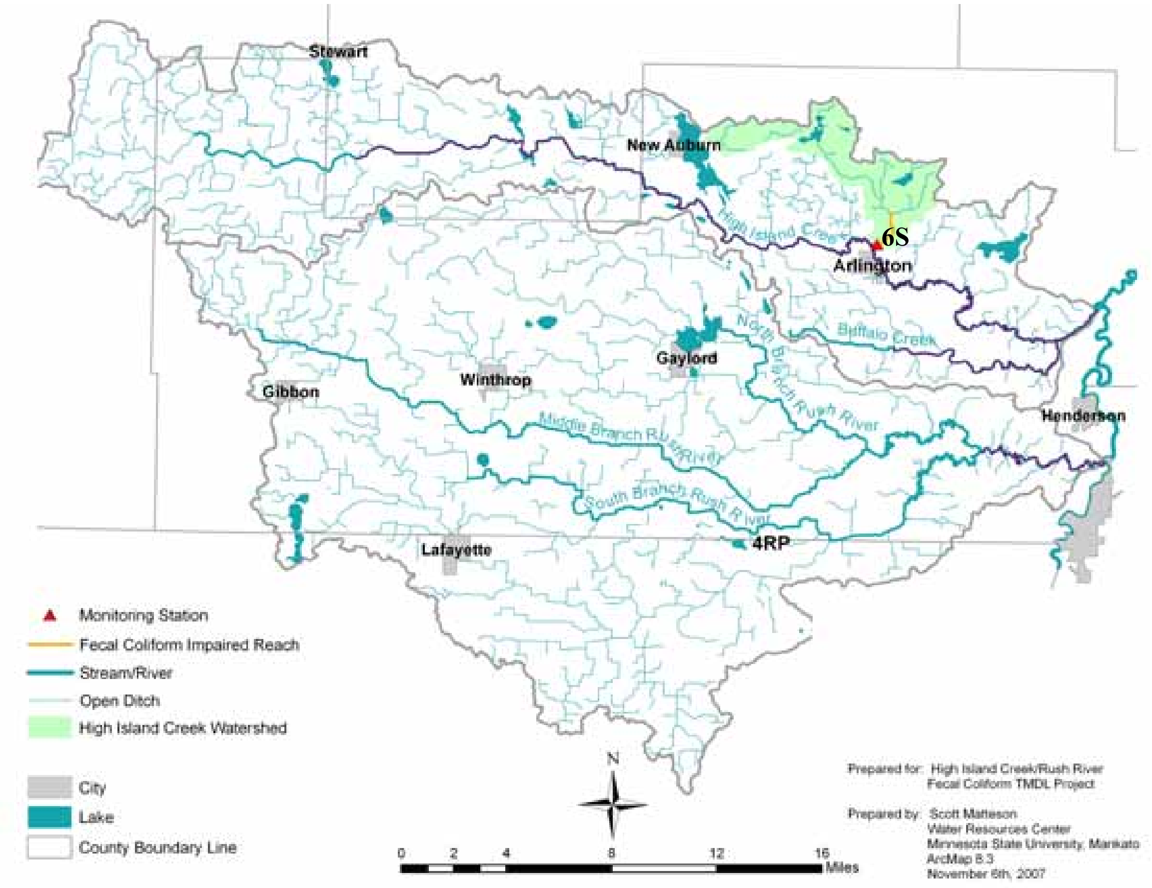


Figure 5.7 - High Island Ditch 2, Unnamed Creek to High Island Creek

The impaired reach watershed includes 10,517 acres (16 square miles) in north Sibley County. The ditch watershed contains no communities and thus no wasteload allocations are provided in the TMDL. (This watershed also contains no livestock facilities with NPDES permits).

Table 5.7a - Wastewater Treatment Facilities

Name/Location	Permit Number	Design Flow (mgd)	WLA (t-orgs./mo.)
None			
Totals		0.000	0.000

Table 5.7b - Livestock Facilities with NPDES Permits

Facility	ID Number
None	None

Table 5.7c describes the monthly fecal coliform loading capacities, as well as the component wasteload allocations, load allocations and margin of safety for this impaired reach.

Table 5.7c - Monthly Fecal Coliform Loading Capacities and Allocations – High Island Ditch 2, Unnamed Creek to High Island Creek

Drainage Area (square miles): 16										
Total WWTF Design Flow (mgd): 0.00	Flow Zone									
	High		Moist		Mid		Dry		Low	
	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily	Monthly	Daily
	values expressed as trillion organisms per month / day									
TOTAL MONTHLY / DAILY LOADING CAPACITY	5.59	1.86	2.07	0.69	0.79	0.26	0.11	0.04	0.02	0.01
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Livestock Facilities Requiring NPDES Permits	0	0	0	0	0	0	0	0	0	0
"Straight Pipe" Septic Systems	0	0	0	0	0	0	0	0	0	0
Load Allocation	3.68	1.23	1.12	0.37	0.40	0.13	0.03	0.01	0.01	0.00
Margin of Safety	1.91	0.64	0.94	0.31	0.38	0.13	0.08	0.03	0.01	0.00
	values expressed as percent of total monthly/daily loading capacity									
TOTAL MONTHLY / DAILY LOADING CAPACITY	100%		100%		100%		100%		100%	
Wasteload Allocation										
Permitted Wastewater Treatment Facilities	0.0%		0.0%		0.0%		0.0%		0.0%	
Livestock Facilities Requiring NPDES Permits	0.0%		0.0%		0.0%		0.0%		0.0%	
"Straight Pipe" Septic Systems	0.0%		0.0%		0.0%		0.0%		0.0%	
Load Allocation	65.8%		54.4%		51.2%		29.1%		50.0%	
Margin of Safety	34.2%		45.6%		48.8%		70.9%		50.0%	

5.7.1 Water Quality Data and Required Reductions

The following reduction represents the percentage reduction in bacterial concentration that would be required to meet the 200 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the surface water standard. This reduction percentage does not supersede the allocations provided for the TMDL.

Table 5.7.1 – Required Fecal Coliform Reductions; Site 6S – High Island Ditch #2

Month	Monthly GM (cfu/100ml)	Required Reduction
April	Inadequate Data	Inadequate Data
May	Inadequate Data	Inadequate Data
June	957	79.1%
July	885	77.4%
August	692	71.1%
September	Inadequate Data	Inadequate Data

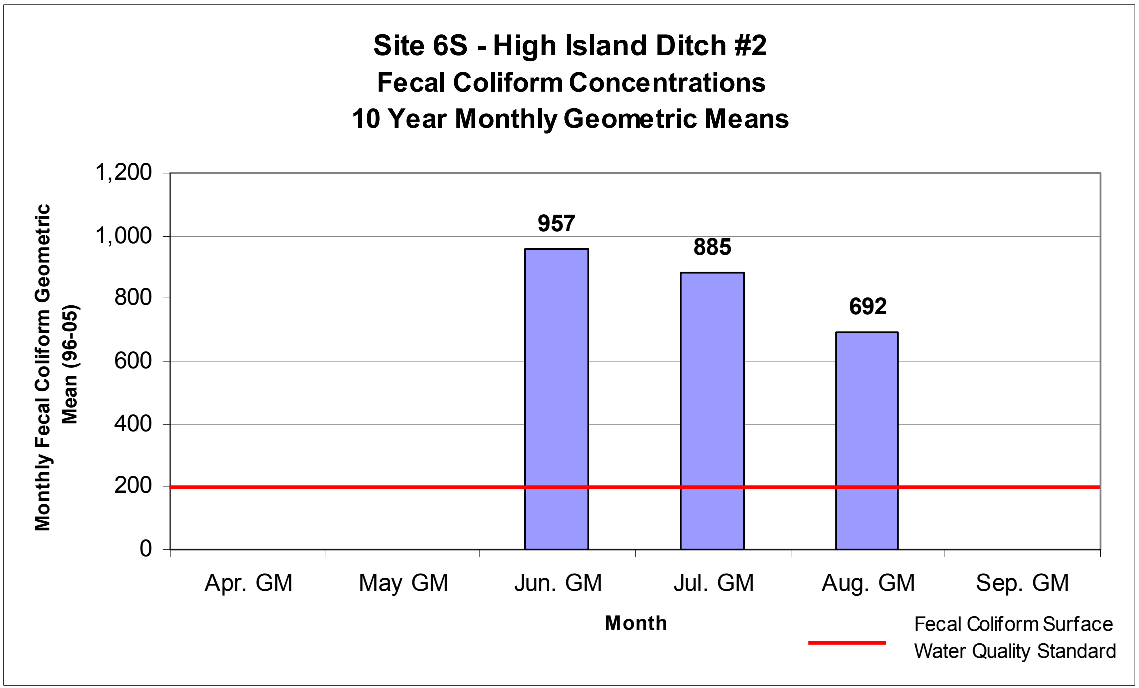


Figure 5.7.1 - Monthly Geometric Mean Fecal Coliform Concentrations (1996-2005)

Section 6.0 – Margin of Safety

The margin of safety is established to account for uncertainty that the load and wasteload allocations will result in attainment of water quality standards. The MOS in TMDLs usually includes "implicit" and "explicit" components. The implicit MOS includes conservative approaches to sampling and conservative assumptions made during load calculation. The explicit MOS takes into account a lack of knowledge concerning flow limitations and water quality. An explicit MOS is incorporated by setting aside a portion of the TMDL as the MOS.

The margin of safety for the five TMDL reaches were the difference between the calculated loading capacity at the mid-point of each flow regime and the minimum flow in each zone. This method insures that allocations will not exceed the load associated with the minimum flow in each zone. As load is directly related to flow (conc. *X* flow = load), a MOS that varies by flow is the appropriate approach.

Section 7.0 – Monitoring Plan

Continued bacterial monitoring will be needed in HICW and RRW to assess if reductions in fecal contamination are being achieved. This monitoring will rely on the current phase HICW and RRW Phase II Implementation CWP projects. These projects focus efforts on implementing best management practices that will improve surface water quality. The projects also involve surface water monitoring to assess how BMP implementation is impacting water quality. This monitoring includes fecal coliform bacteria and/or E. coli bacteria. HICW CWP is funding through 2009 and RRW CWP through 2008. Monitoring after the end of these projects will be dependant on future funding.

Section 8.0 –Bacteria Source Assessment and Implementation Activities

The purpose of the bacteria source assessment work conducted for this project is to suggest the most reasonable bacteria reduction activities on which to focus. The source assessment is not directly related to the total maximum loading capacities and allocations, which are simply a function of the water quality standards, stream flow (i.e. dilution capacity), and NPDES permit limits for point sources. The authors of this report acknowledge substantial uncertainty associated with source identification.

8.1 Source Assessment-Humans

Human waste can be a significant source of fecal coliform contamination during low flow periods. Contamination from individual sewage treatments systems that are not functioning properly can allow untreated or partially treated sewage into waterways. Emergency bypasses from wastewater treatment facilities are an occasional source of bacteria and pollutants. A high priority should be placed on preventing human waste from entering waterways, as human pathogens are often found to be highly communicable.

8.1.1 Human Populations

The 2000 census data indicate HICW has a population of 5,351 and RRW a population of 9,010. Table 8.1.1a presents population statistics for both watersheds. Table 8.1.1b presents estimated populations for each city based on 2000 census figures.

Table 8.1.1a – Population Statistics for HICW and RRW

Watershed	Rural Pop.	% Rural	Urban Pop.	% Urban	Total Pop.
High Island Creek	2,517	47.0%	2,834	53.0%	5,351
Rush River	4,027	44.7%	4,983	55.3%	9,010

HICW contains three cities, Arlington, New Auburn and a portion of Stewart. RRW encompasses four communities, Gaylord, Winthrop, Gibbon and Lafayette.

Table 8.1.1b – City Populations for HICW and RRW

Watershed	City	Population
High Island Creek	Arlington	2,048
High Island Creek	New Auburn	488
High Island Creek	Stewart	298*
Rush River	Gaylord	2,279
Rush River	Winthrop	1,367
Rush River	Gibbon	808
Rush River	Lafayette	529

** Estimated population based on percent of city area in watershed multiplied by total city population.*

HICW has 10.5 and RRW 10.0 persons per square mile living in rural areas. Arlington township, which splits the western half of both watersheds has the highest rural population density at 14.8 persons per square mile. In general, the western portions of both watersheds have lower rural population densities than the eastern townships.

8.1.2 Noncompliant Individual Sewage Treatment Systems (ISTS)

An estimated 53% of Individual Sewage Treatment Systems (ISTS) in HICW and 55% of ISTS in RRW are allowing inadequately treated wastewater into waterways. These systems are often connected directly into county tile drainage which outlet into the nearest ditch or stream. These systems are often called “straight pipe” systems. Under Minnesota statutes, a straight pipe discharge that has no soil treatment is an “imminent threat to public health or safety” (ITPHS) and when discovered, must be upgraded to acceptable standards within ten months.

There are an estimated 533 “straight pipe” systems in HICW and 880 systems in RRW. These estimates are highly subjective however, as the method of inventorying varies from one county to the next. The estimates were obtained from county Environmental Services offices, which often have varying methods of determining the number of ITPHS systems. Tables 8.1.2a and 8.1.2b present statistics on the estimated number of ITPHS septic systems in both watersheds.

Table 8.1.2a – High Island Creek Watershed IPHT Estimates

County	Population in Watershed	% Systems IPHT	# Systems IPHT
Sibley	1,854	59%	434
McLeod	505	30%	60
Renville	158	62%	39
Total	**2,517**	**53%**	**533**

Table 8.1.2b – Rush River Watershed IPHT Estimates

County	Population in Watershed	% Systems IPHT	# Systems IPHT
Sibley	2,968	59%	695
Nicollet	992	45%	177
McLeod	67	30%	8
Total	**4,027**	**55%**	**880**

Sewage from these systems are a significant contributor to fecal coliform bacteria in streams, especially during low flow conditions. These systems are illegal, un-permitted systems pursuant to Minnesota Rules Chapter 7080.

Systems that discharge partially or untreated sewage directly to surface water are often referred to as "straight pipe systems".

Straight pipe septic systems usually discharge to the nearest stream, ditch or lake.

8.1.3 Unsewered Communities

There are no unsewered communities in either HICW or RRW.

8.1.4 MS4 Communities – Stormwater

Pursuant to the TMDL allocation process, cities with populations greater than 5000 are to be provided a wasteload allocation for stormwater discharges. The communities are required to have MS4 stormwater permits. However, there are no MS4 communities in either HICW or RRW.

8.1.5 Municipal Waste Water Treatment Facility Bypasses

Municipal bypasses are emergency discharges of partially or untreated human sewage from waste water treatment facilities. Municipal bypasses usually occur during periods of heavy precipitation, when waste water treatment facilities become overloaded. Municipal bypasses typically last from a few hours to a few days. Table 8.1.5 provides the city and date of bypasses that have occurred from 2000 through 2004.

Table 8.1.5 – WWTP Bypasses in HICW and RRW by Year (2000-2004)

Watershed	Bypass City	Bypass Date
High Island Creek	New Auburn	4/22/2001
High Island Creek	New Auburn	7/14/2004
High Island Creek	New Auburn	4/11/2001
Rush River	Lafayette	4/21/2000
Rush River	Lafayette	4/11/2001
Rush River	Lafayette	4/23/2001
Rush River	Winthrop	4/22/2001
Rush River	Winthrop	8/29/2001

8.1.6 Municipal Wastewater Treatment Facility Violations

Municipal wastewater treatment facilities (WWTF) are required to test fecal coliform bacteria levels in effluent on a weekly basis. Facilities report a geometric mean fecal coliform level for each month, April through October. The geometric mean for all samples collected in a month must not exceed 200 cfu/100 ml fecal coliform bacteria. Exceedance of the 200 cfu/100 limit is considered a WWTF violation.

According to MPCA records no wastewater treatment facility violations for fecal coliform bacteria were reported from 2001 through 2005.

8.1.7 Application of Sewage Sludge to Agricultural Lands

WWTP and sewage disposal contractors are required to properly treat and disinfect sludge and septage through processing or lime stabilization. Treated sewage is then usually disposed of onto agricultural lands. The rules and procedures related to sewage handling and application are intended to insure pathogens have been destroyed.

8.2 Source Assessment - Livestock

Runoff from land application areas, pastures and livestock feedlots has the potential to be a significant source of fecal coliform bacteria and other pollutants. Based on population inventories and the assessment procedures outlined in section 8.7.1, nearly 99% of the fecal matter produced (not what is delivered to waterways) in HICW and RRW is from livestock manure. Of the fecal matter produced by livestock, over 97% is applied to cropland as a fertilizer. In HICW an estimated 65% is incorporated manure and 31% is surface applied manure. In RRW an estimated 74% of livestock manure is incorporated and 24% surface applied. In both watersheds an estimated 2% of livestock manure remains in feedlots or stockpiles without runoff controls. Information on how manure application values were derived is available in section 8.7.1.

The following statements from the Minnesota Generic Environmental Impact Statement on Animal Agriculture (2001) supports attention on land application of manure – "Thus, from a policy perspective, the primary water quality impact of animal manure is from land applied manure. Non-compliant feedlot runoff or seepage, and illegal spills have a negligible overall impact on regional water quality patterns. Without considering this, there is the real potential that the federal, state, and local governments will spend millions of dollars fixing noncompliant feedlots, without the prospect of making much difference in regional water quality problems." The basis for this statement is an analysis of water quality impacts from nitrogen and phosphorus in manure. While there are certainly differences, there are also parallels between the fate and transport characteristics of bacteria and nutrients, particularly phosphorus.

Based on county feedlot inventories, there are an estimated 261 feedlots in HICW with 24,848 animal units. RRW has an estimated 502 feedlots with 78,596 animal units. Swine is the dominant animal type in both watersheds, followed by beef and dairy operations. Table 8.2 provides livestock statistics for both watersheds.

Table 8.2 – HICW and RRW Livestock Statistics

Animal Type	High Island Watershed		Rush River Watershed	
	Animal Units	% Total	Animal Units	% Total
Dairy	6,150	24.75%	11,789	15.00%
Beef	7,112	28.62%	10,817	13.76%
Swine	10,636	42.80%	42,182	53.67%
Chicken	15	0.06%	8,907	11.33%
Turkey	327	1.32%	2,628	3.34%
Horse,Sheep,Duck, etc.	608	2.45%	2,273	2.89%
Total Animal Units	**24,848**		**78,596**	
Total Feedlots	**261**		**502**	

** One animal unit equal to 1000 pound animal.*

Figure 8.2a displays the location of inventoried feedlots in both watersheds. The majority of these facilities are confined operations with little runoff to surface water. However, there are a number of open feedlots, some of which have pollution problems and pose a risk of fecal contamination. In portions of the watersheds runoff from these feedlots may be a significant source of fecal coliform contamination during periods of heavy precipitation. According to county feedlot officers and MPCA reports, most feedlots store and manage manure adequately to avoid runoff problems.

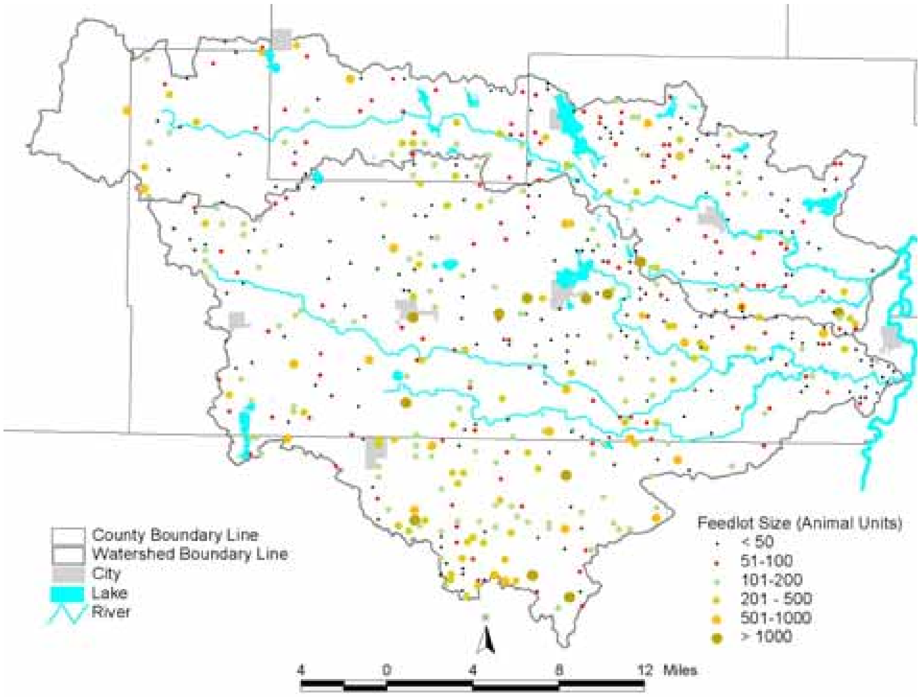


Figure 8.2a – HICW and RRW Livestock Feedlots (2004)

As part of the feedlot inventory process counties require feedlot operators to keep records on the location and amount of manure applied to agricultural land. For Sibley County this information was mapped in year 2000 to show locations of potential manure spread land. The Sibley County inventory and those from neighboring counties indicate roughly 25% of the total land area in the HIRR watersheds is available as manure spread land. Figure 8.2b presents potential manure spread lands in Sibley County based on the 2000 manure spread inventory.

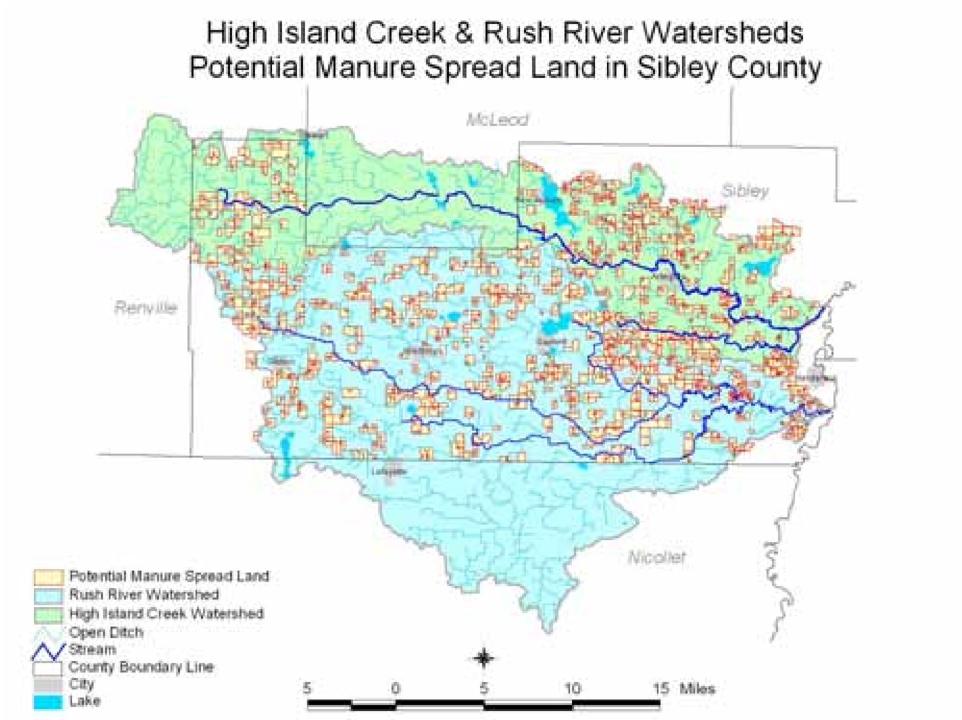


Figure 8.2b - Potential Manure Spread Land in Sibley County

As applied manure is the primary source of fecal material produced in the HICW and RRW, it also has the potential as being a major source of contamination to waterways. There are three potential pathways of fecal coliform transport from fields with applied manure to waterways; 1) overland runoff, 2) open tile intakes and 3) macropores/preferential flow.

8.2.1 Overland Runoff and Open Tile Intakes

During storm events runoff of fecal coliform bacteria from fields with applied manure can occur by direct surface runoff to waterways or indirectly through field tile open intakes. To help address manure runoff concerns, manure application rules were put into place in Minnesota under state rule 7020 (table 8.2.1). This rule requires a setback of 300 feet for surface applied manure from streams, ditches and open tile intakes. The setback of manure application for incorporated fields is 25 feet from streams and ditches and 0 feet from open intakes. The Minnesota statutes represent the minimum setbacks for manure. Counties may develop ordinance with setback rules that are more restrictive. Of counties that are part of the HICW and RRW, only McLeod County has setbacks that are more restrictive than the Minnesota statutes.

Setbacks for field applied manure reduce the movement of manure solids, which in turn reduces bacterial transport to surface waters. The effectiveness of current setbacks for applied manure related to bacterial contamination is largely unknown. Setback distances are primarily based on research involving nutrients (phosphorus), not bacterial transport. It is unclear whether current setbacks for surface applied and incorporated manure are appropriate for preventing bacterial transport to tile drainage systems. According to county and state feedlot officers, it is also difficult to monitor whether setback distance are being observed. As open intakes have the capacity of being a significant route for bacteria transport, further research into setback distances is recommended.

Open tile intake in road ditch, receiving runoff from field with surface applied manure.

An open tile intake along the edge of an agricultural field.

Gessel et al. (2004) found fecal coliform levels in the runoff mixing zone (top 2 centimeters) in a manured plot approximated levels of untreated reference plots within four days of application and incorporation. This emphasizes the importance of manure incorporation as well as timing application so as not to coincide with runoff events (e.g. snowmelt runoff).

Table 8.2.1 - Manure Application Rules for Minnesota

Manure Application – Minimum setbacks near waters (counties can be more restrictive than state Rule 7020)

	Surface Application	Incorporation within 24 hrs.
Lake, stream	300'*	25'**
Wetlands (10+ ac.)	300'*	25'**
Ditches (w/o berms)	300'*	25'**
Open tile intakes	300'	0'
Well, quarry	50'	50'
Sinkhole (w/o berms)		
Downslope	50'	50'
Upslope	300'	50'

*100' vegetated buffer can be used instead of 300' setback for non-winter applications (50' buffer for wetlands/ditches)

**no long-term phosphorus buildup within 300'

8.2.2 Macropores/Preferential Flow

Transport of fecal coliform bacteria and associated pathogens may be enhanced by field tile systems. The retardation and retention of bacteria in soils is apparently less effective than previously believed, primarily due to preferential flow processes, which can aid in the rapid transport of bacteria from manure application (Smith et al, 1998; Geohring et al, 1999). Field studies in various locations across the United States have shown significant transport of fecal coliform bacteria to tile drainage through soil macropores. Beven and Germann (1982) outlined the main processes which contribute to the formation of macropores in natural soils:

- Pores formed by soil fauna such as earthworms, insects, mole and gophers.
- Crack and fissures formed during the shrinkage of clay soils and freeze/thaw cycles.
- Pores formed by plant roots.
- Natural soil pipes that form due to erosive action of subsurface flows.

In Minnesota there has been limited research on macropores and bacterial transport. Earthworms, which are one of the primary creators of macropores, are in lower numbers in Minnesota compared with other portions of the country. Research has shown earthworm macropores are most common in no-till soils, not commonly utilized in south-central Minnesota. Also, soil types/conditions and climate may be different in Minnesota as compared to where other studies have taken place.

The only significant research in Minnesota related to assessing fecal coliform transport to tile drainage was two separate studies conducted by Gyles Randall at the University of Minnesota Southern Experiment Station in Waseca. The first study (Randall, 2000) conducted from 1995-1997 involved collection of tile water samples from a series of 13.5 by 15 meter plots that had received moldboard incorporation of fall applied dairy manure. The following spring samples were collected within three days of precipitation events that caused significant drainage. The study found 100% of samples to test positive for fecal coliform bacteria, yet e-coli was only detected in five of the 30 samples over the three year period. Fecal coliform concentrations were implied to be low and the authors speculated that significant winter die-off may have occurred.

The second study, (Malik et al., 2004) involved spring tile monitoring of fall applied (2002/2003) injected swine manure. The study involved comparing field plots with applied manure vs. urea treatments. The authors found the number of fecal coliform bacteria to be similar in both urea-treated and manure treated plots. They suggested organisms did not survive over winter in the added manure and that levels seen during the six-week drainage sampling period were probably background concentrations.

Studies from other parts of the country have shown that the transport of fecal bacteria under conditions of ideal matrix flow is inversely related to particle size. Soil consisting of primarily silt and clay particles is very effective in physically filtering bacterial cells under conditions of matrix flow. However, column and field experiments have indicated that macropore flow is the dominant transport pathway for fecal bacteria. Therefore, soils more susceptible to shrinking or cracking, such as clays, could be less effective than sandy soils in terms of limiting bacterial transport (Jamieson, 2002).

Research by Dan Janyes (USDA) at the National Soil Tilth Laboratory in Aims, Iowa has looked at movement of tracers, similar to nitrate, through preferential flow. Four tracers were surface applied to a field at staggered time intervals. The area of tracer application was then lightly irrigated (3mm/hr) and the subsurface tile was monitored for preferential flow. Tracer movement from surface to tile line varied from 2 hours to 15 minutes, occurring quicker as soil conditions became wetter. Janyes estimates preferential flow accounts for about 1% of the mass loss of surface applied chemicals.

Work by the Agricultural Resource Service's (USDA) Martin Shipitalo in Ohio has traced macropores made by earth worms from the surface to 4 feet deep. In many cases, these burrows end at a drain tile. Shipitalo and Frank Gibbs of Natural Resources Conservation Service (NRCS) in Ohio have demonstrated the connectivity of the soil surface and tile line via macropores by forcing smoke up tile lines when not flowing.

Fecal coliform bacteria can survive for long periods of time in soils under certain conditions. Gerba et al. (1975) reported survival times of fecal-associated bacteria in soils to range from 2 to 4 months. The survivability of fecal bacteria in soil is largely dependant on moisture, soil type, temperature, pH, and nutrient availability. Crane et al. (1981), Zhai et al. (1995) found manure application rate does not appear to influence bacterial survival, although little research has been done on fields that received excessive applications of manure.

Management strategies to reduce bacterial transport include tillage methods that disrupt preferential flow pathways. Methods of preventing preferential flow may be at odds with other strategies intended to mitigate other environmental impacts. For example, tillage methods that disrupt preferential flow may cause increased soil erosion and nutrient losses when compared to no till and conservation tillage.

The pictures depict a conventionally tilled, clayey soil where earthworms appear to preferentially burrow towards the drains. The tile in this photo is 4 feet deep.

In Ohio, Shipitalo and Gibbs pump smoke into a tile line to show the connectivity of the surface to tile.line.

Figure 8.2.2 – Examples of macropore/preferential flow routes in a no till tiled field in Ohio

8.3 Source Assessment - Pets

The American Veterinary Medical Association estimates there are 0.66 cats and 0.58 dogs per household in the United States. Based on an average household of 2.52 people, this equates to 1,401 cats and 1,232 dogs in HICW and 2,360 cats and 2,074 dogs in RRW. High densities of pets in isolated areas can lead to bacterial contamination of waterways; however pets are normally a minor contributor of fecal coliform bacteria contamination at a watershed scale.

8.4 Source Assessment - Wildlife and Natural Background

Deer, pheasant, Canadian geese and wild turkey density estimates were obtained from the Minnesota Department of Natural Resources – Wildlife Section.

Deer density is estimated annually by the DNR for each hunting permit area. HICW and RRW encompass portions of four permit areas. The average deer density based on this data is 3.26 deer per square mile. This equate to 779 deer in HICW and 1,314 deer in RRW.

Pheasant population estimates were provided for each county in both watersheds, based on estimates made in August of each year. A ten-year average density (1995-2004) was calculated for each county. Based on DNR estimates, there is an average of 50 pheasant per square mile in both watersheds. This equates to an estimated 11,950 pheasants in HICW and 20,150 in RRW. The DNR report that April populations are about ¼ August estimates.

Canadian goose populations are estimated by ecoregion. Estimates are based on 2001-2004 data for the prairie ecoregion. The DNR estimates a prairie ecoregion density of 4.5 geese per square mile. This equate to 1,065 geese in HICW and 1,795 in RRW. The DNR estimate is for the resident geese population, not including migrating geese in the fall. Migrating geese in the fall season can concentrate in lakes and wetlands contributing large quantities of fecal waste. Geese are one of the largest wildlife sources of fecal contamination, simply because they are found directly on waterways.

The DNR bases wild turkey population estimates on harvest. Similar to deer densities, turkey estimates are based on permitted hunting areas. The mean wild turkey density in this region is 1.09 per square mile. However, like other wildlife, they are not equally distributed, instead clumping towards forested areas and ravines. The HICW and RRW have an estimated wild turkey population of 261 and 439 respectively.

Population estimates and monitoring data support that wildlife normally are not a significant contributor of fecal coliform bacteria contamination in these watersheds. Conditions when wildlife can be a significant source include isolated areas of high density and during low flow/drought conditions.

8.5 DNA Fingerprinting Results for High Island Creek Watershed

In 2001 and 2002, the University of Minnesota used a library of DNA fingerprints, created by rep-PCR and HFERP techniques, in an attempt to define sources of fecal bacterial pollution, *E. coli,* in three Minnesota watersheds; High Island Creek, Minneopa Creek and Vermillion River. The U of M partnered with HICW CWP in collection of water samples from 10 sites in 2001 and 2002. A total of 1,651 *E. coli* isolates were DNA fingerprinted from the HICW.

Results of the study indicated that each of the ten sites had a variety of possible sources of fecal coliform contamination, with no one animal type dominating. The U of M reported that the results of the study revealed the known source library size was not large enough to accurately determine sources in High Island Creek with any certainty. Accordingly, results of this study were not used for the development of this TMDL report.

The report did stress that when isolates were categorized into larger source groups, the accuracy improved. Overall the U of M found it was probable that about 16% of the isolates identified were human with the remaining 84% non-human.

Results of this project are available online at *www.ecolirep.umn.edu* and were published in a final report titled Determination of Fecal Pollution Sources in Minnesota Watersheds (Sadowsky, 2004).

8.6 Streambed Sediments

A potential source of fecal coliform bacteria in streams/rivers that is often overlooked is resuspension of streambed sediments. Several studies have reported significantly increased concentrations of water column fecal coliform density after disturbance of the surface sediments. Weiskel et al. (1996) reported greatly increased values of fecal coliform density after artificial disturbance of the surface 2 cm of sediments in Buttermilk Bay, Massachusetts. Ewert (2005) in a study conducted in southern Minnesota, found that physical raking of streambed sediments resulted in bacteria concentrations several factors higher than the water column values before resuspension. Jolley et al. (2004) reported bottom sediment reservoirs of indicator bacteria in surface water increase surface water levels at base flow and should be considered sources of surface water contamination. Davis et al. (2005) reported that in stream observations in Arkansas indicated it is possible for E. coli to survive in certain streambed sediments for at least four months with no fresh external inputs.

As runoff during a storm event begins, the discharge and velocity increase, in turn scouring bacteria from the benthic areas of the stream (Yagow and Shanholtz, 1998). This scouring causes increased levels of bacteria in the water column and decreased levels in stream sediments.

8.7 Targeted Sources

Sections 8.7.1 through 8.7.3 detail the process that was used to estimate the primary sources of fecal coliform contamination in HIW and RRW. This procedure has no bearing on TMDL allocations and has no regulatory implications.

8.7.1 Fecal Coliform Produced (by source)

The first step was compiling population estimates and fecal coliform produced by each animal type. Tables 8.7.1a and 8.7.1b present the estimated population figures (number of individuals or animal units) for the major animal types in each watershed. Figures 8.7.1a and 8.7.1b display the estimated fecal coliform produced by animal type and source groups.

Population figures were obtained from state feedlot inventories, the U.S. Census Bureau and the Wildlife section of the Minnesota Department of Natural Resources. The daily fecal coliform production was obtained from a variety of sources that are all recommended in the EPA’s guidance document Protocol for Developing Pathogen TMDLs (2002). Total fecal coliform produced by each animal type is calculated by multiplying the population by the daily fecal coliform produced per individual or animal unit. These figures represent the total fecal coliform available, not the amount delivered to surface waters.

Table 8.7.1a – High Island Creek Population Inventory

Animal Type	Animal Units	Individuals	FC Produced per Individual or AU Per Day	Total FC Available	Source (Daily FC Production)
Dairy	6,150		7.20E+10	4.43E+14	ASAE**, 1998
Beef	7,112		1.30E+11	9.25E+14	ASAE, 1998
Swine	10,636		8.00E+10	8.51E+14	ASAE, 1998
Chicken	15		3.40E+10	5.10E+11	ASAE, 1998
Turkey	327		6.20E+09	2.03E+12	ASAE, 1998
Horse	291		4.20E+08	1.22E+11	ASAE, 1998
Sheep	119		2.00E+11	2.38E+13	ASAE, 1998
Humans		5,351	2.00E+09	1.07E+13	Metcalf and Eddy, 1991
Cats		1,401	5.00E+09	7.01E+12	Horsley and Witten, 1996
Dogs		1,232	5.00E+09	6.16E+12	Horsley and Witten, 1996
Deer		779	5.00E+08	3.90E+11	Interpolated from Metcalf and Eddy, 1991
Canadian Geese		1,065	1.04E+07	1.11E+10	Alderisio and DeLuca, 1999
Wild Turkey		261	9.50E+07	2.48E+10	turkey value used
Pheasants		11,950	1.53E+04	1.83E+08	geese value used
Other Wildlife*				3.90E+11	

* Unknown, estimated to be roughly the equivalent of the deer population.

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Table 8.7.1b – Rush River Population Inventory

Animal Type	Animal Units	Individuals	FC Produced per Individual or AU Per Day	Total FC Available	Source (Daily FC Production)
Dairy	11,789		7.20E+10	8.49E+14	ASAE, 1998
Beef	10,817		1.30E+11	1.41E+15	ASAE, 1998
Swine	42,182		8.00E+10	3.37E+15	ASAE, 1998
Chicken	8,907		3.40E+10	3.03E+14	ASAE, 1998
Turkey	2,628		6.20E+09	1.63E+13	ASAE, 1998
Horse	428		4.20E+08	1.80E+11	ASAE, 1998
Sheep	283		2.00E+11	5.66E+13	ASAE, 1998
Humans		9,010	2.00E+09	1.80E+13	Metcalf and Eddy, 1991
Cats		2,360	5.00E+09	1.18E+13	Horsley and Witten, 1996
Dogs		2,074	5.00E+09	1.04E+13	Horsley and Witten, 1996
Deer		1,314	5.00E+08	6.57E+11	Interpolated from Metcalf and Eddy, 1991
Canadian Geese		1,795	1.04E+07	1.87E+10	Alderisio and DeLuca, 1999
Wild Turkey		439	9.50E+07	4.17E+10	turkey value used
Pheasants		20,150	1.53E+04	3.08E+08	geese value used
Other Wildlife*				6.57E+11	

* Unknown, estimated to be roughly the equivalent of the deer population.

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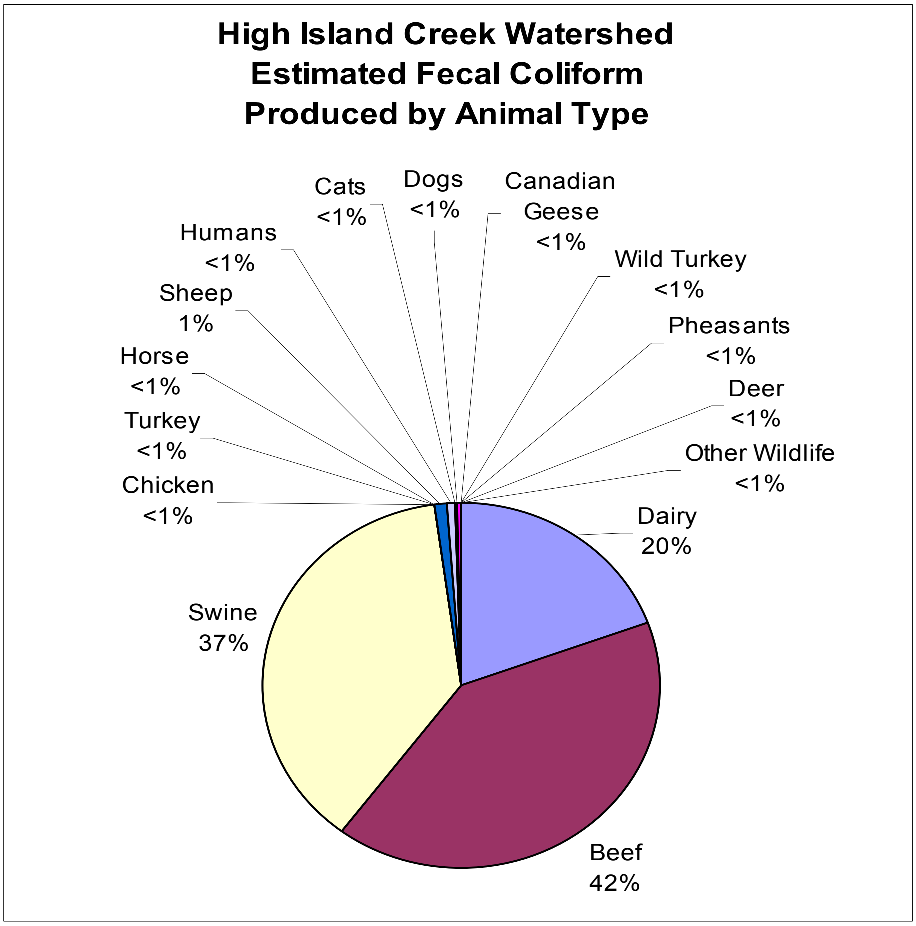


Figure 8.7.1a – High Island Creek Watershed Fecal Coliform Bacteria Produced by Animal Type

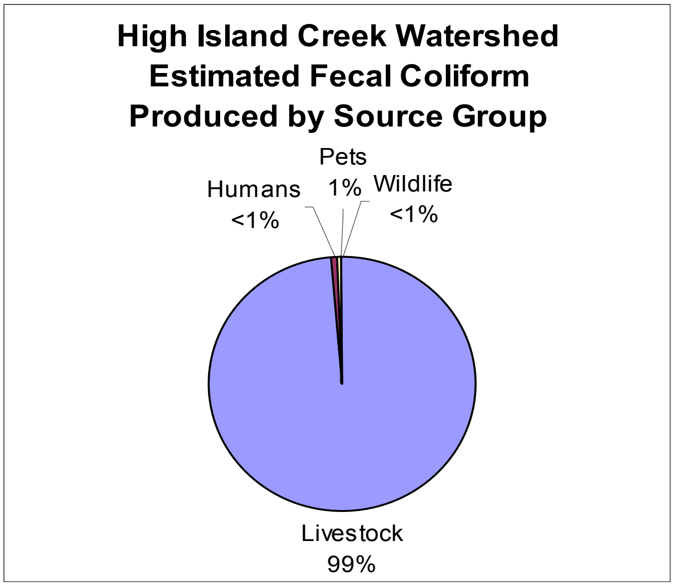


Figure 8.7.1b – High Island Creek Watershed Fecal Coliform Bacteria Produced by Source Group

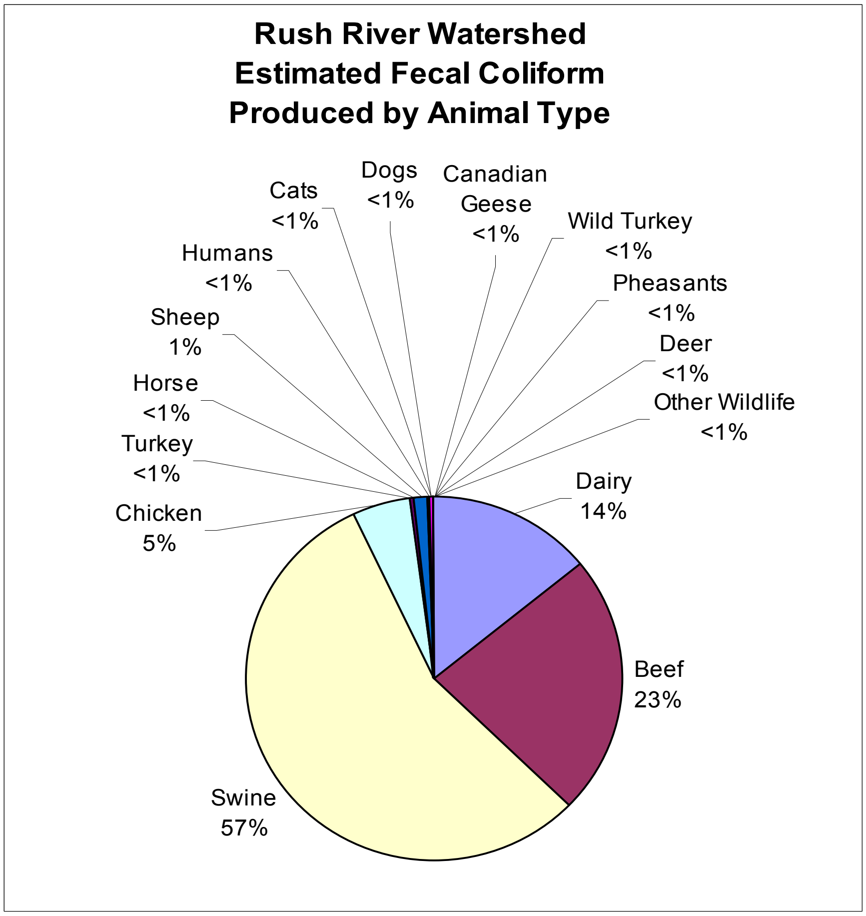


Figure 8.7.1c – Rush River Watershed Fecal Coliform Bacteria Produced by Animal Type

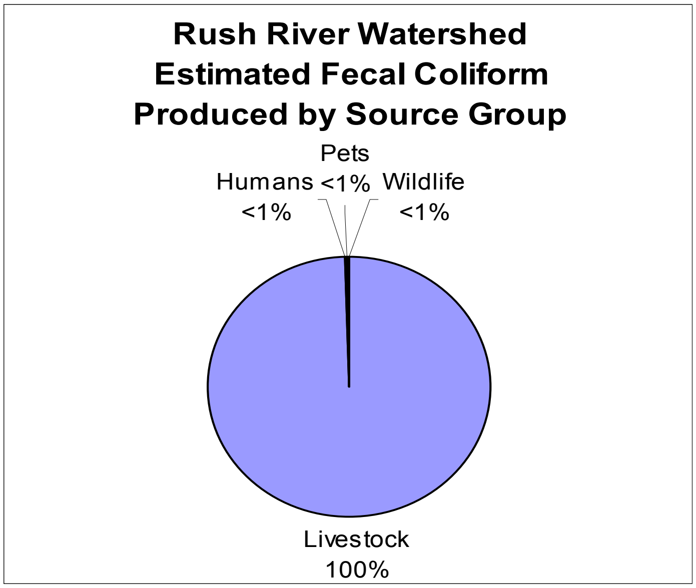


Figure 8.7.1d – Rush River Watershed Fecal Coliform Bacteria Produced by Source Group

Next, the total fecal coliform bacteria produced by each animal type was categorized by application type/method. For humans, this meant calculating the number of people that had adequately treated and inadequately treated wastewater. For livestock, assumptions were derived from the Generic Environmental Impact Statement (GEIS) on Animal Agriculture (Mulla, et al., 2000), prepared by the Minnesota Environmental Quality Board. This document provides general guidelines on how and where livestock manure is applied to farmland in Minnesota. (Slight modifications were made for swine assumptions; changing incorporated swine manure from 80% to 95% and surface applied swine manure from 20% to 5%. These modifications reflect a continuing shift from surface applied to incorporated swine manure). Tables 8.7.1c and 8.7.1d present the assumption used for each watershed and the resulting categories.

Table 8.7.1c – Assumptions Used to Calculate the FC Produced by Different Sources in HICW

Category	Source	Assumptions*	Animal Units or Individuals
Livestock	Overgrazed Pastures near Streams or Waterways	1% Dairy Manure 1% Beef Manure 1% Horse, Sheep, etc. Manure	62 Dairy AU 71 Beef AU 6 Horse, Sheep, etc. AU
	Feedlots or Manure Stockpiles without Runoff Controls	1% of Dairy Manure 5% of Beef Manure 1% of Chicken Manure 1% Turkey Manure	62 Dairy AU 356 Beef AU 0 Chicken AU 3 Turkey AU
	Surface Applied Manure	49% Dairy Manure 47% Beef Manure 5% Swine Manure 49.5% Horse, Sheep, etc. Manure 49.5% Chicken Manure 49.5% Turkey Manure	3,014 Dairy AU 3,343 Beef AU 532 Swine AU 301 Horse, Sheep, etc. AU 7 Chicken AU 162 Turkey AU
	Incorporated Manure	49% Dairy Manure 47% Beef Manure 95% Swine Manure 49.5% Horse, Sheep, etc. Manure 49.5% Chicken Manure 49.5% Turkey Manure	3,014 Dairy AU 3,343 Beef AU 10,104 Swine AU 301 Horse, Sheep, etc. AU 7 Chicken AU 162 Turkey AU
Human	Inadequately Treated Wastewater ("Straight Pipe" Septic Systems)	25.10% of Human	1,343 Humans
	ISTS that are not Imminent Public Health Risk	21.94% of Humans	1,174 Humans
	Municipal Wastewater Treatment Facilities	52.96% of Humans	2,834 Humans
Pets	Cats	100% of Cats	1,401 Cats
	Dogs	100% of Dogs	1,232 Dogs
Wildlife	Canadian Geese (resident population)	100% of Candian Geese	1,065 Canadian Geese
	Deer	100% of Deer	779 Deer
	Wild Turkey	100% of Wild Turkey	261 Wild Turkeys
	Pheasants	100% of Pheasant	11,950 Pheasant
	Other Wildlife	Unknown (est. as deer pop.)	Unknown (est. as deer pop.)

* Assumptions used for livestock were derived from information contained in the *Generic Environmental Impact Statement on Animal Agriculture* prepared by the Minnesota Environmental Quality Board.

Table 8.7.1d – Assumptions Used to Calculate the FC Produced by Different Sources in RRW

Category	Source	Assumptions*	Animal Units or Individuals
Livestock	Overgrazed Pastures near Streams or Waterways	1% Dairy Manure	118 Dairy AU
		1% Beef Manure	108 Beef AU
		1% Horse, Sheep, etc. Manure	7 Horse, Sheep, etc. AU
	Feedlots or Manure Stockpiles without Runoff Controls	1% of Dairy Manure	118 Dairy AU
		5% of Beef Manure	541 Beef AU
		1% of Chicken Manure	89 Chicken AU
		1% Turkey Manure	26 Turkey AU
	Surface Applied Manure	49% Dairy Manure	5,777 Dairy AU
		47% Beef Manure	5,084 Beef AU
		5% Swine Manure	2,109 Swine AU
		49.5% Horse, Sheep, etc. Manure	352 Horse, Sheep, etc. AU
		49.5% Chicken Manure	4,409 Chicken AU
		49.5% Turkey Manure	1,301 Turkey AU
	Incorporated Manure	49% Dairy Manure	5,777 Dairy AU
		47% Beef Manure	5,084 Beef AU
		95% Swine Manure	40,073 Swine AU
		49.5% Horse, Sheep, etc. Manure	352 Horse, Sheep, etc. AU
		49.5% Chicken Manure	4,409 Chicken AU
		49.5% Turkey Manure	1,301 Turkey AU
Human	Inadequately Treated Wastewater ("Straight Pipe" Septic Systems)	24.62% of Human	2,218 Humans
	ISTS that are not Imminent Public Health Risk	20.08% of Humans	1,809 Humans
	Municipal Wastewater Treatment Facilities	55.31% of Humans	4,983 Humans
Pets	Cats	100% of Cats	2,360 Cats
	Dogs	100% of Dogs	2,074 Dogs
Wildlife	Canadian Geese (resident population)	100% of Candian Geese	1,795 Canadian Geese
	Deer	100% of Deer	1,314 Deer
	Wild Turkey	100% of Wild Turkey	439 Wild Turkeys
	Pheasants	100% of Pheasant	20,150 Pheasant
	Other Wildlife	Unknown (est. as deer pop.)	Unknown (est. as deer pop.)

* Assumptions used for livestock were derived from information contained in the *Generic Environmental Impact Statement on Animal Agriculture* prepared by the Minnesota Environmental Quality Board.

Figures 8.7.1e and 8.7.1f display the source/application type for fecal coliform bacteria in the HICW and RRW respectively. The data indicate most fecal material is applied to agricultural land. Again note that the figure represents the estimated fecal coliform bacteria produced by source and application type, not the fecal coliform that is actually delivered to surface water.

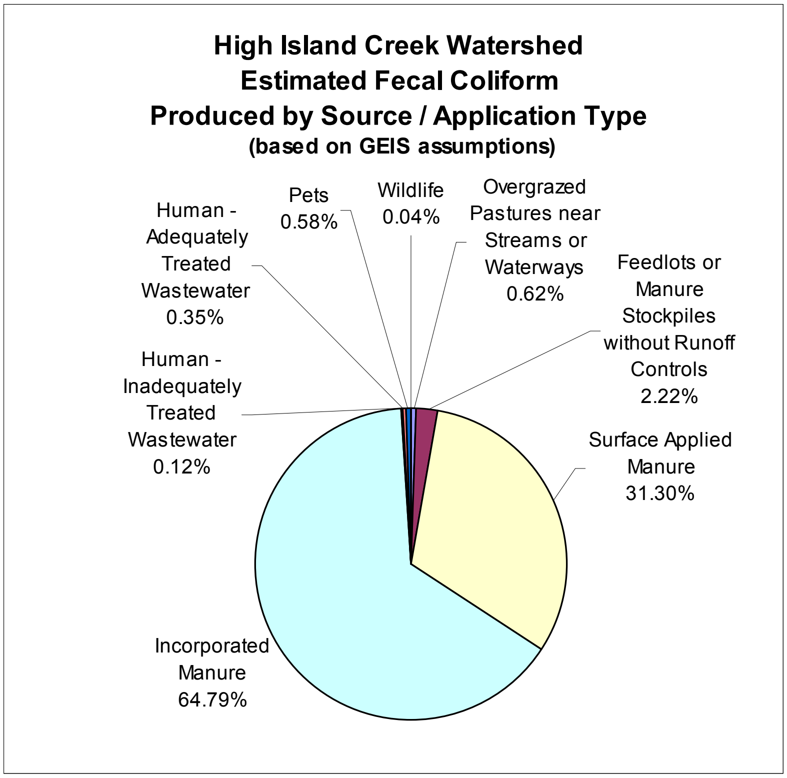


Figure 8.7.1e - Estimated Fecal Coliform Produced by Source/Application Type in HICW

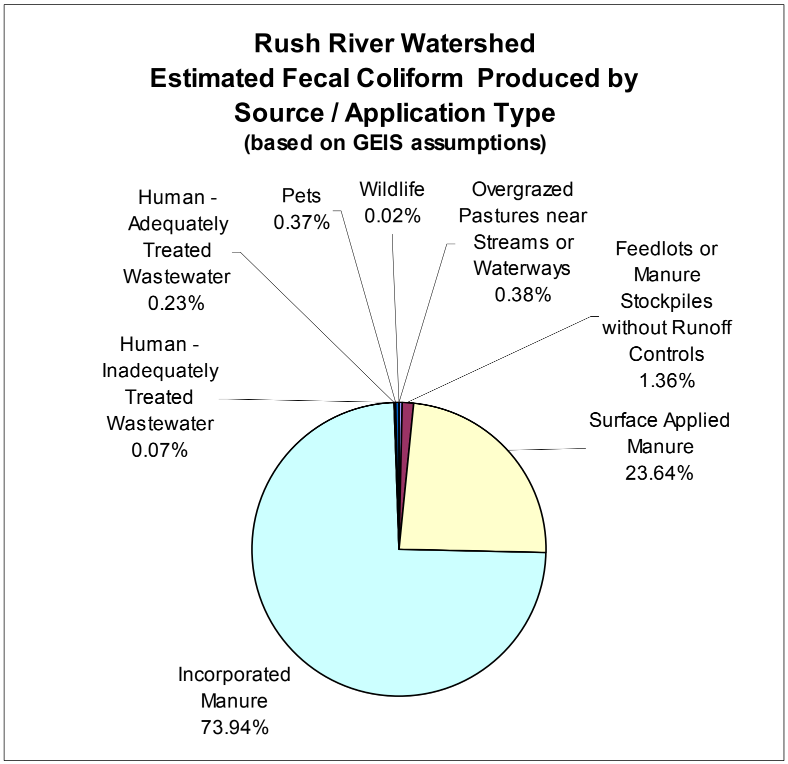


Figure 8.7.1f - Estimated Fecal Coliform Produced by Source/Application Type in RRW

8.7.2 Delivery Assumptions

To help identify what the primary sources of fecal coliform bacteria contamination for HICW and RRW, the delivery ratios in table 8.7.2 were used. The ratios were obtained from Appendix C of the Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota, 2002 (http://www.pca.state.mn.us/publications/reports/tmdl-final-lowermiss-fc02.pdf - revised 2006). While the report did not include delivery estimates, the source contribution process used in the original report still has utility.

These ratios presented in table 8.7.2 were based on expert opinions and should be considered in relative rather then absolute terms. Thus, while 1% of surface applied manure was assumed to be delivered to waterways, only 0.1% of incorporated manure was considered delivered. Straight pipe septic systems were given the highest delivery ratio, at 8%.

Table 8.7.2 – Delivery Assumptions

Category	Source	Wet Conditions	Dry Conditions
Livestock	Overgrazed Pastures near Streams or Waterways	4.0%	
	Feedlots or Manure Stockpiles without Runoff Controls	4.0%	
	Surface Applied Manure	1.0%	
	Incorporated Manure	0.1%	
Human	Inadequately Treated Wastewater	8.0%	8.0%
Pets	Cats/Dogs	0.5%	
Wildlife	Canadian Geese (resident population)	4.0%	4.0%
	Other Wildlife	1.0%	1.0%

8.7.3 Target Areas

Delivery ratios used in section 8.7.2 come with a degree of uncertainty. The amount of fecal material delivered from any one source will vary depending on numerous factors. Because of this uncertainty, it is difficult to accurately break down the percentage contribution of bacterial contamination from each source. Instead, categories were used to list the sources of bacterial contamination in the impaired stream reaches. Table 8.7.3 presents the likely major sources of bacterial loading in HICW and RRW, during wet and dry conditions. Wet conditions are defined as those during and following precipitation events that cause overland flow. Dry conditions are when overland flow is not occurring. A greater percentage of days would be considered dry; however the majority of bacterial loading to streams occurs during wet conditions. Categories were defined as <5% being a low contributor, 5%-20% a moderate contributor and >20% a high contributor.

Table 8.7.3 – HICW and RRW Potential Major Contributors of FC Bacteria

Category	Source	Wet Conditions	Dry Conditions
Livestock	Overgrazed Pastures near Streams or Waterways	🟩	🟩
	Feedlots or Manure Stockpiles without Runoff Controls	🟨	🟩
	Surface Applied Manure	🟧	🟩
	Incorporated Manure	🟨	🟩
Human	Inadequately Treated Wastewater	🟩	🟧
Pets	Cats/Dogs	🟩	🟩
Wildlife		🟩	🟩

Low Contributor	🟩
Moderate Contributor	🟨
High Contributor	🟧

8.8 Implementation Activities

Source inventories and water quality testing as part of this project indicate sources of fecal coliform contamination to streams can vary by a number of factors, especially weather and flow. These analyses indicate the primary sources of fecal coliform contamination during wet conditions to be livestock manure (land applied manure and runoff from feedlots without controls). The primary sources during low flow conditions are inadequately functioning septic systems. Implementation activities will be targeted toward these sources.

An Implementation Strategy Planning meeting was held November 30th, 2006 to solicit recommendations for implementation activities. The below strategies are broad in scope and will be refined in a more thorough implementation plan.

8.8.1 Feedlot Runoff Controls

State rules for feedlot runoff control will reduce, but not eliminate, bacteria transport to waters from open lots by October 2010. At that time, the bacteria contributions from open lot runoff will need to be reassessed. The Environmental Quality Incentive Program assists feedlots that have a high risk for runoff problems. This cost share funding typically goes for high cost fixes, such as manure storage basins.

One issue discussed at the Implementation Strategy Planning meeting was a lack of grant funding for low cost feedlot fixes. It was noted that typically the county Soil and Water Conservation Districts receive only $10,000 to $20,000 annually for cost share practices (this includes practices such as terraces, diversions, sediment control basins, feedlot control structures, etc.) through the State Cost Share program from the Board of Soil and Water Resources (BWSR). When funding is spread across these various practices, funding is quickly expended. The group agreed that additional cost share for feedlot fixes would be beneficial.

8.8.2 Manure Management Planning

State rules dictate that feedlots larger than 300 animal units are required to develop manure management plans. However, the majority of feedlots in the watersheds are under the 300 animal unit limits. The committee recommended promotion of manure management plans for smaller feedlots that are not required to develop plans. Members of the TMDL technical committee suggested obtaining grant dollars to provide 80-90% cost share for livestock operators to develop manure management plans. These plans could be developed by private consultants, co-ops, or the U of M extension. As part of this process, follow-up would be a key. In addition, Spiehs and Goyal (2007) provide several BMP options that might reduce pathogen concentrations in manure prior to land application.

Manure management education for horse owners was also suggested by the committee. There are currently around 200 homesteads in Sibley County alone that have horses, (between 700-1000 animal units between both watersheds). Two ideas from the group were cost share for construction of composting structures for horse manure and educational activities.

Representatives from the MPCA feedlot division made the following recommendations regarding applied manure implementation activities:

- Monitoring and research to determine which soils, soil management practices and land application timing practices prevent bacteria movement vertically into tile lines.

- Conduct a promotional campaign of sweep injection and other effective manure incorporation techniques onto soils which are found not to transmit bacteria through preferential flow into tile lines. This type of practice can also be promoted as a way to conserve manure nitrogen and thereby potentially save fertilizer costs.

- Develop a set of economically viable BMPs for reducing bacteria transport in situations where injection/incorporation alone may lead to bacteria entering tile lines. Practices may consider various combinations of: manure storage, fall timing of manure applications, composting, grass buffers, runoff and erosion control, careful timing of manure application to reduce the likelihood of rainfall within a few days after application;

- Keep track of adoption of the above practices to evaluate progress in achieving implementation goals.

8.8.3 Non-Conforming Septic Systems

Septic upgrades to noncompliant septic systems are occurring at a faster rate now than in the past due to county and watershed initiatives. Still, the group agreed that more effort could be put toward upgrading of non-compliant septic systems if additional resources were available.

It was noted that over the past several years, counties have received only $1,500 to $3,000 for the septic program administration. Administrative dollars will be increased this coming year to around $9,000 for Sibley County (a one-time increase due to Clean Water Legacy dollars). While this was felt to be a positive change, the funding is still inadequate to allow for proper inventorying and educational activities related to septic systems.

Some ideas given during the meeting included:

a.) Demonstration projects across the watersheds, perhaps one per township. Local landowners would be invited to see how the septic systems are installed and how they function. Contractors would be available to answer questions and researchers would be present with information that shows the impact of septic discharges to our streams.

b.) It was also stressed that the regulatory side would progress faster if additional investigative funding were available for:
  - Dye Testing
  - Digging up of tile lines for investigation purposes
  - Costs associated with the water quality sampling that is needed for legal purposes
  - The costs of inventorying noncompliant septic systems (walking the ditches and documenting the obvious straight pipe systems.)

The recommendation of the committee was to hire a full time coordinator for the two watersheds to work on these compliance or regulation issues and education/information activities.

Existing implementation plans and cost estimates for the Lower Mississippi and Greater Blue Earth Fecal Coliform TMDLs can be used to generate a rough estimate of the cost for implementing the practices outlined above at the scale of the Rush and High Island watersheds. Implementing the same suite of practices as called for in the Lower Mississippi and Greater Blue Earth, and accounting for the size of the combined High Island and Rush River watersheds, approximately $20,000,000 over 15 years would be necessary to meet the water quality standards. Though a very large sum of money, it should be noted that many of the practices called for could also help address additional water quality concerns in the watershed including turbidity and elevated nutrient levels.

Section 9.0 – Reasonable Assurance

As a requirement of TMDLs, reasonable assurance must be provided demonstrating the ability to reach and maintain water quality endpoints. The source reduction strategies detailed in section 8.0 have been shown to be effective in reducing pathogen transport and survival and to be capable of widespread adoption by land owners and local resource managers.

9.1 Feedlot Runoff Controls

These are evaluated by professional engineers through the Feedlot Evaluation Model referenced in Minn. R. ch. 7080. These rules are implemented by the MPCA staff and by local counties via a delegation agreement with the Agency. In Minnesota, feedlot rule 7020 requires the registration of feedlots and manure storage areas having a capacity of 50 animal units (AU) or more and 10 AU or more in shoreland areas.

9.2 Land Application of Manure

Buffer strips, immediate incorporation, observance of setback rules, and maintenance of surface residue have been demonstrated to reduce manure and pathogen runoff (Environmental Quality Board, General Environmental Impact State for Feedlots). Minnesota Rules Chapter 7020 require manure application record keeping and manure management planning, with requirements varying according to size of operation and pollution risk of application, based on method, time and place of application.

Section 8.2.1 and 8.2.2 detail the possible routes of transport of fecal coliform bacteria from lands receiving manure application. Current manure application rules are based on the best available research. However, in Minnesota, relatively little research has been conducted examining manure application setback rules related to fecal coliform bacteria. Further research should be put towards refining current manure application rules, especially setback distances for applied manure from open tile intakes.

9.3 Individual Sewage Treatment Systems

ISTS with proper drain fields provide virtually complete treatment of fecal coliform bacteria. Straight-pipe septics discharge untreated wastewater to surface water. Acceptable designs are described in Minn. R. ch. 7080. Minnesota counties in the basin are delegated to implement these rules, which require conformance with state standards for new construction and disclosure of the state of the ISTS when property transfers ownership. Several counties require ISTS upgrades at property transfer.

9.4 Municipal Waste Water Disinfection

Disinfection with chlorine or ultraviolet radiation is required of all NPDES municipal wastewater permittees.

9.5 Erosion Control and Sediment Reduction

Conservation tillage and riparian buffer strips have been demonstrated to be effective in reducing sediment delivery to streams. Since embedded sediment can serve as a substrate for fecal coliform survival, reduction of sediment is considered an effective measure of controlling fecal coliform bacteria in streams.

9.6 Planned Rotational Grazing

Sovell et al, 2000, demonstrated that rotational grazing, in contrast to conventional grazing, significantly reduces both sedimentation and fecal coliform concentrations in water downstream of study sites in southern Minnesota.

9.7 Urban Stormwater Management

Practices such as runoff detention, infiltration, and street sweeping have been shown to be effective in reducing urban runoff and associated pollutants.

Section 10.0 – Public Participation

10.1 Stakeholder Involvement

Public participation opportunities were provided during the project in the form of public open houses, new releases and a project newsletter. The project worked closely with a broad array of county, state and individual stakeholders. The joint HICW and RRW CWP technical committee served as the advisory and review role for the project. This group is comprised of staff from the following groups:

- High Island Watershed District
- Soil and Water Conservation Districts
- Natural Resources Conservation Service
- City of Lafayette
- County Water Planners
- County Commissioners
- Minnesota Pollution Control Agency
- Board of Soil and Water Resources

The technical committee also formed a smaller TMDL subcommittee which assisted in reviewing the project workplan, outreach material and review of the draft TMDL report. The technical committee was updated quarterly on the progress of the project. Key findings were discussed and input was gathered from the group. In addition to this group, presentations regarding the project were also given to the Sibley County Water Resources Advisory Committee in July 2005, December 2005 and July 2006.

Public outreach for this project also included the following activities:

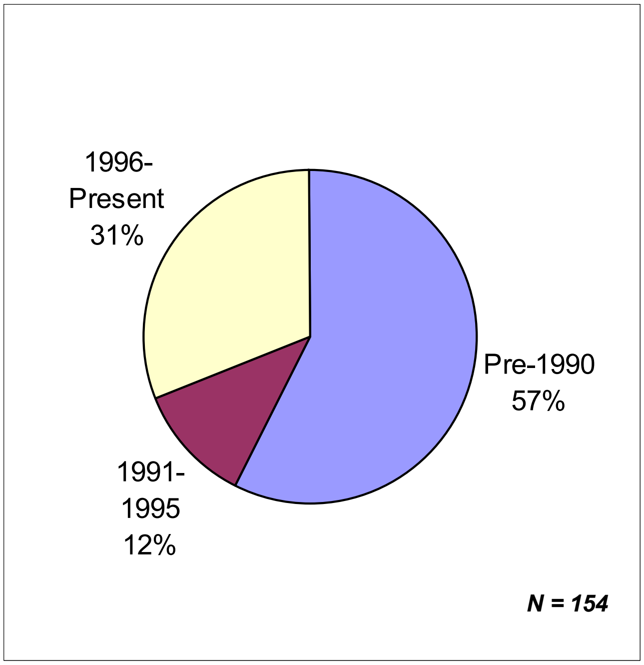
Dec. 2005	Conservation Promotions meeting held in Buffalo Lake. As part of these open houses, information on the TMDLs is provided to the public.
May 2006	A six page newsletter detailing the project is sent to citizens in both watersheds. The newsletter detailed what fecal coliform is, the major sources and information on three June open houses. The newsletter also includes a short survey (see below).
Jun. 2006	Public open house meetings held in the communities of Henderson, Gaylord and Stewart explaining TMDLs, fecal coliform bacteria, associated health risks, potential sources of fecal coliform and water quality monitoring data. This open house is combined with a free well water testing clinic to help draw in citizens. A total of 112 citizens attended these three open houses.
July 2008	The draft High Island Creek - Rush River Fecal Coliform TMDL report is submitted for public/agency review. News releases submitted to newspapers in the project area, notices posted throughout watersheds and

radio announcements made regarding place and time of meeting. A final public open house is held in Gaylord, MN.

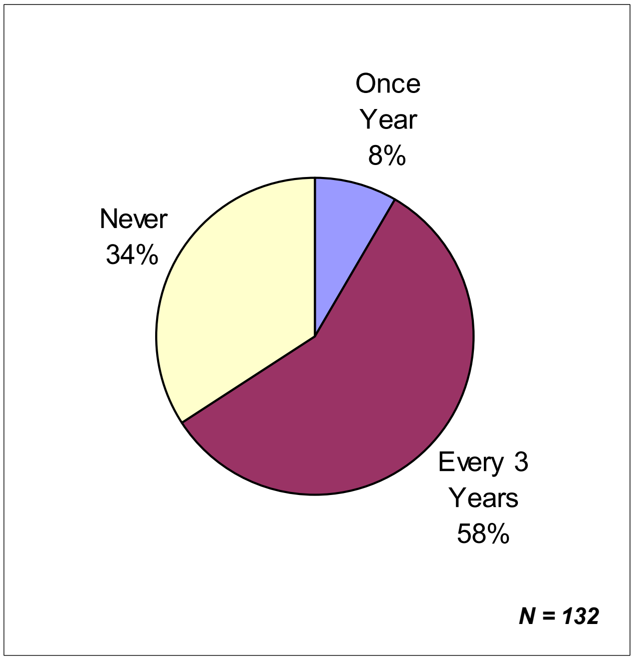
10.2 Results of TMDL Survey

The following survey questions were distributed May 2006 to approximately 1,930 rural households in the High Island Creek and Rush River Watersheds as part of a six page project newsletter. A total of 156 surveys were returned, a response rate of 8.1%.

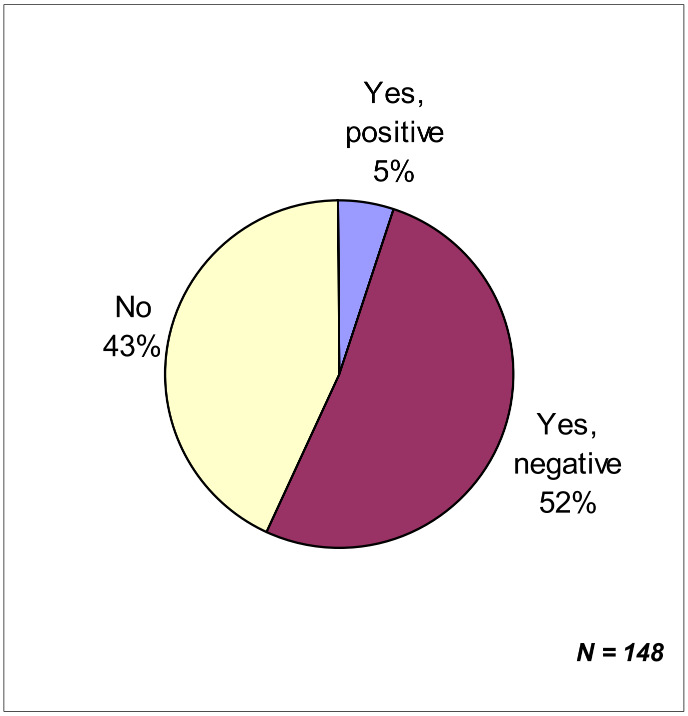
When was your septic system installed?



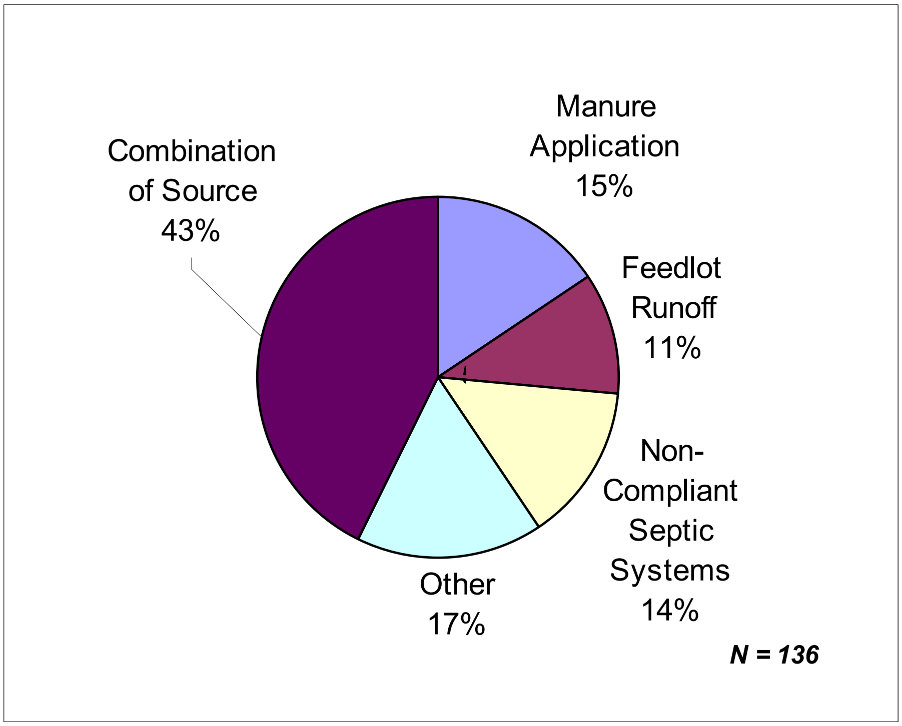
How often do you pump your septic system?



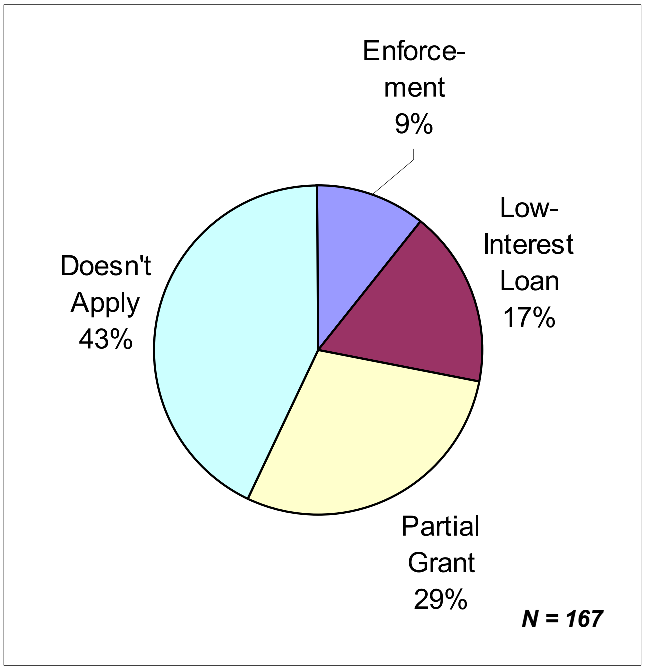
Have you had your well tested for Fecal Coliform Bacteria in the past?



High Island and Rush River have high levels of Fecal Coliform Bacteria. What do you think is/are the source(s)?



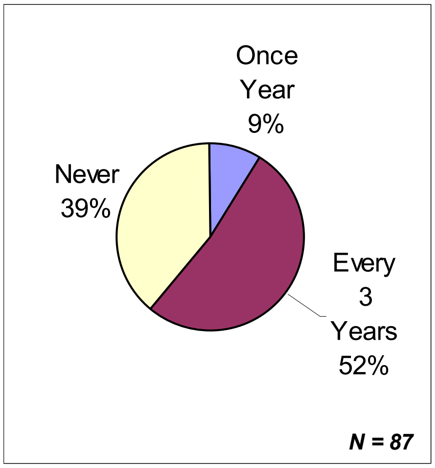
What will it take to upgrade your septic system?



Other comments written on the surveys:

- Current mound systems are worthless and costly-Forced upgrades should be criminal
- Get a good system and get rid of mounds
- Tie the farm payment program (USDA) into the compliance or property tax at a higher rate for non-compliance
- Elderly can't afford to do it alone
- Five wrote that wildlife are a major source
- Four wrote that pesticides/fertilizers are a major source

Eighty-seven (56%) of the respondents indicated that their septic system had been installed prior to 1996. The below chart shows how often these older systems were pumped.



10.3 Input and Comments - Refer to Appendix B for comments and responses.

Appendix A - References

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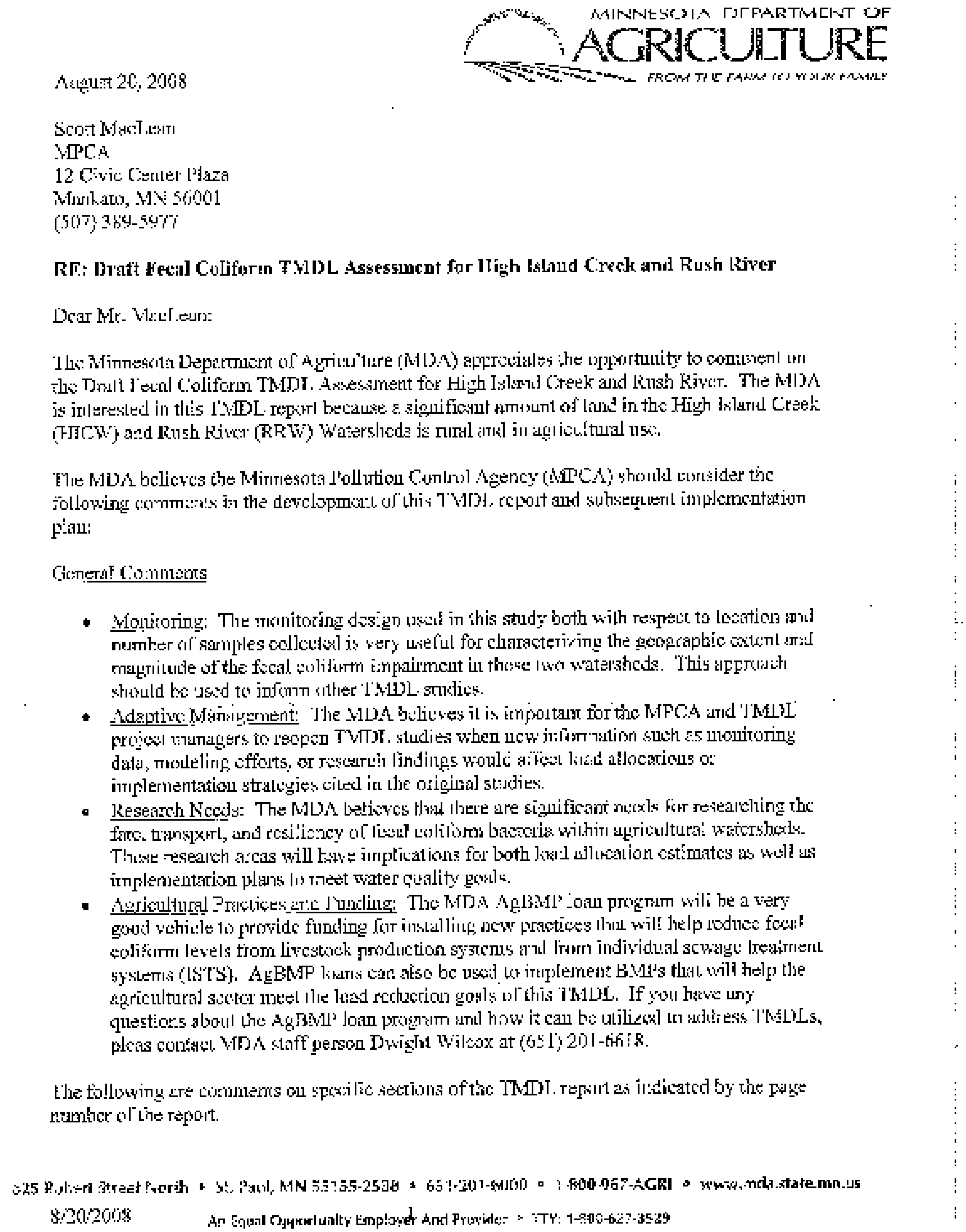
Appendix B – Comment Letter and Responses



MINNESOTA DEPARTMENT OF
AGRICULTURE
FROM THE FARM TO YOUR FAMILY

August 20, 2008

Scott MacLean
MPCA
12 Civic Center Plaza
Mankato, MN 56001
(507) 389-5977

RE: Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River

Dear Mr. MacLean:

The Minnesota Department of Agriculture (MDA) appreciates the opportunity to comment on the Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River. The MDA is interested in this TMDL report because a significant amount of land in the High Island Creek (HICW) and Rush River (RRW) Watersheds is rural and in agricultural use.

The MDA believes the Minnesota Pollution Control Agency (MPCA) should consider the following comments in the development of this TMDL report and subsequent implementation plan:

General Comments

- Monitoring: The monitoring design used in this study both with respect to location and number of samples collected is very useful for characterizing the geographic extent and magnitude of the fecal coliform impairment in these two watersheds. This approach should be used to inform other TMDL studies.
- Adaptive Management: The MDA believes it is important for the MPCA and TMDL project managers to reopen TMDL studies when new information such as monitoring data, modeling efforts, or research findings would affect load allocations or implementation strategies cited in the original studies.
- Research Needs: The MDA believes that there are significant needs for researching the fate, transport, and resiliency of fecal coliform bacteria within agricultural watersheds. These research areas will have implications for both load allocation estimates as well as implementation plans to meet water quality goals.
- Agricultural Practices and Funding: The MDA AgBMP loan program will be a very good vehicle to provide funding for installing new practices that will help reduce fecal coliform levels from livestock production systems and from individual sewage treatment systems (ISTS). AgBMP loans can also be used to implement BMPs that will help the agricultural sector meet the load reduction goals of this TMDL. If you have any questions about the AgBMP loan program and how it can be utilized to address TMDLs, pleas contact MDA staff person Dwight Wilcox at (651) 201-6618.

The following are comments on specific sections of the TMDL report as indicated by the page number of the report.

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- (p viii) The statement from the Minnesota Generic Environmental Impact Statement on Animal Agriculture was referring to regional water quality impacts attributed to nutrients. The study did not evaluate fecal coliform bacteria. Fecal coliform may not show similar fate and transport characteristics as nutrients from land applied manure. The statement was made in the context of regional water quality. Sources such as non-compliant feedlot runoff and overgrazed pastures near streams may have a greater impact on individual stream reach impairments than land application of manure in some instances.
- (p 9. Section 2.4) The data presented in the report doesn't seem to support the statement that the highest bacterial concentrations are associated with the highest intensity precipitation events particularly during the spring. Figures 3.3b and 3.3c suggest that the highest concentrations are observed in June, July, and September though monthly geometric means do exceed the standard in other monitored months as well. Are there data available not presented in the report that document a relationship between fecal coliform bacteria concentration and precipitation intensity of individual events?
- (p 9-11. Sections 2.4, 2.6, and 2.7) It seems more appropriate to include the discussion of factors affecting fecal coliform concentration such as precipitation, streambed sediments, and DNA fingerprinting in the source assessment portion (Section 8) of the report. It would be less confusing if section 2 were limited to information such as climatic records, land use, and other physiographic descriptors describing the watershed.
- (p 12. Section 3.1) Literature references are needed for many of the statements in this section that describe factors that contribute to the transport of fecal coliform bacteria to surface waters.
- (p 14. Section 3.3) Is it possible to include drainage areas for each of the monitoring sites in Table 3.3? This would also assist with characterizing the geographic extent of the impairment.
- (p 16. Section 3.4) Does the information presented in Figure 3.4b conflict with the data presented in 3.3c for the High Island Creek outlet site? Are the elevated concentrations observed in September associated with storm events? Mean monthly flows are relatively low (<100 cfs) during this time period as shown in Figure 2.5. In contrast fecal coliform bacteria concentrations are near the standard for the month of April during the highest monthly flow period (>250 cfs). A plot showing date and flow in relation to fecal coliform bacteria concentrations may help to discern these observations as water temperature seems to be an important factor as well.
- (p 17. Section 3.5) The relationship of fecal coliform bacteria with total suspended solids may be associative rather than causative.
- (p 19. Section 3.7) The discussion on seasonality needs to be linked to the discussion on the influence of stream flow on fecal coliform bacteria concentrations to help discern observed data. Does flow or stream temperature have a bigger impact on observed bacteria concentrations or is it a combination of the two?
- (p 16-20. Sections 3.4-3.8) The primary focus of these sections is to identify explanatory variables that characterize observed fecal coliform concentrations. It causes confusion as presented under the Applicable Water Quality Standards and Numeric Targets section of the report. Could this discussion be addressed in a subsection or be linked to the source assessment section? It is a very important discussion that helps to characterize the multitude of transport and source factors that dictate fecal coliform losses to surface waters.

- (p 26. Section 4.0) Is it possible to present the flow data that compares the normalized flow data with the available data for the Buffalo Creek Site?
- (p 59. Section 8.2.1) Gessel et al. (2004) evaluated fecal coliform concentrations of soil in the runoff mixing zone from plots located in Morris, MN following incorporated swine manure applications at different rates. The study observed fecal coliform forming unit decreases in all manure treatments to levels similar to the reference plot within 4 days of application. The authors concluded that these organisms were at a low risk of transport off-site by runoff. The study did observe elevated levels 143 days following application with no relationship to application rate. The authors cited a need to further study survival of pathogens in the mixing zone over time.
- (p 61 Section 8.2.2) The second study involving Randall (Malik et al., 2004) observed fecal coliform concentrations that were less than 100 cfu/100 ml following sweep injected fall application of swine manure at agronomic rates. Spring precipitation was below the 30-year average for 2002; however, June precipitation was above average. These fecal coliform concentrations are informative given that the fecal coliform geometric means in June in both impaired watersheds are among the highest observed during the monitoring period. The study did highlight the need for long-term experiments to characterize pathogen leaching following swine manure.
- (p 65. Section 8.5.1) It is unclear where in the GEIS on Animal Agriculture the assumptions listed in tables 8.5.1c and 8.5.1d are located. Do these tables represent total fecal coliform produced by source and application method? In addition to the percentages it would be helpful for clarification to list the quantities for each animal type as well. Furthermore, the quantities should reflect losses associated with storage and application method to reflect the true amounts available for loss to surface waters if this isn't already accounted for in the table.
- (p 73. Section 8.5.3) Though section 8.5 and table 8.5.3 have no regulatory implications as the report acknowledges, they are useful for refining the sources of fecal coliform contamination in the impaired watersheds. They also highlight the need for further research into the sources and transport pathways of fecal coliform bacteria to surface waters. For instance the risk of fecal coliform transport from land application of manure is impacted by several factors including method and timing of application, source of manure, and collection and storage of manure. Table 8.5.3 could evolve into a risk assessment index akin to the phosphorus index that would link both the source and transport factors to establish a risk of fecal coliform bacteria transport to surface waters. In addition to the source and transport factors there are also abiotic factor affecting fecal coliform growth and survival rates such as temperature, pH, and nutrient availability that would also need to be considered. These factors also distinguish fecal coliform from other risk assessments developed for sediments and nutrients.
- (p 73. Section 8.6) Spiehs and Goyal (2007) offer a number of best management practices that can be employed to reduce pathogen prior to land application.

References Cited:

Gessel, P.D., N.C. Hansen, S.M. Goyal, L.J. Johnston, and J. Webb. 2004. Persistence of zoonotic pathogens in surface soil treated with different rates of liquid pig manure. Applied Soil Ecology. 25:237-243.

Malik, Y.S., G.W. Randall, and S.M. Goyal. 2004. Fate of Salmonella following application of swine manure to tile-drained clay loam soil. J. Water and Health. 2.2:97-101.

Spiehs, M. and S. Goyal. 2007. Best management practices for pathogen control in manure management systems. M1211. Univ. Minn. Ext., Saint Paul, MN.

Please consider the MDA's comments in the development of the Final High Island Creek and Rush River Fecal Coliform Bacteria TMDL report. If you have any questions about the MDA's comments, please contact Adam Birr at (507) 285-7198.

Sincerely,

Joe Martin
Assistant Commissioner
Minnesota Department of Agriculture

CC:
Jim Boerboom, MDA
Dan Stoddard, MDA
Bob Patton, MDA
Janice Hugo, MDA
Adam Birr, MDA
Wayne Anderson, MPCA

September 10, 2008

Mr. Joe Martin
Minnesota Department of Agriculture
625 Robert Street North
St. Paul, MN 55155

Dear Mr. Martin:

Thank you for your comments in the August 20, 2008 letter on the *Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River.* The MPCA appreciates that your organization took the time to review the draft document. The comments have been restated below, and responses are provided in italics.

(p viii) The statement from the Minnesota Generic Environmental Impact Statement on Animal Agriculture was referring to regional water quality impacts attributed to nutrients. The study did not evaluate fecal coliform bacteria. Fecal coliform may not show similar fate and transport characteristics as nutrients from land applied manure. The statement was made in the context of regional water quality. Sources such as non-compliant feedlot runoff and overgrazed pastures near streams may have a greater impact on individual stream reach impairments than land application of manure in some instances.

In response to your comment, the statement from the Minnesota GEIS on Animal Agriculture has been moved to Section 8.2. We have also provided the following additional context for the statement:

"The basis for this statement is an analysis of water quality impacts from nitrogen and phosphorus in manure. While there are certainly differences, there are also parallels between the fate and transport characteristics of bacteria and nutrients, particularly phosphorus."

(p 9. Section 2.4) The data presented in the report doesn't seem to support the statement that the highest bacterial concentrations are associated with the highest intensity precipitation events particularly during the spring. Figures 3.3b and 3.3c suggest that the highest concentrations are observed in June, July, and September though monthly geometric means do exceed the standard in other monitored months as well. Are there data available not presented in the report that document a relationship between fecal coliform bacteria concentration and precipitation intensity of individual events?

The statement to which you are referring will be changed to better reflect the link between bacterial concentrations and high intensity events resulting in runoff conditions (the statement will also be moved to Section 3.7 of the report to address your following comment - see below). The Rush River and High Island Watersheds as well as other watersheds in the Minnesota River basin display a strong relationship between rainfall intensity, flow and TSS concentrations (State of the Minnesota River, 2003).

Furthermore, there is a strong correlation between TSS concentration and bacterial concentration. This relationship is supported by data presented in Table 3.5a and Table 3.5b as well as Figure 3.5. In addition, the data presented in Table 3.4 indicates a strong relationship between bacteria concentration and flow, supporting our contention that rainfall intensity, runoff, TSS concentration and bacteria concentration are closely linked.

(p 9-11. Sections 2.4, 2.6, and 2.7) It seems more appropriate to include the discussion of factors affecting fecal coliform concentration such as precipitation, streambed sediments, and DNA fingerprinting in the source assessment portion (Section 8) of the report. It would be less confusing if section 2 were limited to information such as climatic records, land use, and other physiographic descriptors describing the watershed.

While we believe the precipitation data presented in Section 2.4 is important information to characterize the watersheds in question, we agree that the sentence describing the relationship between rainfall intensity and fecal coliform bacteria concentration is misplaced and will be reworded (see comment regarding pg 19, Section 3.7) and moved to Section 3.7 of the report. The subsections describing streambed sediments and DNA fingerprinting will be moved to Section 8.

(p 12. Section 3.1) Literature references are needed for many of the statements in this section that describe factors that contribute to the transport of fecal coliform bacteria to surface waters.

References will be added to the second paragraph of Section 3.1.

(p 14. Section 3.3) Is it possible to include drainage areas for each of the monitoring sites in Table 3.3? This would also assist with characterizing the geographic extent of the impairment.

Drainage areas for each of the monitoring sites will be added to Table 3.3.

(p 16. Section 3.4) Does the information presented in Figure 3.4b conflict with the data presented in 3.3c for the High Island Creek outlet site? Are the elevated concentrations observed in September associated with storm events? Mean monthly flows are relatively low (<100 cfs) during this time period as shown in Figure 2.5. In contrast fecal coliform bacteria concentrations are near the standard for the month of April during the highest monthly flow period (>250 cfs). A plot showing date and flow in relation to fecal coliform bacteria concentrations may help to discern these observations as water temperature seems to be an important factor as well.

The September geometric means represented in Table 3.3c are the result of non-typical late season storm events in 2004 and 2005 with resulting high flows and high bacteria concentrations. Relatively few samples were available to calculate the September geometric means, accounting for 2004 and 2005's disproportional effect on the overall monthly geometric mean. Despite this anomaly driven by a non-typical storm during a *normally low-flow period, the overall data suggests a strong positive link between flow and bacteria concentration as indicated by Figure 3.4b.*

(p 17. Section 3.5) The relationship of fecal coliform bacteria with total suspended solids may be associative rather than causative.

We agree with this assertion and will therefore change the wording in Section 3.5 to, "This data show there is a strong correlation between bacterial levels and TSS concentration. While this might not be a causative relationship, best management practices that reduce soil erosion might also reduce bacterial transport to streams."

(p 19. Section 3.7) The discussion on seasonality needs to be linked to the discussion on the influence of stream flow on fecal coliform bacteria concentrations to help discern observed data. Does flow or stream temperature have a bigger impact on observed bacteria concentrations or is it a combination of the two?

As the data indicate, no single factor such as precipitation, runoff, flow, season or water temperature appears to fully explain the variability of bacterial concentrations observed in the watersheds. Rather, a combination of factors seems to be required to account for the temporal variation in fecal coliform concentrations. The following statement will be added at the end of Section 3.7 to describe this relationship more explicitly

"Data presented in Sections 3.3 – 3.7 illustrate the effects of precipitation, runoff, flow, season and water temperature on the presence and/or population of fecal coliform bacteria at the outlet sites of the Rush River and High Island Creek. No single factor appears to fully explain the temporal variability of fecal coliform concentrations observed in the watersheds. A multivariate statistical analysis would be required to identify the factor or combination of factors that is most likely to result in elevated levels of coliform bacteria. For the purposes of this study, it is sufficient to say that a combination of environmental factors as described above accounts for the delivery, proliferation and longevity of fecal coliform bacteria in the Rush River and High Island Creek watersheds."

(p 16-20. Sections 3.4-3.8) The primary focus of these sections is to identify explanatory variables that characterize observed fecal coliform concentrations. It causes confusion as presented under Applicable Water Quality Standards and Numeric Targets section of the report. Could this discussion be addressed in a subsection or be linked to the source assessment section? It is a very important discussion that helps to characterize the multitude of transport and source factors that dictate fecal coliform losses to surface waters.

The title of this section will be changed to "Applicable Water Quality Standards and Description of Factors Affecting Impairments" to better characterize its content.

(p 26. Section 4.0) Is it possible to present the flow data that compares the normalized flow data with the available data for the Buffalo Creek Site?

A table will be added to Section 4.0 providing data on the percent differences between measured Buffalo Creek flow data and the High Island outlet flow data. This will serve to validate the method used to estimate Buffalo Creek flows.

(p 59. Section 8.2.1) Gessel et al. (2004) evaluated fecal coliform concentrations of soil in the runoff mixing zone from plots locates in Morris, MN following incorporated swine manure applications at different rates. The study observed fecal coliform forming unit decreases in all manure treatments to levels similar to the reference plot within 4 days of application. The authors concluded that these organisms were at low risk of transport off-site by runoff. The study did observe elevated levels 143 days following application with no relationship to application rate. The authors cited a need to further study survival of pathogens in the mixing zone over time.

The paper to which you referred will be cited in Section 8.2.1 both in respect to the limited longevity of fecal bacteria in the runoff mixing zone, and the resulting implications for the importance of timing of manure application.

(p 61 Section 8.2.2) The second study involving Randall (Malik et al., 2004) observed fecal coliform concentrations that were less than 100 cfu/100ml following sweep injected fall application of swine manure at agronomic rates. Spring precipitation was below 30-year average for 2002; however, June precipitation was above average. These fecal coliform concentrations are informative given that the fecal coliform geometric means in June in both impaired watersheds are among the highest observed during the monitoring period. The study did highlight the need for long-term experiments to characterize pathogen leaching following swine manure.

The reference cited will be changed to Malik et al., (2004).

(p 65. Section 8.5.1) It is unclear where in the GEIS on Animal Agriculture the assumptions listed in tables 8.5.1c and 8.5.1d are located. Do these tables represent total fecal coliform produced by source and application method? In addition to the percentages it would be helpful for clarification to list the quantities for each animal type as well. Furthermore, the quantities should reflect losses associated with storage and application method to reflect the true amounts available for loss to surface waters if this isn't already accounted for in the table.

The starting point for the assumptions shown in Tables 8.5.1c and 8.5.1d are Tables 5, 7 and 8 of the GEIS Technical Work Paper – "Impacts of Animal Agriculture on Water Quality (Mulla et al., 2001). The assumptions have been adjusted over time in this and other TMDL studies to reflect changing practices and local conditions. Based on stakeholder input, for example, the proportion of swine manure that in incorporated (versus broadcast) was increased to 95%. In response to the second question, the tables contain the animal unit or individual numbers from which manure and bacteria production was estimated. The end product of the bacteria source assessment (Table 8.5.3) does not explicitly reflect bacteria die-off, but does reflect that 92-99.9% of bacteria produced never reaches a waterway.

(p 73. Section 8.5.3) Though section 8.5 and table 8.5.3 have no regulatory implications as the report acknowledges, they are useful for refining the sources of fecal coliform contamination in the impaired watersheds. They also highlight the need for further research into the sources and transport pathways of fecal coliform bacteria to surface waters. For instance the risk of fecal coliform transport from land application of manure is impacted by several factors including method and timing of application, source of manure, and collection of manure. Table 8.5.3 could evolve into a risk assessment index akin to the phosphorus index that would link both the source and transport factors to establish a risk of fecal coliform transport to surface waters. In addition to the source and transport factors there are also abiotic factor affecting fecal coliform growth and survival rates such as temperature, pH, and nutrient availability that would also need to be considered. These factors also distinguish fecal coliform from other risk assessments developed for sediments and nutrients.

It is clear from this TMDL study and others like it that additional research is needed regarding source, fate and transport of fecal bacteria. At present a number of studies are being conducted with a focus on bacterial transport in subsurface tile, macropore/preferential flow and DNA fingerprinting to name a few. As the data and results from these and other studies become available, new information will be incorporated into implementation efforts in these watersheds as well as future TMDL studies.

(p 73. Section 8.6) Spiehs and Goyal (2007) offer a number of best management practices that can be employed to reduce pathogen prior to land application.

This article will be cited in Section 8.8.

Again, thank you for reviewing and commenting on the *Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River.* Your comments provide valuable insight to the success of this project and future TMDL projects. If you have any further questions about this project, please contact me at 507-344-5250 or visit the project website: http://www.pca.state.mn.us/water/tmdl/project-highislandrush-fecal.html

Sincerely,

Scott MacLean
MPCA Project Manager
Mankato Office
Regional Division

MAWRC

"a farmer focused effort to protect soil and water resources"

Physical Address: 3080 Eagandale Place, Eagan , MN 55121-2118
Mailing Address: P.O. Box 64370, St. Paul, MN 55164-0370
Phone: 651.905.2106 Fax: 651.905.2159
Email: info@mawrc.org www.mawrc.org

August 20, 2008

Scott MacLean
Minnesota Pollution Control Agency
Mankato Place
12 Civic Center Plaza Suite 2165
Mankato, Minnesota 56001-8704

Dear Mr. MacLean,

The Minnesota Agricultural Water Resources Coalition offers the following comments regarding the Fecal Coliform TMDL Assessment for High Island Creek and Rush River.

We appreciate the recognition throughout the document that there is significant uncertainty in identification of the sources of this fecal coliform impairment (pages viii, 53, 72). As indicated in previous fecal coliform TMDL reports, there are significant data gaps in the delivery mechanisms, survivability and reproduction of fecal coliform bacteria. Significant research areas have been identified, some of which are underway. We encourage the MPCA to incorporate new information into the TMDL process as part of an overall adaptive management strategy.

We are concerned with the executive summary statement justifying the focus on applied manure based on a statement from the Generic Environmental Impact Statement on Animal Agriculture (page viii). This statement does not fit into the context of a TMDL report, which should be written from a non-policy perspective. Further, the TMDL report should strive to identify the source of the impairment on a local, not regional, basis. The point behind this statement as used in the GEIS report is that accurate identification of impairment sources is a critical step in determining effective, cost-efficient corrective actions, however in the GEIS the context was only relating to livestock, while this TMDL report should consider <u>all</u> potential sources. Thus we consider the statement to be of little benefit as included in this report.

We are also concerned with the delivery assumptions used in table 8.5.2 on page 72. These numbers are assumptions based on at least two other sets of estimates and assumptions found in an earlier TMDL report and the 2001 Animal Agriculture GEIS, which should be subject to review and update if it is to continue to be used in this way. We also suggest that analysis of potential bacteria delivery should incorporate a greater emphasis on manure management, rather than the current primary focus on animal units. Again, current research is needed to develop a more accurate assessment tool, to enable better implementation of corrective actions.

We would also point out that the overview indicates that the High Island Creed Watershed receives an average of 27 inches of annual precipitation (page 1), while the background section states that the two watersheds average 29 to 30 inches of precipitation annually (page 8).

We suggest that as the project moves into the implementation phase a more complete evaluation be included on the benefits of subsurface drainage on ag land. Subsurface tile can moderate flow, potentially reducing re-suspension of in-stream bacteria and sediment. Subsurface tile reduces surface runoff and associated potential sediment and bacteria discharge. Subsurface drainage allows timely field operations, which enable producers to manage manure as a resource more effectively by choosing more appropriate field locations, application methods and timing.

And finally, we support emphasizing the importance of addressing nonpoint sources through voluntary BMPs and suggest substituting the word "exclusively" for "primarily" on page viii— "addressing land application will be ~~primarily~~ exclusively through research, education, and the promotion of voluntary BMPs." We look forward to working with to increase the level of producer involvement in developing effective B MPs as the project moves into the implementation phase. Please notify our organization of all future stakeholder meetings so that we can assist in coordinating local producer participation.

Please consider these comments in formation of the final report. If you have any questions or would like to discuss these comments, please contact me at 651-905-2106.

Best regards,

Warren Formo

Warren Formo, Director
Minnesota Agricultural Water Resources Coalition

September 10, 2008

Mr. Warren Formo
Minnesota Agricultural Water Resources Coalition
P.O. Box 64370
St. Paul, MN 55164-0370

Dear Mr. Formo:

Thank you for your comments in the August 20, 2008 letter on the *Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River.* The MPCA appreciates that your organization took the time to review the draft document. The comments have been restated below, and responses are provided in italics.

The Minnesota Agricultural Water Resources Coalition offers the following comments regarding the Fecal Coliform TMDL Assessment for High Island Creek and Rush River.

We appreciate the recognition throughout the document that there is siginificant uncertainty in identification of the sources of this fecal coliform impairment (pages viii, 53, 72). As indicated in previous fecal coliform TMDL reports, there are significant data gaps in the delivery mechanisms, survivability and reproduction of fecal coliform bacteria. Significant research areas have been identified, some of which are underway. We encourage MPCA to incorporate new information into the TMDL process as part of an overall adaptive management strategy.

We are concerned with the executive summary statement justifying the focus on applied manure based on a statement from the Generic Environmental Impact Statement on Animal Agriculture (page viii). This statement does not fit into the context of a TMDL report, which should be written from a non-policy perspective. Further, the TMDL report should strive to identify the source of the impairment on a local, not regional, basis. The point behind this statement as used in the GEIS report is that accurate identification of impairment sources is a critical step in determining effective, cost-efficient corrective actions, however in the GEIS the context was only relating to livestock, while this TMDL report should consider all potential sources. Thus we consider the statement to be of little benefit as included in this report.

In response to your comment, the statement from the Minnesota GEIS on Animal Agriculture has been moved to Section 8.2. We have also provided the following additional context for the statement:

"The basis for this statement is an analysis of water quality impacts from nitrogen and phosphorus in manure. While there are certainly differences, there are also parallels between the fate and transport characteristics of bacteria and nutrients, particularly phosphorus."

We are also concerned with the delivery assumptions used in table 8.5.2 on page 72. These numbers are assumptions based on at least two other sets of estimates and assumptions found in an earlier TMDL report and the 2001 Animal Agriculture GEIS, which should be subject to review and update if it is to continue to be used in this way. We also suggest that analysis of potential bacteria delivery should incorporate a greater emphasis on manure management, rather than the current primary focus on animal units. Again current research is needed to develop a more accurate assessment tool, to enable better implementation of corrective actions.

In regard to your first comment, Table 8.5.2 has already been moved to the implementation section of the TMDL study in response to an earlier discussion with your organization. As such, the delivery assumptions have no bearing on the TMDL allocations themselves. The source assessment of Section 8 is intended to serve as an outline for targeting future (largely voluntary) implementation activities. A more thorough implementation plan will be developed within a year of EPA approval of the TMDL. An approved implementation plan will permit local groups to pursue TMDL implementation funds to assist watershed residents complete local BMPs. We invite you and your organization to participate in the development of the implementation plan.

In regard to your second comment, as indicated in the delivery assumptions listed in Table 8.5.2, incorporated manure is assigned a delivery ratio of 0.1%. This is 1/10th the delivery ratio for surface applied manure and the lowest delivery ratio of any source listed in the table. We feel that the 90% delivery reduction associated with incorporation accounts for an important manure management practice.

We would also point out that the overview indicates that the High Island Creek Watershed receives an average of 27 inches of annual precipitation (page 1), while the background section states that the two watersheds average 29 to 30 inches of precipitation annually (page 8).

This was an oversight and will be corrected in the final draft of the report.

We suggest that as the project moves into the implementation phase a more complete evaluation be included on the benefits of subsurface drainage on ag land. Subsurface tile can moderate flow, potentially reducing re-suspension of in-stream bacteria and sediment. Subsurface tile reduces surface runoff and associated potential sediment and bacteria discharge. Subsurface drainage allows timely field operations, which enable producers to manage manure as a resource more effectively by choosing more appropriate field locations, application methods and timing.

Subsurface drainage continues to be a local, state and national research focus with recent and current studies being performed by The University of Minnesota – Mankato Water Resources Center, the Southern Research and Outreach Center in Waseca, the University of Minnesota and the Minnesota Department of Agriculture. As results and data from studies such as bacteria transport in tile lines, macropore/preferential flow, *and DNA fingerprinting become available, information will be incorporated into implementation efforts in these watersheds as well as future TMDL studies.*

And finally, we support emphasizing the importance of addressing nonpoint sources through voluntary BMPs and suggest substituting the word "exclusively" for "primarily" on page viii – "addressing land application will be ~~primarily~~ exclusively through research, education, and the promotion of voluntary BMPs." We look forward to working with to increase the level of producer involvement in developing effective BMPs as the project moves into the implementation phase. Please notify our organization of all future stakeholder meetings so that we can assist in coordinating local producer participation.

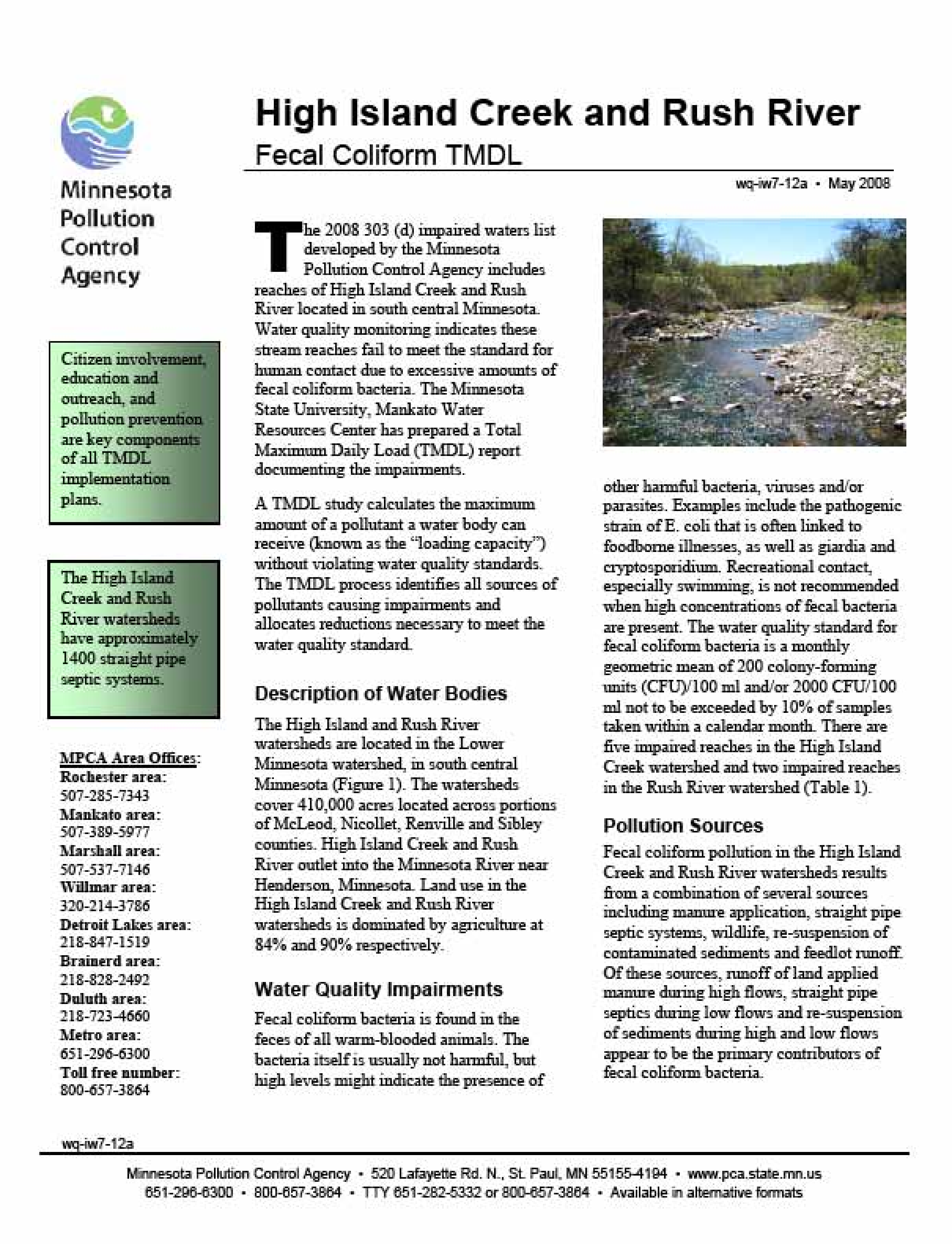
The word "primarily" when referring to future implementation activities was used with the understanding that there is existing local and state regulatory authority with respect to some aspects of manure management. The statement you cited will be reworded as, "While there is existing state and local regulatory authority related to both septic systems and land application of manure, research, education, and the promotion of voluntary BMPs will be the primary means to address the water quality impairments."

Again, thank you for reviewing and commenting on the *Draft Fecal Coliform TMDL Assessment for High Island Creek and Rush River.* Your comments provide valuable insight to the success of this project and future TMDL projects. If you have any further questions about this project, please contact me at 507-344-5250 or visit the project website: http://www.pca.state.mn.us/water/tmdl/project-highislandrush-fecal.html

Sincerely,

Scott MacLean
MPCA Project Manager
Mankato Office
Regional Division

Appendix C – Fecal Coliform TMDL Assessment for HIC and RR Fact Sheet



Minnesota
Pollution
Control
Agency

High Island Creek and Rush River

Fecal Coliform TMDL

wq-iw7-12a • May 2008

The 2008 303 (d) impaired waters list developed by the Minnesota Pollution Control Agency includes reaches of High Island Creek and Rush River located in south central Minnesota. Water quality monitoring indicates these stream reaches fail to meet the standard for human contact due to excessive amounts of fecal coliform bacteria. The Minnesota State University, Mankato Water Resources Center has prepared a Total Maximum Daily Load (TMDL) report documenting the impairments.

A TMDL study calculates the maximum amount of a pollutant a water body can receive (known as the "loading capacity") without violating water quality standards. The TMDL process identifies all sources of pollutants causing impairments and allocates reductions necessary to meet the water quality standard.

Description of Water Bodies

The High Island and Rush River watersheds are located in the Lower Minnesota watershed, in south central Minnesota (Figure 1). The watersheds cover 410,000 acres located across portions of McLeod, Nicollet, Renville and Sibley counties. High Island Creek and Rush River outlet into the Minnesota River near Henderson, Minnesota. Land use in the High Island Creek and Rush River watersheds is dominated by agriculture at 84% and 90% respectively.

Water Quality Impairments

Fecal coliform bacteria is found in the feces of all warm-blooded animals. The bacteria itself is usually not harmful, but high levels might indicate the presence of other harmful bacteria, viruses and/or parasites. Examples include the pathogenic strain of E. coli that is often linked to foodborne illnesses, as well as giardia and cryptosporidium. Recreational contact, especially swimming, is not recommended when high concentrations of fecal bacteria are present. The water quality standard for fecal coliform bacteria is a monthly geometric mean of 200 colony-forming units (CFU)/100 ml and/or 2000 CFU/100 ml not to be exceeded by 10% of samples taken within a calendar month. There are five impaired reaches in the High Island Creek watershed and two impaired reaches in the Rush River watershed (Table 1).

Pollution Sources

Fecal coliform pollution in the High Island Creek and Rush River watersheds results from a combination of several sources including manure application, straight pipe septic systems, wildlife, re-suspension of contaminated sediments and feedlot runoff. Of these sources, runoff of land applied manure during high flows, straight pipe septics during low flows and re-suspension of sediments during high and low flows appear to be the primary contributors of fecal coliform bacteria.

Citizen involvement, education and outreach, and pollution prevention are key components of all TMDL implementation plans.

The High Island Creek and Rush River watersheds have approximately 1400 straight pipe septic systems.

MPCA Area Offices:
Rochester area:
507-285-7343
Mankato area:
507-389-5977
Marshall area:
507-537-7146
Willmar area:
320-214-3786
Detroit Lakes area:
218-847-1519
Brainerd area:
218-828-2492
Duluth area:
218-723-4660
Metro area:
651-296-6300
Toll free number:
800-657-3864

wq-iw7-12a

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651-296-6300 • 800-657-3864 • TTY 651-282-5332 or 800-657-3864 • Available in alternative formats