Redwood River Fecal Coliform

Total Maximum Daily Load

Report

October 2013

For Submission to:

U.S. Environmental Protection Agency
Region 5
Chicago, Illinois

Submitted by:

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Table of Contents

Executive Summary 1
1.0 Introduction 4
    1.1 Purpose 4
    1.2 Project Background 6
2.0 Watershed Characteristics 7
    2.1 Demographics 7
    2.2 Location and Topography 9
    2.3 Land Use 12
    2.4 Temperature 16
    2.5 Precipitation 16
    2.6 Stream Flow Dynamics 17
3.0 Description of Applicable Water Quality Standards and
  Assessment Procedures 19
    3.1 Classification and Beneficial Uses 19
    3.2 Applicable Minnesota Water Quality Standards 20
    3.3 Impaired Assessment 21
    3.4 Fecal Coliform and *E. coli* Standards 27
    3.5 Monthly Fecal Coliform Concentrations in the Redwood River 27
    3.6 MPCA Non-degradation Policy 28
    3.7 Trends in Fecal Coliform Surface Water Quality 28
4.0 Description of Fecal Coliform Bacteria and Its Sources 30
    4.1 Fecal Coliform Bacteria Description 30
    4.2 Fecal Coliform Bacteria Sources 31
        4.2.1 Human Sources 31
        4.2.2 Livestock Sources 35
        4.2.3 Pet Sources 40
        4.2.4 Wildlife/Natural Background Sources 40
    4.3 Summary of Sources 40
5.0 TMDL Development for the Redwood River Watershed 42
    5.1 Approach to Allocations Needed to Satisfy the TMDLs 42
    5.2 Components of TMDL Allocations 44
        5.2.1 Wasteload Allocation 45
        5.2.2 Load Allocations 46
        5.2.3 Margin of Safety 47
        5.2.4 Reserve Capacity 47
    5.3 TMDL Allocations for Individual Impaired Reaches 51
        5.3.1 Redwood River; Ramsey Creek to Minnesota River 51
        5.3.2 Redwood River; Clear Creek to Redwood Lake 56
        5.3.3 Clear Creek; Headwaters to Redwood River 60
        5.3.4 Redwood River; T111 R42W S33 Westline to
            Threemile Creek – Below Marshall 64
        5.3.5 Redwood River; T111 R42W S33 Westline to
            Threemile Creek – Above Marshall 68
        5.3.6 Threemile Creek; Headwaters to Redwood River 72

5.3.7 Redwood River; Headwaters to Coon Creek 76
5.3.8 Tyler Creek; Headwaters to Redwood River.............................. 81
5.3.9 Coon Creek; Lake Benton to Redwood River............................ 85
6.0 Margin of Safety 89
7.0 Seasonal Variation 89
8.0 Monitoring Plan 91
9.0 Implementation Strategy 91
9.1 Implementation through Source Reduction Strategies........................... 91
9.2 Locally Targeted Implementation... 94
10.0 Reasonable Assurance.. 96
10.1 Evidence of BMP Implementability 96
10.2 Non-regulatory, Regulatory, and Incentive-Based Approaches........... 98
11.0 Public Participation.. 98
12.0 References.. 99

Figures

2.01 Population Centers in the Redwood River Watershed 8
2.02 Location of Redwood River Watershed 10
2.03 Elevation of Redwood River Watershed 11
2.04 Average Monthly Temperatures 16
2.05 Average Monthly Rainfall 17
2.06 Mean Monthly Flow; Redwood River at Redwood Falls (RR1-S001-679) 17
2.07 Mean Monthly Flow; Marshall (S003-702) 18
3.01 Redwood River Watershed Sampling Sites 22
3.02 *E. coli* – Fecal Coliform Ratio 27
3.03 1997-2006 Redwood River Watershed Fecal Coliform Geometric Mean by Site 28
3.04 Fecal Coliform Geometric Mean Trend by Decade 29
3.05 Fecal Coliform Geometric Mean by Half-Decade 29
4.01 Feedlots in the Redwood River Watershed, 2003 39
5.01 Redwood River Flow Duration Curve Daily Mean (1940-2006) 43
5.3.1A Redwood River; Ramsey Creek to Minnesota River 52
5.3.1B (RWR-1) Monthly Geometric Mean Fecal Coliform Concentrations (1997-2006) 55
5.3.2A Redwood River; Clear Creek to Redwood Lake 56
5.3.2B (RR1) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 59
5.3.3A Clear Creek; Headwaters to Redwood River 60
5.3.3B (CC3) Monthly Geometric Mean Fecal Coliform Concentreations (1999-2006) 63
5.3.4A Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion including and below the city of Marshall) 64
5.3.4B (RWR-53) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 67
5.3.5A Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion excluding and above the city the Marshall) 68
5.3.5B (MARSHALL) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 71
5.3.6A Threemile Creek; Headwaters to Redwood River 72
5.3.6B (TC4A) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 75
5.3.7A Redwood River; Headwaters to Coon Creek 76
5.3.7B (RRUS) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 79
5.3.7C (RUSSELL) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 78
5.3.8A Tyler Creek; Headwaters to Redwood River 81
5.3.8B (RWR008) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006) 84

5.3.9A Coon Creek; Lake Benton to Redwood River 85
5.3.9B (RWR007) Montly Geometric Mean Fecal Coliform Concentrations (1999-2006) 88
7.01 Seasonal Variation of Fecal Coliform (cfu/100mL) & Flow (MGD) At Site RR1 (STORET #S001-679) 90

Tables

1.01 Redwood River Watershed Impaired Reaches Descriptions and Assessment Summaries ... 5
2.01 Local Units of Government in the Redwood River Watershed ... 7
2.02 Redwood River Watershed Land Use by County in Acres and Percentages ... 14
2.03 Redwood River Land Use by Impaired Reach ... 15
2.04 Cumulative Land Use in the Redwood River Watershed by Impaired Reach ... 15
3.01 RWR-1 site (S00-299): 1974-2006 Fecal Coliform (cfu/100 ml) Sampling by Month ... 24
3.02 Redwood River Watershed 1999-2006 Fecal Coliform Bacteria (cfu/100 ml) Sampling ... 25
3.03 Redwood River Watershed Assessment Site Descriptors ... 26
4.01 Redwood River Watershed Permitted WWTF ... 33
4.02 Redwood River "Unsewered" Communities ... 33
4.03 Redwood River Watershed Feedlot Inventory ... 37
4.04 Inventory of Fecal Coliform Producers in the Watershed ... 41
5.01 Flow Categories for the Redwood River at USGS Station #05316500 ... 43
5.02 Conversion Equations ... 44
5.03 Total Daily Loading Capacity for the Redwood River at USGS Station #05316500 ... 49
5.04 Redwood River Watershed Impaired Reaches Description And Watershed Areas ... 49
5.3.1A Wastewater Treatment Facilities ... 53
5.3.1B Permitted Municipal Separate Storm Sewer System (MS4) Communities ... 53
5.3.1C Livestock Facilities with NPDES Permits ... 53
5.3.1D Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; Ramsey Creek to Minnesota River (AUID: 07020006-501) ... 54
5.3.2A Wastewater Treatment Facilities ... 57
5.3.2B Permitted Municipal Separate Storm Sewer System (MS4) Communities ... 57
5.3.2C Livestock Facilities with NPDES Permits ... 57
5.3.2D Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; Clear Creek to Redwood Lake (AUID: 07020006-509) ... 56
5.3.3A Wastewater Treatment Facilities ... 61
5.3.3B Permitted Municipal Separate Storm Sewer System (MS4) Communities ... 61
5.3.3C Livestock Facilities with NPDES Permits ... 61
5.3.3D Daily Fecal Coliform Loading Capacities and Allocations – Clear Creek; Headwaters to Redwood River (AUID: 07020006-506) ... 62
5.3.4A Wastewater Treatment Facilities ... 65
5.3.4B Permitted Municipal Separate Storm Sewer System (MS4) Communities ... 65
5.3.4C Livestock Facilities with NPDES Permits ... 65
5.3.4D Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion including and below the city of Marshall) (AUID: 07020006-502A) ... 66

5.3.5A Wastewater Treatment Facilities 69
5.3.5B Permitted Municipal Separate Storm Sewer System (MS4) Communities.. 69
5.3.5C Livestock Facilities with NPDES Permits 69
5.3.5D Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion excluding and above the city of Marshall) (AUID: 07020006-502B) 70
5.3.6A Wastewater Treatment Facilities 73
5.3.6B Permitted Municipal Separate Storm Sewer System (MS4) Communities.. 73
5.3.6C Livestock Facilities with NPDES Permits 73
5.3.6D Daily Fecal Coliform Loading Capacities and Allocations – Threemile Creek; Headwaters to Redwood River (AUID: 07020006-504) 74
5.3.7A Wastewater Treatment Facilities 77
5.3.7B Permitted Municipal Separate Storm Sewer System (MS4) Communities.. 77
5.3.7C Livestock Facilities with NPDES Permits 77
5.3.7D Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; Headwaters to Coon Creek (AUID: 07020006-505) 78
5.3.8A Wastewater Treatment Facilities 82
5.3.8B Permitted Municipal Separate Storm Sewer System (MS4) Communities.. 82
5.3.8C Livestock Facilities with NPDES Permits 82
5.3.8D Daily Fecal Coliform Loading Capacities and Allocations – Tyler Creek; Headwaters to Redwood River (AUID: 07020006-512) 83
5.3.9A Wastewater Treatment Facilities 86
5.3.9B Permitted Municipal Separate Storm Sewer System (MS4) Communities.. 86
5.3.9C Livestock Facilities with NPDES Permits 86
5.3.9D Daily Fecal Coliform Loading Capacities and Allocations – Coon Creek; Lake Benton to Redwood River (AUID: 07020006-511) 87
7.01 Flow Duration Curve Loading by Months 88
9.01 Implementation Opportunities for the Different flows Regimes........ 90

Appendix A: Redwood River Fecal Coliform TMDL: Methodology for TMDL Equations and Load Duration Curves 101
Appendix B: Load Duration Curves for the Impaired Reaches 104
Appendix C: Fecal Coliform Loading by Source: Methodology and Estimates of Relative Contributions 109
Appendix D: Agendas, Presentations and Handouts........ 113
Appendix E: Responses to Written Comments 121

TMDL Summary Table		
Waterbody ID	Redwood River: Ramsey Creek to MN River Fecal Coliform 07020006-501 Redwood River: Clear Creek to Redwood Lake Fecal Coliform 07020006-509 Clear Creek: Headwaters to Redwood River Fecal Coliform 07020006-506 Redwood River: T111 R42W S33 west line to Threemile Creek (including and below city of Marshall) Fecal Coliform 07020006-502A Redwood River: T111 R42W S33 west line to Threemile Creek (excluding and above city of Marshall) Fecal Coliform 07020006-502B Threemile Creek: Headwaters to Redwood River Fecal Coliform 07020006-504 Redwood River: Headwaters to Coon Creek Fecal Coliform 07020006-505 Tyler Creek: Headwaters to Redwood River Fecal Coliform 07020006-512 Coon Creek: Lake Benton to Redwood River Fecal Coliform 07020006-511	TMDL Page # 5
Location	The Redwood River Watershed is located in Southwestern Minnesota and is a tributary to the Minnesota River Basin. The Redwood River originates in Pipestone County and flows to the East-Northeast through parts of Murray, Lincoln, Lyon and Yellow Medicine before entering the Minnesota River in Redwood County.	9, 10
303(d) Listing Information	The MPCA's projected schedule for TMDL completions, as indicated on Minnesota's 303(d) impaired waters list, implicitly reflects Minnesota's priority ranking of this TMDL. Portions of the project were scheduled to begin at 2004, 2007, and 2009 and be completed in 2012. All listings are for Fecal Coliform impairment and include; Redwood River from Ramsey Creek to the Minnesota River (listed 1994), Redwood River from T111 R42W S33 west line to Threemile Creek (2004), Threemile Creek from headwaters to Redwood River (2006), Redwood River from Clear Creek to Redwood Lake (2006), Redwood River from headwaters to Coon Creek (2008), Clear Creek from headwaters to Redwood River (2008), Coon Creek from Lake Benton to Redwood River (2008) and Tyler Creek from headwaters to Redwood River (not listed, but data indicates impairment)	4, 5, 6

Impairment / TMDL Pollutant(s) of Concern	Impaired for Aquatic Recreation by Fecal Coliform	5
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 lists applicable water quality standards for the impaired reaches for Aquatic Recreation.	5
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 organism 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.	19
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 daily loading capacity for each flow regime was multiplied by a conversion factor of 4,892,279,040. 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.	42

Wasteload Allocation Fecal Coliform Redwood River: Ramsey Creek to Minnesota River (07020006-501)				53, 54
	Source	**Permit #**	**Individual WLA***	
	CAFOs			
	Alpha Acres	127-50018	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	Redwood Falls	MS400236	Flow Dependant	
		Total =	See Page 50	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Redwood River: Clear Creek to Redwood Lake (07020006-509)	**Source**	**Permit #**	**Individual WLA***	57, 58
	CAFOs			
	Charles & Glen Rohlik Farm	127-55073	0	
	Andrew Schiller Farm – Vesta Site	127-50087	0	
	Bruce Meier Farm	127-50004	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	

		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Vesta	MNG580043	.27	
		Total =	.27	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Clear Creek: Headwaters to Redwood River (07020006-506)	**Source**	**Permit #**	**Individual WLA***	61, 62
	CAFOs			
	Jim Tauer Farm	083-65820	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Milroy	MN0041211	.26	
		Total =	.26	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation	**Source**	**Permit #**	**Individual WLA***	65, 66
	CAFOs			

Fecal Coliform Redwood River: T111 R42W S33 west line to Threemile Creek (including and below city of Marshall) (07020006-502A)	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	Marshall	#MS400241	Flow Dependant	
		Total =	See page 66	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Marshall	MN0022179	34.07	
		Total =	34.07	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Redwood River: T111 R42W S33 west line to Threemile Creek (excluding and above the city of Marshall) (07020006-502B)	**Source**	**Permit #**	**Individual WLA***	69, 70
	CAFOs			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Russell	MNG580062	.64	
	Lynd	MNG580030	.35	
		Total =	.99	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual**	

			WLA*	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Threemile Creek: Headwaters to Redwood River (07020006-504)	**Source**	**Permit #**	**Individual WLA***	73, 74
	CAFOs			
	Grandview Farms Inc.	083-60023	0	
	Dieken Inc.	083-50016	0	
	Robert Buysee Farm	083-89076	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Ghent	MN0039730	.28	
		Total =	.28	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Redwood River: Headwaters to Coon Creek (07020006-505)	**Source**	**Permit #**	**Individual WLA***	77, 78
	CAFOs			
	Norgaard Family Farms	081-87296	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual**	

			WLA*	
	WWTF			
	Ruthton	MN0049654	.39	
		Total =	.39	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Tyler Creek: Headwaters to Redwood River (07020006-512)	**Source**	**Permit #**	**Individual WLA***	82, 83
	CAFOs			
	Donald L. Buhl Farm	081-50002	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	Tyler	MN0022039	1.32	
		Total =	1.32	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	
Wasteload Allocation Fecal Coliform Coon Creek:	**Source**	**Permit #**	**Individual WLA***	86, 87
	CAFOs			
	David & Karen Keifer Farm	083-50005	0	

Lake Benton to Redwood River (07020006-511)		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	MS4			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	WWTF			
	N/A	N/A	N/A	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Straight-Pipe-Septics			
	Illegal Discharges	N/A	0	
		Total =	0	
	Source	**Permit #**	**Individual WLA***	
	Reserve Capacity			
	N/A	N/A	N/A	
		Total =	0	

Load Allocation Fecal Coliform Redwood River: Ramsey Creek to Minnesota River (07020006-501)	**Flow Regime**	**Individual LA***	**Page #**
	High	2784.3	54
	Moist	628.2	
	Mid	237.2	
	Dry		
	Low		
Load Allocation Fecal Coliform Redwood River: Clear Creek to Redwood Lake (07020006-509)	**Flow Regime**	**Individual LA***	58
	High	2618.6	
	Moist	431.3	
	Mid	165.7	
	Dry		
	Low		
Load Allocation Fecal Coliform Clear Creek: Headwaters to Redwood River (07020006-506)	**Flow Regime**	**Individual LA***	62
	High	356.0	
	Moist	62.6	
	Mid	26.9	
	Dry	4.1	
	Low		

Load Allocation Fecal Coliform Redwood River: T111 R42W S33 west line to Threemile Creek (including and below city of Marshall) (07020006-502A)	**Flow Regime**	**Individual LA***	66
	High	457.4	
	Moist	38.5	
	Mid		
	Dry		
	Low		
Load Allocation Fecal Coliform Redwood River: T111 R42W S33 west line to Threemile Creek (excluding and above city of Marshall) (07020006-502B)	**Flow Regime**	**Individual LA***	70
	High	451.5	
	Moist	65.6	
	Mid	23.4	
	Dry	2.1	
	Low		
Load Allocation Fecal Coliform Threemile Creek: Headwaters to Redwood River (07020006-504)	**Flow Regime**	**Individual LA***	74
	High	520.4	
	Moist	91.5	
	Mid	39.5	
	Dry	6.1	
	Low		
Load Allocation Fecal Coliform Redwood River: Headwaters to Coon Creek (07020006-505)	**Flow Regime**	**Individual LA***	78
	High	400.9	
	Moist	58.9	
	Mid	21.4	
	Dry	2.6	
	Low		
Load Allocation Fecal Coliform Tyler Creek: Headwaters to Redwood River (07020006-512)	**Flow Regime**	**Individual LA***	83
	High	448.0	
	Moist	66.3	
	Mid	24.5	
	Dry	3.4	
	Low		
Load Allocation Fecal Coliform Coon Creek: Lake Benton to Redwood River (07020006-511)	**Flow Regime**	**Individual LA***	87
	High	168.7	
	Moist	25.4	
	Mid	9.7	
	Dry	1.8	
	Low	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 and turbidity 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.	89
Seasonal Variation	Monitoring data show an apparent relationship between season and fecal coliform bacteria concentrations. 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.	89
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.	96
Monitoring	A detailed monitoring plan will be included in the Implementation Plan to be completed. Currently, there are monitoring efforts in the watershed.	91
Implementation	A summary of potential management measures was included. More detail will be provided in the implementation plan.	91
Public Participation	A group of local state and federal official have been meeting periodically to receive TMDL updates and will be contributing to the development of the implementation plan. There have been news releases and website updates regarding this project. Public Comment period: April 25-May 25, 2011 Meeting location: Redwood Falls Comments received? Yes	98

* All WLA and LA values are in billions of organisms per day.

Fecal Coliform Total Maximum Daily Load Assessment Report
Redwood River Watershed, Minnesota

Executive Summary

There are currently two impaired uses on the Redwood River (HUC – 07020006): Aquatic Recreation and Aquatic Life, due to fecal coliform bacteria, turbidity, and impaired biota. The Redwood River from Ramsey Creek to Minnesota River is listed as swimming impaired due to fecal coliform bacteria. The Redwood River from below trout stream southwest of Marshall to Three Mile Creek is listed as aquatic recreation impaired due to fecal coliform bacteria and aquatic life impaired due to turbidity and impaired biota. Both reaches were listed in 1992 and have immediate target start dates resulting in Phase I priority under Section 303(d) of the Clean Water Act by the Minnesota Pollution Control Agency (MPCA). The portion of the Redwood from Clear Creek to the lake and all of Threemile Creek were listed on the 2006 303(d) list due to ongoing monitoring. There are other impairments due to turbidity and impaired biota, but they are not addressed directly by this plan. This Total Maximum Daily Load (TMDL) report (Report) describes the magnitude of the problem and provides direction for improving water quality at the listed reaches, as well as reaches not formally assessed but believed to exhibit similar water quality conditions. Eight reaches are assessed in this Report. This Report evaluates the fecal coliform concentrations and load reductions needed for the eight reaches in the Redwood River to meet Minnesota water quality standards.

The Redwood River originates near Ruthton in northeast Pipestone County, Minnesota and flows about 125 miles northeast through Redwood Lake and to the Minnesota River at North Redwood. The dominant land use in the Redwood River Watershed is cultivated agricultural crops. The largest cities within the watershed include Lake Benton, Marshall, and Redwood Falls. The Redwood River watershed is approximately 451,250 acres or 705.1 square miles. The Redwood-Cottonwood Rivers Control Area (RCRCA) monitors the watershed at four sampling stations on a regular basis. The focus of this report is to better identify fecal coliform bacteria levels, probable sources, and estimate load reduction needs to meet water quality goals for the Redwood River. Sub-watershed bacterial loading allocation methods were used to assess the magnitude of point and non-point sources and determine a cause-effect linkage of loading sources and their contributions to stream concentrations. The TMDL was also calculated for spring, summer, and fall conditions.

The majority of water quality monitoring data used in this Report was collected from 1985 to 2006 by MPCA and RCRCA staff. Findings based on these tests results showed that several reaches of the Redwood River watershed were impaired due to excess fecal coliform bacteria, as well as other pollutants. Analyses of samples taken through MPCA's 1999 study show that none of the sites were above the impaired status in the spring (through May). Most sites, in June and July were considered impaired, but most reaches were not impaired through August and September. RWR-1 (STORET# S000-299), one of the reaches listed for impairment, was within impairment standards through the testing period of 1999. Test results through 2004 agree with this pattern,

although it appears that more reaches are impaired during August and September in recent years.

The Report describes several contributing sources of fecal coliform bacteria. The identified contributing sources are wastewater treatment facilities, urban and rural area stormwater, unsewered communities, straight pipe septic systems, wildlife, pets, and livestock manure. Livestock manure and untreated human waste appear to be the primary 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.

Livestock manure represents more than 98% of the fecal matter produced in the watershed. Nearly all manure is either incorporated or surface applied to 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 is important to note that livestock and livestock manure have environmental and economic benefits that must be taken into account and weighed against potential bacteria 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.

Potential sources of fecal coliform contamination during low flows appear to be pastured livestock with access to waterways, wildlife, “straight pipe” septic systems, and unsewered communities that discharge untreated sewage directly or through tile drainage to surface waters. There are five unsewered communities and an estimated to be 334 of these systems in the Redwood River watershed. Direct discharge of these systems to surface waters during low flow periods can be a major contributor of fecal coliform contamination. The potential sources of fecal coliform contamination during rain events that produce runoff associated with high flows could be from feedlots with no runoff controls, improper land applied manure, untreated human waste, and stormwater containing wildlife and pet waste.

The document also describes conditions when bacterial concentrations are highest in the Redwood River and tributaries. Monitoring data show bacterial concentrations appear to increase as water temperature increases. During both wet and dry periods, it appears that a portion of fecal coliform contamination from human and animal sources may stay in the stream channel sediments as a reservoir. Increases in flow during storm runoff can cause re-suspension of sediments that are high in 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.

This Report used a flow duration curve approach to determine the fecal coliform loading capacity at the impaired reaches under varying flow regimes. The Report focuses on fecal coliform loading capacity and general allocations necessary to meet water quality standards at individual impaired river or stream reaches, rather than on precise loading reductions that may be required from specific sources.

Fecal coliform loading capacities were calculated for each individual impaired reach, and those capacities are allocated among point sources (wasteload allocation), nonpoint sources (load allocation), and a margin of safety. A loading capacity is the product of stream flow at each impaired reach and the fecal coliform water quality standard. Five flow zones, ranging from low flow to high flow are utilized, so that the entire range of conditions is accounted for in the Report. The loading capacity and allocation vary by impaired reach, and by flow zone for a given reach. A description of the duration curve approach is in Appendix A.

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

1.0 Introduction

1.1 Purpose

Section 303(d) of the Clean Water Act (CWA) provides authority for completing Total Maximum Daily Loads (TMDLs) to achieve state water quality standards and/or their designated uses. The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources.

A TMDL or Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Section 303(d) of the Clean Water Act (CWA) and its implementing regulations (40 C.F.R. § 130.7) require states to identify waters that do not or will not meet applicable water quality standards and to establish TMDLs for pollutants that are causing non-attainment of water quality standards.

Water quality standards are set by States, Territories, and Tribes. They identify the uses for each water body; for example, drinking water supply, contact recreation (swimming), aquatic life support (fishing), and the scientific criteria to support that use.

A TMDL needs to account for seasonal variation and must include a margin of safety (MOS). The MOS is a safety factor that accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality. Also, a TMDL must specify pollutant load allocations among sources. The total of all allocations, including wasteload allocations (WLA) for point sources, load allocations (LA) for nonpoint sources (including natural background), and the MOS (if explicitly defined) cannot exceed the maximum allowable pollutant load:

TMDL =sum**WLAs +** sum**LAs + MOS + RC***

* The MPCA also requires that "Reserve Capacity" (RC) which is an allocation for future growth be addressed in the TMDL.

A TMDL study identifies all sources of the pollutant and determines how much each source must reduce its contribution in order to meet the quality standard. The sum of all contributions must be less than the maximum daily load.

Sources that are part of the waste load allocation, with the exception of "straight-pipe" septic systems, are largely controlled through National Pollutant Discharge Elimination System (NPDES) permits. Load allocation sources are controlled through a variety of regulatory and non-regulatory efforts at the local, state, and federal level.

The state agency responsible for assessing, listing, and reporting impaired waters is the Minnesota Pollution Control Agency (MPCA). In 1994 and in 2004 respectively, the MPCA identified one reach impaired for fecal coliform bacteria in the Redwood River watershed. In 2006, the MPCA listed two additional reaches impaired for fecal coliform bacteria. Data shows that four other reaches also meet the impairment thresholds and are included in this report, but they are not yet on the 303(d) list. It is important to note that two different sampling sites; Marshall (STORET# S003-702) and RWR-53 (STORET# S001-199) are being used to assess reach 07020006-502. Table 1.01 summarizes the listings, sites and data collected at each of the impaired reaches.

The MPCA's projected schedule for TMDL completions, as indicated on Minnesota's 303(d) impaired waters list, implicitly reflects Minnesota's priority ranking of this TMDL. Portions of the project were scheduled to begin at 2004, 2007, and 2009 and be completed in 2012. A willing local group allowed for an earlier completion of the TMDL. Ranking criteria for scheduling TMDL projects include, but are not limited to: impairment impacts on public health and aquatic life; public value of the impaired water resource; likelihood of completing the TMDL in an expedient manner, including a strong base of existing data and restorability of the waterbody; technical capability and willingness, locally, to assist with the TMDL; and appropriate sequencing of TMDLs within a watershed or basin.

Table 1.01: Redwood River Watershed Impaired Reaches Descriptions and Assessment Summaries

Reach	Description	Year listed	River Assessment Unit ID	STORET ID# Monitoring Stations Used for Assessment	% of data >200 cfs	Years of Data
Redwood River	T111 R42W S33 west line to Threemile Cr	04	07020006-502B	S003-702	28%	'99
Redwood River	T111 R42W S33 west line to Threemile Cr	04	07020006-502A	S001-199	73%	'99
Redwood River	Clear Cr to Redwood Lk	06	07020006-509	S001-679	50%	'99-'06
Redwood River	Ramsey Cr to Minnesota R	94	07020006-501	S000-299	33%	'74-'06
Three Mile Creek	Headwaters to Redwood R	06	07020006-504	S002-313	58%	'99-'06
Redwood River	Headwaters to Coon Creek	Not Listed	07020006-505	S000-696	52%	'03-'06
Tyler Creek*	Headwaters to Redwood R	Not Listed	07020006-512	S002-315	44%*	'99
Clear Creek	Headwaters to Redwood R	Not Listed	07020006-506	S002-311	55%	'99-'06
Coon Creek	Lake Benton to Redwood R	Not Listed	07020006-511	S002-314	56%	'99

*Uses the Class 7: Limited Resource Value water quality standard of 1,000 cfu/100mL standard

The protocol for this assessment is outlined in MPCA "Listing Methodology" publications found at: http://www.pca.state.mn.us/water/tmdl/index.html#support. The applicable water body classifications and water quality standards are specified in Minnesota Rules Chapter 7050. Minn. R. ch. 7050.0222, subp. 5 lists applicable water quality standards for the impaired reaches and Minn. R. ch. 7050.0407 lists water body classifications. Assessment summary information for the nine reaches is listed in Table 1.01. The assessment protocol includes pooling of data by month over a 10-year period. Three reaches had more than two months with at least five fecal coliform samples that violated the geometric mean water quality standard of 200 colony forming units (cfu) /100ml.

Three reaches violated the water quality standard for two or less months. The reach is partially supporting if the standard is violated two or less months, and non-supporting if violated greater than two months. In addition, three sites that were sampled less than five times a month, exceeded the 2000 cfu/100mL standard, and were considered in this report. See section 3.0 - 3.2 Applicable Water Quality Standards and Assessment Procedures for further explanation.

1.2 Project Background

The Redwood River Clean Water Project (RRCWP) was awarded a Clean Water Partnership (CWP) Phase I Diagnostic Study grant by the MPCA in 1989 to begin an intensive study of land use and water quality in the Redwood River Watershed. The RRCWP was awarded a Phase II Implementation grant from the MPCA in 1994 to carry out the remediation strategies determined in the Phase I CWP. Subsequent grants were carried out to continue the implementation of Best Management Practices (BMPs) outlined in the RRCWP Implementation Plan as well as continued monitoring of surface waters in the watershed. Most of the data used in this report is a result of monitoring efforts through the RRCWP.

The diagnostic study focused on monitoring the watershed to determine water quality and determine non-point sediment sources to the Redwood River corridor to get a better grasp on the sedimentation of Redwood Lake. The history of bacteria monitoring in the Redwood River Watershed began with the diagnostic study. Four samples were taken in Redwood Lake for fecal coliform bacteria in 1992 and then sampling was dropped for unspecified reasons. The results of these samples on Redwood Lake were well within the standards set today, but the scarcity of samples would make their representativeness questionable. The quality assurance objective of the diagnostic study was as follows "… all reasonable actions to prevent erroneous data from being produced. In the event that did occur, they were identified and corrected; suspected data were not utilized as a basis for conclusions and subsequent actions."

Fecal coliform bacteria sampling post CWP Phase II by the RRCWP was limited to one sample per month between April and September, starting in 2000, and stepped up to include storm events in 2005. Sampling during this period was limited to the four sites; two on the Redwood mainstem and one each near the mouth of tributaries Clear Creek and Threemile Creek. Given the scarcity of bacteria sampling in from the CWP phases in the Redwood River watershed, targeted implementation recommendations for bacteria reduction in surface streams were not made at the time. However, subsequent monitoring/sampling and placement of sampled reaches on the federal 303(d) list will allow the project to produce an implementation plan for targeted implementation.

2.0 Watershed Characteristics

2.1 Demographics

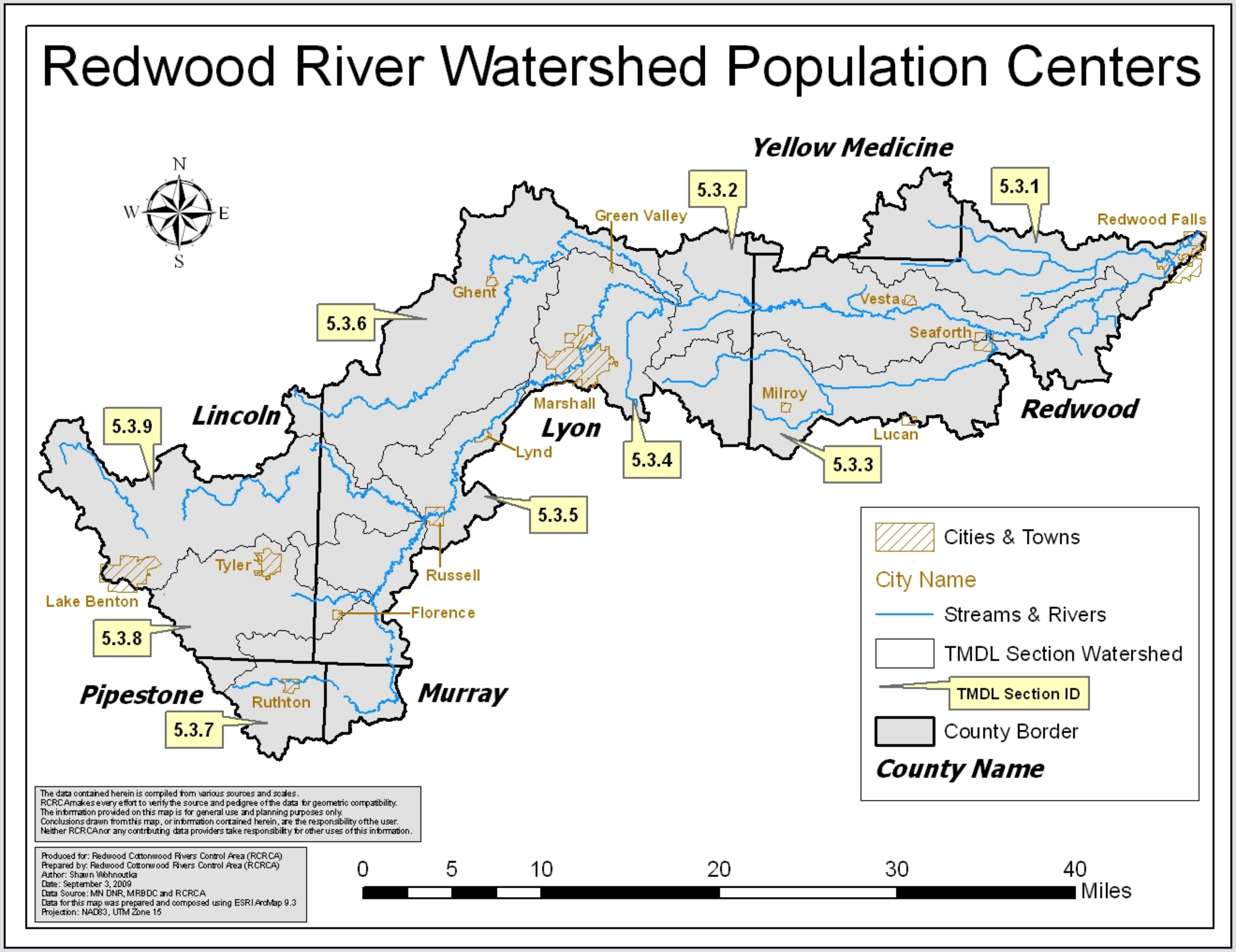
The Redwood River is a tributary to the Minnesota River located in southwestern Minnesota in the counties of Lincoln, Lyon, Murray, Pipestone, Redwood, and Yellow Medicine. There are eleven incorporated communities located within the watershed include Marshall, Redwood Falls, Tyler, Russell, and Vesta and there are three unincorporated communities. Table 2.01 shows the townships and cities located in the watershed in each county.

Table 2.01: Local Units of Government in the Redwood River Watershed

County	Township	Cities
Pipestone	2	1
Murray	1	0
Lincoln	8	2
Lyon	15	7
Yellow Medicine	2	0
Redwood	11	4
Total	**39**	**14**

Southwestern Minnesota is predominantly rural with a relatively dispersed population. About one percent of the watershed is urban. Urban population for communities and cities within the Redwood River watershed is approximately 15,879. Rural population within the Redwood River watershed is approximately 5,202, based on the number of septic systems reported to the State of Minnesota by each county multiplied by 2.67 persons per household, a statistic calculated by the 2000 Census. The total population is 21,081 people. About 60 percent of the total population lives in the City of Marshall (12,735), the largest city within the watershed. Portions of the city of Redwood Falls (5,459) is also in the watershed and affect the Redwood River through storm water runoff related to urban land uses and impervious surfaces. Figure 2.01 shows city locations in the watershed.

Figure 2.01: Population Centers in the Redwood River Watershed



2.2 Location and Topography

The watershed area is located roughly north of Latitude 44 07' 00" and east of Longitude -96 24' 00" covering an area of 705 square miles. The Redwood River Watershed is located in Southwestern Minnesota and is a tributary to the Minnesota River Basin. The Redwood River originates in Pipestone County and flows to the East-Northeast through parts of Murray, Lincoln, Lyon and Yellow Medicine before entering the Minnesota River in Redwood County. Figure 2.02 shows the watershed location within the state.

The topography of the Redwood River watershed is that of a rolling upland area. Altitudes descend from west to east with the Coteau des Prairies serving as a watershed divide. Natural drainage patterns in the area were established by valleys formed from glacial meltwaters during the Pleistocene Epoch. End moraines, which were formed during the recession of the last glacier, are the most prominent features. They formed a series of morainic belts, generally running from north to south or northwest to southeast. An elevation map with TMDL reaches in Figure 2.03 shows the high variation of terrain in the watershed.

The Redwood River drops from an elevation of about 1,850 feet above sea level in northeastern Pipestone County to 1140 feet at Marshall, an average of about eighteen feet per mile. The river slope then flattens to an average of about four feet per mile between Marshall and Redwood Falls. Between Redwood Falls and its confluence with the Minnesota River near North Redwood, the river's slope increases sharply to an average of 24 feet per mile.

The upland plain is characterized by parallel glacial moraines and glacial till superimposed on bedrock. Natural drainage of the plain is relatively poor, and there are many small marshes, ponds, and shallow lakes. Installation of widespread artificial drainage systems, however, has reduced today's numbers to only a fraction of what once existed. Significant channel alterations were made to the river between the city of Marshall and Lake Redwood. Alterations between State Highway 23 (river mile 58.3) and Seaforth (river mile 20.3) included excavation and straightening in three reaches and eight cutoffs and continuous clearing. Later, seven additional cutoffs were authorized and completed. This section of the river was designated Judicial Ditch 37.

The lowland plain's geologic composition is glacial till derived from ground moraines overlying bedrock. The land is gently rolling to flat. Row crop agriculture is the predominant land use which has been aided by use of extensive artificial drainage systems.

Figure 2.02: Location of Redwood River Watershed

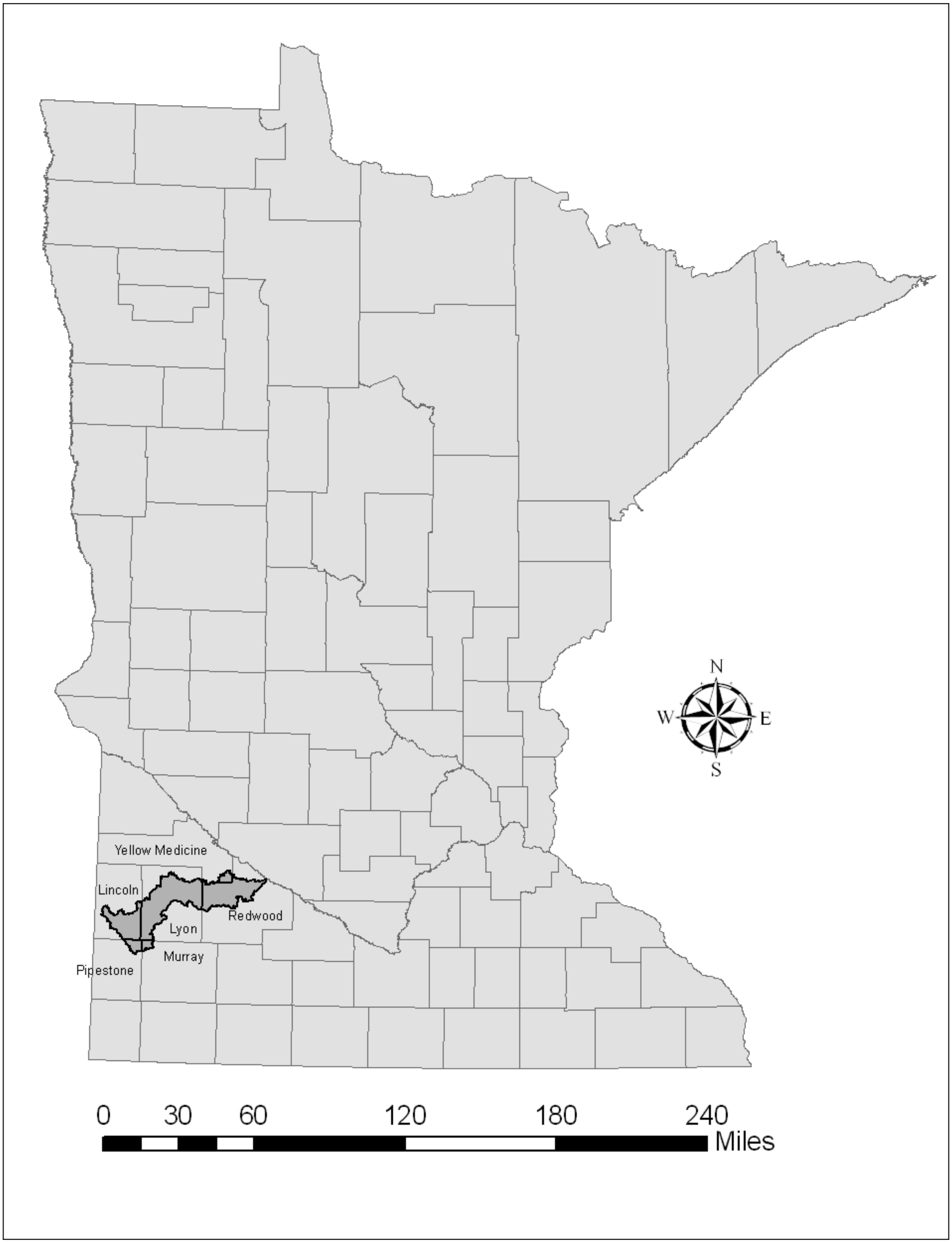
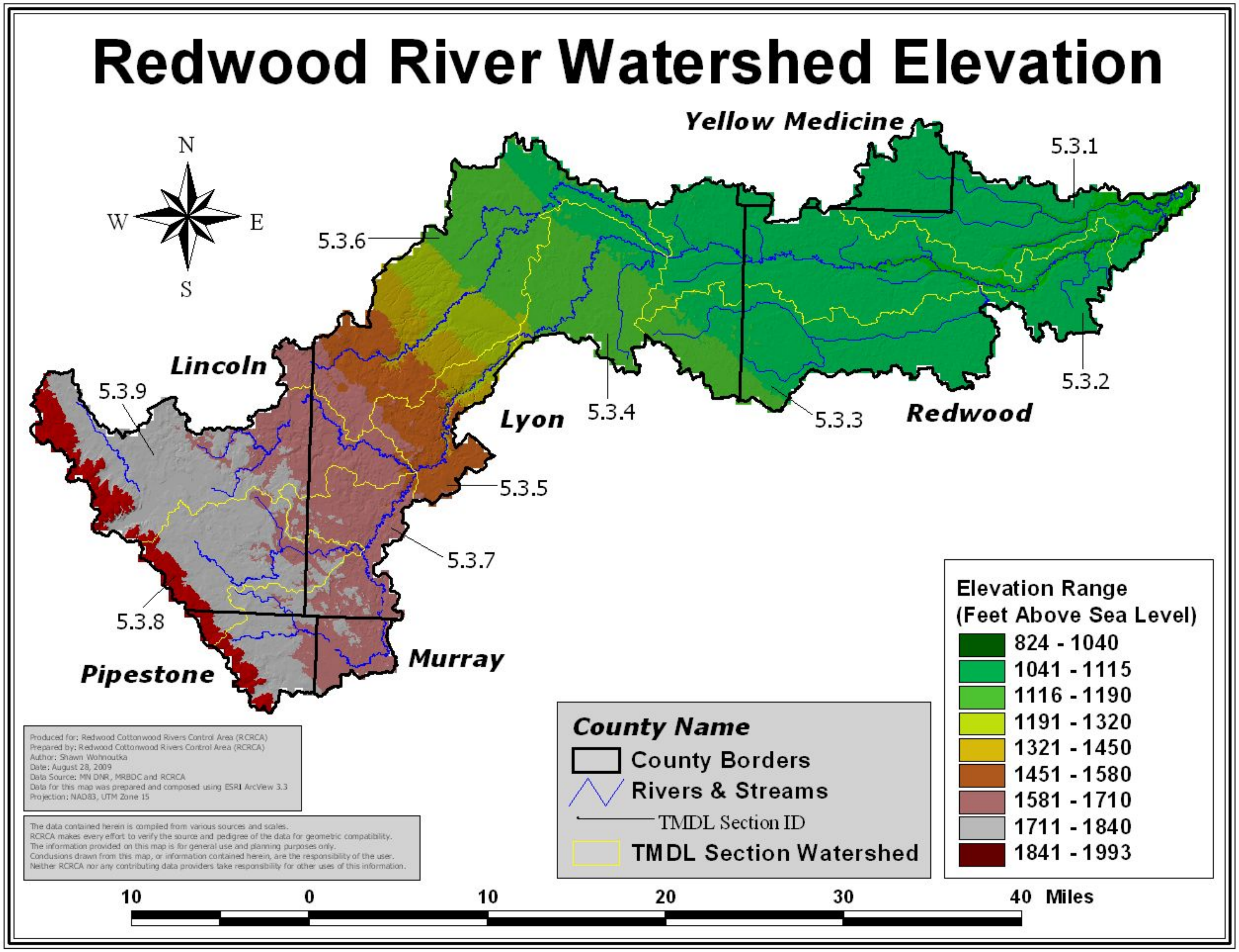

Yellow Medicine
Lincoln
Lyon
Redwood
Murray
Pipestone
N
W
E
S
0
30
60
120
180
240
Miles

Figure 2.03: Elevation of Redwood River Watershed



2.3 Land Use

The Redwood River corridor has several different land uses. The lower reach from Lake Redwood to the city of Marshall is on a lowland plain with a valley one-eighth to one-quarter mile wide and twenty-five to fifty feet deep. Bank vegetation includes a twenty to one-hundred foot belt of hardwoods and willows bordering row crops and pasture. The second reach of the river, from the inlet of the diversion channel in Marshall upstream to the city of Russell has a deep, narrow valley and heavily forested terrain. Trees include oak, sugar maple, basswood, and elm. A definite open flood plain forms only near the town of Lynd and downstream. The third reach of the river, extending from Russell upstream to Florence has narrow, short floodplains surrounded by rolling terrain. Immediate banks and floodplains are twenty-five to forty percent forested and sixty to seventy-five percent grasses, sedges, and small shrubs. The upper reach is a series of gullies, ditches, marshes, and small lakes. Vegetation consists of grasses, sedges, and small scattered shrubs and trees. Flow is confined to spring runoff and storm events at the headwaters of the Redwood River. The entire Redwood River watershed has 85.5 percent (approximately 385,665 acres) of the land in cultivation, 7.3 percent of the land in grassland, 1.5 percent in water, and 0.465 percent in wetlands. The remainder of the land is in forest, farmsteads, gravel pits, rural development, and other land uses. For detailed information by county and of the watershed as a whole, refer to Table 2.02, Table 2.03, and Table 2.04.

Table 2.02: Redwood River Watershed Land Use by County in Acres and Percentages

Entire Watershed		Land Use	Pipestone		Murray		Lincoln		Yellow Medicine		Lyon		Redwood	
Acres	%		Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
1.78	0.00	Coniferous Forest							1.78	0.01				
385,663.30	85.47	Cultivated Land	13,659.10	82.11	7,993.91	84.53	68,640.04	79.59	14,031.09	97.16	163,081.23	83.10	118,257.92	92.22
11,562.91	2.56	Deciduous Forest	287.33	1.73	122.29	1.29	2,067.42	2.40	152.05	1.05	5,414.46	2.76	3,519.35	2.74
38.06	0.01	Exposed Soil, Sandbars, & Sand Dunes									14.00	0.01	24.06	0.02
5,550.21	1.23	Farmsteads & Rural Residences	207.24	1.25	88.38	0.93	1,230.68	1.43	157.29	1.09	2,474.30	1.26	1,392.33	1.09
32,871.35	7.28	Grassland	2,256.60	13.57	1,093.46	11.56	8,913.57	10.34	64.04	0.44	17,504.73	8.92	3,038.94	2.37
392.17	0.09	Grassland-Shrub-Tree (Deciduous)	13.35	0.08	2.02	0.02	77.27	0.09	0.57	0.00	205.56	0.10	93.41	0.07
260.94	0.06	Gravel Pits & Open Mines	0.55	0.00			32.54	0.04			173.04	0.09	54.81	0.04
689.68	0.15	Other Rural Developments	26.73	0.16	2.48	0.03	165.02	0.19	20.24	0.14	318.65	0.16	156.57	0.12
155.76	0.03	Rural Residential Development					49.37	0.06			106.39	0.05		
394.50	0.09	Transitional Agricultural Land	12.93	0.08			191.92	0.22			167.51	0.09	22.15	0.02
6,799.56	1.51	Water	24.62	0.15	37.98	0.40	3,692.90	4.28	12.66	0.09	2,445.43	1.25	585.96	0.46
2,100.18	0.47	Wetlands	44.44	0.27	115.84	1.22	438.57	0.51	1.32	0.01	1,203.14	0.61	296.87	0.23
4,769.10	1.06	Other	102.25	0.61			743.31	0.86			3,128.80	1.59	794.74	0.62
451,249.49	100.00	**Totals**	**16,635.15**	**100.00**	**9,456.36**	**100.00**	**86,242.61**	**100.00**	**14,441.05**	**100.00**	**196,237.22**	**100.00**	**128,237.11**	**100.00**

Table 2.03: Redwood River Land Use by Impaired Reach

Impaired Reach (Section #)	Description	Drainage Area (mi^2)	Land use Percentages					
			Cult.	Grass*	Forest	Water/ Wetland	Residential / Urban**	Other***
Redwood River (5.3.1)	Ramsey Cr to Minnesota R	75.12	92.5%	1.6%	3.2%	0.5%	2.2%	0.03%
Redwood River (5.3.2)	Clear Cr to Redwood Lk	116.22	91.1%	3.9%	2.6%	0.8%	1.4%	0.09%
Clear Creek (5.3.3)	Headwaters to Redwood R	83.41	94.4%	1.5%	1.5%	1.0%	1.6%	0.00%
Redwood River (5.3.4)	T111 R42W S33 west line to Threemile Cr Below Marshall	49.63	82.3%	4.2%	2.0%	0.5%	10.9%	0.01%
Redwood River (5.3.5)	T111 R42W S33 west line to Threemile Cr Above Marshall	31.22	65.0%	20.6%	9.8%	1.4%	2.5%	0.65%
Threemile Creek (5.3.6)	Headwaters to Redwood R	121.92	86.5%	8.5%	1.9%	1.6%	1.5%	0.06%
Redwood River (5.3.7)	Headwaters to Coon Creek	80.21	82.1%	11.9%	1.9%	2.5%	1.5%	0.01%
Tyler Creek (5.3.8)	Headwaters to Redwood R	51.23	83.2%	10.9%	2.0%	0.6%	3.3%	0.00%
Coon Creek (5.3.9)	Lake Benton to Redwood R	96.12	76.3%	11.9%	2.6%	7.2%	1.9%	0.05%

(Percentages may not add to 100% due to rounding)

Table 2.04: Cumulative Land Use in the Redwood River Watershed by Impaired Reach

Sections Contributing	TMDL Section #	Drainage Area (mi^2)	Cumulative Land Use Percentages					
			Cultivated	Grass*	Forest	Water / Wetland	Residential/ Urban**	Other***
All Sections Contribute	**5.3.1**	705.08	85.5%	7.5%	2.6%	2.0%	2.5%	0.07%
5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7, 5.3.8, 5.3.9	**5.3.2**	629.96	84.6%	8.2%	2.5%	2.2%	2.5%	0.07%
5.3.3	**5.3.3**	83.41	94.4%	1.5%	1.5%	1.0%	1.6%	0.00%
5.3.4, 5.3.5, 5.3.7, 5.3.8, 5.3.9	**5.3.4**	308.41	78.8%	11.4%	2.9%	3.2%	3.6%	0.09%
5.3.5, 5.3.7, 5.3.8, 5.3.9	**5.3.5**	258.78	78.1%	12.8%	3.1%	3.7%	2.1%	0.10%
5.3.6	**5.3.6**	121.92	86.5%	8.5%	1.9%	1.6%	1.5%	0.06%
5.3.7, 5.3.8, 5.3.9	**5.3.7**	227.56	79.9%	11.7%	2.2%	4.1%	2.1%	0.03%
5.3.8	**5.3.8**	51.23	83.2%	10.9%	2.0%	0.6%	3.3%	0.00%
5.3.9	**5.3.9**	96.12	76.3%	11.9%	2.6%	7.2%	1.9%	0.05%

(Percentages may not add to 100% due to rounding)

***Grass** includes: “Grassland”, “Grassland-Shrub-Tree” and “Transitional Ag. Land”

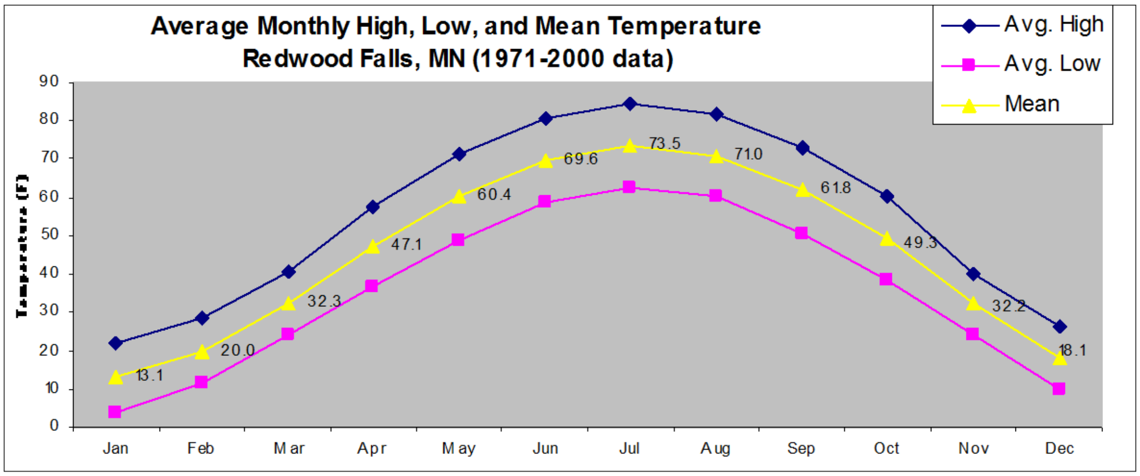
**** Residential/Urban** includes: “Urban & Industrial”, “Farmsteads & Rural Residences”, “Rural Residential Development” and “Other Rural Developments”

*****Other** includes: “Gravel Pits and Open Mines” and “Exposed Soil, Sandbars & Sand Dunes”

2.4 Temperature

Figure 2.04 presents the average monthly high, low, and mean temperatures at Redwood Falls, MN. Ice-out conditions in the Redwood River typically occur in late March or early April with smaller tributaries usually following. Warmest air temperatures reach their peak in July, while the warmest water temperatures are usually in late July and August. Monitoring data indicates that temperature relates to bacteria levels in surface waters. Warmer waters tend to have higher bacteria levels.

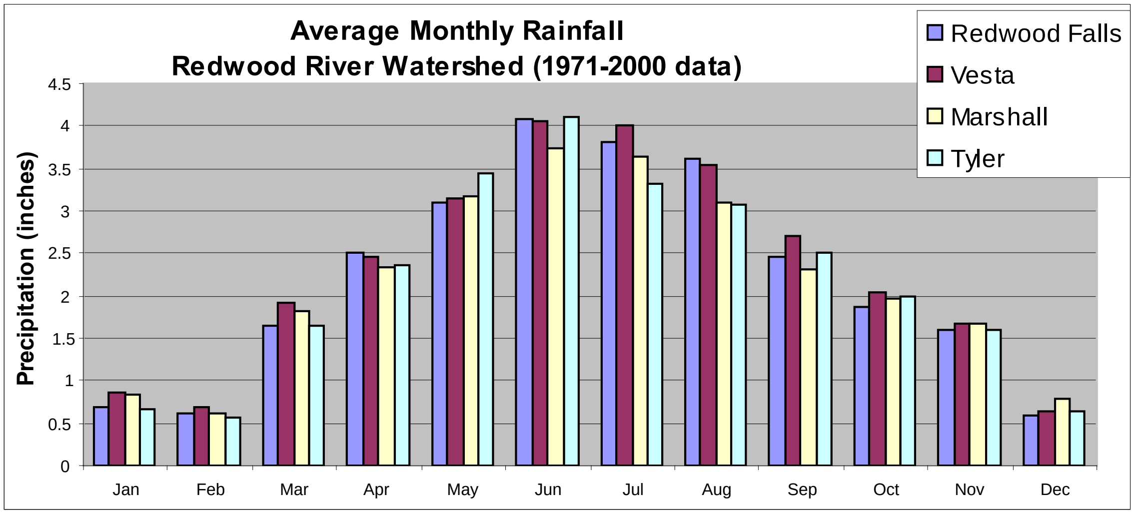
Figure 2.04: Average Monthly Temperatures



2.5 Precipitation

The Redwood River watershed averages 26.6 inches annually. 79.5 percent of precipitation occurs within the months of April and October. Figure 2.05 presents the average monthly precipitation values for towns across the Redwood River watershed. Communities are shown in order from outlet to Minnesota River (Redwood Falls) to upper watershed (Tyler).

Figure 2.05: Average Monthly Rainfall



2.6 Stream Flow Dynamics

Figure 2.06 displays the mean monthly flow for the Redwood River in Redwood Falls (USGS gage #05316500) and Figure 2.07 displays the mean monthly flow for the Redwood River in Marshall (USGS gage #05315000) for the months of April through October. These are the months in which a majority of the flow occurs and the months that are used in the assessment for fecal bacteria. April has higher flows, on average due to snowmelt and overland runoff while June, having the most precipitation, has the second highest mean monthly flow. Flow is measured in cubic feet per second (cfs).

Figure 2.06: Mean Monthly Flow; Redwood Falls (RR1 – S001-679)

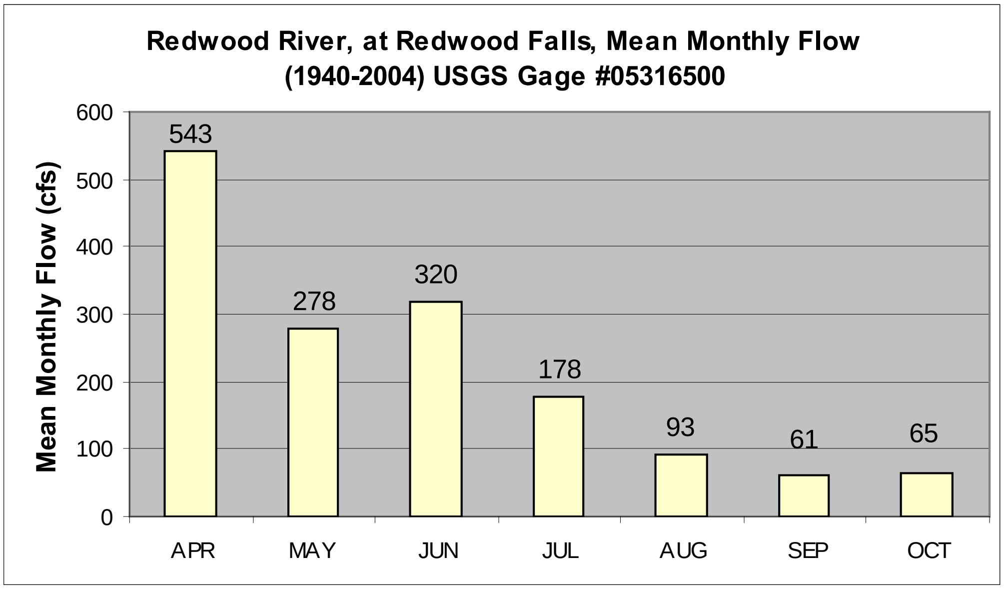
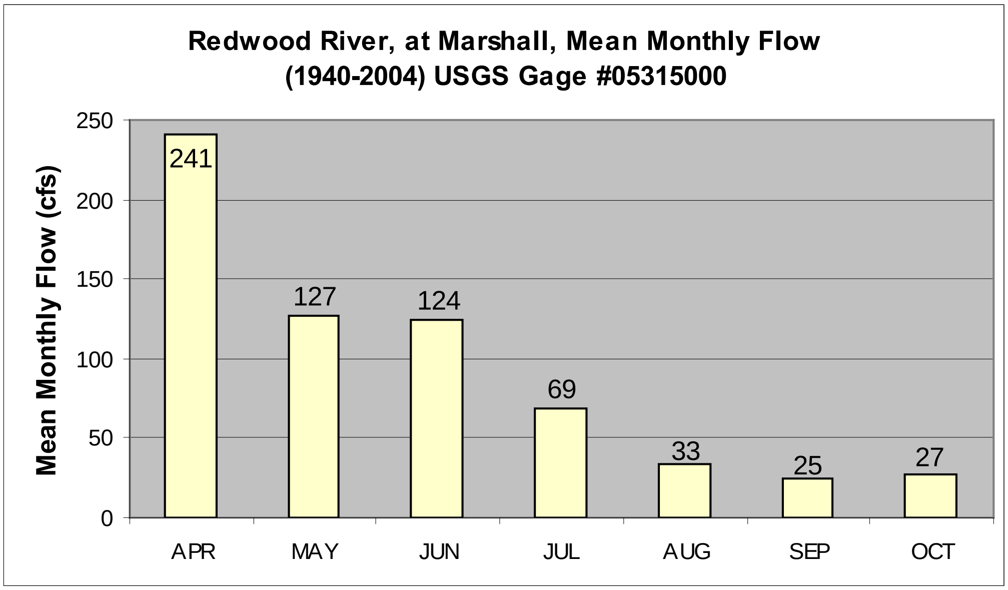


Figure 2.07: Mean Monthly Flow; Marshall (S003-702)



3.0 Description of Applicable Water Quality Standards and Assessment Procedures

3.1 Classification and Beneficial Uses

The TMDL evaluation is a method of addressing and assessing the waters that exceed the state water quality standard for fecal coliform bacteria. All waters of Minnesota are assigned classes, based on their suitability for the following beneficial uses (Minn. Rules part 7050.0200):

Class 1 – Domestic consumption
Class 2 – Aquatic life and recreation
Class 3 – Industrial consumption
Class 4 – Agriculture and wildlife
Class 5 – Aesthetic enjoyment and navigation
Class 6 – Other uses
Class 7 – Limited resource value

All surface waters of the state that are not specifically listed in Chapter 7050 and are not wetlands, which include most lakes and streams in Minnesota, are classified as Class 2B, 4A, 5 and 6 waters (Minn. R. ch. 7050.0430).

According to Minn. R. ch. 7050.0220-0227, the designated beneficial use for the different use classes is as follows:

Class1B: For domestic consumption following approved disinfection, such as simple chlorination or its equivalent.

Class 2A: Aquatic life support refers to cold water sport or commercial fish and associated aquatic life, and their habitats. Recreation support refers to aquatic recreation of all kinds, including bathing, for which the waters may be usable. Class 2A also is protected as a source of drinking water.

Class 2B: Aquatic life support refers to cool or warm water sport and commercial fish and associated aquatic life. Recreation support refers to aquatic recreation of all kinds, including bathing.

Class 2C: Aquatic life support and recreation includes boating and other forms of recreation for which the water may be suitable (i.e., swimming). Class 2C waters may also support indigenous aquatic life, but not necessarily sport or commercial fish.

Class 3B: General industrial purposes, except for food processing, with only a moderate degree of treatment. Similar to Class 1D waters of the state used for domestic consumption.

Relative to the fecal coliform standard, all of the waters covered in this report are either Class 2B, 3B, 2C, or 7. All class 3B waters here are also classified as 2B or 2C and are required to meet the more stringent requirements of a class 2B or 2C water so there is no explanation of 3B requirements as they would not be applicable for these waters.

3.2 Applicable Minnesota Water Quality Standards

Minn. R. ch. 7050.0222 subp. 4 and 5, *Escherichia (E.) coli* water quality standard for Class 2B and 2C waters states that *E. coli* shall not exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Minn. R. ch. 7050.0227 subp. 2, *Escherichia (E.) coli* water quality standard for Class 7 waters states that *E. coli* shall not exceed 630 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31. MPCA did not list or assess Class 7 waters, but will in 2010.

The *E. coli* standards as described in the Minnesota Rules chapter 7050.0222 and 7050.0227, above, replaced the standards for fecal coliform bacteria during the crafting of this report. Fecal coliform standards have an equivalent value of 200 fecal coliforming organisms per 126 *E. coli* organisms; 1,000 fecal coliforming organisms per 630 *E. coli* organisms for class 7 streams; 2,000 fecal coliforming organisms per 1,260 *E. coli* organisms in the case of the acute standard based on studies done by the MPCA as described in section 3.4. The *E. coli* standards were set accordingly. This Report uses the fecal coliform standards to derive load values and allocations because river reaches listed in this Report (Table 1.01) were based on fecal coliform sampling. Another reason for sticking with the fecal coliform standards is to avoid converting a majority of the sample data in this Report from fecal coliform to *E. coli* values and perhaps losing accuracy in the conversion.

This Report focuses on 200 organisms per 100 ml monthly geometric mean as an environmental goal for impaired reaches. Establishing TMDLs to meet the geometric mean of 200 organisms/100ml rather than not exceeding 2,000 organisms per 100 ml in more than 10 percent of single samples is consistent with EPA's recent promulgation of water quality criteria for coastal recreational waters. The preamble of the coastal recreational water rule states: *"the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality because it is a more reliable measure, being less subject to random variation"* (EPA, 2004). The same source-reduction measures that are required to attain compliance with the "chronic" standard also will lead to attainment of compliance with the "acute" standard of 2,000 organisms/100ml cited above. This Report requires compliance with both parts of the standard.

3.3 Impaired Assessment

Impairment assessment is based on the procedures found at:
http://www.pca.state.mn.us/water/tmdl/index.html#support

For support of swimming and recreation, the fecal coliform methodology (303(d) listing) is as follows: Data is aggregated over a ten-year period by month and by reach. If the geometric mean for at least five samples for each appropriate month (all years combined) exceeded 200 organisms per 100ml, the reach will be placed on the 303(d) list. In addition, if at least 10 percent of the entire data set for a reach during the ten-year period exceeded 2,000 organisms per 100ml, then that reach will also placed on the list. Class 7 streams had not been assessed in this manner but will be in 2010.

The MPCA and RCRCA monitored the Redwood River and its tributaries for fecal coliform at the locations identified in Figure 3.01. Table 1.01, as well as Table 3.03, provides summary information of the data used to determine the impairment status of the eight stream reaches included in this Report.

Table 3.01 and Table 3.02 display the data collected from 1974-2006 for the impaired reaches. Table 3.01 lists the data collected at RWR-1 (STORET# S000-299) at the Hwy 101 bridge in North Redwood. All reaches exceeded the water quality standards at least once during the years of sampling used in this report. Figure 3.03 shows the geometric mean for each month at each site with adequate data (five samples/ month).

Figure 3.01: Redwood River Watershed Sampling Sites

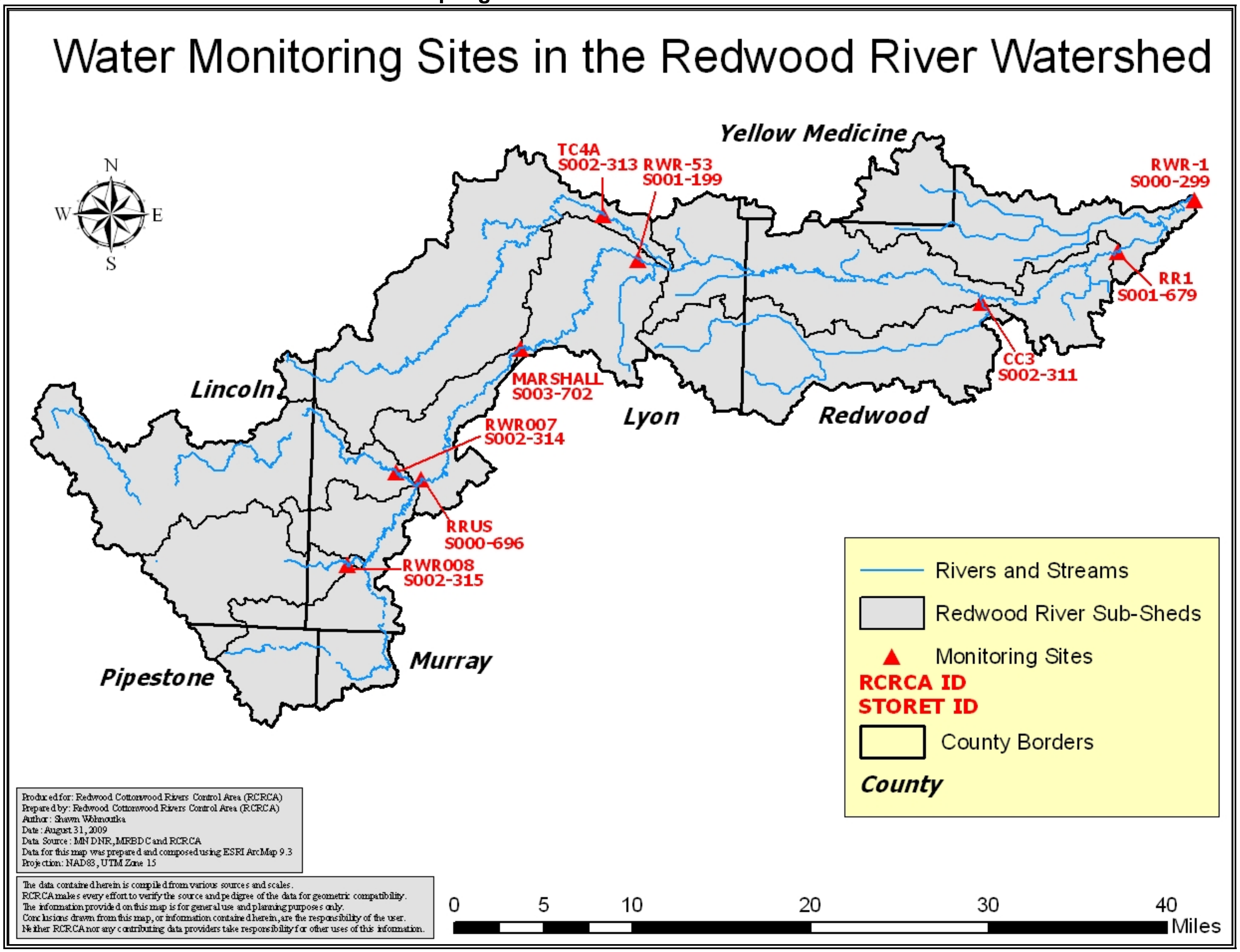


Table 3.01: RWR-1 Site (S000-299): 1974-2006 Fecal Coliform (cfu/100ml) Sampling by Month

RCRCA Site ID	RWR-1												
STORET ID #	S000-299												
Date	Value	Date	Value	Date	Value	Date	Value	Date	Value	Date	Value	Date	Value
4/16/1975	490	5/20/1975	1	6/17/1975	130	7/2/1974	790	8/6/1974	110	9/4/1974	50	10/21/1975	20
4/27/1976	1	5/25/1976	50	6/21/1977	1300	7/15/1975	330	8/26/1975	110	9/23/1975	50	10/7/1981	110
4/19/1977	70	5/17/1977	3300	6/6/1985	200	7/21/1976	1	8/17/1976	20	9/28/1976	50	10/9/1985	100*^
4/8/1981	1	5/6/1981	70	6/6/1985	246	7/19/1977	170	8/16/1977	1100	9/20/1977	80	10/5/1988	8
4/5/1982	1700	5/3/1982	20	6/3/1987	81	7/8/1981	170	8/5/1981	300	9/1/1981	330	10/5/1989	12
4/6/1983	80	5/4/1983	460	6/9/1988	220	7/6/1982	790	8/2/1982	790	9/22/1982	80	10/22/1990	44
4/11/1984	230	5/10/1984	330	6/7/1989	190	7/7/1983	1300	8/1/1983	40	9/6/1983	310	10/8/1991	18
4/11/1985	15*^	5/9/1985	145*^	6/11/1990	16	7/11/1984	13000	8/8/1984	790	9/12/1984	1300	10/12/1992	680
4/30/1987	24	5/6/1987	24	6/10/1991	380	7/11/1985	100*^	8/8/1985	396*^	9/5/1985	3551*^	10/26/1993	45
4/7/1988	12	5/26/1988	200	6/28/1993	780	7/9/1986	230	8/6/1986	390	9/11/1986	140	10/24/2000	190
4/5/1989	36	5/3/1989	1	6/27/1994	520	7/8/1987	480	8/5/1987	110	9/10/1987	200	10/22/2003	72*^
4/26/1990	8	5/9/1990	28	6/2/1998	64	7/6/1988	200	8/11/1988	360	9/6/1988	20	10/13/2005	402^
4/8/1991	16	5/21/1991	170	6/8/1998	72	7/12/1989	150	8/3/1989	110	9/7/1989	260	10/17/2005	260
4/13/1992	1	5/20/1992	20	6/16/1998	110	7/11/1990	52	8/1/1990	110	9/6/1990	48	10/30/2006	7^
4/7/1993	28	5/12/1993	240	6/23/1998	110	7/23/1991	740	8/12/1991	1200	9/24/1991	130		
4/25/2001	1670*^	5/1/1994	2100	6/30/1998	72	7/1/1992	760	8/24/1992	720	9/14/1992	130		
4/27/2004	10*^	5/22/1994	45	6/1/1999	68	7/27/1992	120	8/16/1993	4900	9/27/1993	160		
4/27/2006	10	5/5/1998	8	6/7/1999	120	7/29/1993	460	8/31/1994	630	9/19/1994	340		
		5/12/1998	18	6/16/1999	260	7/11/1994	360	8/4/1997	340	9/3/1997	88		
		5/19/1998	56	6/22/1999	135*	7/30/1997	620	8/5/1997	310	9/9/1997	56		
		5/26/1998	44	6/28/1999	270	7/7/1998	220	8/14/1997	110	9/16/1997	240		
		5/28/1998	70	6/6/2001	54*^	7/14/1998	88	8/19/1997	480	9/23/1997	110		
		5/3/1999	16	6/28/2004	200*^	7/21/1998	250	8/26/1997	36	9/24/1997	44		
		5/10/1999	210	6/8/2006	55^	7/28/1998	45	8/2/1999	73	9/29/1997	60		
		5/18/1999	63	6/22/2006	83^	7/6/1999	170	8/9/1999	2800	9/8/1999	57*		
		5/24/1999	56			7/12/1999	150*	8/16/1999	120	9/15/1999	52		
		5/25/1999	28			7/19/1999	44	8/23/1999	67	9/20/1999	72		
		5/15/2001	37			7/22/1999	150	8/26/1999	100	9/29/1999	32		
		5/24/2004	1282*^			7/26/1999	72	8/28/2001	106*^	9/30/1999	64		
		5/16/2006	81^			7/11/2001	63*^	8/25/2004	2902*^	9/19/2001	134^		
		5/24/2006	59^			7/21/2004	389*^	8/17/2005	45	9/8/2004	192*^		
						7/19/2005	10	8/9/2006	19^	9/14/2006	68^		
						7/19/2006	324^	8/29/2006	78^	9/28/2006	223^		
						7/25/2006	17^						
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER
GEOMEAN	28		64		145		179		222		116		58

*Averaged Duplicates,

^At least one value figured from *E. coli*

Table 3.02: Redwood River Watershed 1999-2006 Fecal Coliform Bacteria(cfu/100ml) Sampling

RCRCA Site ID STORET ID #	RR1 S001-679	CC3 S002-311	TC4A S002-313	RRUS S000-696	RWR-53 S001-199	RWR007 S002-314	RWR008 S002-315	MARSHALL S003-702	003-703 S003-703
4/15/1999	72	38							
4/19/1999			31						
4/14/2004	440	240	10	20					
4/26/2005	40	140	55	30					
GEOMEAN									
5/3/1999	80				150	24	16*	18	18
5/10/1999	180				160	96	130	16	36*
5/18/1999	110				54	76	190	36	36*
5/24/1999	56				96	36	240	40	44*
5/25/1999	64	13	65		170	140	630*	56	12
5/17/2000		105	98						
5/30/2001	100	100	120						
5/27/2003	70								
5/28/2003		900	500	400					
5/5/2004	20	360	30	170					
5/24/2005	80	220	230	170					
5/15/2006	207*^	157*^	84*^	102*^					
5/30/2006	4^	58^	4^	12^					
GEOMEAN	**62**	**131**	**74**	**107**	**116**	**62**	**143**	**30**	**26**
6/1/1999	56				290	140	680	64	175*
6/7/1999	54*				640	200	1400	90	150
6/16/1999	240				400	60	2150*	300	720
6/22/1999	110				440	170	1300	310	820
6/23/1999	300	174	2290						
6/28/1999	400				790	2300	2200	1200*	1100
6/5/2000	189								
6/29/2000	220	171	109						
6/29/2001	5000	6000	7000						
6/26/2003	800	3600	6000	3000					
6/29/2004				900					
6/30/2004	700	2300	1100						
6/8/2005	1600		4000	1600					
6/27/2005	1640*^		1140*^	1040*^					
6/28/2005		1300*^							
6/12/2006	167^	324^	123^	190^					
GEOMEAN	**354**	**935**	**1263**	**969**	**481**	**231**	**1424**	**230**	**443**
7/6/1999	500				750*	210	1800	490	900
7/12/1999	120				880	150	1100	270	320
7/19/1999	225*				560	290	1200	190	220
7/22/1999	210				580	330	1550*	290	360
7/26/1999	150				580	440	1150*	120	330
7/30/1999	240	120	210						
7/28/2000	813	373	380						
7/19/2001	1400	120	1000						
7/31/2003	700	500	1900	3100					
7/27/2004	370	360	500	240					
7/5/2005	1500		800	130					
7/19/2005	70								
7/29/2005		910	1500	1000					
7/10/2006	223^	56^	87^	268^					
7/28/2006	156^	61^	26^	81^					
GEOMEAN	**318**	**204**	**389**	**358**	**659**	**266**	**1335**	**245**	**376**

RCRCA Site ID	RR1	CC3	TC4A	RRUS	RWR-53	RWR007	RWR008	MARSHALL	003-703
STORET ID #	S001-679	S002-311	S002-313	S000-696	S001-199	S002-314	S002-315	S003-702	S003-703
8/29/1990					497*^				
8/2/1999	64				280	190	1150*	110	260
8/9/1999	600				610*	420	740	72	20
8/16/1999	110				180	480	700	92	74*
8/23/1999	290				2900	1900	3250*	220	160
8/26/1999	73				440	740	640	140	305*
8/27/1999	160	370	1560						
8/25/2000	130	30	130						
8/14/2001	8000	8000	270						
8/13/2003	1200	410	1100	6000					
8/23/2004	390	550	410	800					
8/17/2005	140	260	330	350					
8/29/2006	56^	156^	1340^	68^					
GEOMEAN	**248**	**362**	**525**		**519**	**558**	**1044**	**118**	**113**
9/8/1999	420				830	740	300	120	850
9/15/1999	82				460	1600	135*	72	590
9/20/1999	660				2500*	1500	420	160	820
9/23/1999	594	70	2010						
9/29/1999	73				250	680	235*	92	73
9/30/1999	80				140	560	99*	32	110
9/29/2000	70	50	110						
9/26/2001	280	120	60						
9/29/2003	120	500	160	90					
9/29/2004	360	500		410					
9/14/2005	18000	17000	60000						
9/12/2006	107^	313^	71^	145^					
9/26/2006	179^	2010^	536^	1790^					
GEOMEAN	**259**	**428**	**467**		**507**	**925**	**209**	**84**	**319**
10/26/2000	315								
10/22/2003	400								
10/17/2005	300	200	220	220					

*Averaged Duplicates
^At least one value figured from *E. coli*

Table 3.03: Redwood River Watershed Assessment Site Descriptors

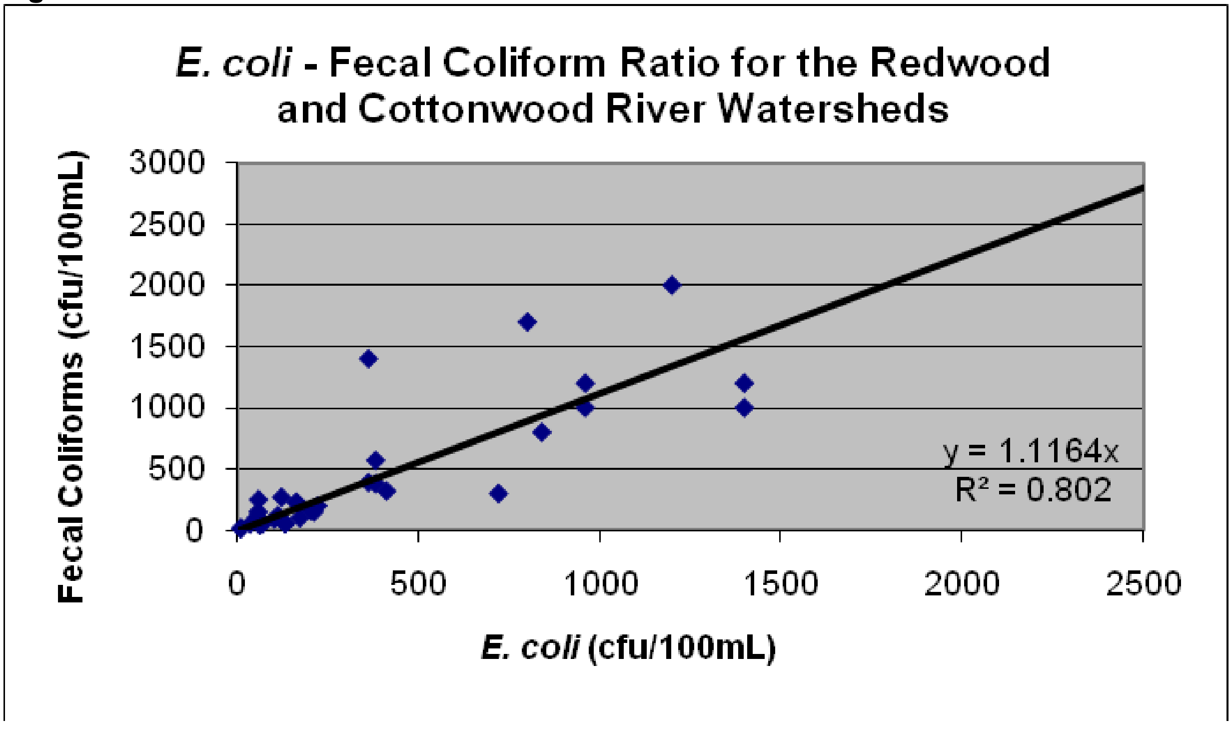
Sample Site Name	TMDL Section #	Reach	Description	River Assessment Unit ID	STORET ID Site Used for Assessment	Years of Data
RWR-1	5.3.1	Redwood River	Ramsey Cr to Minnesota R	07020006-501	S000-299	‘74-‘06
RR1	5.3.2	Redwood River	Clear Cr to Redwood Lk	07020006-509	S001-679	‘99-‘06
CC3	5.3.3	Clear Creek	Headwaters to Redwood R	07020006-506	S002-311	‘99-‘06
RWR-53	5.3.4	Redwood River	T111 R42W S33 west line to Threemile Cr	07020006-502A	S001-199	‘99
MARSHALL	5.3.5	Redwood River	T111 R42W S33 west line to Threemile Cr	07020006-502B	S003-702	‘99
TC4A	5.3.6	Three Mile Creek	Headwaters to Redwood R	07020006-504	S002-313	‘99-‘06
RRUS	5.3.7	Redwood River	Headwaters to Coon Creek	07020006-505	S000-696	‘03-‘06
RWR008	5.3.8	Tyler Creek*	Headwaters to Redwood R	07020006-512	S002-315	‘99
RWR007	5.3.9	Coon Creek	Lake Benton to Redwood R	07020006-511	S002-314	‘99

3.4 Fecal Coliform and *E. coli* Standards

As the writing of this report began, the MPCA was proposing to change the bacterial water quality standard from fecal coliform to *E. coli* bacteria. Paired comparison studies conducted by MPCA have shown on average that 63 percent of fecal coliform tested to be *E. coli* bacteria. This means that the 200 org/100 ml fecal coliform standard would be equivalent to 126 *E. coli* bacteria per 100ml. This *E.coli* standard has replaced the fecal coliform standard by the completion of this report. Because the vast majority of data collected is based on fecal coliform, both data sources are used and existing *E. coli* data was converted to the equivalent fecal coliform values."

Values noted as derived from *E. coli* samples were converted using a factor of 179 *E. coli* coliform units = 200 fecal coliform units. Though this varies with the proposed 126 *E. coli* coliform units to 200 fecal coliform units conversion, we substantiate this using 35 *E. coli*/Fecal Coliform sample pairs from the Redwood and Cottonwood River Watersheds from 1985-2006. Values are charted in Figure 3.02

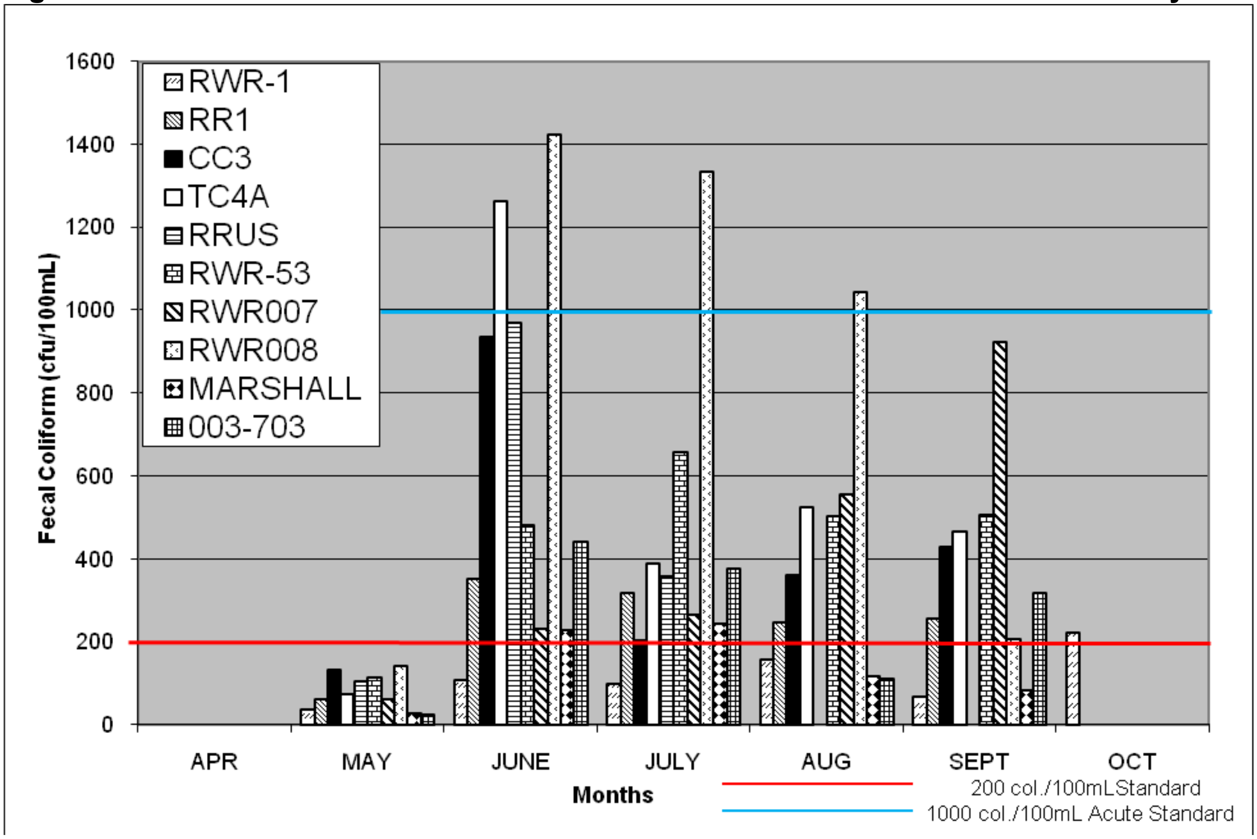
Figure 3.02: *E. coli* – Fecal Coliform Ratio



3.5 Monthly Fecal Coliform Concentrations in the Redwood River

The criteria used for determining fecal coliform impairments are described in Section 3.3. The procedure involves calculating monthly geometric means April through October. Figure 3.03 displays the monthly geometric means from April through October.

Figure 3.03: 1997-2006 Redwood River Watershed Fecal Coliform Geometric Mean by Site



3.6 MPCA Non-degradation Policy

Non-degradation is an important component of water quality standards in Minnesota. MPCA policy distinguishes non-degradation for all waters from non-degradation for Outstanding Resource Value Waters (ORVW), as follows:

Minn. R. ch 7050.0185, subp. 1. Non-degradation for All Waters. The potential capacity of the water to assimilate additional wastes and the beneficial uses inherent in water resources are valuable public resources. It is the policy of the state of Minnesota to protect all waters from significant degradation from point and nonpoint sources and wetland alterations, and to maintain existing water uses, aquatic and wetland habitats, and the level of water quality necessary to protect these uses.

3.7 Trends in Fecal Coliform Surface Water Quality

Figure 3.04 and Figure 3.05 track long-term fecal coliform geometric means by decade at the legacy site in North Redwood (RWR-1; STORET# S000-299), based on 188 samples. The data indicates a general downward trend in bacterial concentration over the past four decades.

Figure 3.04: Fecal Coliform Geometric Mean Trend by Decade

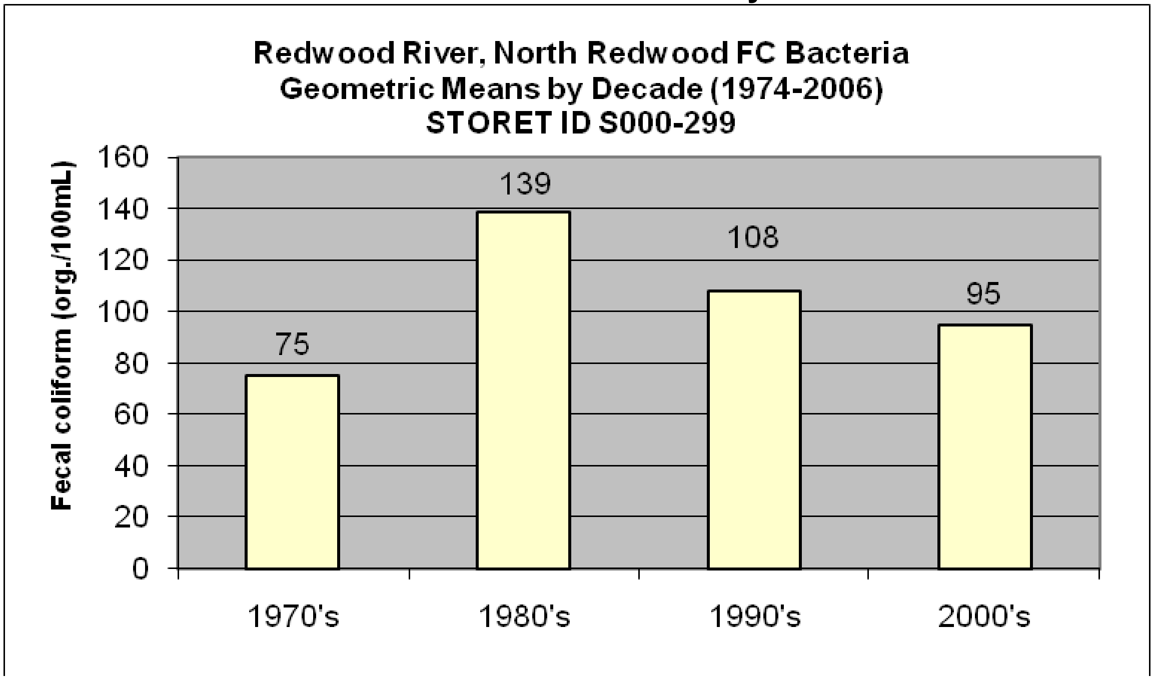
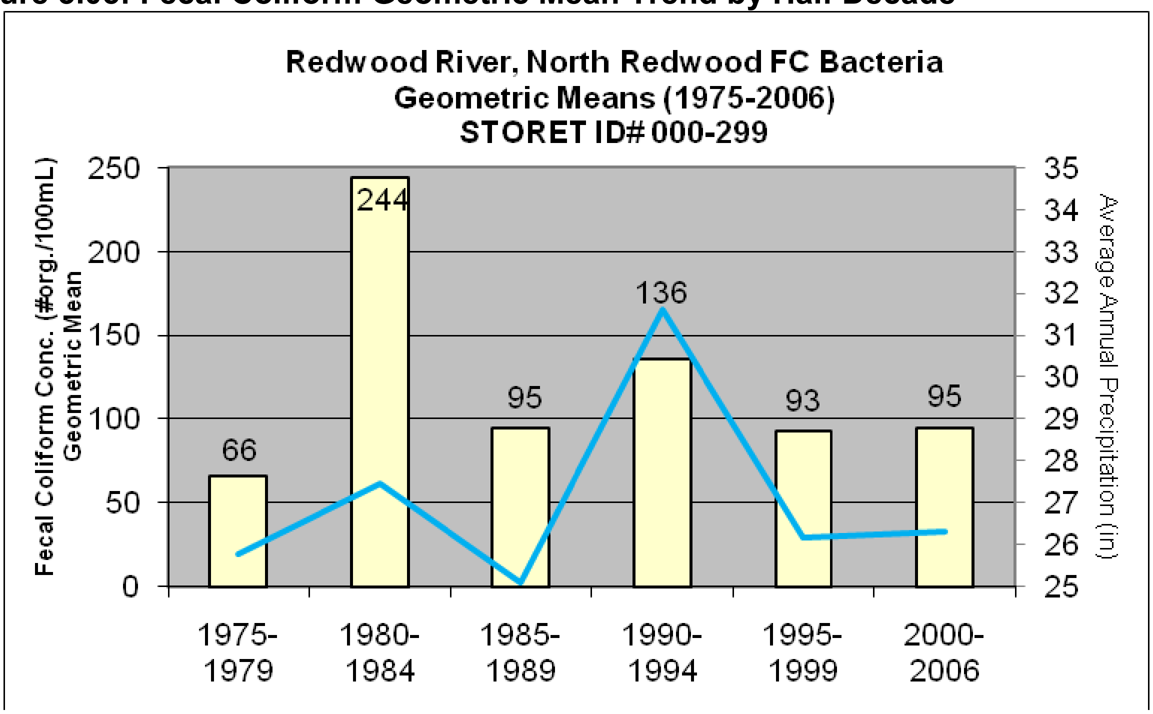


Figure 3.05 uses the same data as Figure 3.04 coupled with precipitation data for the same area from the daily cooperative records at the Minnesota State Climatology Office, broken down a little bit more. The bacteria concentrations appear, in part, to have a relationship to the dry years in the mid 1970's, the drought of 1988-89, and the wet years of the early 1980's and 1990's.

Figure 3.05: Fecal Coliform Geometric Mean Trend by Half Decade



4.0 Description of Fecal Coliform Bacteria and Its Sources

4.1 Fecal Coliform Bacteria Description

Fecal coliform bacteria represent a group of several genera found in the intestines of warm-blood animals and is always associated with fecal matter. Certain strains of the fecal coliform bacteria group e.g. *Escherichia coli* are extremely pathogenic. Public health uses fecal coliform as an indicator of the presence of pathogens, due to the similarity between their habitats and the characteristics of pathogenic organisms. Excessive fecal coliform concentrations in water bodies (e.g. lakes, rivers and streams) can pose a public health threat when humans come in contact with the water.

The assessment of fecal coliform sources within a watershed and establishing the cause-effect relationship between the sources, the transport mechanisms, and the subsequent stream loading is complex and difficult to quantify. The survival rate of fecal coliform in terrestrial and aquatic environments is poorly understood and further exacerbates efforts to track sources.

Once fecal coliform bacteria have reached streams and rivers, it can survive in streambed sediments. One thing that is often overlooked is that fecal coliform bacteria can be re-suspension with the 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. Water Resources Center (2006) reported a study conducted in southern Minnesota, which found that physical raking of streambed sediments resulted in bacteria concentrations several factors higher than the water column values before re-suspension. 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. It must be noted, however, that though the mechanisms cited above have a possible effect on the values of pollutant calculated in this Report, but are not quantifiable at this time.

Two Minnesota studies describe the presence and growth of “naturalized” or “indigenous” strains of *E. coli* in watershed soils (Ishii et al., 2006) and ditch sediment and water (Sadowsky et al., 2010). The latter study, supported with Clean Water Land and Legacy funding, was conducted in the Seven Mile Creek watershed, an agricultural landscape approximately 30 miles to the east of the mouth of the Cottonwood River. DNA fingerprinting of *E. coli* from sediment and water samples collected in Seven Mile

Creek from 2008-2010 resulted in the identification of 1568 isolates comprised of 452 different *E. coli* strains. Of these strains, 63.5% were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. Discussions with the primary author of the Seven Mile Creek study suggest that while 36% might be used as a rough indicator of “background” levels of bacteria at this site during the study period, this percentage is not directly transferable to the concentration and count data of *E. coli* used in water quality standards and TMDLs. Additionally, because the study is not definitive as to the ultimate origins of this bacteria, it would not be appropriate to consider it as “natural” background. Finally, the author cautioned about extrapolating results from the Seven Mile Creek watershed to other watersheds without further studies. From a pragmatic standpoint, this study suggests that there is a fraction of bacteria that may exist regardless of most traditional implementation strategies that are employed to control the sources of *E. coli*.”

Despite the complexity of the relationship between sources and in-stream concentrations of fecal coliform, the following can be considered major source categories:

4.2 Fecal Coliform Bacteria Sources

4.2.1 Human Sources

Wastewater Treatment Facilities

There are eight municipal wastewater treatment facilities (WWTF) in the watershed servicing approximately 16,000 people (Table 4.01). As of 2006, there were seven pond systems and one continuous discharge plant in the Redwood River watershed. According to state rule, each facility is required to meet a discharge limit of 200 cfu/100ml fecal coliform or *E. coli* equivalent concentration as a monthly geometric mean. This is accomplished through disinfection of the wastewater at the final treatment stage, through chlorination or equivalent processes. The cities of Redwood Falls and Lake Benton WWTFs discharge outside of the watershed

All permitted facilities are required to monitor their effluent to ensure that concentrations of specific pollutants remain within levels specified in the discharge permit. The MPCA regularly reviews the Discharge Monitoring Reports to determine if violations have occurred.

Pond system permits allow for two discharge windows between April 1 and June 30 and between September 1 and December 15. In general these windows coincide with either high flow periods or low recreational value periods, which help to minimize the risk to humans.

Municipal bypasses are emergency discharges of partially or untreated human sewage from waste water treatment facilities. Municipal wastewater facilities shall not allow an anticipated bypass to occur unless the bypass is unavoidable to prevent loss of life, personal injury, or severe damage to the facility or private property. Municipal bypasses sometimes occur during periods of heavy precipitation, when treatment facilities become hydraulically overloaded. Conditions for bypasses are detailed in the facility's NPDES permit and Minn. R. 7001.1090.

The seven year average discharge from the eight WWTFs with available data is 4.34E+09 organisms per day. The seven year load equivalent at the allowable standard is 2.47E+10 organisms per day.

It should be noted that Milroy (MN0041211) discharged over 200 orgs/100mL, on average, in June of 2004 and that Tyler (MN0022039) discharged over 200 orgs/100mL, on average, in May 2002 and Oct. 2005. With these violations, MPCA oversees and takes action through enforcement. These violations were isolated and non-repeat offenses that were rectified with improved handling methods.

Table 4.01: Redwood River Watershed Permitted WWTF

WWTF	System Type	Permit No.	Sub-watershed	County	(2000-2006) Mean FC Discharge (org/day)[1]	Load at Standard (org/day)	Population[2]
GHENT WWTP	Pond	MN0039730	Three Mile Creek	Lyon	7.47E+06	1.59E+09	315
LYND WWTP	Pond	MNG580030	Middle Redwood	Lyon	7.54E+06	1.55E+09	346
MARSHALL WWTP	Cont. Discharge	MN0022179	Middle Redwood	Lyon	3.38E+09	1.95E+10	12,735
MILROY WWTP	Pond	MN0041211	Clear Creek	Redwood	7.95E+07	8.20E+07	271
RUSSELL WWTP	Pond	MNG580062	Middle Redwood	Lyon	2.33E+07	3.30E+08	371
RUTHTON WWTP	Pond	MN0049654	Upper Redwood	Pipestone	8.60E+07	4.36E+08	284
TYLER WWTP	Pond	MN0022039	Tyler Creek	Lincoln	7.47E+08	1.06E+09	1,218
VESTA WWTP	Pond	MNG580043	Lower Redwood	Redwood	6.37E+06	1.24E+08	339
					4.34E+09	2.47E+10	15,879

[1]MPCA 2000-2006 Daily Monitoring Report Data

[2]United States Census 2000

Unsewered Communities

The population in the unsewered communities in the Redwood River watershed is nearly 350 people (Table 4.02). Two of the small hamlets on this list are not incorporated or have been deemed low priority. Work was completed by November 2008 to upgrade all Subsurface Septic Treatment Systems (SSTS) in the city of Florence. Lyon County is working on a plan for the city of Green Valley. The city of Seaforth is in the process of completing their pond system, which should be on line soon.

Table 4.02: Redwood River "Unsewered" Communities

CITY	COUNTY	SUB-SHED	POPULATION
BURCHARD[1]	Lyon	Upper Redwood	30
FLORENCE[2]	Lyon	Tyler Creek	46
GREEN VALLEY[1]	Lyon	Middle Redwood	170
SEAFORTH[2]	Redwood	Lower Redwood/Clear	77
THOMSONBURG[1]	Lincoln	Upper Redwood	20

[1]Estimated Population

[2]United States Census 2000

Urban Stormwater and Rural Areas

Several of the unsewered communities are combined sewer and stormwater systems. Other than human, sources of fecal coliform in urban stormwater and rural areas include pet and wildlife waste. Pet and wildlife waste can be directly deposited to streams and rivers or from runoff via impervious surfaces to storm sewer systems and overland flow. Untreated pet and wildlife waste in stormwater from cities, small towns, and rural areas can be a source for many pollutants including fecal coliform bacteria and associated pathogens. Fecal coliform concentrations in urban runoff can be as great as or greater than those found in cropland runoff and feedlot runoff (USEPA 2001). Newer urban development often includes stormwater treatment such as sedimentation basins, infiltration areas, and vegetated filter strips. Marshall and Redwood Falls are the two cities in the watershed, which are required to have a Municipal Separate Storm Sewer System (MS4) permit. The MS4 permit requires a range of actions that will ultimately reduce the impact of stormwater from the community to downstream water bodies. Smaller communities or even rural residences not covered under MS4 permits may still need to take action to reduce stormwater and associated bacteria runoff.

Subsurface Septic Treatment Systems

The number of failing (includes imminent threats to public health) Subsurface Sewage Treatment Systems (SSTS) was determined from using the actual number of SSTS reported by each county to MPCA (2006 data set). The number of SSTS attributed to the Redwood River watershed was generated by multiplying the percentage of the county in the watershed by the number of SSTS in the county. This was done for each reach in the watershed. Each county had varying levels of “failing” systems, and this was taken into account for each county within a reach. Using MPCA records and the analysis method described above, it was determined there were 1,948 SSTS in the Redwood River Watershed (including seasonal and non-residential), of which, 1,051 were designated as failing. Of those 1,051 failing systems (includes unsewered communities), 334 of those were estimated to be imminent threats to public health (ITPH). For the purpose of this report, a straight-pipe system, a system that directly discharges into surface waters, is considered an imminent health threat as defined below.

A SSTS that fails to protect groundwater is defined as “failing”. At a minimum, a system that is failing to protect groundwater is a system that is a seepage pit, cesspool, drywell, leaching pit, or other pit; a system with less than the required vertical separation distance (between the system and groundwater level) or a system not abandoned in accordance with state law (Rule: 7080.2500)

A SSTS system that is not protective of public health and safety is defined as imminent threats to public health (ITPH). At a minimum, a system that is an imminent threat to public health of safety is a system with a discharge of sewage or sewage effluent to the ground surface, drainage systems, ditches, storm water drains or directly to surface water; systems that cause a reoccurring sewage backup into a dwelling or other establishment; systems with electrical hazards; or sewage tanks with unsecured, damages, or weak maintenance hole covers.

4.2.2 Livestock Sources

Livestock manure represents more than 98% of the fecal matter produced in the watershed. Nearly all manure is either incorporated or surface applied to 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 most likely 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 is important to note that livestock manure has environmental and economic benefits that must be taken into account and weighed against potential bacteria 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.

Livestock facilities with NPDES Permits

A feedlot designated as a Concentrated Animal Feeding Operation (CAFO) is required to operate in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. The feedlot meets the definition of a CAFO as defined in Federal Regulations (40 CFR: 122.23(b)(4)); or the feedlot is capable of holding 1,000 or more animal units (AU) (as defined under Minn. R. 7020.0300, subp.5) or the manure storage area is capable of storing the manure generated by 1,000 AU or more.

According to the MPCA Feedlot database, there are eleven NPDES permitted facilities in the watershed. The NPDES permittees are listed in Section 5.0. Three facilities are located in both the Middle Redwood Main Stem and Three Mile Creek. One permitted facility is located in each of the following five reaches; Tyler Creek, Coon Creek, Upper Redwood – Russell, Clear Creek and Lower Redwood/Ramsey Creek. The eleven permitted facilities represent 1824 beef animal unit (AU)s, 2538 turkey AUs and 8024 swine AUs throughout the Redwood River watershed (Table 4.03).

Livestock facilities without NPDES Permits

Runoff from livestock feedlots, pastures, and land application areas has the potential to be a significant source of fecal coliform bacteria and other pollutants. There is considerable spatial variation in the type and density of livestock across the watershed Table 4.03.

The MPCA feedlot database of facilities lists over 70,000 animal units (AUs) at locations without NPDES permits in the watershed mainly representing dairy, beef, swine, sheep and turkey (MPCA, 2003). Other animals include horse, chicken, buffalo, goat, fowl, fox, bulls and dogs. The type and number of Animal Units in each reach is listed in Table 4.03.

Feedlot proximity to water has an effect on potential fecal coliform sources, delivery assumptions and for determining target areas for BMP implementation. Figure 4.01 shows feedlot locations and proximity in the Redwood River Watershed. Table 4.04 includes a breakdown of animal units (AU) by proximity to surface water. More information related to surface water proximity is in Appendix C of this report.

For the entire watershed, Beef AUs represented just under 45 percent of all Animal Units and Swine were 41 percent. Dairy made up just under 8 percent, Poultry below 5 percent and Sheep less than 2 percent. Horse and “Other” combined for just .32 percent of all AUs in the Redwood Watershed.

Table 4.03: Redwood River Watershed Feedlot Inventory

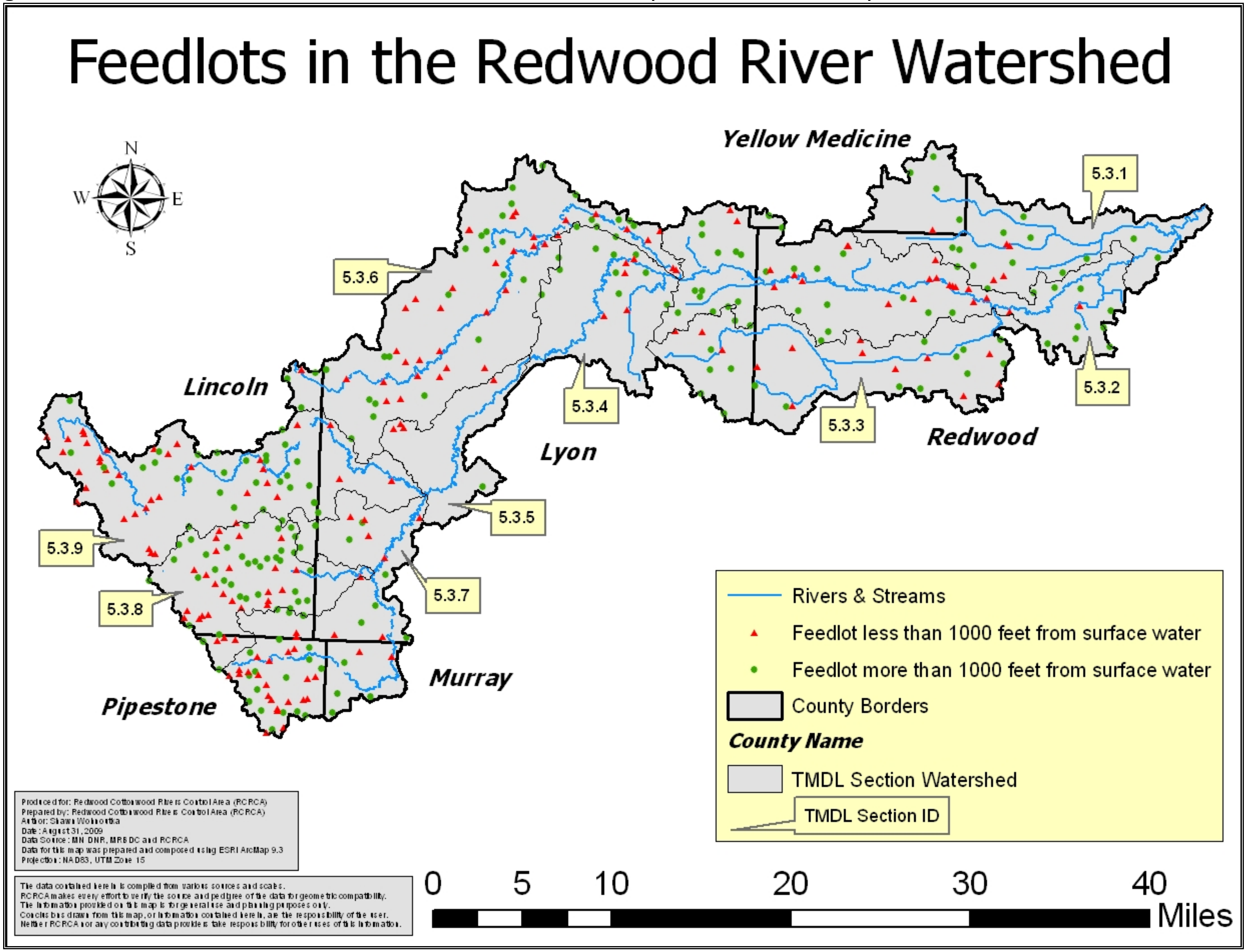
Reach Name Sample Site ID Report Section # Animal Unit Density	Source	With NPDES Permits AU	Without NPDES Permits AU	Total AU
Coon Creek RWR007 Section 5.3.9 80.41 AU/mi^2	Dairy		1,073	1,073
	Beef		4,180	4,180
	Swine	969	1,160	2,129
	Poultry			
	Sheep		296	296
	Horse		51	51
	Other*		1	1
Tyler Creek RWR008 Section 5.3.8 179.14 AU/mi^2	Dairy		1,453	1,453
	Beef		3,901	3,901
	Swine	1,335	1,799	3,134
	Poultry			
	Sheep		664	664
	Horse		16	16
	Other*		10	10
Upper Redwood at Russell RRUS Section 5.3.7 100.60 AU/mi^2	Dairy		1,152	1,152
	Beef		3,349	3,349
	Swine	1,200	2,157	3,357
	Poultry		0	0
	Sheep		108	108
	Horse		103	103
	Other*			
Three Mile Creek TC4A Section 5.3.6 177.27 AU/mi^2	Dairy		507	507
	Beef		10,751	10,751
	Swine	480	6,565	7,045
	Poultry	2,538	721	3,259
	Sheep		10	10
	Horse		36	36
	Other*		4	4
Redwood Main Stem above MARSHALL Section 5.3.5 39.55 AU/mi^2	Dairy		71	71
	Beef		740	740
	Swine		371	371
	Poultry		3	3
	Sheep		50	50
	Horse			
	Other*			

Table 4.03(Continued): Redwood River Watershed Feedlot Inventory

Reach Name Sample Site ID Report Section # Animal Unit Density	Source	With NPDES Permits AU	Without NPDES Permits AU	Total AU
Redwood Main Stem below Marshall RWR-53 Section 5.3.4 110.24 AU/mi²	Dairy		712	712
	Beef		2,642	2,642
	Swine		2,110	2,110
	Poultry			
	Sheep			
	Horse		8	8
	Other*			
Clear Creek CC3 Section 5.3.3 105.17 AU/mi²	Dairy		691	691
	Beef	600	3,029	3,629
	Swine	740	3,608	4,348
	Poultry		0	0
	Sheep		100	100
	Horse		5	5
	Other*			
Redwood Main Stem above Lake Redwood RR1 Section 5.3.2 145.81 AU/mi²	Dairy		650	650
	Beef	1,200	6,374	7,574
	Swine	2,760	5,605	8,365
	Poultry		222	222
	Sheep		102	102
	Horse		8	8
	Other*		25	25
Lower Redwood and Ramsey Creek RWR-1 Section 5.3.1 48.73 AU/mi²	Dairy		192	192
	Beef	24	169	193
	Swine	540	2,541	3,081
	Poultry		174	174
	Sheep		20	20
	Horse			
	Other*			
Redwood Watershed RW27 117.25 AU/mi²	Dairy		6,501	6,501
	Beef	1,824	35,134	36,958
	Swine	8,024	25,916	33,940
	Poultry	2,538	1,119	3,657
	Sheep		1,350	1,350
	Horse		227	227
	Other*		40	40
	Totals =	**12,386**	**70,287**	**82,673**
As a percentage =		**14.98%**	**85.02%**	**100.00%**

Animal Unit values have been rounded to nearest whole number.
Animal Unit Density is for Total Animal Units
* Other includes: Buffalo, Bulls, Dogs, Fowl, Fox and Goats

Figure 4.01: Feedlots in the Redwood River Watershed, 2003 (Listed in Table 4.03)



4.2.3 Pet Sources

Pet numbers are calculated using information gathered from a 2007 study by the American Veterinary Medical Association (AVMA) and human census data from the United States 2006-2007 Census estimates. These numbers generate a value of .2387 dogs for every person and .2709 cats for every person. The urban and rural populations were multiplied by the values above to determine number of dogs and cats. Typically, urban households have fewer dogs and more cats and rural households are more likely to have more cats and more dogs. These numbers reflect national averages and may not reflect ownership accurately.

4.2.4 Wildlife/Natural Background Sources

Wildlife populations were determined by multiplying the animal density for each animal by the area of land in each watershed. The animal density numbers for the Redwood River Watershed were provided from the Minnesota Department of Natural Resources' Farmland Wildlife Population and Research Group (deer, pheasants & turkeys). Duck and geese estimates were obtained from the U.S. Fish and Wildlife Wetland Management District.

Section 4.1 discusses the potential of "naturalized" or "indigenous" bacteria in soils, ditch sediment, and water as an additional source. However, the studies cited are not definitive as to the magnitude of this contribution. Additionally, the studies are not definitive as to the ultimate origins of this bacteria, so it may not be appropriate to consider it as "natural" background.

4.3 Summary of Sources

Table 4.04 summarizes the primary sources of fecal coliform in the Redwood River watershed. It is recognized that there is some uncertainty regarding the numbers in the table. That being said, the data compiled for Table 4.04 is the best-known data possible. The facility numbers and livestock animal units come from county feedlot inventory records and Minnesota Pollution Control Agency-permitted feedlots. The rural population with inadequate Subsurface Septic Treatment Systems (SSTSs) is based on county reports of malfunctioning SSTSs to the Minnesota Pollution Control Agency. The SSTS data is proportional to the area of the watershed included in each county. According to the 2000 Census estimates there is an average of 2.67 people/household; the SSTS figures were multiplied by 2.67 to obtain an estimate of the rural population. The urban population was obtained from the 2000 Census.

Table 4.04: Inventory of Fecal Coliform Producers in the Watershed

		Animal Units or individuals		
Category	**Source**	**Within 1000' surface water**	**Not within 1000' surface water**	**Total**
With NPDES Permits	Dairy			0 AU
	Beef	600 AU	1,224AU	1,824 AU
	Swine	3,149AU	4,875 AU	8,024 AU
	Poultry	1,680 AU	858 AU	2,538 AU
	Sheep			0 AU
	Horse			0 AU
	Other/Misc **			0 AU
Without NPDES Permits	Dairy	1,968.7 AU	4,532.4 AU	6,501.1 AU
	Beef	17,404.6 AU	17,729 AU	35,133.6 AU
	Swine	8,613 AU	17,303 AU	25,916 AU
	Poultry	943 AU	174 AU	1,117 AU
	Sheep	830 AU	520 AU	1,350 AU
	Horse	132 AU	95 AU	227 AU
	Other/Misc **	28.6 AU	11.2 AU	39.75 AU
Human	Population with inadequate septic systems	2,406 People		2,406 People
	Population with adequate septic systems	2,746 People		2,746 People
	WWTP	15,879 People		
Wildlife*	Deer	3,525 Deer		3,525 Deer
	Pheasants	54,285 Pheasants		54,285 Pheasants
	Turkeys	155 Turkeys		155 Turkeys
	Ducks	15,389 Ducks		15,389 Ducks
	Geese	1,293 Geese		1,293 Geese
	Other wildlife	3,525*** Individuals		3,525*** Individuals
Pets*	Dogs and Cats	10,874 Individuals		10,874 Individuals

*Pet and wildlife population numbers are explained in the paragraphs above this table.
** Other/Misc sources include: Buffalo, Fowl, Bull, Goat, Fox & Dogs
***Used Total Fecal Coliform Produced by Deer Population as Equivalent to unknown "Other Wildlife" population

5.0 TMDL Development for the Redwood River Watershed

5.1 Approach to Allocations Needed to Satisfy the TMDLs

The TMDLs developed for the eight reaches in this report consists of four main components: Load Allocations (LA), Wasteload Allocations (WLA), Margins of Safety (MOS), and Reserve Capacity (RC) as defined in Section 1.0. The WLA includes four sub-categories: Permitted wastewater treatment facilities, communities subject to Stormwater MS4 NPDES permit requirements, livestock facilities requiring NPDES permits, and “straight pipe” septic systems. *As additional data become available after US EPA approval of this TMDL, WLAs for individual permitted sources may be modified, provided the overall WLA does not change. Modifications in individual WLAs will be public noticed.* The LA, reported as a single category, includes manure runoff from farm fields, pastures, and smaller non-NPDES permitted feedlots, runoff from smaller non-permitted MS4 communities, and fecal coliform contributions from pets and wildlife. The LA includes land-applied manure from livestock facilities requiring NPDES permits, provided the manure is applied in accordance with the 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. Lastly, RC is the portion of the total load used to account for growth in the area.

The four components (WLA, LA, MOS, and RC) were calculated as average total daily load of fecal organisms (with the average being met over a calendar month). The daily number of fecal coliform organisms was calculated for each of a series of five flow zones ranging from low flow to high flow. Partitioning the daily fecal coliform loads between five flow regimes is referred to as the duration curve approach in this Report and is the methodology created by Bruce Cleland (Cleland, 2002; MPCA, 2006)

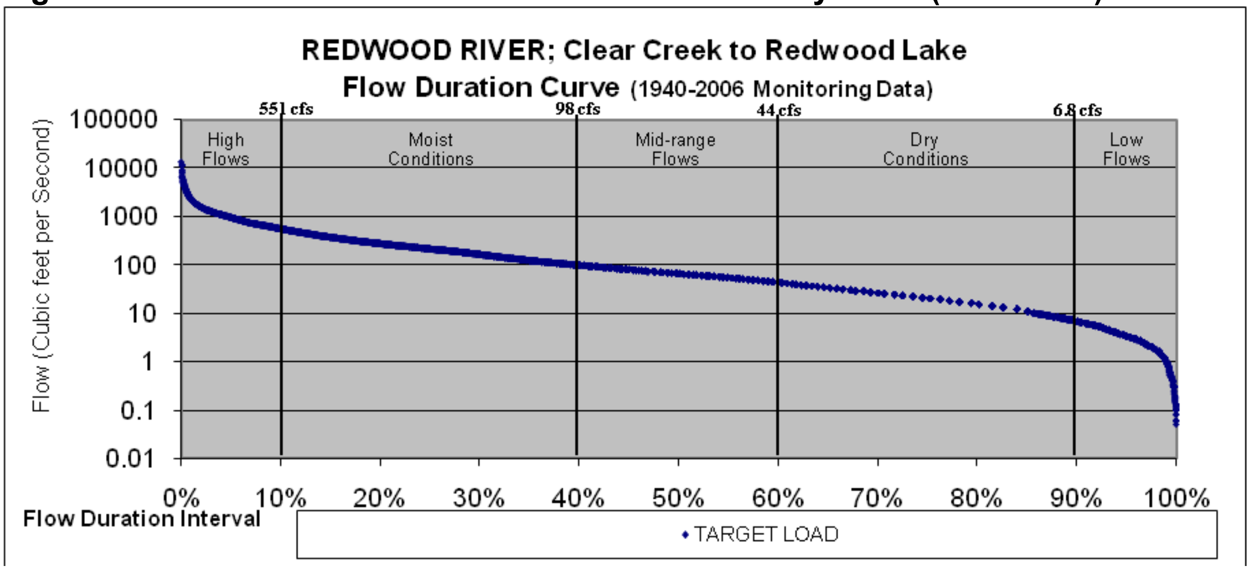
TMDLs can be developed using a variety of approaches. In Minnesota, the MPCA recommends the use of the “Duration Curve” approach for developing TMDLs. Steps used in the development of this TMDL are found in Appendix A.

The duration curve approach involved using long-term (1940-2006) flow monitoring data from two U.S. Geological Survey gage stations (USGS Station #05315000 and USGS Station #0516500). USGS site #05316500 is located near the outlet of the Redwood River in to Redwood Lake near Redwood Falls, MN. USGS site #05315000 is located on the Redwood River just upstream of the City of Marshall, MN. Daily mean flow values for each site were obtained from 1940 through 2006, April through October. The April through October period was selected as this corresponds with the fecal coliform standard.

Data at these sites have been very consistent and contain a good record of historical data. Site #05316500 was originally established in 1909 and daily data is available for a period during open water periods until 1913 and re-established in 1931 with daily flows during open water periods. The site reported daily flow values through the year from mid-1938 on. Site #05315000 was established and reported daily flow values through the year from 1940 on.

The daily flow values were sorted by flow volume, from highest to lowest to develop a flow duration curve. Figure 5.01 displays the flow duration curve for the USGS gage site which is also the Redwood River monitoring site (RR1, STORET# S001-679). The chart depicts the percentage of time any particular flow is exceeded. For example, during the flow record 552 CFS was exceeded by 10 percent of daily flow values, and thus represents “high flow” conditions. A value of 6.7 CFS was exceeded by 90 percent of flow values and represents “low flow” conditions.

Figure 5.01: Redwood River Flow Duration Curve Daily Mean (1940-2006)



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 fifth percentile. At this flow value, the mean monthly flow would be exceeded by five percent of all flow values in the dataset. Table 5.01 presents the flow regimes that were determined for the Redwood River gaging site, along with the flow value used to calculate the TDLC.

Table 5.01: Flow Categories for the Redwood River at USGS Station #05316500

Flow Condition	Flow Duration Interval	Flow Range	Flow Value Used to Calculate Daily Load Capacity
High	0-10%	>551	944
Moist	10-40%	98-551	212
Mid	40-60%	44-97	65
Dry	60-90%	6.8-43	21
Low	90-100%	<6.8	3.3

Allocations in the duration curve approach for each impaired stream reach are developed for the full range of flows experienced during the April 1 – October 31 period of the fecal coliform standard. By adjusting the wasteload allocation, load allocation, and margin of safety 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 (WLA + LA + MOS + RC), at the range of flow conditions experienced historically at each site. This approach also makes it possible to relate fecal coliform sources to allocations more specifically. For example, continuous discharges such as failing SSTS that are imminent health threats will be more prominent at lower flows, and manure runoff will be more prominent at higher flows.

Table 5.02 shows the conversion of flow from cubic feet per second (cfs) to million gallons per day (MGD), and loads from colony forming units (cfu)/ 100ml to organisms per day and vice versa. This Report states flow in MGD, concentrations in cfu/100mLand load in organisms per day.

Table 5.02: Conversion Equations

Flow: cubic feet/second (cfs) and Millions gallons per day (MGD); 1 cfs = 0.646 MGD	
To change cfu/100ml to organisms/day using flow in cfs or MGD	
Flow in cfs	cfu/100ml x cfs x 28,317 mL/ ft^3 x 86,400 seconds/day = orgs/day
Flow in MGD	cfu/100ml x 3,785 mL/gallon x 1E+6 gal/1MG x MGD = orgs/day
To change organisms/day to cfu/100ml using flow in cfs or MGD	
Flow in cfs	Orgs/day x 1/cfs x 1/28,317mL/ft^3 x 1/86,400sec/day x 100 = cfu/100ml
Flow in MGD	Orgs/day x 1/MGD x 1MG/1E+6 gal x gal/3,785 mL x 100 = cfu/100ml

*cfu (colony forming units) is equivalent to organisms

5.2 Components of TMDL Allocations

Each impaired reach in this Report is associated with a stream reach within the entire watershed and were listed to the 303(d) list based on sampling data. When allocating the total daily loading capacity in the Redwood River watershed, the sum of all reaches contributing to the reach that was listed as impaired would be included as part of the summation of that impaired reaches loading capacity. For instance, to determine the loading capacity the site RRUS, the entire area of the watershed above that point is considered in the total daily loading capacity. This would mean that the components (WLA, LA, MOS, and RC) for the impaired reaches associated with RWR007 and RWR008 would also be included in the impaired reach associated with RRUS, yet components of RWR007 and RWR008 are independent of each other in their own right. Furthermore, the impaired reaches of RWR007 and RWR008 would also be part of the components of the load capacities in the reaches associated with sites, MARSHALL, RWR-53, RR1, and RWR-1 but would not be included in the reaches at TC4A or CC3 (see sites, STORET #s and how they relate to each other in Figure 3.01).

For each impaired reach and flow condition, the total daily loading capacity or total maximum daily load (TMDL) was divided into its component wasteload allocation, load allocation, reserve capacity, and margin of safety. The process was as follows:

5.2.1 Wasteload Allocation

Wastewater Treatment Facilities (WWTF)

- Continuous discharge (mechanical) 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). Since wet-weather design flows represent a “maximum” flow for a mechanical treatment (continuous discharge) facility, the WWTF allocations are conservative in that they are substantially greater than what is actually being discharged. This builds the case for an implicit margin of safety for these facilities. Consequently, the WWTF design flows for both of the mainstem sites exceed the stream flow at the low flow zone. Of course, actual WWTF flow can never exceed stream flow as it is a component of stream flow.
- Non–continuous (stabilization ponds) discharge WWTF allocations were calculated by multiplying the maximum flow volumes (all discharge periods) by the permitted discharge limit requirement (200 organisms per 100mL). Pond systems typically discharge over a 1-2 week period in the spring and in the fall. 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. As long as WWTFs discharge at or below their permit limit, they will not cause violations of the fecal coliform water quality standard. See Section 4.2.1 for more information.
- The total daily loading capacities in the low flow zone are very small and the calculated margins of safety are relatively large. This is due to the occurrence of zero to near-zero flows in the long-term flow records used for the USGS sites (see Section 5.1). In the case of the USGS site at Marshall, the calculated MOS takes up nearly all of the remaining load capacity after assigning wasteload allocation values. To account for these situations, 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 cfu/100 ml)

  In essence, this amounts to assigning a concentration-based limit to the MS4 community and nonpoint source load allocation sources for this low flow zone. While this might be seen as quite stringent, these sources tend not to be significant contributors under the low flow zone 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.

Straight-Pipe Septic Systems
Straight-pipe septic systems are illegal and un-permitted, and as such are assigned a zero wasteload allocation.

Stormwater NPDES Permits
To account for permitted Municipal Separate Storm Sewer Systems (MS4) communities, the WWTF allocation and MOS were subtracted from the total loading capacity. The remaining capacity was divided between municipal separate storm sewer system (MS4) permits (wasteload allocations) and all nonpoint sources (load allocation) based on the percentage of land in an impaired reach watershed covered by MS4 permits. For example, if 10 percent of an impaired reach watershed is covered by a MS4 permit, 10 percent of the remaining capacity is allocated to that permit. The same land area would factor into all reaches downstream of the reach that holds the MS4 permit as a percentage of the total area of the watershed to that point. Let us continue with the example above: Let's say the area of the watershed to the impaired reach is 100 square miles. The area of the city in the watershed with the MS4 permit is 10 square miles so we allocate 10 percent of the Load Allocation to the permit for this impaired reach. Now let's say there is an impaired reach downstream of the first reach in which the watershed to that point is 400 square miles and includes the city with the MS4 permit 10 square miles of the entire 400 square mile area so we allocate 2.5 percent of the Load Allocation to the permit for this impaired reach. In addition to being a practical way to allocate between MS4 permits and all other nonpoint sources, it is also equitable from the standpoint of rural and urban fecal coliform sources being held to the same "standard".

Livestock Facilities Requiring NPDES Permits
Livestock facilities that have been issued NPDES permits are assigned a zero wasteload allocation. This is consistent with the conditions of the permit, which allow no pollutant discharge from the livestock housing facilities and associated sites. 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.

5.2.2 Load Allocations

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 with exception to land application of manure. The nonpoint pollution sources are largely related to livestock production, inadequate human wastewater treatment, non-permitted municipal stormwater systems, pets and "natural background" sources such as wildlife.

5.2.3 Margin of Safety

- 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 daily flows, accounting for potential flow variability is the appropriate way to address the MOS. This is done within each of the five flow zones.
- The margin of safety was calculated based on the difference between the median flow and minimum flow in each zone. For example, the MOS for the low flow zone is the 100th percentile flow value subtracted from the 95th percentile flow value. The resulting value was converted to a load and used as the MOS. For the low flow zone, this reflects the lowest daily flow observed over the period of record at the specific flow gage site.
- For the impaired reach in which the allocation for the dry and low flow zones required use of an alternative method of calculation, i.e., a concentration-based limit, an implicit MOS was used. An implicit MOS means that conservative assumptions were built in to the TMDL and/or allocations. In this instance the listed section is expected to meet the TMDL because the permitted point source dischargers are limited to discharge concentrations below the impairment target, thereby providing additional capacity. In addition, the creek flow itself is primarily being fed by ground water at these low flows, which is believed to convey very little of the impairment.

5.2.4 Reserve Capacity

Reserve capacity is a portion of total allocation that shall accommodate future growth. A reserve capacity in this watershed was considered, but in light of the decrease in population and relative stagnancy in animal numbers, it was decided that the LA would not be held to reserve capacity. For the MS4 permits however, the land area of the city in the watershed was increased by 10 percent of the footprint of the city to account for development, though the populations of these cities have been decreasing per US Census estimates. This would also mean that current permitted volumes for WWTFs could serve the functions they were designed for and would probably not need to change significantly.

The overall population growth in the past decade for the Redwood River watershed averaged a loss of just over 5 percent. Changes in the human population should not change the load allocations provided in this Report. There is no clear trend in livestock numbers in the watershed; however livestock numbers appear to be concentrated in fewer operations.

<u>Straight Pipe Septic Systems</u>
The number of straight pipe septic systems will decrease over time, as a result of the implementation of state and local rules, ordinances, and programs. Because these systems constitute illegal discharges, they are not provided a wasteload

allocation for the impaired reaches 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 not likely to change greatly over time with negligible changes in the populations they serve. As long as current fecal coliform discharge limits are met at these facilities, the flows most likely will not impact the allocation given to other sources. The population is expected to decline; currently there is adequate treatment such that fecal coliform will not increase. Municipal WWTF currently represent a small proportion of the watershed loads and are regulated through NPDES permits. Under these permits, WWTFs must discharge below the standard of 200 cfu/100ml.

Municipal Separate Storm Sewer Systems

Expansion of the current MS4 community in the watershed is not likely to take place, because of the declining population trend in the counties. That being said, values used to account for MS4 permitting in this study have been purposefully over estimated to account for development though the populations of these cities appear to be decreasing.

Livestock

The other major source of fecal coliform in the watershed, besides human, is livestock. While there have been changes in the sizes and types of feedlots, 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 feedlots themselves to land application practices may be warranted in the future. If growth in livestock 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 in the watershed.

For the above reasons, no explicit adjustments were made to the wasteload or load allocations 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.

Table 5.03 presents the resulting TMDL (WLA+LA) and MOS for the Redwood River impaired reach based on the five flow regimes. The values expressed are in total organisms per day. For each of the five flow regimes, the monthly flow volume was multiplied by the water quality standard of 200 organisms/100 ml.

Table 5.03: TDLC for the Redwood River at USGS Station #05316500

Flow Condition	Allocation *	MOS*	TDLC *
High	2690.9	1924.8	4615.7
Moist	474.6	552.9	1027.5
Mid	205.5	112.5	318.0
Dry	32.8	65.1	97.9
Low	0.3	15.4	15.7

*Values expressed in billions of organisms per day

Table 5.03 is not meant to represent the final loading numbers for the Redwood River but is the basis for which TDLC values are broken down into flow regimes. TDLC values for reach 07020006-501 is extrapolated from the calculated values at the USGS site as a ratio as referenced in Table 5.04. Several of the fecal coliform impaired reaches did not have sufficient flow monitoring data. To estimate flow at the ends of the listed reaches it was assumed that the flow at those reaches was proportional to the USGS gage station near Redwood Falls based on respective drainage areas represented. For example, the Clear Creek impaired reach drainage area is 13.24 percent of the drainage area monitored by the Redwood Falls USGS gaging station. To determine flow zones for the Clear Creek site, mean monthly flows were assumed to be 13.24 percent of the flow volumes at the Redwood Falls gauging station. Calculated flows were then checked against 12 years of measured flow data for the small stream. This check showed that the magnitudes were generally similar between the actual vs. proportionally-calculated flows; however, there were some discrepancies in timing of peak flows following significant rain events. This approach represents a valid method of determining flow values for ungaged areas of the watershed. Table 5.04 lists the ungaged sites and watershed area.

Table 5.04: Redwood River Watershed Impaired Reaches Descriptions and Watershed Areas

Reach	Description	Year listed	River Assessment Unit ID	STORET # Used for Assessment	Area of sub-watershed (sq. miles)	Percentage of Watershed Area/Area at USGS Site	Area of Redwood River Watershed
Redwood River	T111 R42W S33 west line to Threemile Cr	04	07020006-502B	S003-702	258.8	100.00%^	36.7%
Redwood River	T111 R42W S33 west line to Threemile Cr	04	07020006-502A	S001-199	289.2	111.75%^	41.0%
Redwood River	Clear Cr to Redwood Lk	06	07020006-509	S001-679	630.0	100.00%#	89.3%
Redwood River	Ramsey Cr to Minnesota R	94	07020006-501	S002-193	705.1	111.92%#	100%
Three Mile Creek	Headwaters to Redwood R	06	07020006-504	S002-313	121.9	19.35%#	17.3%
Redwood River	Headwaters to Coon Creek	Not Listed	07020006-505	S000-696	229.4	88.64%^	32.5%
Tyler Creek*	Headwaters to Redwood R	Not Listed	07020006-512	S002-315	51.2	19.78%^	7.3%
Clear Creek	Headwaters to Redwood R	Not Listed	07020006-506	S002-311	83.4	13.24%#	11.8%
Coon Creek	Lake Benton to Redwood R	Not Listed	07020006-511	S002-314	96.1	37.13%^	13.6%

* Uses the Class 7: Limited Resource Value water quality standard of 1,000 cfu/100mL standard
[#] Uses the USGS site above Lake Redwood near Redwood Falls (Site #05316500)
[^] Uses the USGS site near Marshall (Site #05315000)

5.3 TMDL Allocations for Individual Impaired Reaches

In Sections 5.3.1 through 5.3.9 below, TMDL allocations are provided for the individual impaired reaches. Please note the following explanations and clarifications for portions of presented information in these sections:

- Tables showing permitted wastewater treatment facilities, livestock facilities, and MS4 communities that are unique to the sub-watershed described in the section. These values along with any values upstream of the sub-watershed to calculate waste load allocations for the impaired reach of the sub-watershed.

- Calculations for the TMDL, (WLA, LA, and MOS) consider the total drainage area represented by the end of each listed reach. As such, listed reaches lower in the watershed will have allocations for the same sources covered in listed reaches upstream. In terms of actual load contributions, some upstream sources may not be as significant as those sources within or close to the downstream listed reaches due to the potential for die-off of bacteria as waters travel downstream in the watershed.

- Tables showing the fecal coliform loading capacities and allocations are provided and illustrate the TMDL, (WLA, LA and MOS) for the midpoints of five flow zones. (Due to rounding the (WLA, LA, and MOS) may not exactly add up to the loading capacities for some flow zones.)

- An estimated reduction percentage is provided for each listed reach (where sufficient data are available) to indicate how much of a decrease from geometric means are needed to meet the water quality standard (i.e., 200 organisms/100 ml). The calculation is as follows:

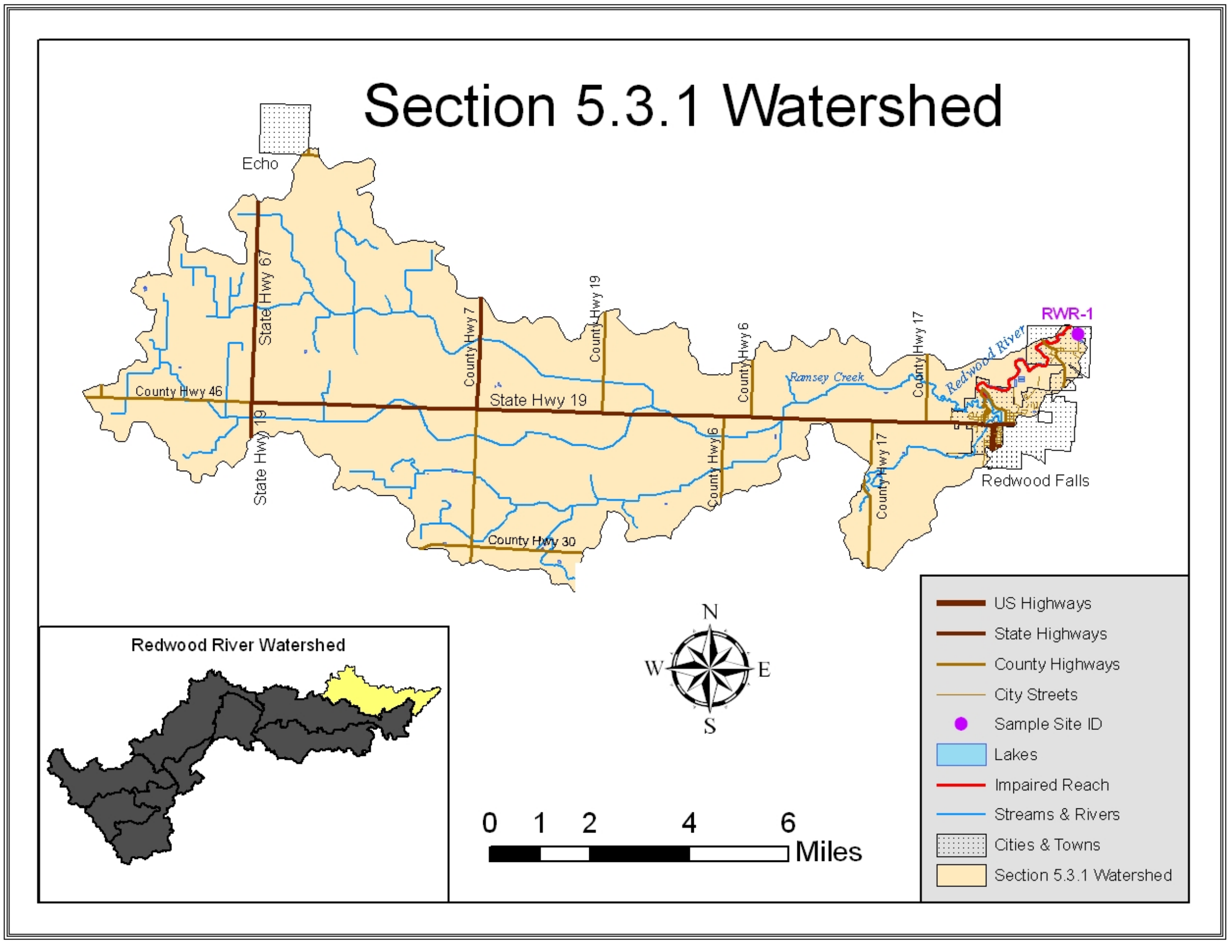
  (geometric mean – 200) / geometric mean)

  The resulting reduction percentage is only intended as a rough approximation, as it does not account for flow and since bacterial data is inherently highly variable. Sample sizes are low and vary. This contributes uncertainty in the percent reduction calculations. Reduction percentages are not a required element of a TMDL (and do not supersede the allocations provided), but are included here to provide a starting point to assess the magnitude of the effort needed in the watershed to achieve the standard.

5.3.1 Redwood River; Ramsey Creek to Minnesota River (AUID: 07020006-501)

This reach of the Redwood River from Ramsey Creek to the Minnesota River (Figure 5.3.1A) was added to the Section 303(d) Clean Water Act impaired waters list in 1994. The primary source of data that led to this listing was the MPCA long-term monitoring program. The sampling site is RWR-1 (STORET# S000-299). The drainage area to the downstream end of this impaired reach is 705 square miles. This represents 100 percent of the Redwood River watershed area.

Figure 5.3.1A: Redwood River; Ramsey Creek to Minnesota River



Land use in this reach is 92.5 percent cultivated, 3.2 percent forest, 2.2 percent urban/residential, 1.6 percent grass and <1 percent is water/wetland or other. Parts of Redwood Falls and North Redwood are in this sub-watershed of the Redwood River watershed. Their permitted wastewater treatment facilities do not enter the Redwood River system. Redwood Falls has an MS4 NPDES stormwater permit (Table 5.3.1B). The MS4 permit covers approximately 2.72 square miles, or .38 percent of the entire watershed to this point, and allows for growth. There is no urban population serviced by WWTFs in this reach and the rural population, serviced by SSTS, is approximately 531, or 199 homes. Of these about 134 systems are considered failing. There is one NPDES permitted animal feeding operation in the sub-watershed (Table 5.3.1C). The number of animal units at locations without NPDES permits for dairy, beef, swine, poultry, and sheep in this reach are 192, 169, 2541, 174, and 20 respectively. Animal units (AUs) without NPDES permits account for 84.6% of all AUs and NPDES permitted facilities have 15.4% of all AUs in this reach.

Table 5.3.1D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the USGS gage site station (USGS #05316500) on the Redwood River above Lake Redwood. Substantial reductions in fecal coliform loading from straight-pipe septic systems, and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in Appendix B.

Table 5.3.1A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
none			

Table 5.3.1B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Permit Number	Population Estimate	Category
Redwood Falls	MS400236	5,459	Designated by rule: >5,000 populations and within ½ mile of impaired waters. 2.72 square miles of the watershed

Table 5.3.1C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Alpha Acres	127-50018	1800 Swine – 55 lbs. or more – 564 AU

Table 5.3.1D: Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; Ramsey Creek to Minnesota River (AUID: 07020006-501)

Drainage area for listed reach (sq mi): 705.1
Flow gage used: Redwood River near Redwood Falls - USGS 05316500
Land Area MS4 Urban (%): 1.56
Total WWTF Flow (mgd): 4.964**

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	5165.8	1149.9	355.9	109.5	17.5
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	37.6	37.6	37.6	37.6	*
Communities Subject to MS4 NPDES Requirements	46.4	7.7	3.0	*	*
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	2784.3	628.2	237.2	*	*
Margin of Safety	2346.9	624.8	129.4	*Implicit*	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.7%	3.3%	10.6%	34.3%	*
Communities Subject to MS4 NPDES Requirements	0.9%	0.7%	0.8%	*	*
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	56.7%	42.3%	53.2%	*	*
Margin of Safety	41.7%	53.8%	35.4%	*Implicit*	*Implicit*

* See Section 5.2 ** Includes WWTF in upstream reaches that drain to this TMDL section

Reductions Needed by Month

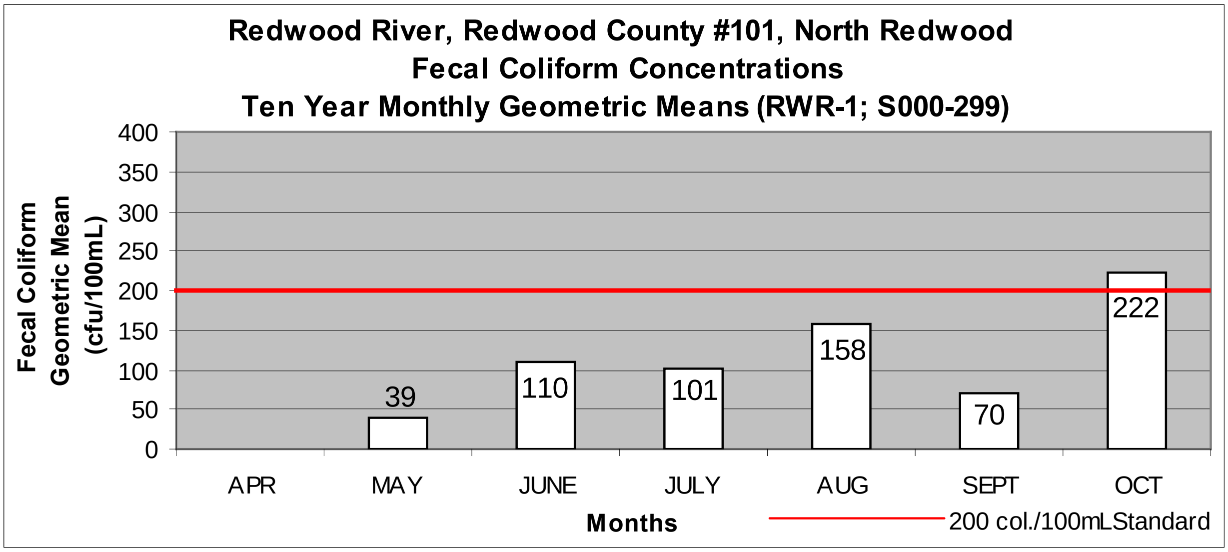
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1997 through 2006
Samples Collected: 81

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.1B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RWR-1 (S000-299)

Month	**Required Reduction**
April	Inadequate Data
May	None Required
June	None Required
July	None Required
August	None Required
September	None Required
October	09.91%

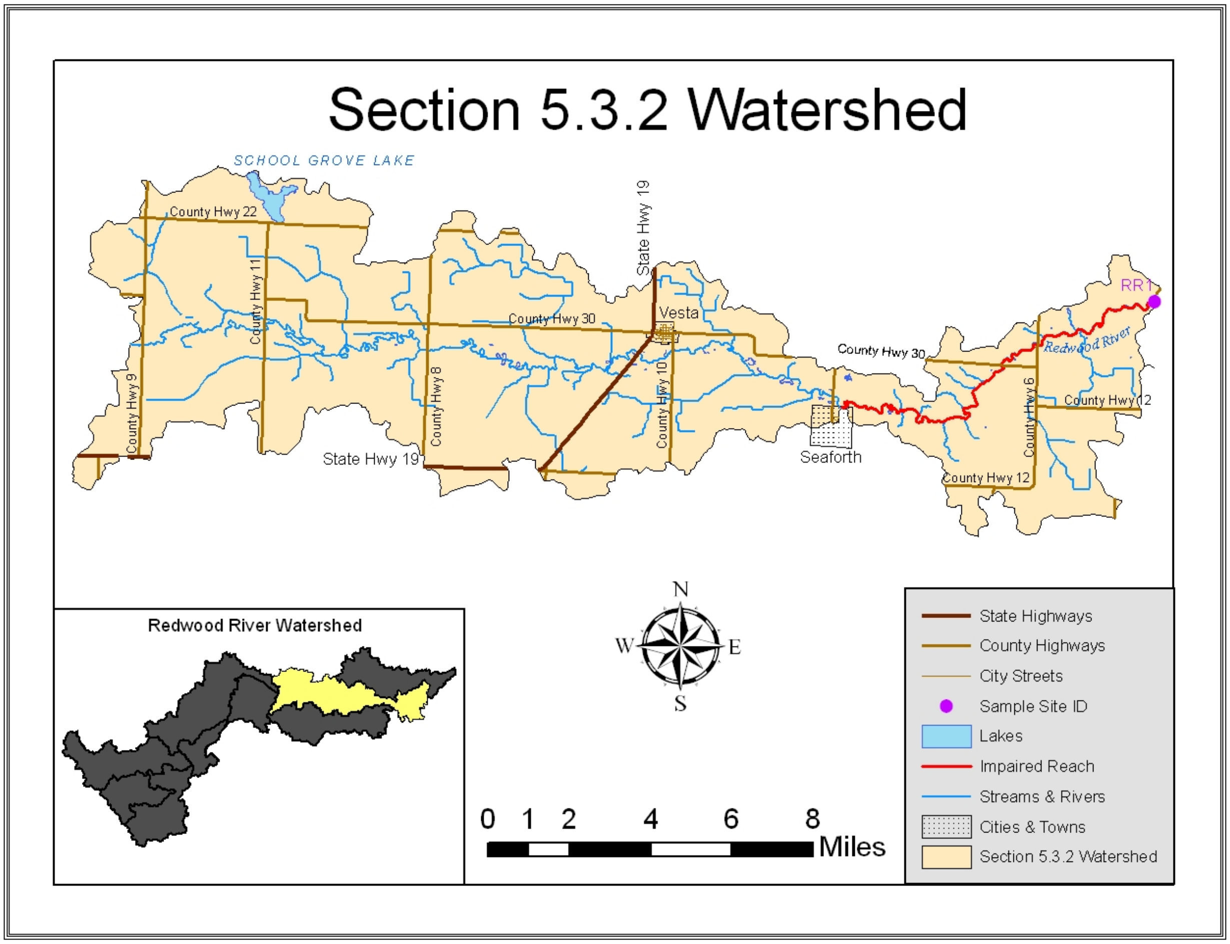
Figure 5.3.1B: (RWR-1) Monthly Geometric Mean Fecal Coliform Concentrations (1997-2006)



5.3.2 Redwood River; Clear Creek to Redwood Lake (AUID: 07020006-509)

The Redwood River reach from Clear Creek to Redwood Lake (Figure 5.3.2A) was added to the Section 303(d) Clean Water Act impaired waters list in 2006. The primary source of data that led to this listing was from the Redwood River Watershed Project (RRWP) Phase I Redwood River Clean Water Partnership (CWP). The sampling site is RR1 (STORET# S001-679). The drainage area to the downstream end of this impaired reach is 630 square miles.

Figure 5.3.2A: Redwood River; Clear Creek to Redwood Lake



Land use in the reach upstream of the impairment is 91.1 percent cultivated 3.9 percent grass, 2.6 percent forest, 0.8 percent water/wetlands, and 1.4 percent urban. This reach contains one community, Vesta, served by a permitted wastewater treatment facility (Table 5.3.2A), and there are no communities requiring MS4 permits (Table 5.3.2B). The rural population, served by SSTS, is approximately 868 people, or 325 homes. Of these, about 224 septic systems are considered failing systems. There are three livestock facilities with issued NPDES permits (Table 5.3.2C).The number of animal units at locations without NPDES permits for dairy, beef, swine, poultry, sheep, horses and miscellaneous (goat, fox & fowl) in the sub-watershed are 650, 6374, 5605, 222, 102, 8 and 25 respectively. Animal units (AUs) without NPDES permits account for 76.6% of all AUs and NPDES permitted facilities have 23.4% of all AUs in this reach.

Table 5.3.2D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the USGS gage site station (USGS #05316500) on the Redwood River above Lake Redwood. Substantial reductions in fecal coliform loading from straight-pipe septic systems, and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in Appendix B.

Table 5.3.2A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Vesta	MNG580043	0.036	0.27

Table 5.3.2B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
none		

Table 5.3.2C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Charles & Glenn Rohlik Farm	127-55073	4800 Swine – 55 lbs. or more – 1440 AU
Andrew Schiller Farm – Vesta Site	127-50087	4400 Swine – 55 lbs. or more – 1320 AU
Bruce Meier Farm	127-50004	1200 Other Cattle – 1200 AU

Table 5.3.2D: Daily Fecal Coliform Loading Capacities and Allocations – Redwood River; Clear Creek to Redwood Lake (AUID: 07020006-509)

Drainage area for listed reach (sq mi): 630.0
Flow gage used: Redwood River near Redwood Falls - USGS 05316500
Land Area MS4 Urban (%): 1.31
Total WWTF Flow (mgd): 4.964**

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	4615.7	1027.5	318.0	97.9	15.7
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	37.6	37.6	37.6	37.6	*
Communities Subject to MS4 NPDES Requirements	34.8	5.7	2.2	*	*
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	2618.6	431.3	165.7	*	*
Margin of Safety	1924.8	552.9	112.5	*Implicit*	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.8%	3.7%	11.8%	38.4%	*
Communities Subject to MS4 NPDES Requirements	0.8%	0.6%	0.7%	*	*
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	56.7%	42.0%	52.1%	*	*
Margin of Safety	41.7%	53.8%	35.4%	*Implicit*	*Implicit*

* See Section 5.2 ** Includes WWTF in upstream reaches that drain to this TMDL section

Reductions Needed by Month

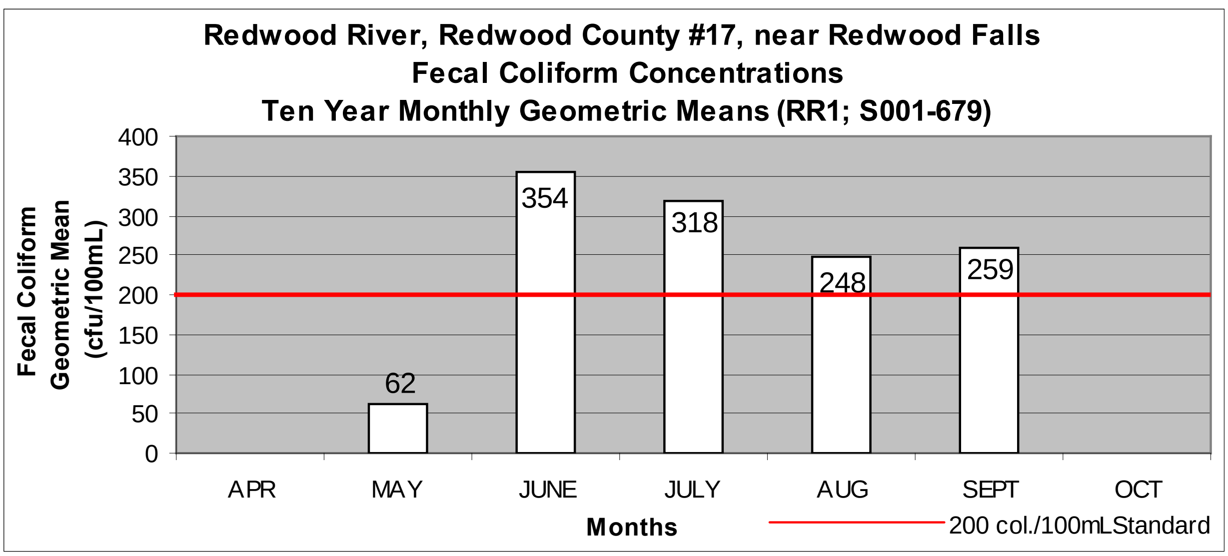
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999 through 2006
Samples Collected: 70

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.2B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RR1 (S001-679)

Month	**Required Reduction**
April	Inadequate Data
May	None Required
June	43.50%
July	37.11%
August	19.35%
September	22.78%
October	Inadequate Data

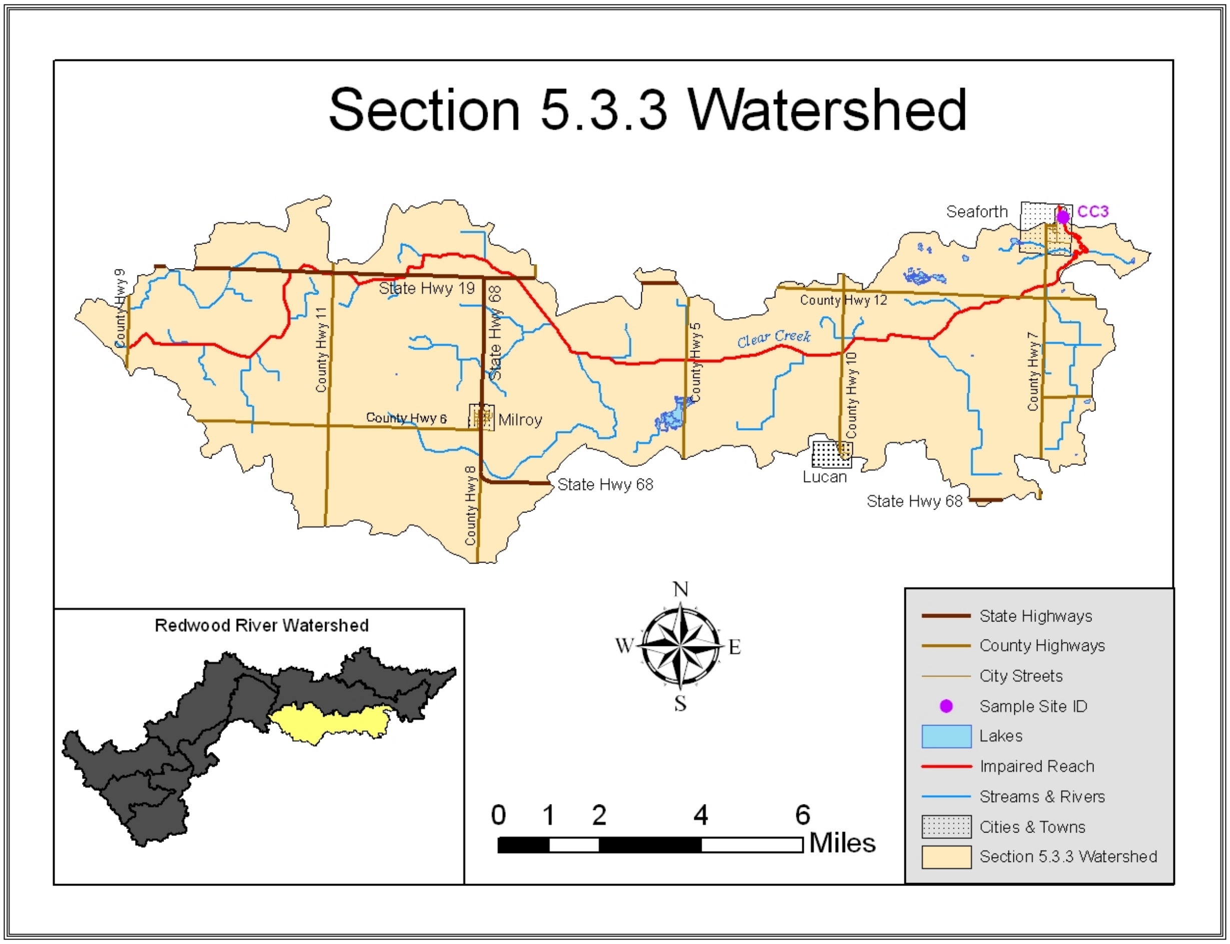
Figure 5.3.2B: (RR1) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.3 Clear Creek, Headwaters to Redwood River (AUID: 07020006-506)

Clear Creek from its headwaters to the Redwood River (Figure 5.3.3A) is not yet listed in the 303(d) Clean Water Act impaired waters list. Sampling data shows that this reach is impaired. The primary source of data that led to this listing was from the RRWP Phase I Redwood River CWP. The sampling site is CC3 (STORET# S002-311). The drainage area to the downstream end of this reach is 83.4 square miles.

Figure 5.3.3A: Clear Creek; Headwaters to Redwood River



Land use in the reach includes 94.4 percent cultivated, 1.6 percent urban, 1.5 percent grass, 1.5 percent forest and 1.0 percent water/wetlands. There is one wastewater treatment facility in the reach (Table 5.3.3A) servicing the community of Milroy. The community does not require a MS4 Stormwater permit (Table 5.3.3B). The rural population serviced by SSTS is approximately 625 people or about 234 homes. Of these approximately 162 septic systems are considered failing. One feedlot was issued a NPDES permit (Table 5.3.3C). The number of animal units at locations without NPDES permits for dairy, beef, swine, sheep, and horses in the reach are 691, 3029, 3608, 100, and 5 respectively. Animal units (AUs) without NPDES permits account for 84.7% of all AUs and NPDES permitted facilities have 15.3% of all AUs in this reach.

Table 5.3.3D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the USGS gage site station (USGS #05316500) on the Redwood River above Lake Redwood. Substantial reductions in fecal coliform loading from straight-pipe septic systems, and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in Appendix B.

Table 5.3.3A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Milroy	MN0041211	0.035	0.26

Table 5.3.3B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.3C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Jim Tauer Farm	083-65820	2300 Swine – 55 lbs. or more, 600 Other Cattle – Total 1345 AU

Table 5.3.3D: Daily Fecal Coliform Loading Capacities and Allocations – Clear Creek; Headwaters to Redwood River (AUID: 07020006-506)

Drainage area for listed reach (sq mi):	83.4
Flow gage used:	Redwood River near Redwood Falls - USGS 05316500
Land Area MS4 Urban (%):	0
Total WWTF Flow (mgd):	0.035

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	611.0	136.0	42.1	13.0	2.1
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.3	0.3	0.3	0.3	0.3
Communities Subject to MS4 NPDES Requirements	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	356.0	62.6	26.9	4.1	*
Margin of Safety	254.8	73.2	14.9	8.6	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.0%	0.2%	0.6%	2.0%	12.8%
Communities Subject to MS4 NPDES Requirements	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	58.3%	46.0%	64.0%	31.5%	*
Margin of Safety	41.7%	53.8%	35.4%	66.5%	*Implicit*

* See Section 5.2

Reductions Needed by Month

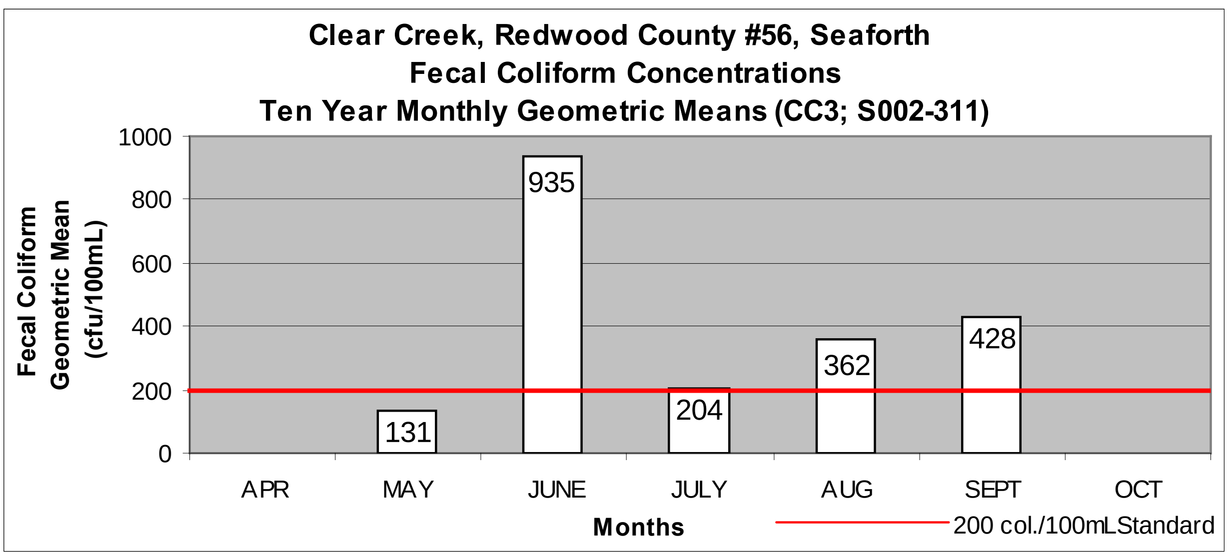
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999 through 2006
Samples Collected: 42

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.3B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

CC3 (S002-311)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	78.61%
July	01.96%
August	44.75%
September	53.27%
October	Inadequate Data

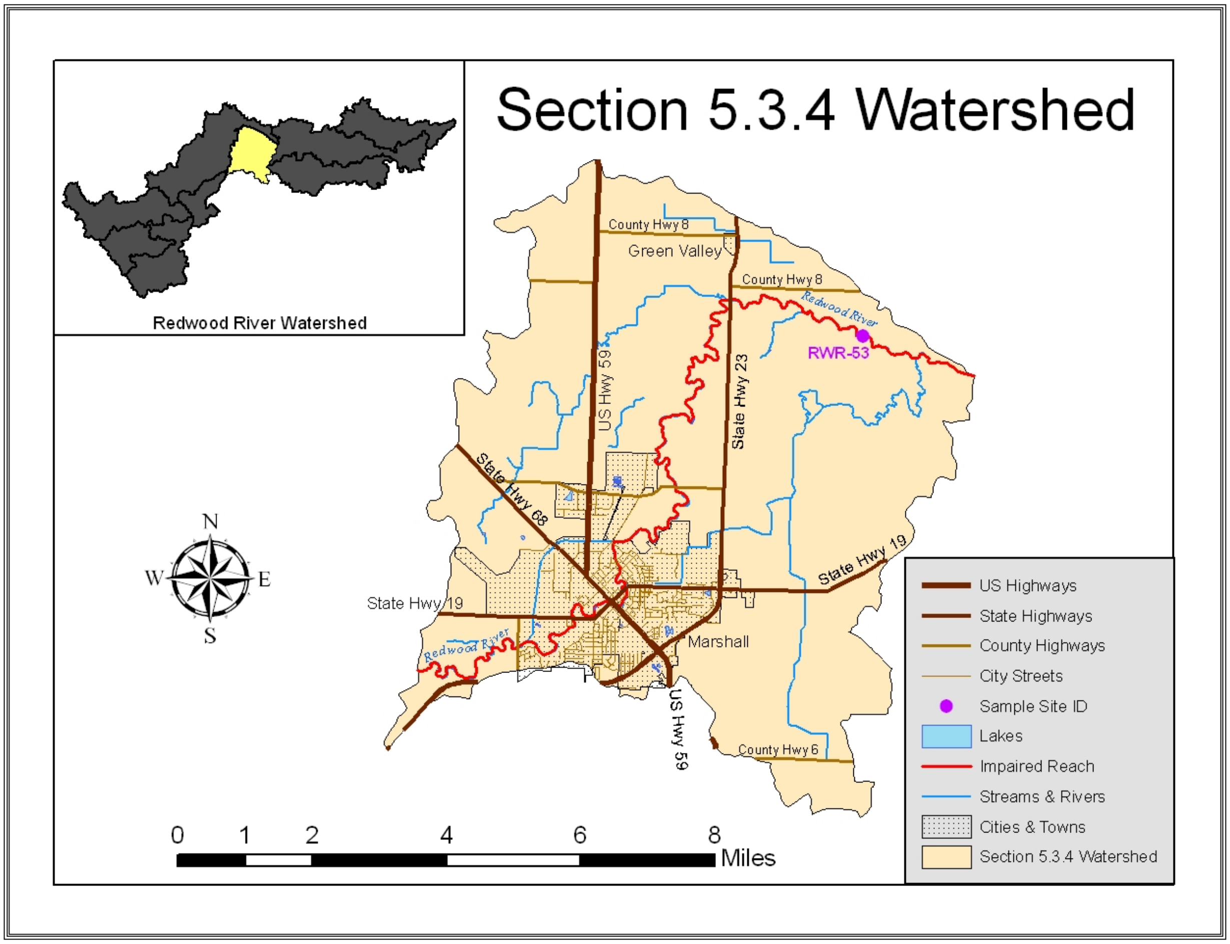
Figure 5.3.3B: (CC3) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.4 Redwood River, T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion including and below the city of Marshall) (AUID: 07020006-502A)

Redwood River from near Lynd, MN to Threemile Creek was added to the Section 303(d) Clean Water Act impaired waters list in 2004. The sampling site is RWR-53 (STORET# S001-199). The drainage area to the downstream end of this reach is 308.4 square miles. The drainage area to the sampling location is 289.2 square miles.

Figure 5.3.4A: Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion including and below the city of Marshall)



Land use in this reach is approximately 82.3 percent cultivated, 10.9 percent urban, 4.2 percent grass, 2.0 percent forest, 0.5 percent water/wetlands. There is one wastewater treatment facility in this reach (Table 5.3.4A) servicing the community of Marshall which also requires a MS4 Stormwater permit (Table 5.3.4B). The MS4 permit covers approximately 8.27 square miles, or 2.86 percent of the entire watershed to this point, and allows for growth. No feedlots were issued NPDES permits (Table 5.3.4C). The number of animal units at locations without NPDES permits for dairy, beef, swine, and horses in the sub-watershed are 712, 2642, 2110, and 8 respectively. The rural population serviced by SSTS is approximately 374 people or about 140 homes. Of these approximately 56 homes have septic systems that are considered failing.

Table 5.3.4D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the Marshall USGS flow gage (USGS #05316500). Substantial reductions in fecal coliform loading from straight-pipe septic systems and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in appendix B.

Table 5.3.4A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Marshall	MN0022179	4.5	34.07

Table 5.3.4B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Permit Number	Population Estimate	Category
Marshall	#MS400241	12,735	Designated by rule: Over 10,000 people. 8.27 square miles of the watershed

Table 5.3.4C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description

Table 5.3.4D: Daily Fecal Coliform Loading Capacities and Allocations – Redwood River, T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion including and below the city of Marshall) (AUID: 07020006-502A)

Drainage area for listed reach (sq mi): 289.2
Flow gage used: Redwood River near Marshall - USGS 05315000
Land Area MS4 Urban (%): 2.86
Total WWTF Flow (mgd): 4.856**

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	875.9	175.2	44.9	14.4	1.8
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	36.8	36.8	36.8	*	*
Communities Subject to MS4 NPDES Requirements	13.5	1.1	*	*	*
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	457.4	38.5	*	*	*
Margin of Safety	368.3	98.8	*Implicit*	*Implicit*	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	4.2%	21.0%	81.8%	*	*
Communities Subject to MS4 NPDES Requirements	1.5%	0.6%	*	*	*
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	52.2%	22.0%	*	*	*
Margin of Safety	42.1%	56.4%	*Implicit*	*Implicit*	*Implicit*

* See Section 5.2 ** Includes WWTF in upstream reaches that drain to this TMDL section

Reductions Needed by Month

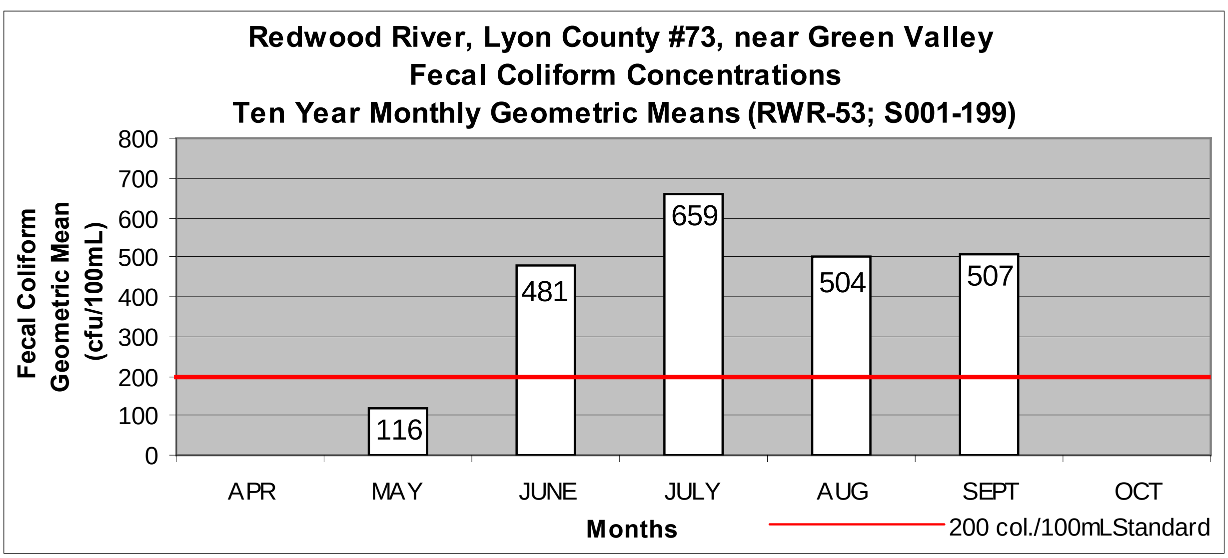
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999
Samples Collected: 25

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.4B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RWR-53 (S001-199)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	58.42%
July	69.65%
August	60.32%
September	60.55%
October	Inadequate Data

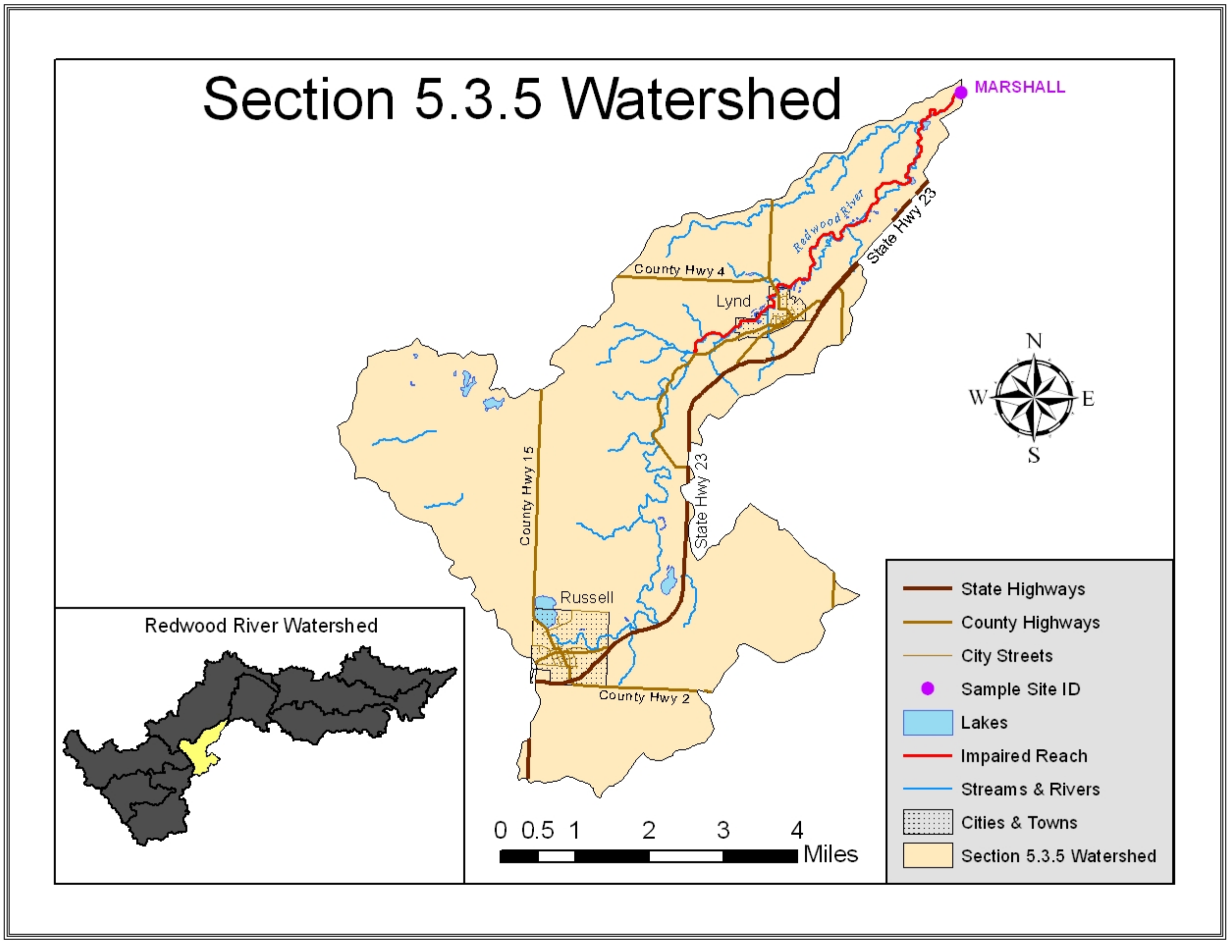
Figure 5.3.4B: (RWR-53) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.5 Redwood River, T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion excluding and above the city of Marshall) (AUID: 07020006-502B)

Redwood River from near Lynd, MN to Threemile Creek (Figure 5.3.5A) was added to the Section 303(d) Clean Water Act impaired waters list in 2004. The sampling site is Marshall USGS Site (STORET# S003-702). The drainage area to the portion of this reach above Marshall is 258.8 square miles.

Figure 5.3.5A: Redwood River; T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion excluding and above the city of Marshall)



Land use in this reach is approximately 65.0 percent cultivated, 20.6 percent grass, 9.8 percent forest, 2.5 percent urban, 1.4 percent water/wetlands and 0.65 percent other. The drainage area contains the cities of Russell and Lynd which are served by permitted wastewater treatment facilities (Table 5.3.5A). There are no communities that require an MS4 permit (Table 5.3.5B). No livestock facilities were issued NPDES permits (Table 5.3.5C). The number of animal units at locations without NPDES permits for dairy, beef, swine, sheep and poultry in this reach are 71, 740, 371, 50 and 2.5 respectively. The rural population serviced by SSTS is approximately 235 people or about 88 homes. Of these, approximately 35 septic systems are considered failing.

Table 5.3.5D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the Marshall USGS flow gage (USGS #05316500). Substantial reductions in fecal coliform loading from straight-pipe septic systems and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in appendix B.

Table 5.3.5A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Russell	MNG580062	0.084	0.64
Lynd	MNG580030	0.046	0.35

Table 5.3.5B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.5C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
None		

Table 5.3.5D: Daily Fecal Coliform Loading Capacities and Allocations – Redwood River, T111 R42W S33 west line (Lynd, MN) to Threemile Creek (portion excluding and above the city of Marshall) (AUID: 07020006-502B)

Drainage area for listed reach (sq mi): 258.8
Flow gage used: Redwood River near Marshall - USGS 05315000
Land Area MS4 Urban (%): 0
Total WWTF Flow (mgd): 0.356**

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	783.7	156.7	40.2	12.9	1.6
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	2.7	2.7	2.7	2.7	*
Communities Subject to MS4 NPDES Requirements	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	451.5	65.6	23.4	2.1	*
Margin of Safety	329.6	88.4	14.1	8.0	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.3%	1.7%	6.7%	21.0%	*
Communities Subject to MS4 NPDES Requirements	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	57.6%	41.9%	58.3%	16.5%	*
Margin of Safety	42.1%	56.4%	35.0%	62.5%	*Implicit*

* See Section 5.2 ** Includes WWTF in upstream reaches that drain to this TMDL section

Reductions Needed by Month

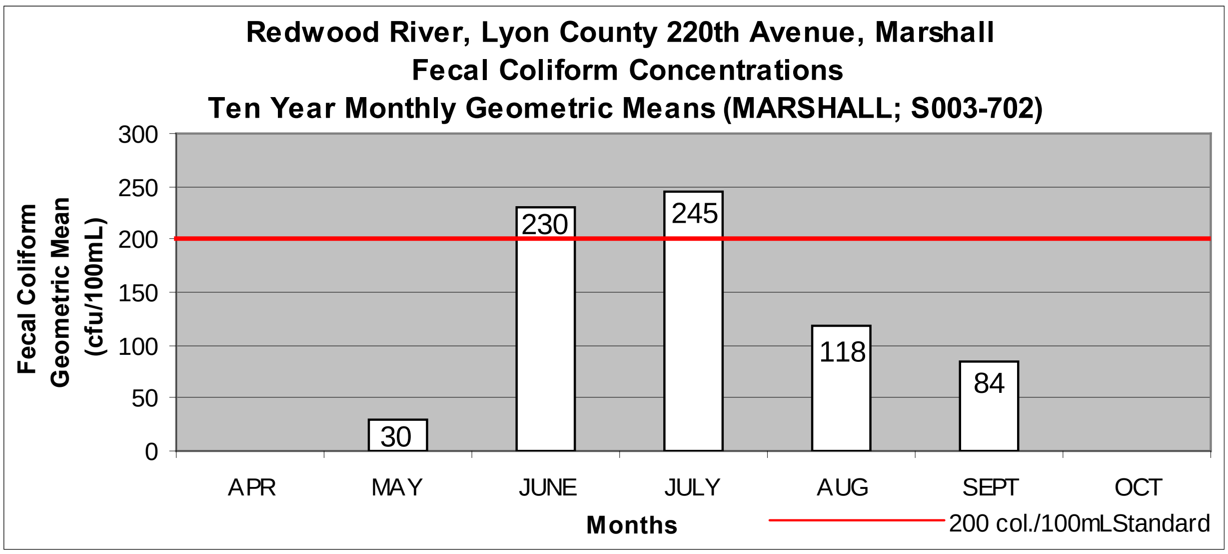
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999
Samples Collected: 25

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.5B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

MARSHALL (S003-702)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	13.04%
July	18.37%
August	None Required
September	None Required
October	Inadequate Data

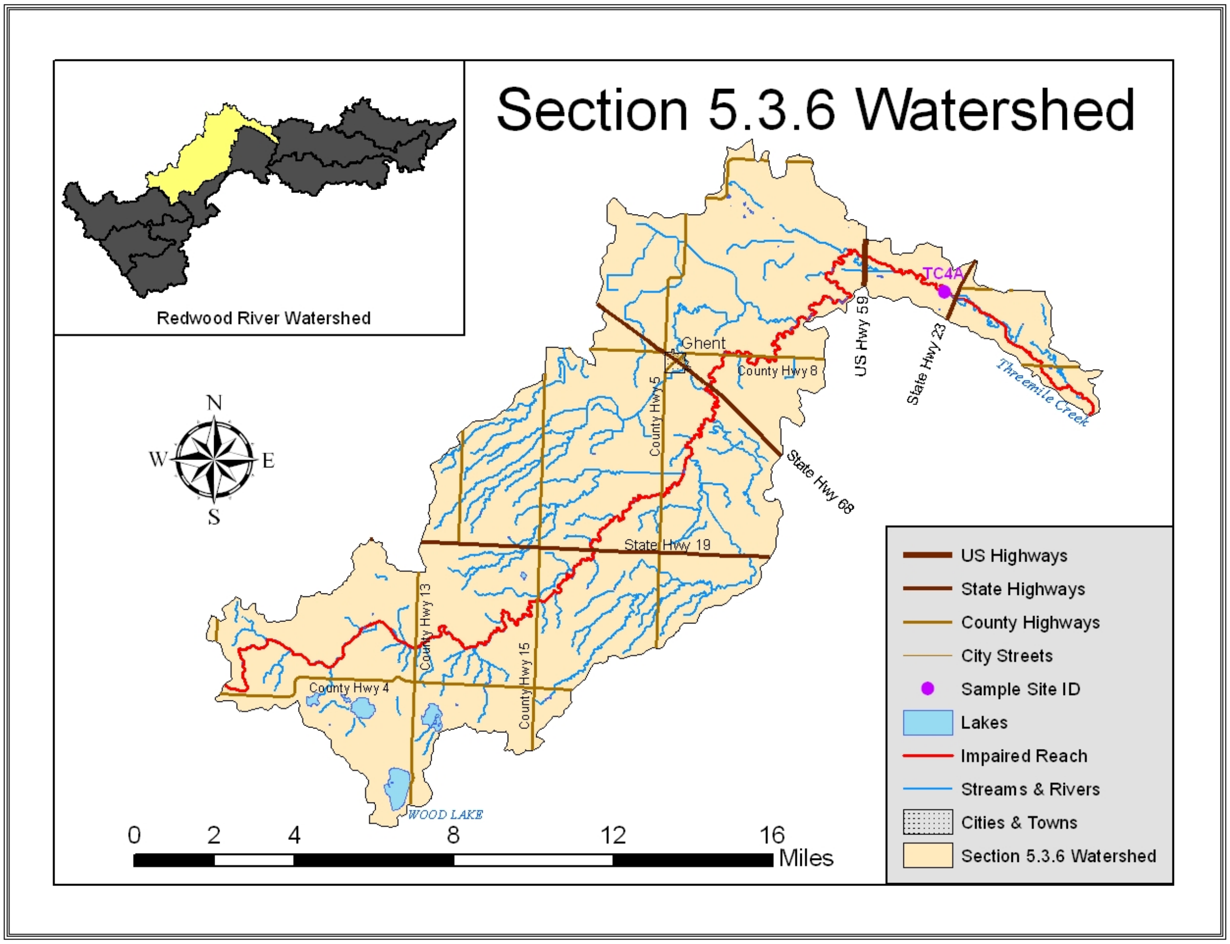
Figure 5.3.5B: (MARSHALL) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.6 Threemile Creek, Headwaters to Redwood River (AUID: 07020006-504)

Threemile Creek, Headwaters to Redwood River (Figure 5.3.6A) was added to the Section 303(d) Clean Water Act impaired waters list in 2006. The primary source of data that led to this listing was from the RRWP Phase I CWP. The sampling site is TC4A (STORET# S002-313). The drainage area to the downstream end of this reach is 121.9 square miles.

Figure 5.3.6A: Threemile Creek; Headwaters to Redwood River



Land use in this reach is approximately 86.5 percent cultivated, 8.5 percent grass, 1.9 percent forest, 1.6 percent water/wetlands and 1.5 percent urban. The drainage area contains the city of Ghent which served by a permitted wastewater treatment facilities (Table 5.3.6A), and there are no communities requiring MS4 permits (Table 5.3.6B). The rural population serviced by SSTS is approximately 916 people or about 343 homes. Of these, approximately 141 homes have septic systems that are considered failing. Three livestock facilities were issued NPDES permits (Table 5.3.6C). The number of animal units at locations without NPDES permits for dairy, beef, swine, poultry, horse and sheep in this reach are 507, 10751, 6565, 721, 36 and 10 respectively. Animal units (AUs) without NPDES permits account for 86.0% of all AUs and NPDES permitted facilities have 14.0% of all AUs in this reach.

Table 5.3.6D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the USGS gage site station (USGS #05316500) on the Redwood River above Lake Redwood. Substantial reductions in fecal coliform loading from straight-pipe septic systems, and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in Appendix B.

Table 5.3.6A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Ghent	MN0039730	0.037	0.28

Table 5.3.6B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.6C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Grandview Farms Inc.	083-60023	180,000 Turkeys – 1680 AU
Dieken Inc.	083-50016	68,500 Turkeys – 858 AU
Robert Buysee Farm	083-89076	1600 Swine – 55 lbs. or more – 480 AU

Table 5.3.6D: Daily Fecal Coliform Loading Capacities and Allocations – Threemile Creek, Headwaters to Redwood River (AUID: 07020006-504)

Drainage area for listed reach (sq mi): 121.9
Flow gage used: Redwood River near Redwood Falls - USGS 05316500
Land Area MS4 Urban (%): 0
Total WWTF Flow (mgd): 0.037

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	893.1	198.8	61.5	18.9	3.0
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.3	0.3	0.3	0.3	0.3
Communities Subject to MS4 NPDES Requirements	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	520.4	91.5	39.5	6.1	*
Margin of Safety	372.4	107.0	21.8	12.6	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.0%	0.1%	0.5%	1.6%	9.7%
Communities Subject to MS4 NPDES Requirements	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	58.3%	46.0%	64.1%	31.9%	*
Margin of Safety	41.7%	53.8%	35.4%	66.5%	*Implicit*

* See Section 5.2

Reductions Needed by Month

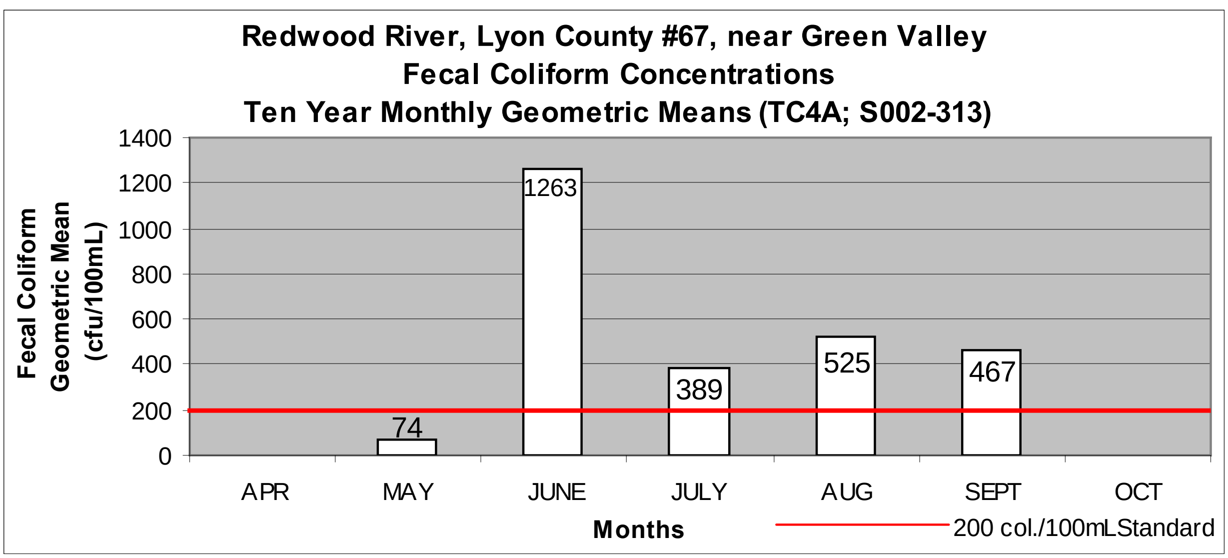
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999-2006
Samples Collected: 43

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.6B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

TC4A (S002-313)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	84.16%
July	48.59%
August	61.90%
September	57.17%
October	Inadequate Data

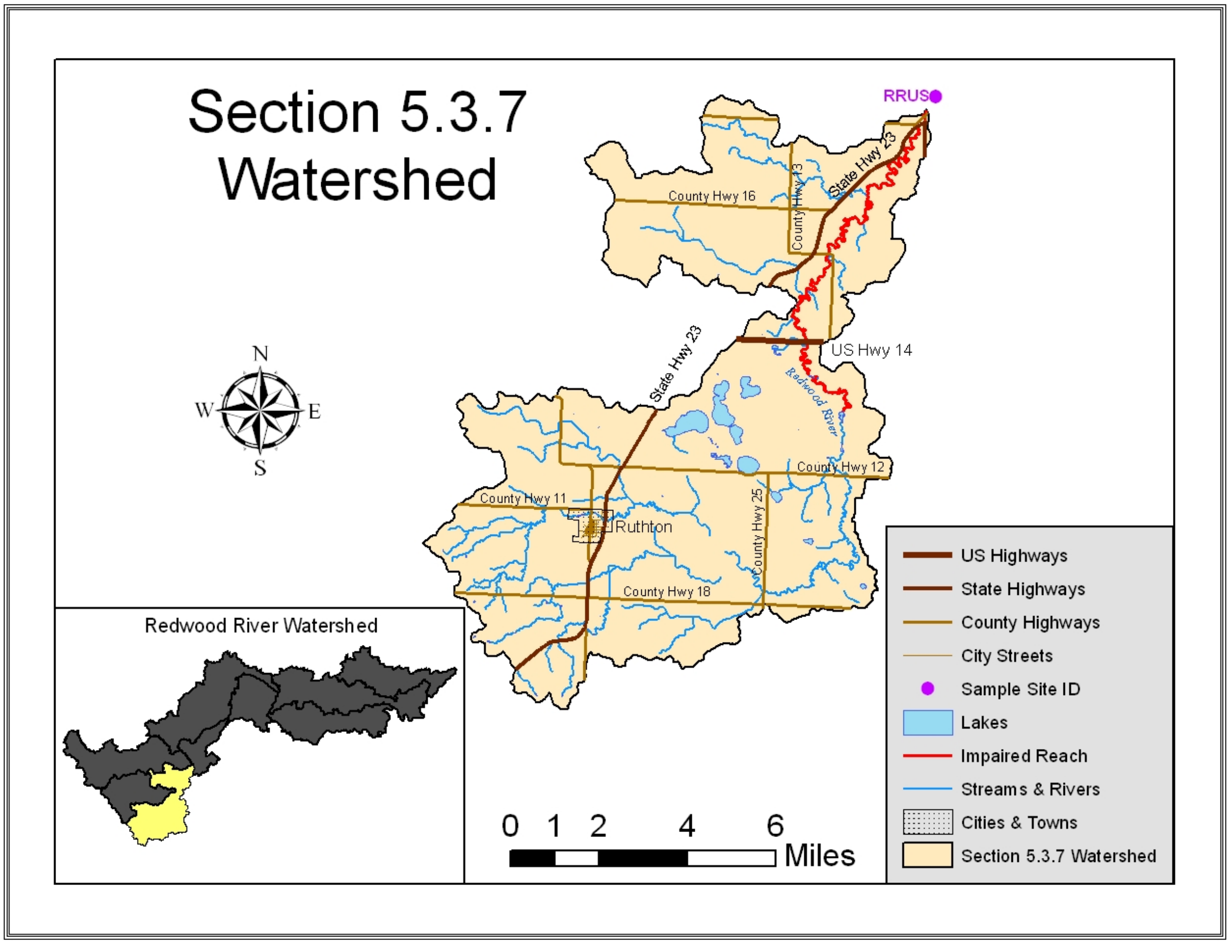
Figure 5.3.6B: (TC4A) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.7 Redwood River, Headwaters to Coon Creek (AUID: 07020006-505)

Redwood River, headwaters to Coon Creek (Figure 5.3.7A) is not currently listed on the Section 303(d) Clean Water Act impaired waters list. Sampling data shows that this reach is impaired. The primary source of data that led to this listing was from the RRWP Phase I Redwood River CWP. The sampling site is RRUS in the Redwood River CWP Report (STORET# S000-696). The drainage area to the sampling location at the end of this reach is 229.4 square miles.

Figure 5.3.7A: Redwood River; Headwaters to Coon Creek



Land use in this reach is approximately 82.1 percent cultivated, 11.9 percent grass, 2.5 percent water/wetlands, 1.9 percent forest and 1.5 percent urban. The drainage area contains Ruthton which is served by a permitted wastewater treatment facility (Table 5.3.7A). There are no communities in this reach requiring MS4 permits (Table 5.3.7B). The rural population serviced by SSTS is approximately 620 people or about 232 homes. Of these, approximately 69 homes have septic systems that are considered failing. One livestock facility was issued a NPDES permit (Table 5.3.7C). The number of animal units at locations without NPDES permits for dairy, beef, swine, sheep and horse in this reach are 1152, 3349, 2157, 108 and 103 respectively. Animal units (AUs) without NPDES permits account for 85.1% of all AUs and NPDES permitted facilities have 14.9% of all AUs in this reach.

Table 5.3.7D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the Marshall USGS flow gage (USGS #05316500). Substantial reductions in fecal coliform loading from straight-pipe septic systems and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in appendix B.

Table 5.3.7A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Ruthton	MN0049654	0.051	0.39

Table 5.3.7B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.7C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Norgaard Family Farms	081-87296	4000 Swine – 55 lbs. or more – 1200 AU

Table 5.3.7D: Daily Fecal Coliform Loading Capacities and Allocations – Redwood River, Headwaters to Coon Creek (AUID: 07020006-505)

Drainage area for listed reach (sq mi): 229.4
Flow gage used: Redwood River near Marshall - USGS 05315000
Land Area MS4 Urban (%): 0
Total WWTF Flow (mgd): 0.226**

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	694.7	138.9	35.6	11.4	1.5
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	1.7	1.7	1.7	1.7	*
Communities Subject to MS4 NPDES Requirements	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	400.9	58.9	21.4	2.6	*
Margin of Safety	292.1	78.4	12.5	7.1	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.2%	1.2%	4.8%	15.0%	*
Communities Subject to MS4 NPDES Requirements	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	57.7%	42.4%	60.2%	22.5%	*
Margin of Safety	42.1%	56.4%	35.0%	62.5%	*Implicit*

* See Section 5.2 ** Includes WWTF in upstream reaches that drain to this TMDL section

Reductions Needed by Month

Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999-2006
Samples Collected: 52

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.7B and Figure 5.3.7C) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RRUS (S000-696)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	79.36%
July	44.13%
August	Inadequate Data
September	Inadequate Data
October	Inadequate Data

RUSSELL (S003-703)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	54.85%
July	46.81%
August	None Required
September	37.30%
October	Inadequate Data

Figure 5.3.7B: (RRUS) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)

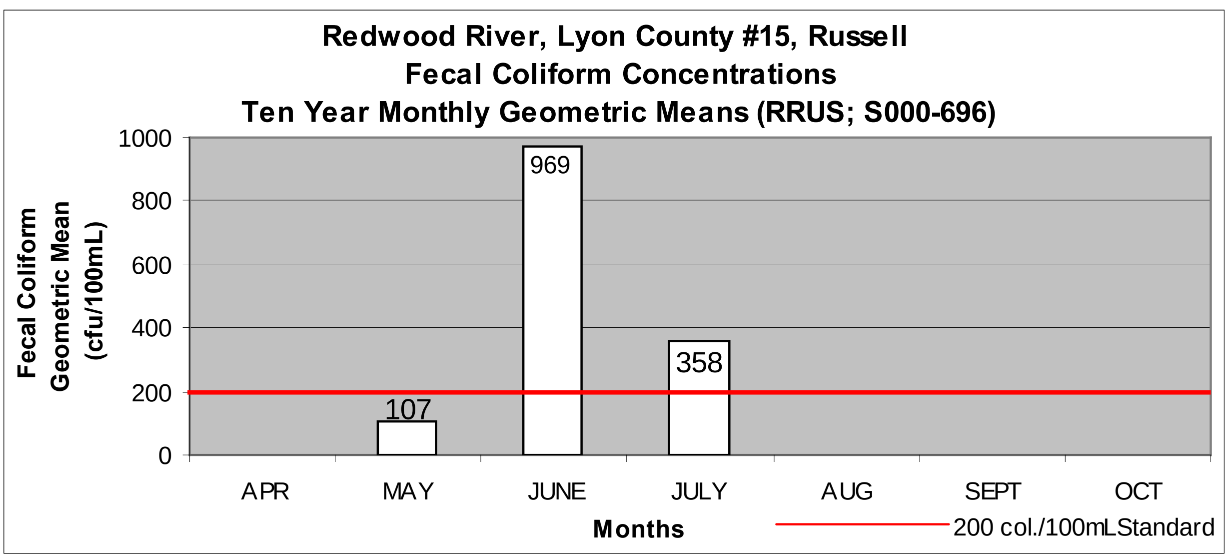
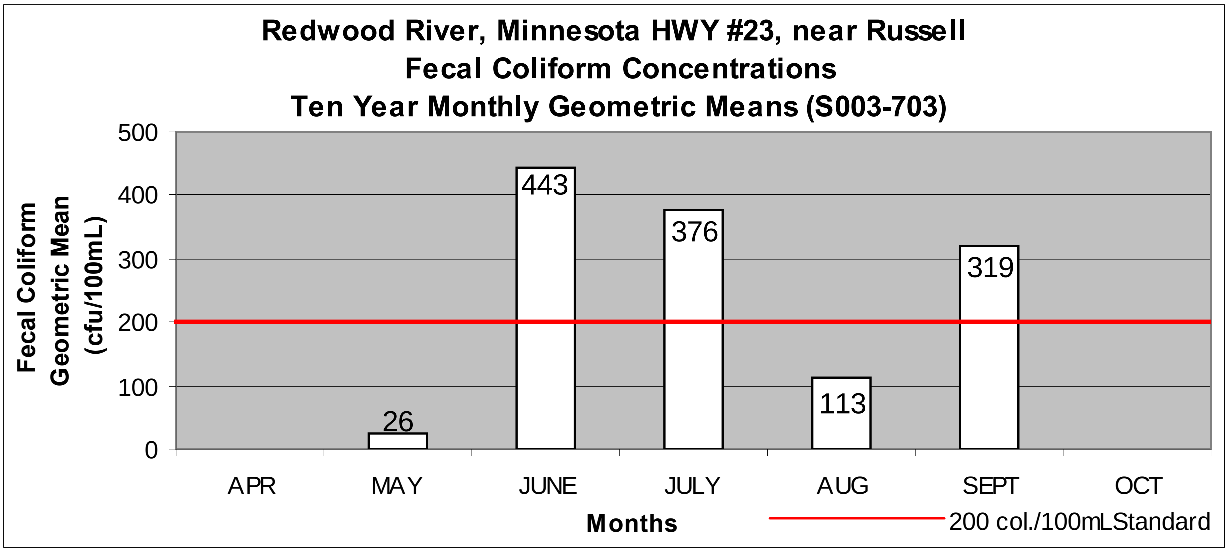


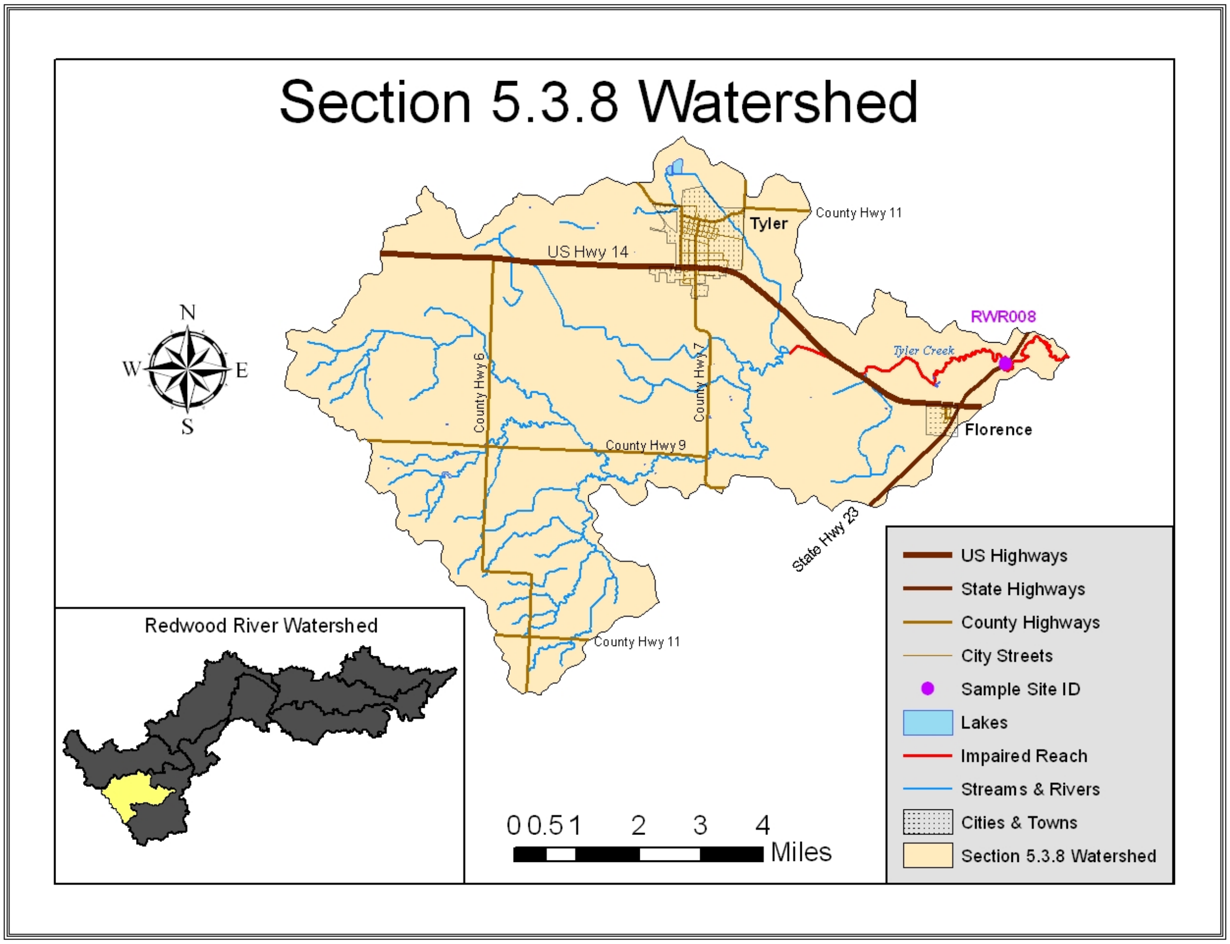
Figure 5.3.7C: (RUSSELL) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.8 Tyler Creek Headwaters to Redwood River (AUID: 07020006-512)

Tyler Creek, Headwaters to Redwood River (Figure 5.3.8A) has not yet been added to the Section 303(d) Clean Water Act impaired waters list. The primary source of data that led to this listing was from the MPCA Water Assessment project of 1999. The sampling site is RWR008 (STORET# S002-315). Tyler Creek has been assigned as Class 7 waters, which means it is held to a 1000 organism per 100mL standard. Load allocation in this section reflects a higher capacity per volume than in other reaches in this Report. The drainage area to the downstream end of this reach is 51.2 square miles.

Figure 5.3.8A: Tyler Creek; Headwaters to Redwood River



Land use in this reach is approximately 83.2 percent cultivated, 10.9 percent grass, 3.3 percent urban, 2.0 percent forest and 0.6 percent water/wetlands. There is a wastewater treatment facility in this reach servicing the community of Tyler (Table 5.3.8A). These communities do not require a MS4 Stormwater permit (Table 5.3.8B). The urban population serviced by WWTFs is approximately 206. The rural population serviced by SSTS is approximately 363 people or about 136 homes. Of these, approximately 79 homes have septic systems that are considered failing. One feedlot was issued a NPDES permit (Table 5.3.8C). The number of animal units at locations without NPDES permits for dairy, beef, swine, sheep, horses and buffalo in this reach are 1453, 3901, 1799, 664, 16 and 10 respectively. Animal units (AUs) without NPDES permits account for 85.5% of all AUs and NPDES permitted facilities have 14.5% of all AUs in this reach.

Table 5.3.8D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the Marshall USGS flow gage (USGS #05316500). Substantial reductions in fecal coliform loading from straight-pipe septic systems and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in appendix B.

Table 5.3.8A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
Tyler	MN0022039	0.175	1.32

Table 5.3.8B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.8C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
Donald L. Buhl Farm	081-50002	4000 Swine – 55 lbs. or more – 1335 AU

Table 5.3.8D: Daily Fecal Coliform Loading Capacities and Allocations – Tyler Creek, Headwaters to Redwood River (AUID: 07020006-512)

Drainage area for listed reach (sq mi): 51.2
Flow gage used: Redwood River near Marshall - USGS 05315000
Land Area MS4 Urban (%): 0
Total WWTF Flow (mgd): 0.175

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	775.4	155.1	39.8	12.7	1.6
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	1.3	1.3	1.3	1.3	1.3
Communities Subject to MS4 NPDES Requirements	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	448.0	66.3	24.5	3.4	*
Margin of Safety	326.1	87.5	13.9	8.0	*Implicit*
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.2%	0.9%	3.4%	10.6%	82.5%
Communities Subject to MS4 NPDES Requirements	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	57.8%	42.7%	61.6%	26.9%	*
Margin of Safety	42.1%	56.4%	35.0%	62.5%	*Implicit*

* See section 5.2

Note: These are "CLASS 7" waters and are held to a 1000fcu's / 100mL standard.
Loads are calculated as such. Class 7 waters were not assessed by MPCA but will be in 2010

Reductions Needed by Month

Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999
Samples Collected: 25

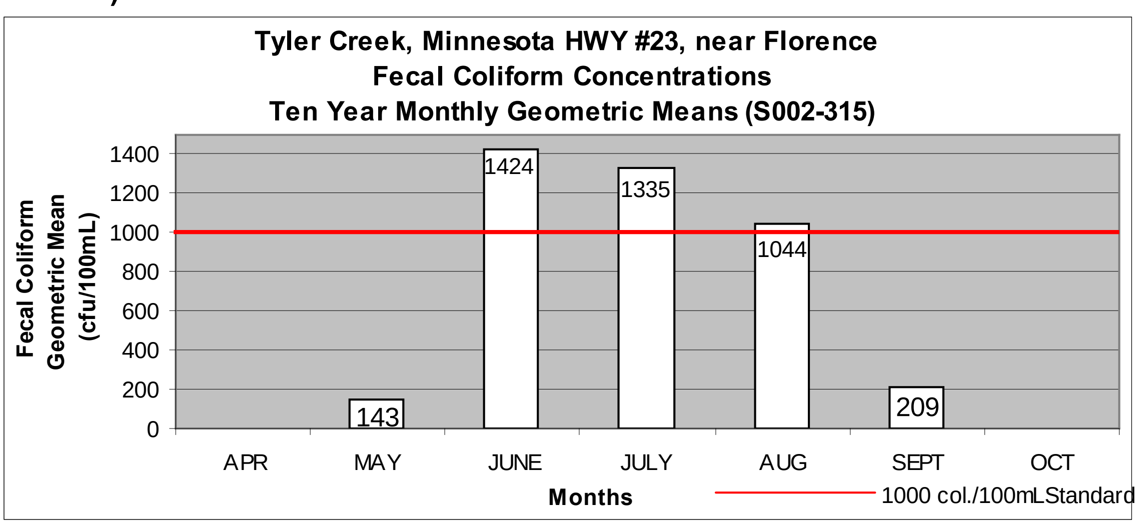
The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.8B) that would be required to meet the 1000 cfu/100 ml water quality standard. This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RWR008 (S002-315)

Month	**Required Reduction**
April	Inadequate Data
May	None Required
June	29.78%
July	25.09%
August	04.21%
September	None Required
October	Inadequate Data

This site is not included on the 2008 TMDL list as these are “Class 7” waters. “Class 7” waters will be assessed by MPCA starting in 2010. Five samples per month were taken in 2007 and would exceed the chronic standard. This report was written based on the 2006 303(d) list. This site will be listed for 2010.

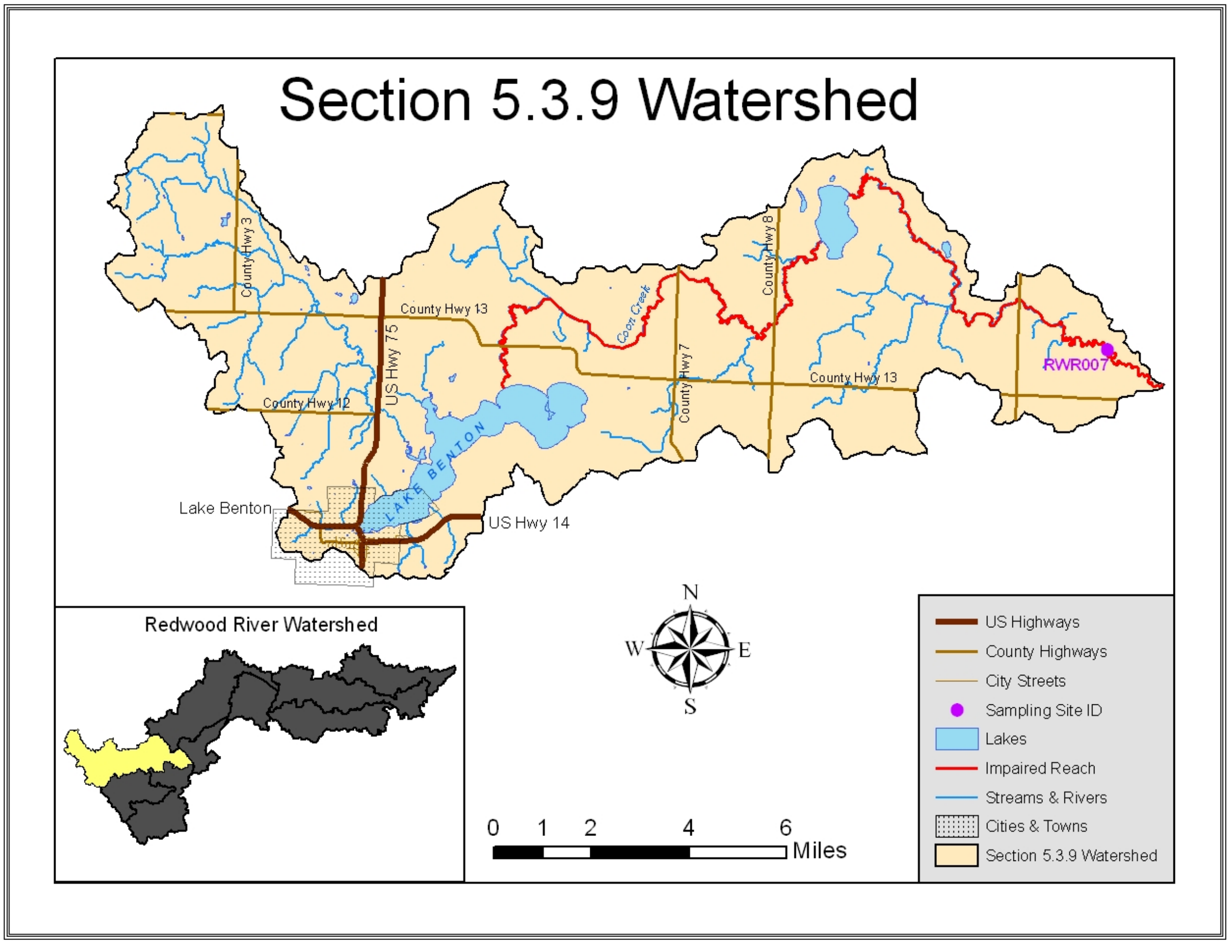
Figure 5.3.8B: (RWR008) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



5.3.9 Coon Creek, Lake Benton to Redwood River (AUID: 07020006-511)

Coon Creek, from Lake Benton to the Redwood River (Figure 5.3.9A) has not yet been added to the Section 303(d) Clean Water Act impaired waters list. The primary source of data that led to this listing was from the RRWP Phase I CWP. The sampling site is RWR007 (STORET# S002-314). The drainage area to the downstream end of this reach, including Norwegian Creek and Lake Benton, is 96.1 square miles.

Figure 5.3.9A: Coon Creek; Lake Benton to Redwood River



Land use in this reach is approximately 76.3 percent cultivated, 11.9 percent grass, 7.2 percent water/wetlands, 2.6 percent forest and 1.9 percent urban. There are no wastewater treatment facilities in this reach (Table 5.3.9A) or any communities that require an MS4 Stormwater permit (Table 5.3.9B). The urban population serviced by WWTFs is approximately 206. The rural population serviced by SSTS is approximately 670 people or about 251 homes. Of these, approximately 151 septic systems are considered failing. One feedlot was issued a NPDES permit (Table 5.3.9C). The number of animal units at locations without NPDES permits for dairy, beef, swine, sheep, and horses in this reach are 1073, 4180, 1160, 296 and 51 respectively. Animal units (AUs) without NPDES permits account for 87.5% of all AUs and NPDES permitted facilities have 12.5% of all AUs in this reach.

Table 5.3.9D describes the average daily fecal coliform loading capacities for this reach to achieve water quality standards, as well as the component wasteload allocations, load allocations, and margin of safety. The loading capacities for five flow zones were developed using flow data from the Marshall USGS flow gage (USGS #05316500). Substantial reductions in fecal coliform loading from straight-pipe septic systems and a variety of nonpoint sources will likely be required to meet the allocations. The flow duration curve for this reach is in appendix B.

Table 5.3.9A: Wastewater Treatment Facilities

Name	Permit Number	Discharge (mgd)	WLA (billions/day)
None			

Table 5.3.9B: Permitted Municipal Separate Storm Sewer System (MS4) Communities

Community	Population Estimate	Category
None		

Table 5.3.9C: Livestock Facilities with NPDES Permits

Facility	ID Number	Description
David & Karen Keifer Farm	083-50005	3230 Swine – 55 lbs. or more – 969 AU

Table 5.3.9D: Daily Fecal Coliform Loading Capacities and Allocations – Coon Creek, Lake Benton to Redwood River (AUID: 07020006-511)

Drainage area for listed reach (sq mi): 96.1
Flow gage used: Redwood River near Marshall - USGS 05315000
Land Area MS4 Urban (%): 0
Total WWTF Flow (mgd): 0

	Flow Zone				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	291.1	58.2	14.9	4.8	0.6
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.0	0.0	0.0	0.0	0.0
Communities Subject to MS4 NPDES Requirements	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	168.7	25.4	9.7	1.8	0.0
Margin of Safety	122.4	32.8	5.2	3.0	0.6
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.0%	0.0%	0.0%	0.0%	0.0%
Communities Subject to MS4 NPDES Requirements	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	57.9%	43.6%	65.0%	37.5%	0.0%
Margin of Safety	42.1%	56.4%	35.0%	62.5%	100.0%

Reductions Needed by Month

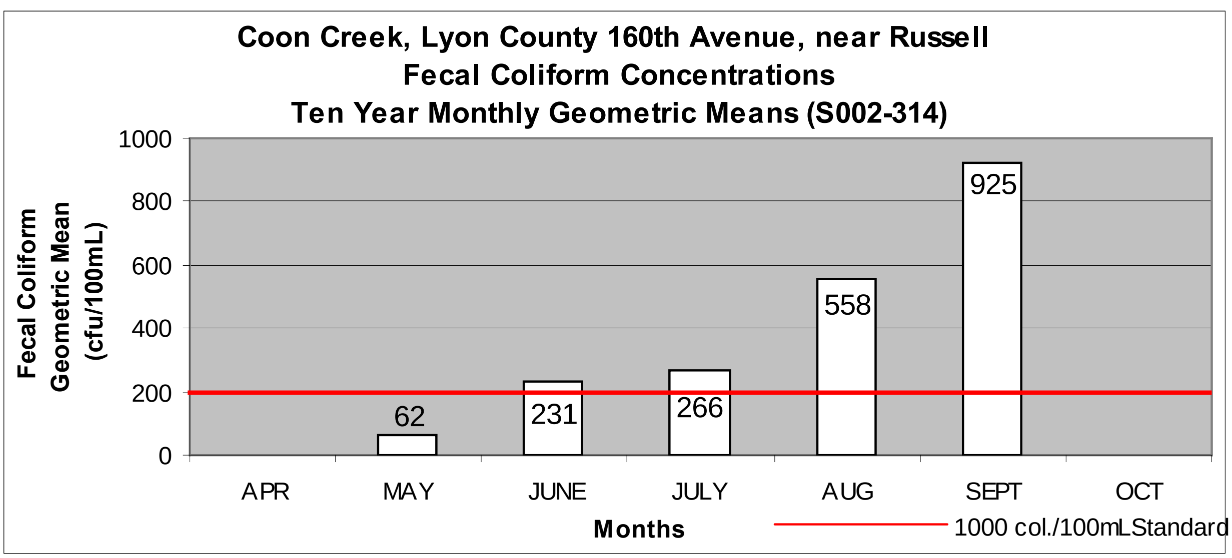
Monitoring Conducted by: Redwood-Cottonwood River Control Area/MPCA
Years Monitored: 1999
Samples Collected: 25

The following represents the percentage reduction in monthly bacterial concentration (Figure 5.3.9B) 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. See also, Table 3.02 for sampling data and Section 9.2 for locally targeted implementation plan.

RWR007 (S002-314)

Month	Required Reduction
April	Inadequate Data
May	None Required
June	13.42%
July	24.81%
August	64.16%
September	78.38%
October	Inadequate Data

Figure 5.3.9B: (RWR007) Monthly Geometric Mean Fecal Coliform Concentrations (1999-2006)



6.0 Margin of Safety

Under Section 303(d) of the Clean Water Act, a MOS is required as part of a TMDL report. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. For the nine impaired reaches covered in this Report, an explicit margin of safety is provided for each of the flow periods for each impaired reach. As described in Section 5 and Appendix A of this document, the MOS is based on the difference between the loading capacity as calculated at the mid-point of each of the five flow ranges, and the loading capacity calculated at the minimum flow in each zone. Given that the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point, a substantial MOS is provided. The MOS ensures that allocations will not exceed the load associated with the minimum flow in each zone. Because the allocations are a direct function of daily flow, accounting for potential flow variability is the appropriate way to address the MOS. The minimum daily flows over long periods of record define the MOS for the low flow zone. For the impaired reach in which the allocation for the dry and low flow zones required use of an alternative method of calculation, i.e., a concentration-based limit, an implicit MOS was used. An implicit MOS means that conservative assumptions were built in to the TMDL and/or allocations. In this instance the listed section is expected to meet the TMDL because the permitted point source dischargers are limited to discharge concentrations below the impairment target, thereby providing additional capacity. In addition, the creek flow itself is primarily being fed by ground water at these low flows, which is believed to convey very little of the impairment.

7.0 Seasonal Variation

The flow duration approach utilized in this Report captures the full range of flow conditions over the April-October period when the fecal coliform water quality standard applies. Seasonal variation in flow is a key part of TMDL development. Daily loads are directly proportional to flows.

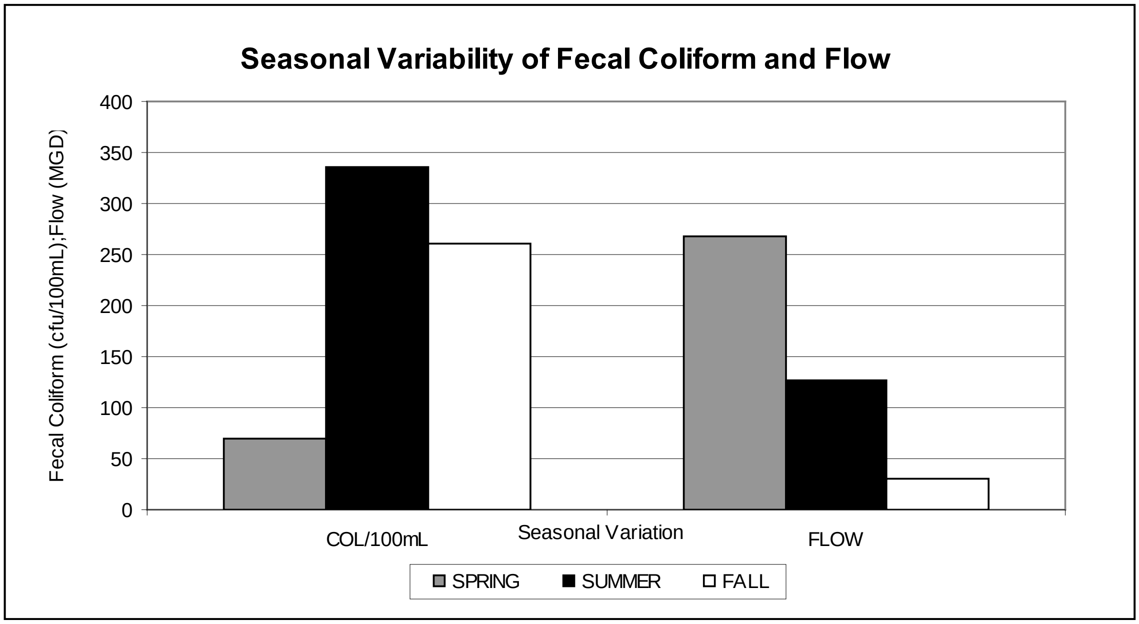
Fecal coliform samples and flow measurements were conducted over the spring, summer, and fall months (April-October). The results indicated a wide range of flows and fecal coliform concentrations. The large flows associated with snow melt events in the spring did not exceed the impaired levels. Generally, land application of manure occurs in October - March. The summer period from June through August is the critical period when fecal coliform levels exceeded the level of impairment. The summer impairment was driven by storm events.

RR1 (STORET# S001-679) in the Lower sub-watershed illustrates the variation in fecal coliform concentrations and flows by season (Table 7.01 and Figure 7.01).

The EPA requires that TMDLs take into account “critical conditions for stream flow, loading, and water quality parameters.” This requirement is fulfilled through the analysis and discussion of seasonality, and effects of weather and streamflow, contained in

Sections 3.2, 4.0, and Appendix A of this Report. While there is some variability among the impaired reaches addressed in this Report, critical conditions include storm events, and summer (June-September).

Figure 7.01: Seasonal Variation of Fecal Coliform (cfu/100ml) & Flow (MGD) at site RR1 (STORET# S001-679)



Duration curve zones can be used to reflect seasonal variation. Table 7.01 uses duration curve zones to identify loading capacity information. Loading capacities are organized in a way that reflects actual flow conditions for any given month.

Table 7.01: Flow Duration Curve Loading by Months

	Duration Curve Zone (Loading Capacity expressed as billion organisms per day)				
	High	**Moist**	**Mid**	**Dry**	**Low**
Redwood River above Redwood Lake RR1	4615.7	1027.5	318.0	97.9	15.7
Seasonal Considerations [most likely zone(s) by month]	**April** **May** **June** **July** **August** **September** **October**				

8.0 Monitoring Plan

The goal of the monitoring plan is to assess if the reduction strategies are effective in attaining water quality standards and designated uses.

RCRCA plans to continue their annual condition monitoring efforts in the Redwood River Watershed. In an effort to maintain a contiguous monitoring database, the subsequent implementation plan will include a monitoring plan and quality assurance project plan. Further effectiveness monitoring sites may be added upon recommendations from the stakeholder technical advisory committee. Implementation activities supported by an approved implementation plan will be evaluated every five years and modified as needed. Annual results will be included in the yearly Redwood River Watershed Monitoring Summary. Five samples per month/geometric mean *E coli* monitoring will be conducted every five years to be conterminous with the implementation plan's evaluation and to assess the plans effectiveness in delisting the impaired reaches.

The majority of bacteria monitoring collected over the past ten years is attributed to the Redwood River Clean Water Partnership (CWP) project in the basin. The diagnostic and implementation phases of this CWP are complete and provided funding for this watershed through 2007. RCRCA is maintaining the contiguous monitoring through the use of CWA 319 and general fund dollars for 2008. Monitoring after 2008 will depend on the approval of this TMDL and implementation plan to maintain the sampling data base and evaluate effectiveness.

9.0 Implementation Strategy

9.1 Implementation through Source Reduction Strategies

This section provides an overview of implementation options and considerations to primarily address nonpoint sources of fecal coliform bacteria for these TMDLs. RCRCA has proposed a watershed-wide approach to achieving water quality standards for fecal coliform bacteria within ten years. Methods in the implementation plan set forth in the original Redwood River diagnostic study, a plan which has been in place since 1993, will be used as a template for the implementation plan for this TMDL project. The final implementation plan will be developed within a year of the final approval of the Report by the EPA. The implementation plan developed by the stakeholder advisory committee will spell out what type of best management practice (BMP) to use and where they will be applied in the sub-watersheds of the impaired reaches and will project the cost and funding sources for their application.

Table 9.01 below brings the main potential sources (municipal wastewater, septic systems, grazing livestock, urban stormwater, feedlots, and field-applied manure) into the analysis. In this table these sources are portrayed in terms of "implementation opportunities" and are associated with the likely flow zones in which they would be effective. Using this table in conjunction with the load duration curve, local stakeholder knowledge and other information, a project team can start to rule in or out some sources and potentially rank them from most significant to least significant as well as point towards some implementation strategies.

Table 9.01: Implementation Opportunities for the Different Flows Regimes

<table>
<tr><th rowspan="2"></th><th colspan="5">Duration Curve Zone</th></tr>
<tr><th>High</th><th>Moist</th><th>Mid</th><th>Dry</th><th>Low</th></tr>
<tr><td rowspan="6">Implementation Opportunities</td><td colspan="2">Wastewater bypass elimination</td><td></td><td colspan="2">WWTF</td></tr>
<tr><td></td><td colspan="4">SSTS</td></tr>
<tr><td></td><td colspan="4">Pasture management & riparian protection</td></tr>
<tr><td colspan="3">Urban stormwater management</td><td colspan="2"></td></tr>
<tr><td colspan="3">Feedlots</td><td colspan="2"></td></tr>
<tr><td colspan="2">Manure management</td><td colspan="3"></td></tr>
</table>

Adapted from Revised SE Regional Fecal Coliform TMDL, Appendix A.

Appendix B includes load duration curves for each sub-watershed in an attempt to target areas for reducing bacteria concentrations. A preliminary strategy for bacteria source load inventory is described in Appendix C.

RCRCA received a 319 grant in 2001 and in 2004 to implement best management practices for improving water quality. The BMPs include: CRP buffers, alternative tile intakes, grassed waterways, livestock exclusion, sediment basins, nutrient management plans, wetland restorations, and streambank stabilization. Some of these activities can directly affect bacteria concentrations by reducing availability of direct conveyance to surface water and some of these methods can reduce surface water bacteria by reducing bacteria transport through erosion reduction mechanisms. Some of these activities are listed below.

- Pasture Management/Livestock Exclusion Plans – Many pastured animals use nearby surface waters for drinking water when they are pastured. Unfortunately, the activity in or near surface waters allows for direct transport of fecal bacteria into surface waters. Livestock exclusion, by fencing off areas where livestock activity exists and replacing the surface water sources with an alternate watering system will exclude livestock from waters and with proper buffering, can reduce the conveyance of fecal bacteria associated with runoff. Another way to ensure better coverage in pastures and pasture health is through rotational grazing. Rotational grazing is a method of grazing where pastures are divided into sections with the goal of allowing pasture grass time to grow back after being grazed. Other pasture activities to ensure that pastures aren't overgrazed include proper grazing timing and grazing the proper amount of animals per acre.

- Manure/Nutrient Management Plans – State rules dictate that feedlots larger than 300 animal units are required to develop manure management plans. Manure management plans serve to account for the storage and application of manure to ensure that there is enough land to accommodate the amount of manure produced by a livestock operation. Manure management is one of the integral parts of a nutrient management plan. Both serve to plan nutrient/manure application according to the need of the land. Rates of application consider the crop, soil type, previous crops, history of fertilizer/manure application and incorporation/application methods. Proper application rates, placement, and timing of fertilizer and manure application can reduce the movement and availability of bacteria to surface water sources.

- Feedlot Runoff Controls – Runoff from feedlots can be diverted into holding areas and stored with adequate buffers from surface water to be land applied at a later time or simply buffered from water sources using adequate vegetation. Clean water can be diverted away from feedlots so as not to pick up pollutants including fecal coliform bacteria which may be incorporated in surface water systems. Smaller feedlots would be the focus of manure managing practices as larger feedlots, subject to permitting, are required to do such activities under their NPDES Permits.

Estimations based on EQIP payment history and the number of non-NPDES permitted animal units listed in this Report estimate that the cost to put animal agricultural activities under manure management and feedlot runoff mitigation plans would cost around $25,000,000. This figure would include storage structures, runoff controls, nutrient management plans, and pasture management programs. The cost would roughly be $350 per animal unit.

- Sediment Reduction Practices – Some fecal bacteria reduction could occur through efforts where sediment reduction was a primary factor. BMPs designed to intercept runoff or filter sediments out of sheet flows before entering surface water systems would also serve to reduce manure and other nutrient rates in the watershed.

- Waste Water Treatment Facilities – Counties, Regional Development Commissions and MPCA staff will work with WWTFs to ensure continued compliance as part of their permits.

- Unsewered Communities – Counties, Regional Development Commissions and MPCA staff will work with unsewered areas to bring them into compliance. Currently plans to build a community WWTF for the City of Seaforth are underway. The five unsewered areas in this Report are listed in Table 4.02.

- Subsurface Septic Treatment Systems – Three percent low interest loan dollars are available to aid landowners in upgrading their SSTS. An approximate number of SSTS needs can be inferred from the estimation of non-compliant septic systems. We can also include SSTS needs in unsewered communities by household. With a cost estimated at about $7,500, the 1,051 failing systems would cost on the order of $7,882,500 to replace failing systems in the Redwood river watershed.

9.2 Locally Targeted Implementation

The eight impaired reaches can be used as priority areas in the implementation plan. Smaller watershed area will ensure targeted BMP implementation. RCRCAs goal is to help make these changes happen through education, training, and monetary incentives. Below are implementation plan ideas by subwatershed. Most of the proposed practices relate to agricultural BMPs, but SSTS and unsewered communities will also be addressed.

- The Bottom Redwood Watershed (RWR-1, STORET# S000-299): The Redwood River from Ramsey Creek to (Assessment reach ID #07020006-501) was first identified a priority area in the watershed in 1994 due to elevated levels and bacteria. As this subshed is the lower end of the Redwood River, it reflects all tributaries to the river as well as areas immediate to the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “high” conditions. Implementation of projects such as manure management plans are plans that should help to realize the improvement needed to bring this subshed below the standard.

- The Lower Redwood Watershed (RR1, STORET# S001-679): The Redwood River from Clear Creek to Redwood Lake (Assessment reach ID #07020006-509) was first identified a priority area in the watershed in 2006 due to elevated levels of bacteria. As this subshed is a section of the Redwood River, it reflects tributaries to the lower end of this section as well as areas immediate to the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “moist” and “mid-range” flow conditions. Implementation of projects such as manure management plans and pasture management regiments are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- The Middle Redwood Watershed (RWR-53, STORET# S001-199 and Marshall, STORET# S003-702): The Redwood River from the west line of T111 R42w S33 to Three Mile Creek (Assessment reach ID #07020006-502) was first identified a priority area in the watershed in 2004 due to elevated levels of bacteria. As this subshed is a section of the Redwood River, it reflects tributaries to the lower end of this section as well as areas immediate to the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “moist”, “average”, and “dry” flow conditions. However, sampling at the USGS site south of Marshall suggests that the site generally was compliant with the standards. So the focus of implementation in this subshed would seem to be of better use in the portion of the subshed below the Marshall site. Implementation of projects such as manure management plans, urban runoff controls and pasture management regiments would be prudent for the higher flows. Municipal discharge management, animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- Upper Redwood River Watershed (RRUS, STORET# S000-696): The Redwood River from its headwaters to Coon Creek (Assessment reach ID #07020006-505) was first identified a priority area in the watershed in 2007 due to elevated levels of bacteria. As this subshed is a section of the Redwood River, it reflects tributaries to the lower end of this section as well as areas immediate to the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “moist” and “average” conditions but is most problematic during “dry” flow conditions. Implementation of projects such as manure management plans and pasture management regiments would be prudent for higher flows. Municipal discharge management, animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- Clear Creek (CC3, STORET# S002-311): Clear Creek from its headwaters to the Redwood River (Assessment reach ID #07020006-506) was first identified a priority area in the watershed in 2007 due to elevated levels of bacteria. The Clear Creek subshed reflects the whole of the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “moist”, “average”, and “dry” flow conditions. Implementation of projects such as manure management plans and pasture management regiments would be prudent for the higher flows. Animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- Three Mile Creek (TC4A, STORET# S002-313): Three Mile Creek from its headwaters to the Redwood River (Assessment reach ID #07020006-504) was first identified a priority area in the watershed in 2006 due to elevated levels of bacteria. The Three Mile Creek subshed reflects the whole of the subshed itself. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “average” and “dry” flow conditions but is most problematic during “moist” flow conditions. Implementation of projects such as manure management plans and pasture management regiments would be prudent for the higher flows. Municipal discharge management, animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- Coon Creek (RWR007, STORET# S002-314): Coon Creek from Lake Benton to the Redwood River (Assessment reach ID #07020006-511) was sampled in 1999 and was found to have levels of bacteria exceeding the standard; the subshed is part of the Redwood watershed. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “average” and “moist” flow conditions but is most problematic during “dry” flow conditions. Implementation of projects such as manure management plans and pasture management regiments would be prudent for the higher flows. Animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

- Tyler Creek (RWR008, STORET# S002-315): Tyler Creek (JD 12) from its headwaters to the Redwood River (Assessment reach ID #07020006-512) was sampled in 1999 and again in 2007 and was found to have elevated levels of bacteria; the subshed is part of the Redwood watershed. Tyler Creek is a Class 7 water and was not assessed by MPCA, however, it will be assessed in 2010 According to the data this creek will be listed as levels of bacteria were found to be over the standard. Remedial actions in this reach should help the watershed as a whole. Based on sampling and the load duration curve, this subshed tends to exceed the standard during “moist” flow conditions. Implementation of projects such as manure management plans and pasture management regiments would be prudent for the higher flows. Municipal discharge management, animal exclusion, pasture management, and replacement of failing Subsurface Septic Treatment Systems would better serve the sub-shed during the dry periods. These are a few actions that should help to realize the improvement needed to bring this subshed below the standard.

10.0 Reasonable Assurance

10.1 Evidence of BMP Implementability

The source reduction strategies listed are shown to be successful in reducing pathogen transport and survival and to be capable of widespread adoption by land owners and local resource managers. Many of the BMPs listed below are part of the original Redwood River Clean Water Project’s implementation plan. RCRCA will apply for available grants and loans to continue implementation of these BMPs. RCRCA has a proven history backed with an extensive database, a long-term monitoring program, and an organizational structure that remains supportive and flexible to ensure that projects such as the Redwood River Clean Water Project and the Cottonwood River Restoration Project are successful. This success can be viewed in the 2001 Final Report, “Evolution of Watershed Restoration", which can also be found at our website. Continued best management projects concentrated in priority areas of the watershed have helped the Redwood River Watershed realize a reduction and stabilization in sediment and nutrient loads. In the same way, acheivements in *E. coli* bacteria reductions will be effective if the methods and efforts listed below are tailored to priority areas but more importantly, in such a way that will be effective at priority times of the year in these areas.

- Feedlot runoff controls – these are evaluated by professional engineers using the Minnesota Feedlot Annualized Runoff Model referenced in Minn. R. ch. 7020. These rules are implemented by the MPCA staff and by local staff of counties via a delegation agreement with the Agency.
- Subsurface Septic Treatment Systems –SSTS with proper drain fields provide virtually complete treatment of fecal coliform bacteria. Acceptable designs are described in Minn. R. ch. 7080. All counties in the watershed are delegated to implement these rules, which require conformance with state standards for new construction and disclosure of the state of the system when property transfers ownership.
- Municipal Wastewater Disinfection – Disinfection with chlorine or ultraviolet radiation is required of all NPDES permitted facilities.
- Land Application of Manure – Buffer strips, immediate incorporation, and maintenance of surface residue have been demonstrated to reduce manure and pathogen runoff (EQB, 1999). The state feedlot rules (Minn. Rules part 7020) require manure application record-keeping and manure management planning, with requirements differing according to operation size, and manure application pollution risk based on method, time and place of application.
- Erosion Control and Sediment Reduction – Conservation tillage and riparian buffer strips have been shown to be effective in reducing sediment delivery to streams. Since embedded sediment can serve as a substrate for fecal coliform survival, reduction of sediment sources is considered an effective measure for controlling fecal coliform bacteria in streams.
- 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 southeastern Minnesota.
- Urban Stormwater Management – Practices such as runoff detention, infiltration, and street sweeping have been shown to be effective in reducing urban runoff and associated pollutant.
- Redwood River Watershed in Lincoln County – A CWP implementation grant for the Lincoln county portion of the Redwood River watershed was procured in 2004. The grant had $210,000 of funds for BMPs and technical service as well as $440,000 for upgrading SSTS.

10.2 Non-regulatory, Regulatory, and Incentive-Based Approaches

The lead for implementation will be sponsored by the Redwood-Cottonwood Rivers Control Area. The local work group of the RCRCA is composed of RCRCA technical staff, county representatives and personnel from Soil and Water Conservation Districts, Board of Soil and Water Resources, Department of Natural Resources, Minnesota Pollution Control Agency, and the Natural Resources and Conservation Services. The local work group will monitor and evaluate the implementation strategies, and will advise and make recommendations on the progress of the strategies to RCRCA.

11.0 Public Participation

The Redwood-Cottonwood Rivers Control Area (RCRCA) conducted four public meetings in Redwood Falls. The meetings were held February 20, 2008, April 7, 2008, May 28, 2008 and June 25, 2008, to solicit feedback from the technical committee and stakeholders. These meetings also provided information to citizens on the impact of the fecal coliform TMDL on the Redwood River. Invitations were mailed or emailed to citizens and interested parties in the watershed, and notices of the meetings were put on the RCRCA website. Invitations, agendas and meeting minutes are found in Appendix D. This Report was also discussed at RCRCA annual meetings (December 8, 2007 and December 9, 2006) and as part of the educational efforts at the RCRCA annual Golf Tournament (September 13, 2007 and September 14, 2006) and canoe paddles on various dates in the last four years.

The draft TMDL report is available to the public via the MPCA web site at http://www.pca.state.mn.us/water/tmdl/index.html as well as on the RCRCA web site at http://www.rcrca.com/TMDL_info.htm

Many local, state, and federal agencies have been involved in the public participation process including, but not limited to, representatives from the Soil and Water Conservation Districts and Natural Resources Conservation Services, County Boards, County Environmental Services, Cities of Redwood Falls and Marshall, MN Department of Natural Resources, MN Pollution Control Agency, Board of Soil and Water Resources, County Extension Service, MN Soybean Growers Association, MN Corn Growers Association, MN State Cattlemen's Association, MN Farm Bureau and Pork Producer Organizations. These agencies, in cooperation with the local residents, landowners, and farm operators, have contributed to the understanding of the political, economic, and natural resource aspects of the report and ultimately the implementation plan.

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Appendix A:
Redwood River Fecal Coliform TMDL: Methodology for TMDL Equations and Load Duration Curves

The loading capacity determination used for this Report is based on the process outlined in the MPCA report, “Bacteria Protocols and Submittal Requirements” (Dec 2006). This process is known as the “Duration Curve” method.

Loading capacities for fecal coliform bacteria are related directly to flow volume. As flows increase, the loading capacity of the stream will also increase. Thus, it is necessary to determine loading capacities for a variety of flow zones.

For this approach, daily flow values for each site are sorted by flow volume, from highest to lowest and a percentile scale is then created (where a flow at the X^{th} percentile means X percent of all measured flows equal or exceed that flow). Five flow zones are used in this approach: “high” (0-10^{th} percentile), “moist” (10^{th}- 40^{th} percentile), “mid-range” (40^{th}-60^{th} percentile), “dry” (60^{th}-90^{th} percentile) and “low” (90^{th}-100^{th} percentile). The flows at the mid-points of each of these zones (i.e., 5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles) are multiplied by the fecal coliform standard (200 org/100 mL) except for Class 7 waters which is 1,000 org/100 mL. A conversion factor reports the allowable maximum loads in units of billions of organisms per day. For example, if the “mid-range” (50^{th} percentile) flow is 100 cubic feet per second (cfs), the loading capacity or TMDL would be:

100 cfs x 200 orgs/100 mL x 28,312 mL/cubic ft x 86,400 sec/day ÷ 1 billion = 489 billion organisms per day

The flow monitoring data used in this project was from two U.S. Geological Survey gage stations. Sixty-eight years of flow data from the USGS stations were used for the Redwood River calculations (1940-2006).

Flow data for the sites was estimated by normalizing data from the two U.S. Geological Survey gage stations. For example, the Clear Creek impaired reach drainage area is 13.24 percent (83.4/630) of the drainage area monitored by the RR1 USGS gaging station. Calculated flows were then checked against 12 years of available flow data for the small stream which showed a reasonable degree of alignment.

It was decided to use USGS data for all sites in the Redwood River watershed to better reflect the range of hydrologic conditions in the watershed by having a wider variety of conditions to use for the Duration Curve. The sites were split into two categories to reflect the two major types of land types, larger more sinuous streams in the flatter portion below Marshall and smaller streams on the coteau. The appropriate USGS site was used to calculate the flow using drainage area. It should also be noted that only flow data from April through October was used in the duration curve as these are the only flows/months used in assessing for bacteria TMDL’s.

TMDLs were calculated for all the flow zones for each listed reach of the project. The TMDLs were then divided into a Margin of Safety (MOS), Wasteload Allocations (WLAs), Load Allocation (LA), and Reserve Capacity (RC).

The MOS accounts for uncertainty in the TMDL allocation process. The MOS was established so that the load associated with the minimum flow for each zone would not be exceeded. For each zone, the MOS is the difference between the central and lowest flow value for each zone. For example, to determine the MOS for the high flow zone, the 10^{th} percentile flow value was subtracted from the 5^{th} percentile flow value. The resulting value was converted to a load and used as the MOS. The final available load and wasteload allocation is the TMDL minus the MOS.

The final step in the process was determining the portion of the load that needs to be allocated for wastewater treatment facilities (WWTFs) and the two permitted stormwater municipal separate storm sewer system (MS4) communities in the watershed (Marshall and Redwood Falls). A 10 percent increase of land area in the MS4 communities was use to account for Reserve Capacity in the Waste Load Allocation.

The allowable wasteload allocated to WWTFs was determined by totaling the potential daily discharge for all upstream facilities. For continuous discharge facilities the average wet weather design flow was used; for facilities with pond systems the effluent volume equivalent to six inches per day drawdown from their pond was used. The resulting daily volumes of effluent were converted to a load using the permitted concentration limit (200 organisms/100 ml) and a conversion factor to arrive at a load in billions of organisms per day. The wasteload allocation for a given WWTF will be the same under all flow zones since its allocation is based on the volume it is permitted to discharge. Example WLA calculation for a WWTF discharging 3,000,000 gallons of effluent per day:

$$3{,}000{,}000 \text{ gallons/day} \times 200 \text{ orgs/100ml} \times 3785 \text{ ml/gallon} \div 1 \text{ billion}$$
$$= 23 \text{ billion organisms per day}$$

The WWTF allocation and MOS were subtracted from the total loading capacity. The remaining capacity was divided between MS4 permitted stormwater and all nonpoint sources (load allocation) based on the percentage of land in an impaired reach watershed covered by MS4 permits. In the case of the Lower Redwood USGS site (RR1) watershed the percentage of land area covered by Marshall was 1.31 percent, so 1.31 percent of the remaining capacity was allocated to that permit. In addition to being a practical way to allocate between MS4 permits and all other nonpoint sources, it is also equitable from the standpoint of rural and urban fecal coliform sources being held to the same "standard." (Note: The land area percentage used for Marshall was 110 percent of the actual municipal boundary found in the GIS layer to account for future growth in the short term)

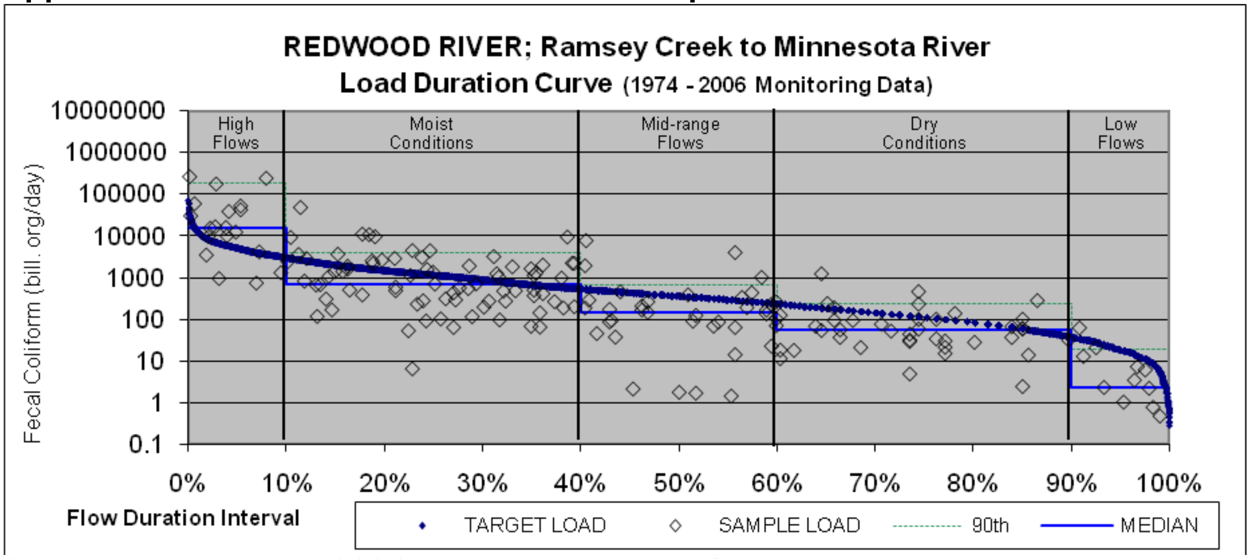
Load duration curves used the flow duration data and factored in the fecal coliform standard to determine and display the allowable load for each flow percentile. The loads represented by grab samples were calculated and plotted.

Table A. Redwood River Fecal Coliform TMDL general reach information

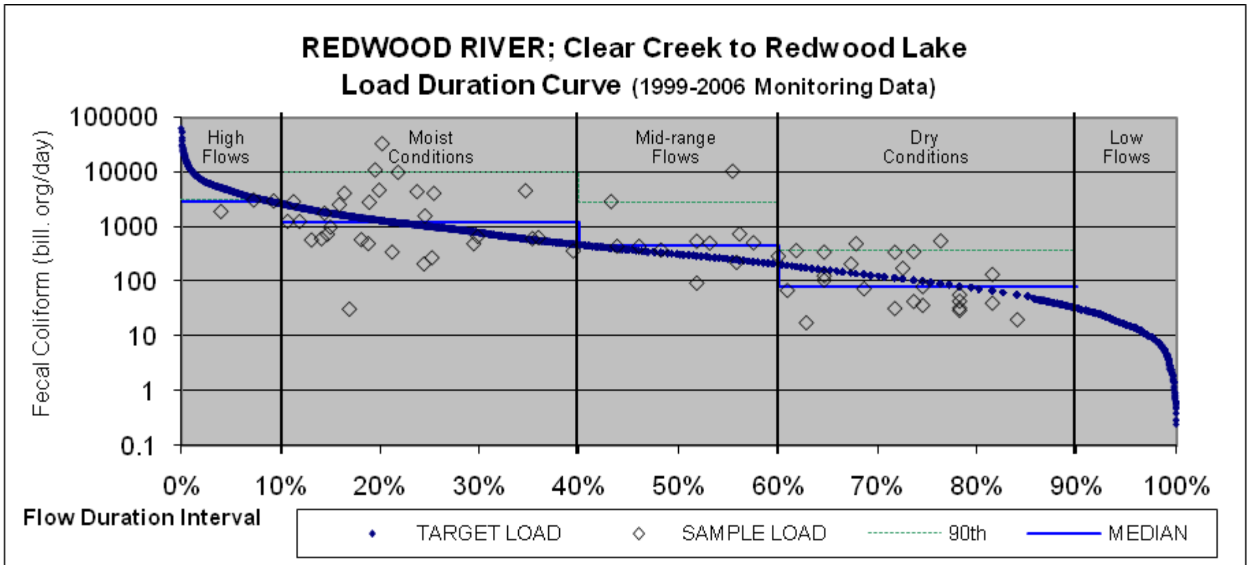
Reach	Description	Assessment Unit ID	STORET	CWRP MPCA Site #	Subshed	Flow Data source (years)	Area (sq. miles
Redwood River	T111 R42W S33 west line to Threemile Cr	07020006-502B	S003-702	MARS HALL	Middle	USGS 05315000 (40-06)	258.8
Redwood River	T111 R42W S33 west line to Threemile Cr	07020006-502A	S001-199	RWR-53	Lower	USGS 05315000 (40-06)	289.2
Redwood River	Clear Cr to Redwood Lk	07020006-509	S001-679	RR1	Lower	USGS 05316500 (40-06)	630
Redwood River	Ramsey Cr to Minnesota R	07020006-501	S002-193	RWR-1	Lower	USGS 05316500 (40-06)	705.1
Threemile Creek	Headwaters to Redwood R	07020006-504	S002-313	TC4A	Three Mile Creek	USGS 05316500 (40-06)	121.9
Redwood River	Headwaters to Coon Cr	07020006-505	S000-696	RRUS	Upper	USGS 05315000 (40-06)	229.4
Tyler Creek	Headwaters to Redwood R	07020006-512	S002-315	RWR0 08	Tyler Cr	USGS 05315000 (40-06)	51.2
Clear Creek	Headwaters to Redwood R	07020006-506	S002-311	CC3	Clear Cr	USGS 05316500 (40-06)	83.4
Coon Creek	Lake Benton to Redwood R	07020006-511	S002-314	RWR0 07	Coon Cr	USGS 05315000 (40-06)	96.1

* Drainage areas were determined using GIS. Major and minor watershed data was obtained from the MN DNR Data Deli. Subsheds were determined using the minor watershed data. Samplesheds were determined using the minor watershed data in conjunction with drainage delineation determined by RCRCA watershed technicians and engineers. The datum and projection that this was done in is NAD 1983, UTM 15N.

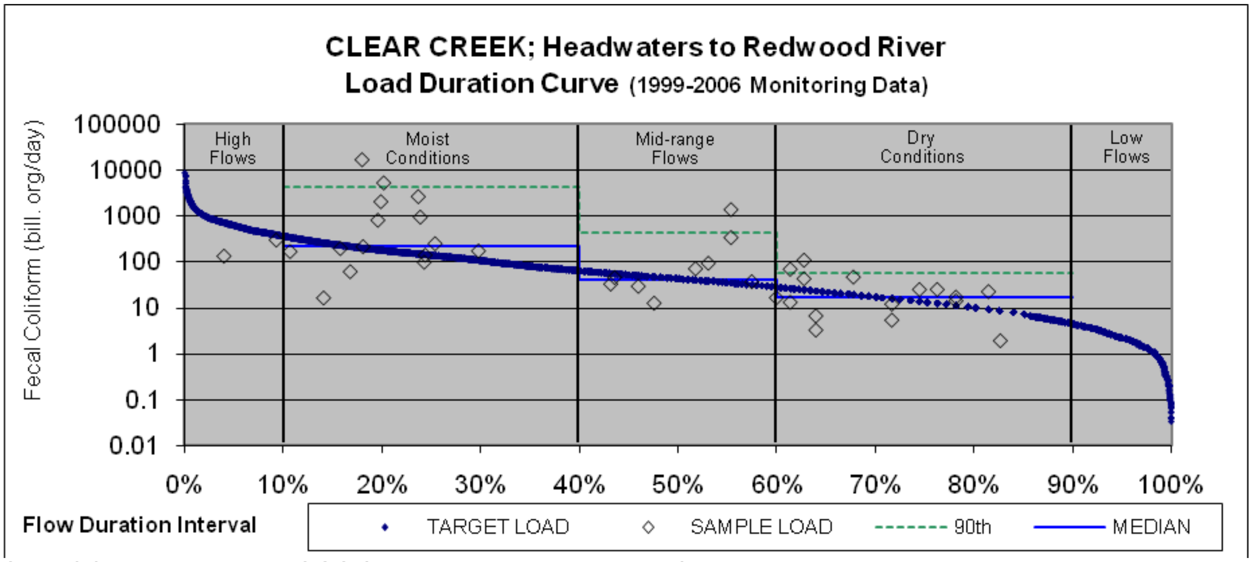
Appendix B: Load Duration Curves for the Impaired Reaches



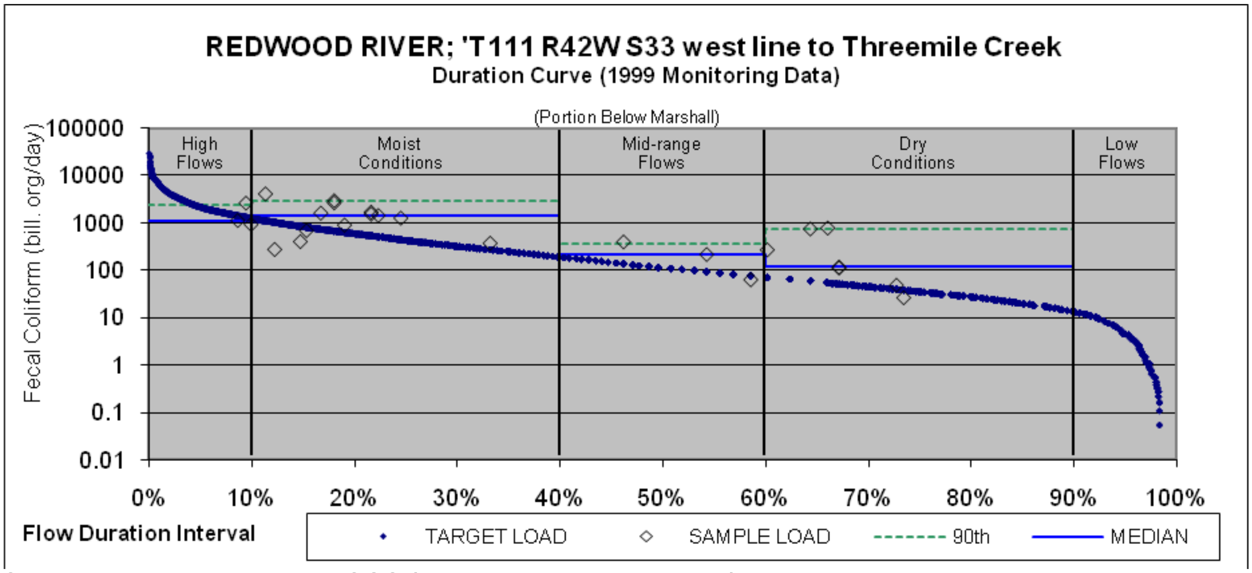
Site: RWR-1, Flow Data: USGS (estimated based on area), Area: 705.1 square miles



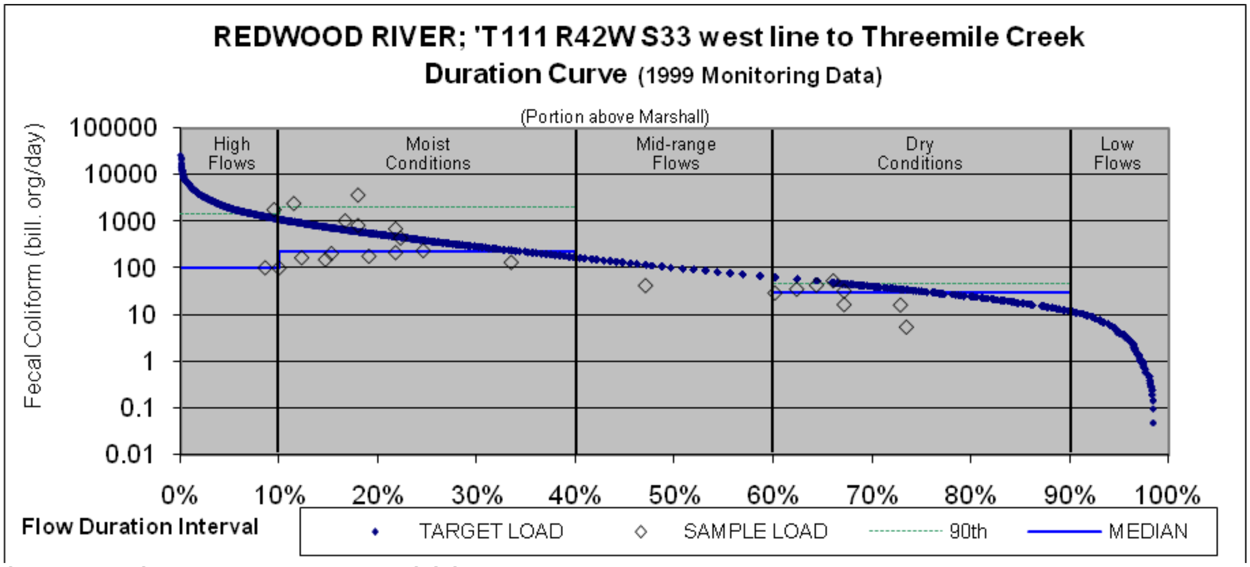
Site: RR1, Flow Data: USGS, Area: 630 square miles



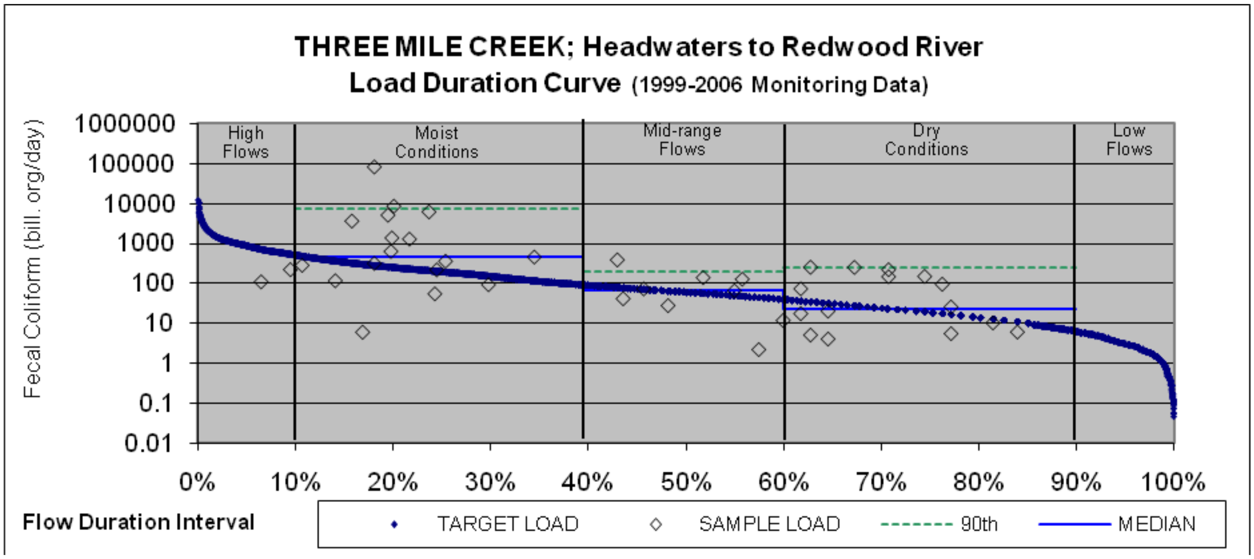
Site: CC3, Flow Data: USGS (estimated based on area), Area: 83.4 square miles



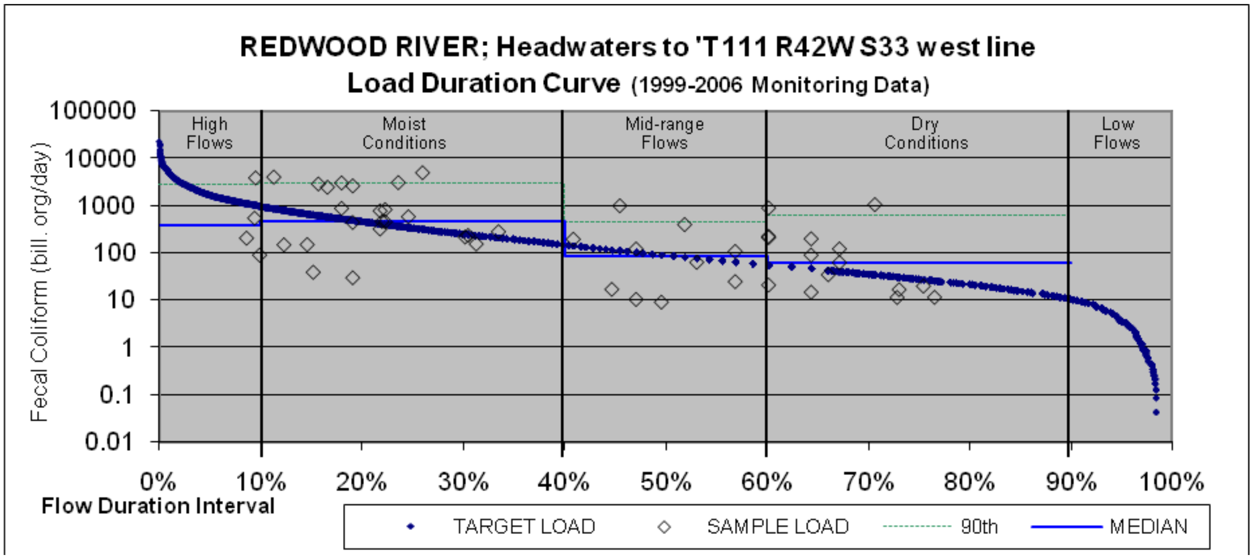
Site: RWR-53, Flow Data: USGS (estimated based on area), Area: 289.2 square miles



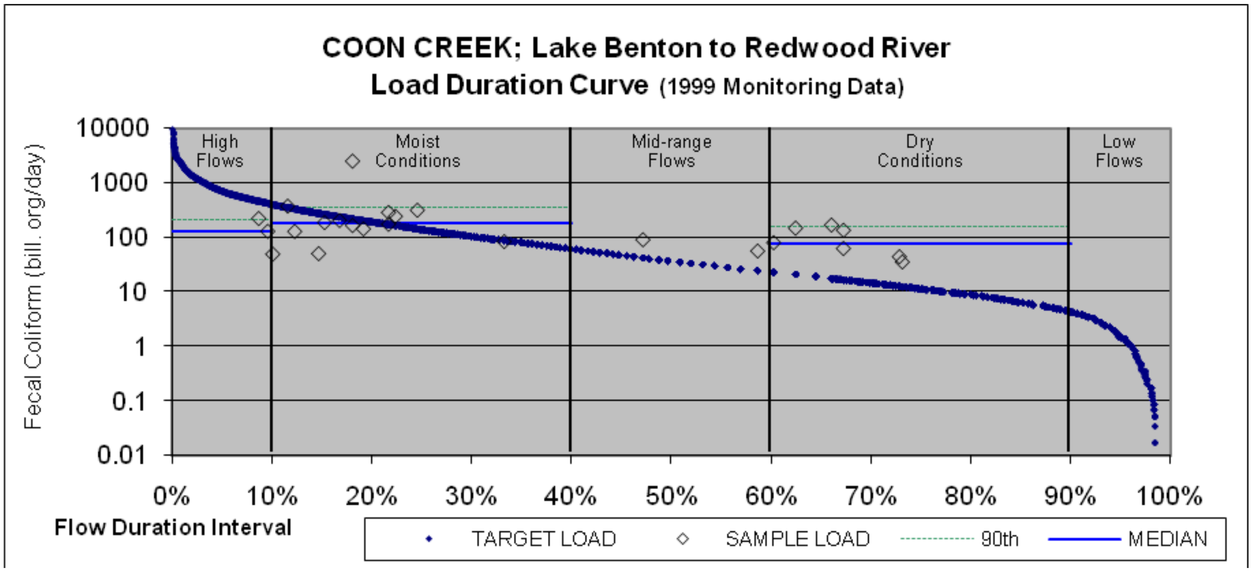
Site: 'MARSHALL', Flow Data: USGS, Area: 258.8 square miles



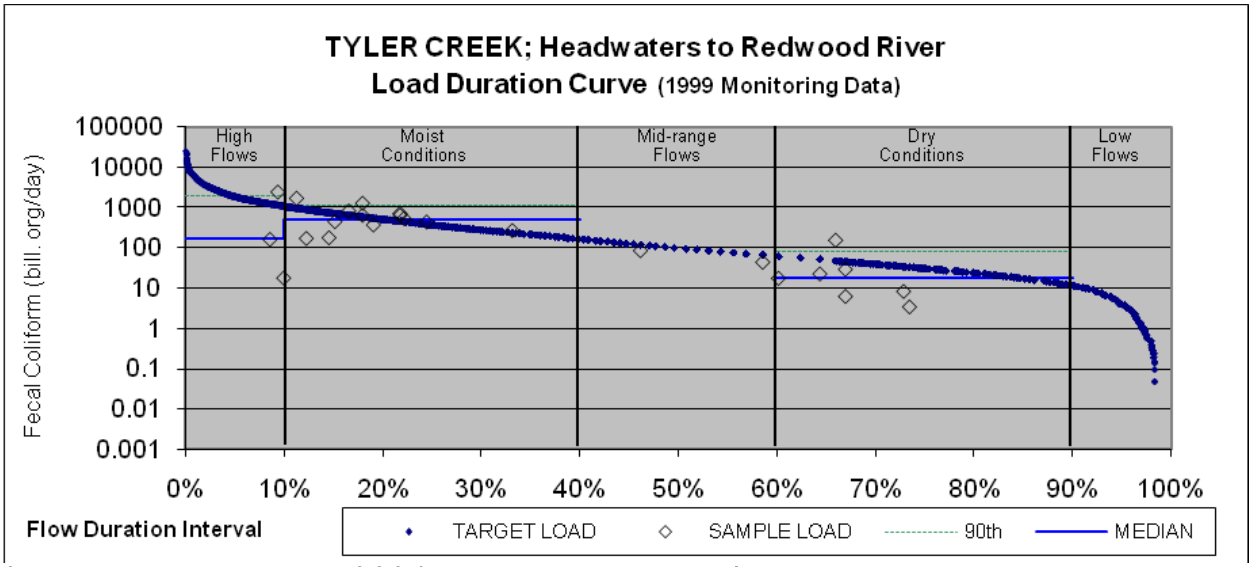
Site: TC4A, Flow Data: USGS (estimated based on area), Area: 121.9 square miles



Site: RRUS, Flow Data: USGS (estimated based on area), Area: 229.4 square miles



Site: RWR007, Flow Data: USGS (estimated based on area), Area: 96.1 square miles



Site: RWR008, Flow Data: USGS (estimated based on area), Area: 51.2 square miles
NOTE: The target load of this subshed is 1000 org/100 mL as these are "Class 7" waters, they are not assessed by MPCA.

Appendix C: Fecal Coliform Current Loading by Source: Methodology and Estimates of Relative Contribution

This Appendix serves to outline the process that was used for each impaired stream reach to estimate the primary sources of fecal coliform contamination. These are approximations because neither river flow nor the dynamics of fecal coliform growth and die-off cycle were factored in. Also, availability and delivery percentages rely on professional judgment as opposed to research derived estimates. This procedure has no bearing on TMDL allocations and has no regulatory implications. The entire Redwood River Watershed is used as an example.

The first step to estimating bacteria contribution was compiling population estimates and fecal coliform produced by each animal type in the Watershed. Table 1 displays the fecal coliform (FC) producers, amount of FC per producer and the source of the information. Figure 1 displays the FC produced by each of the four major sources; livestock produces about 97 percent of the FC in the watershed. Figure 2 breaks out the FC source by type where swine and beef cattle produce 87 percent of the FC. The amount of fecal coliform produced daily by each animal type was obtained from a variety of sources, which are all recommended in the Environmental Protection Agency's (EPA) guidance document *Protocol for Developing Pathogen TMDLs*. Total FC produced by each animal type is calculated by multiplying the population figure by the daily FC produced per individual or animal unit. Note that the below table and graphs represent the total FC available, not the amount delivered to surface waters.

Table 1: Population and Total Estimated Potential Fecal Coliform Produced by Animal Type

Animal Type	Animal Units	Individuals	FC Produced per Individual or AU Per Day	Total FC Available	Source (FC Produced per Day)
Dairy	6,501		7.14E+10	4.64E+14	ASAE*,1998
Beef	36,958		1.00E+11	3.70E+15	ASAE*,1998
Swine	33,940		7.11E+10	2.41E+15	ASAE*,1998; Metcalf and Eddy, 1991
Turkeys	3,657		6.28E+09	2.30E+13	ASAE*,1998; Metcalf and Eddy, 1991
Sheep	1,350		1.50E+11	2.03E+14	ASAE*,1998; Metcalf and Eddy, 1991
Horses	227		4.20E+08	9.53E+10	ASAE*,1998
Other	40		1.00E+11	3.98E+12	Used Beef (Mostly Buffalo)
Human (all)		21,081	2.00E+09	4.22E+13	Metcalf and Eddy, 1991
Deer		3,525	2.00E+08	7.05E+11	Metcalf and Eddy, 1991
Geese		1,293	1.04E+07	1.34E+10	Alderiso and DeLuca, 1999
Pheasants		54,285	1.90E+08	1.03E+13	Used Chickens
Ducks		15,389	4.54E+09	6.99E+13	ASAE*,1998; Metcalf and Eddy, 1991; Roll and Fujioka, 1997
Wild Turkey		155	1.13E+08	1.75E+10	Used Turkey
Other wildlife		2,651	5.00E+09	1.33E+13	Used Pets
Dogs and Cats		10,874	5.00E+09	5.44E+13	Horsley and Witten, 1996

*American Society of Agricultural Engineers

Figure 1: Estimated Fecal Coliform Produced by Source Category

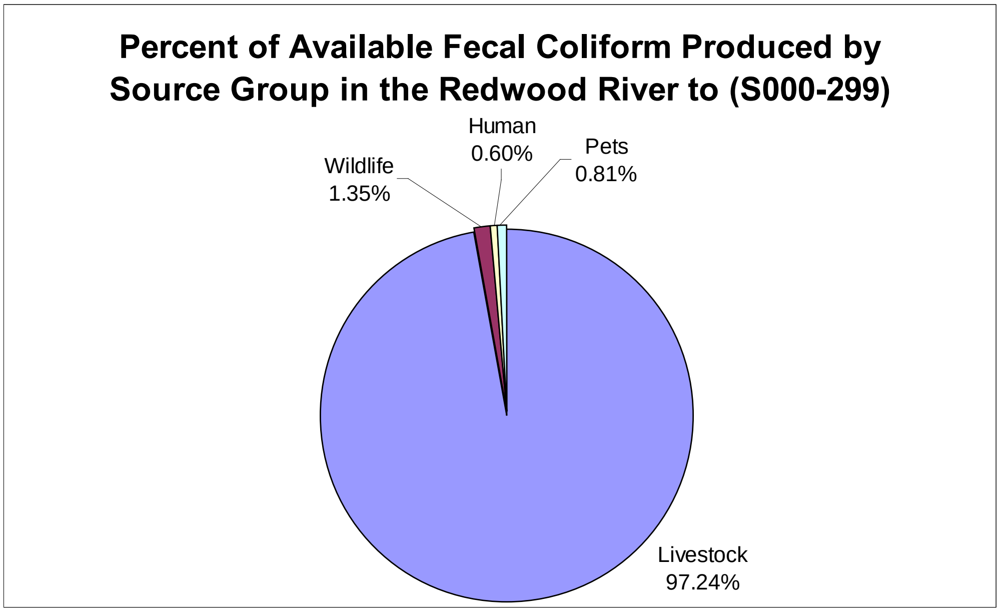
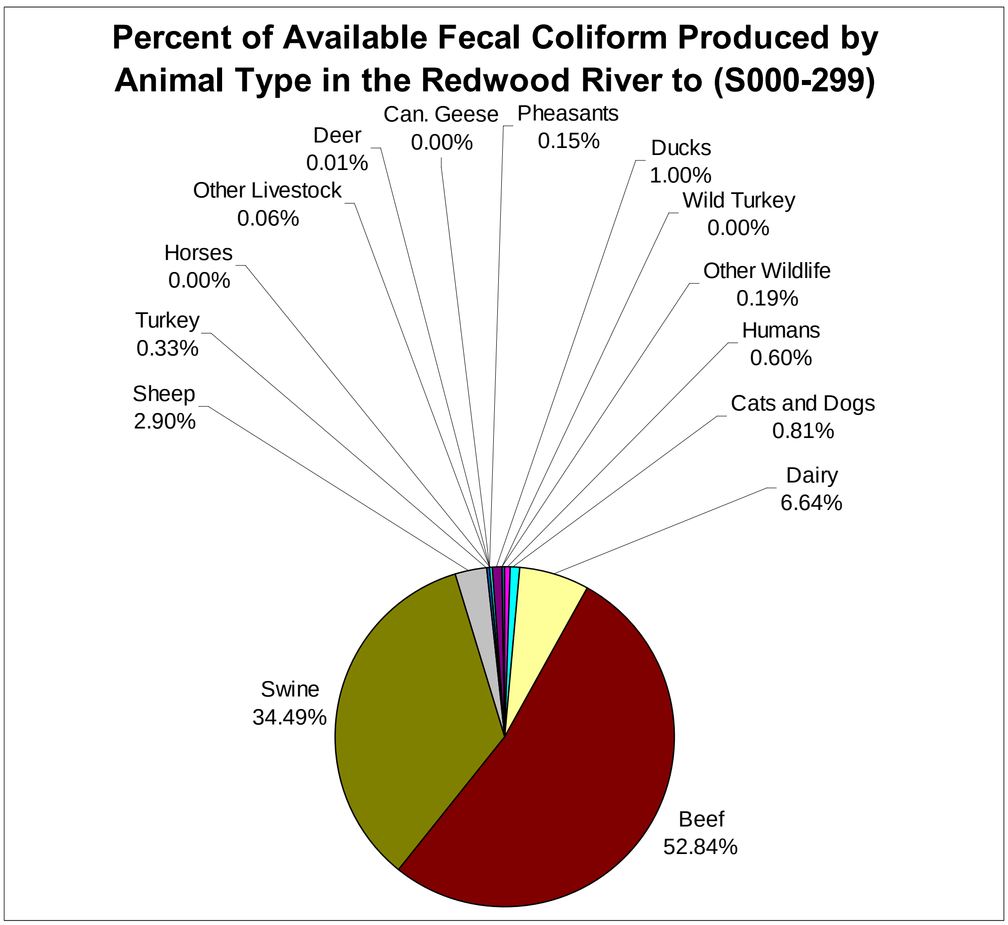


Figure 2: Estimated Fecal Coliform Bacteria Produced by Source



Potential Fecal Coliform Sources by Application Type/Method

The total potential fecal coliform produced in the Redwood River Watershed was further dissected. For the human population, the number of people that have adequately and inadequately treated wastewater systems were counted in both rural and urban areas. For livestock, assumptions were made regarding the method of manure application and animal type. The ratio of potential manure sources based on application/source method was based on assumptions derived from the Generic Environmental Impact Statement (GEIS) on Animal Agriculture, prepared by the Minnesota Environmental Quality Board. The document provides general guidelines on how and where livestock manure is applied to land in Minnesota. Like other projects in Minnesota, the assumptions of manure were modified to portrayed activities in the watershed. The GEIS states that 80 percent of swine manure is incorporated and 20 percent is land applied. Based on trends in the application of swine manure from surface applied to incorporated we elected to assume 95 percent of swine manure is incorporated, five percent surface applied. Table 2 provides the assumptions used and their resulting categories for the entire Redwood River watershed.

Table 2: Assumptions for Calculating FC by Source/Application Method

Category	Source	Assumptions*	Animal Units or Individuals
Livestock	Pastures within 1000' of Streams and Waterways	20% Dairy Manure 47% Beef Manure 1% Horse Manure 1% Sheep Manure	1,300 Dairy AU 17,370 Beef AU 2 Horse AU 14 Sheep AU
	Pastures Greater than 1000' from Streams and Waterways	5% Dairy Manure 13% Beef Manure	325 Dairy AU 4,804 Beef AU
	Feedlots and Stockpiles without Runoff Controls	1% Dairy Manure 5% Beef Manure 1% Turkey Manure	65 Dairy AU 1,848 Beef AU 37 Turkey AU
	Surface Applied Manure	37% Dairy Manure 17.5% Beef Manure 5% Swine Manure 49.5% Horse Manure 49.5% Sheep Manure 49.5% Turkey Manure 50% Other Livestock	2,405 Dairy AU 6,468 Beef AU 1,697 Swine AU 112 Horse AU 668 Sheep AU 1,810 Turkey AU 20 Other Livestock AU
	Incorporated Manure	37% Dairy Manure 17.5% Beef Manure 95% Swine Manure 49.5% Horse Manure 49.5% Sheep Manure 49.5% Turkey Manure 50% Other Livestock	2,405 Dairy AU 6,468 Beef AU 32,243 Swine AU 112 Horse AU 668 Sheep AU 1,810 Turkey AU 20 Other Livestock AU
Human	Inadequately Treated Wastewater Adequately Treated Rural Wastewater Municipal Wastewater Treatment Facilities	13.27% of Human Waste 11.41% of Human Waste 75.32% of Human Waste	2,796 People 2,406 People 15,879 People
Wildlife	Wildlife	100% of Deer 100% of Geese 100% of Pheasants 100% of Ducks 100% of Wild Turkeys 100% of Other Wildlife	3,525 Deer 1,293 Geese 54,285 Pheasants 15,389 Ducks 155 Wild Turkeys 2,651 Other Wildlife
Pets	Pets	100% of Dogs and Cats	10,874 Cats and Dogs

*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.

Delivery Assumptions

To estimate the primary sources of fecal coliform bacteria contamination in the Redwood River watershed, the delivery ratios presented in Table 3 were used. These figures were derived from Appendix C of the Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota, 2002 (revised 2006). The delivery ratios are based on expert opinions and should be taken in relative rather than absolute terms.

Table 3: Delivery Assumptions

Category	Source	Wet Conditions	Dry Conditions
Livestock	Pastures within 1000' of Streams and Waterways	1.0%	0.1%
	Pastures Greater than 1000' from Streams and Waterways	0.1%	0.0%
	Feedlots and Stockpiles without Runoff Controls	4.0%	0.0%
	Surface Applied Manure	1.0%	0.0%
	Incorporated Manure	0.1%	0.0%
Human	Inadequately Treated Wastewater	8.0%	8.0%
Wildlife	Wildlife	0.5%	0.0%
Pets	Pets	4.0%	1.0%

Target Areas for Fecal Coliform Bacteria

The amount of fecal material delivered from any one source will vary depending on many factors. Because of this uncertainty, it is difficult to accurately breakdown the percent of bacterial contamination from each source. Instead, categories were used to list the sources of bacterial contamination in the impaired reaches. Table 4 presents the likely major sources of bacterial loading in the Redwood River watershed, 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 are considered dry; however the majority of bacterial loading to streams occurs during wet conditions. Categories were defined as less than five percent being a low contributor, five to twenty percent a moderate contributor and greater than twenty percent a high contributor.

Table 4: Target Areas for FC Reduction in the Redwood River

Category	Source	Wet Conditions	Dry Conditions
Livestock	Pastures within 1000' of Streams and Waterways	High Contributor	High Contributor
	Pastures Greater than 1000' from Streams and Waterways	Low Contributor	Low Contributor
	Feedlots and Stockpiles without Runoff Controls	Moderate Contributor	Low Contributor
	Surface Applied Manure	High Contributor	Low Contributor
	Incorporated Manure	Moderate Contributor	Low Contributor
Human	Inadequately Treated Wastewater	Low Contributor	Moderate Contributor
Wildlife	Wildlife	Moderate Contributor	High Contributor
Pets	Pets	Low Contributor	Low Contributor

Appendix D: Agendas, Presentations and Handouts

Redwood and Cottonwood River Watershed Fecal Coliform Stakeholder and Technical Advisory Group 1st Meeting on Implementation Summary

Agenda:

10:00 Start- Welcome/Introductions

10:30 TMDL Overview/RCRCA's Goals and Objective as a Third Party Vendor

10:45 Responsibilities of a Technical Committee

11:00 Summary TMDLs/Watershed Characteristics/Load Equation (WLA, LA, MOS, RC and Resulting Duration Curves -Doug

Noon: Lunch

1:00 Presentation on Developing Accurate Animal Unit Numbers and Sources for both Production Ag and Wildlife -Shawn

1:30 Questions/Comments/Set Date for next month-Adjourn

2:00 Other business – available cost-share

Minutes of the February 20th Technical Advisory/Enhanced Stakeholder Meeting Concerning the Redwood and Cottonwood River Fecal TMDL Rough Drafts.

Attendees: Marilyn Bernhardson, Redwood County SWCD; Bob Jahn, City of Marshall; LouAnn Nagel, Yellow Medicine SWCD; Desiree Hoenstein, Brown County; Cheryl Isder, NRCS DC Yellow Med; Howard Konkel, Murray County SWCD; Randy Kraus, Lincoln SWCD; Dennis Johnson, NRCS DC Lincoln; Jon Mitchell, Redwood County PZ; Tom Maher, Brown County SWCD; Chris Hansen, Murray County Environmental; Dave Voigt, NRCS Soil Con Tech, Lyon Co.; Beth Stueven, Redwood County PZ; Lance Otto, Redwood County Landowner-C/SB growers; Kelly Heather, NRCS DC, Redwood Co.
Staff: Jim Doering, RCRCA Executive Director; Doug Goodrich, Watershed Technician; Shawn Wohnoutka, RCRCA Education/GIS Technician.

Agenda Items:

Welcome/Meet and Greet
TMDL overview
RCRCA's Goals and Objectives and Role as a third party vendor
Doug Goodrich's presentation on TMDLs, watershed characteristics, WLA, LA, MOS, RC and resulting flow duration curves.
Lunch
Shawn Wohnoutka's presentation on developing accurate animal unit numbers and sources for both production ag and wildlife.
Set next meeting/Adjourn

Concerns/Comments raised during the meeting:

1. Purpose of the meeting and its relation to a stakeholder meeting? Jim Doering explained that this is a technical advisory meeting and the stakeholder meetings will happen after these working sessions. Doering explained that RCRCA has taken the data it has generated since 1990 to present and used that to develop the draft TMDLs. The format has been set based on currently approved fecal TMDLs and RCRCA has added it's information into the same format and produced a tangible working product to review and revise if needed.
2. Various questions were raised on how the WLA, LA, MOS, and RC values were generated with no major concerns.
3. Comments were made they wish there were more local landowners present.
4. Doering closed with the instructions for the committee to review the TMDLs and send comments and concerns via e-mail to be addressed at the next meeting.
5. Doering also stated that RCRCA will add the implementation summary to the TMDLs for the next meeting and the committee is to be prepared to revise them according to other water quality plans in order to remain consistent and to develop implementation strategies that will satisfy these TMDLs and existing plans.

The group set the next meeting for April 7th with the location TBA

Redwood and Cottonwood River Watershed Fecal Coliform Stakeholder and Technical Advisory Group 2nd Meeting on Implementation Summary

Agenda:

10:00 Start- Welcome

10:15 Review- TMDL report so far- question and answers

11:15 Summary Implementation Plan-Doug

Noon: Lunch

1:00 Current plans addressing Fecal Coliform

1:30 BMP selection by reach –Current and Premier Suggestions

2:00 Set Date for next month-Adjourn

Minutes of the April 7th Technical Advisory/Enhanced Stakeholder Meeting Concerning the Redwood and Cottonwood River Fecal TMDL Rough Drafts.

Attendees: Steve Soderman, MNCGA; Marilyn Bernhardson, Redwood County SWCD; Matt Drewitz, BWSR; Bob Jahn, City of Marshall; LouAnn Nagel, Yellow Medicine SWCD; Desiree Hoenstein, Brown County; Cheryl Isder, NRCS DC Yellow Med; Howard Konkel, Murray County SWCD; Ron Madsen, Lincoln SWCD; Pauline VanOverbeck, Lincoln Co. SWCD; Tom Maher, Brown County SWCD; Lance Otto, Redwood County Landowner-C/SB growers; Kelly Heather, NRCS DC, Redwood Co.; Dave Englin, Comfrey Area; Brian Johnson, Redwood Co. Pork Producers; Greg Bartz, Farmers Union; Gorge Goblish, MSGA; Steven Commerford, Crop Consultant; Arland Roiger, Springfield Area; Butch Kerkhoff, Redwood Area; April Sullivan, NRCS DC, Cottonwood Co.; Dave Bucklin, Cottonwood Co. SWCD; Mark T. Hanson, MPCA; Kerry Netzke, AreaII;
Staff: Jim Doering, RCRCA Executive Director; Doug Goodrich, Watershed Technician; Shawn Wohnoutka, RCRCA Education/GIS Technician.

Agenda Items:
Welcome/Meet and Greet
TMDL overview
Lunch/Networking
TMDL overview cont.
Set next meeting/Adjourn

In light of the many new faces RCRCA followed reviewed the previous meetings agenda.
Concerns/Comments raised during the meeting:

1. Doering explained that RCRCA has taken the data it has generated since 1990 to present and used that to develop the draft TMDLs. The format has been set based on currently approved fecal TMDLs and RCRCA has added it's information into the same format and produced a tangible working product to review and revise if needed.
2. Various questions were raised on how the WLA, LA, MOS, and RC values were figured. Questions and much discussion related to what specific groups were actually included in the LA portion of the equation and why the MOS was so large in some cases. Goodrich explained the equations in more detail and walked through examples of what groups could be included. Goodrich and Doering explained that no calculations in terms of LA values were done at this point in the load equations. Concerns that agricultural activities may not contribute a significant amount to the overall load equation were discussed at length. Some in the group put it to the staff to produce studies involving the actual reasoning behind pathogen standards used in these studies. Staff members acknowledged this request and others to explain bacteria life cycles and relation to sediment and natural conditions (temperature, moisture, etc.)
3. Comments were made they wish there were more local landowners present.
4. Discussions ran long at this meeting and the explanation of the TMDL process would need to finish at the next meeting.
5. Doering closed with the instructions for the committee to review the TMDLs and send comments and concerns via e-mail to be addressed at the next meeting. The group set the next meeting for May 28th with the located at the Redwood Area Community Center. Start time 10:00 a.m. until 2:00 p.m.

Redwood and Cottonwood River Watershed Fecal Coliform Stakeholder and Technical Advisory Group 3rd Meeting on Implementation Summary

Agenda:

10:00 Start- Welcome

10:15 Review- TMDL report so far- question and answers

11:15 Individual Reach Summary/Load Duration Curves/Implementation Techniques - Doug

Noon: Lunch

1:00 Pathogens in Water/Studies and Reasoning Behind FC Standard -Shawn

1:30 BMP selection by reach –Current and Premier Suggestions

2:00 Set Date for next month-Adjourn

Minutes of the May 28th Technical Advisory/Enhanced Stakeholder Meeting Concerning the Redwood and Cottonwood River Fecal TMDL Rough Drafts.

Attendees: LouAnn Nagel, Yellow Medicine SWCD; Desiree Hoenstein, Brown County; Pauline VanOverbeke, Lincoln Co. SWCD; Lance Otto, Redwood County Landowner-C/SB growers; Kelly Heather, NRCS DC, Redwood Co.; Brian Johnson, Redwood Co. Pork Producers; Steven Commerford, Crop Consultant; Butch Kerkhoff, Redwood Area; Mark T. Hanson, MPCA; Kerry Netzke, AreaII; Richard Trebesch, Landowner; Bob VanMoer, City of Marshall; Warren Formo, MN AgWater Resources Center; Jeremy Geske, Farm Bureau; Jeff Strock, University of Minnesota Southwest Research Center; Glenn Graff, Landowner; Howard Hamilton, Landowner; Mark Pankonin, MSCA Feedlot Council; Doug Albin, MCGA; Sam Ziegler, MSGA

Staff: Jim Doering, RCRCA Executive Director; Doug Goodrich, Watershed Technician; Shawn Wohnoutka, RCRCA Education/GIS Technician.

Agenda Items:
Welcome
Recap
Finish presentation on TMDL process
Lunch
Presentation information on surface water pathogens/Standards Reasoning
Set next meeting/Adjourn

Concerns/Comments raised during the meeting:

1. Comments that failing septic systems would be a major contributer in dry periods according to the loading curve. The staff agreed that failed septic system would have a greater impact during dryer periods and could possibly provide a large source of new bacteria as a percentage under the right conditions.
2. Other comments and discussion involving what types of activities would help reduce fecal bacteria movement during different flows. Comments were made on how it made sense to use the actual volume of the river was better to use than a temporal regime.
3. Much disagreement was expressed on whether standards made sense for rivers in southwestern Minnesota and that studies such as this one shouldn't be conducted until actual sources could be accounted for by species/specific source. Staff and agency staff expressed again that this study was undertaken because it is a requirement of the EPA and that the standards used were set by EPA and MPCA. Staff also expressed that this was not the forum to voice opposition to the standards and that the TMDL process serves to determine what reduction of pollutant would be needed to bring a water body to standards and that the TMDL equation and Stream Load Capacity needs to be part of that process.
4. Doering closed with the instructions for the committee to review the TMDLs and send comments and concerns via e-mail to be addressed at the next meeting.

The group set the next meeting for June 25th with the located at the Redwood Area Community Center. Start time 10:00 a.m. until 2:00 p.m.

Redwood and Cottonwood River Watershed Fecal Coliform Stakeholder and Technical Advisory Group 4th Meeting on Implementation Summary

Agenda:

10:00 Start- Welcome

10:15 RCRCA's Responsibility in the TMDL Process/Federal and State Requirements in Relation to the Clean Water Act -Doug

11:15 Load Duration Curves and Sampling Data/Inventory of Available Bacteria Load and Calculation of Bacteria Delivery per Source Based on Estimations of Professional Judgment -Doug

Noon: Lunch

1:00 BMP selection by reach –Current and Premier Suggestions

1:30 Group Selection/Suggestions for Bacteria Reduction for Each Reach and Flow Type

2:00 Adjourn- Discuss Future Correspondence

Minutes of the June 25th Technical Advisory/Enhanced Stakeholder Meeting Concerning the Redwood and Cottonwood River Fecal TMDL Rough Drafts.

Attendees: Steve Soderman, MNCGA; Marilyn Bernhardson, Redwood County SWCD; Steven Commerford, Crop Consultant; Mark T. Hanson, MPCA; Kerry Netzke, Area II; Paul Hagen, C-SB Growers; Glen Graff, Landowner; Harley Vogel, Landowner New Ulm Area; Warren Formo, MAWRC

Staff: Jim Doering, RCRCA Executive Director; Doug Goodrich, Director/Watershed Technician; Shawn Wohnoutka, RCRCA Education/GIS Technician.

Agenda Items:
Welcome
Recap
Presentation – Requirements of Various Agencies in the TMDL Process/Load Duration Curve and Sampling Analysis
Lunch
Presentation – Inventory of Available Bacteria Load and Calculation of Bacteria Delivery per Source Based on Estimations of Professional Judgment
Adjourn

Concerns/Comments raised during the meeting:

1. Goodrich explained the relationship of sampling data to load duration curve with no major concerns. A question was raised as to whether or not enough monitoring sites were being used. Discussion was pursued as to where agricultural activities fit into the "flow zones"
2. Discussion was revisited on whether or not the LA portion of the equation was overstating the amount of contribution due to agricultural activity. Staff explained that available pollutant and delivered pollutant are two different figures and quite possibly the delivery of agricultural manure, with proper handling, can have a low delivery rate. The fact of the matter is, that even with low delivery rate the available pollutant for agricultural practices far outweighs that of all other sources in terms of raw bacteria count. Much discussion followed. A breakdown of calculations step by step was performed by staff.
3. Doering closed with the instructions for the committee to review the TMDLs and send comments and concerns via e-mail due to the small turnout, and staff would answer concerns on a one to one basis.

Appendix E: Responses to Written Comments

Compilation of comments received for the Cottonwood River Fecal Coliform Total Maximum Daily Load (TMDL) and the Redwood River Fecal Coliform TMDL. (Responses apply to both TMDLs because identical comments were received for each.)

The following comments were received from the Minnesota Corn Growers Association's (MCGA):

Concern #1-
"The description of seasonal variation offers one perspective based on water monitoring trends ("Monitoring data show an apparent relationship between season and fecal coliform bacteria concentrations. 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"). We would suggest that this seasonality be explained more completely, especially the general link between lower flows and higher temperature and bacteria concentrations. The water monitoring data suggests that there is a minimal association between manure applications and bacteria concentrations, as the majority of manure applications occur in the October-November and April-May timeframes, both periods of lower bacteria concentrations."

MPCA response: The quotation cited is taken from the brief draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs Summary Tables. More detail on the seasonality of bacteria is given in Section 7 (Seasonal Variation) of the draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs.

Concern #2-
"The Executive Summary discussion of livestock manure suggests that a majority of livestock producers in the watersheds are "probably" handling manure and conducting land application consistent with current rules, guidelines, and University of Minnesota recommendations. A scientific assessment should not be based on "probably". Was there an effort to quantify or characterize the manure management practices of farmers in the watersheds? Further, this section also suggests that "even if less than 1% of the land applied manure enters surface waters, it could account for violations of water quality standards. Again, this statement appears to be based on conjecture, not science. What if the correct estimate is 0.1%, or 0.01%? Will similar use of conjecture be applied equally to all sources and to resulting 1oad allocations?"

MPCA response: There was not an effort to quantify or characterize manure management practices; rather the comment is intended to recognize the observation of local water quality professionals that in general, citizens of the watershed try to do the right thing.

The statement "even if less than 1% of the land applied manure enters surface waters, it could account for violations of water quality standards" was not based on conjecture. It was a calculation based on the animal units of land applied manure known, calculated bacteria content per animal unit type applied to the watershed, and actual calculated TMDLs of the systems. At the low flow rates equal to the 90th percentile, historic flows on the Cottonwood River would be exceeded if only 0.74% of all land applied manure reached the river; the Redwood River would be exceeded under the same flow conditions (90th percentile) by only 0.53% of available manure reaching the river.

Concern #3-
"Land use values provided in section 2.3 seem to overstate the area of cultivated cropland. The Redwood River watershed is listed at 85.5% cultivated land. The Cottonwood River watershed is listed at 88% cultivated lane. While it is a relatively small issue in these reports, it is important that methods and definitions be consistent. USDA data suggests that actual cultivated area is overstated by 6-8%. Please provide clarification of the data sources."

MPCA Response: Data from the Land Management Information Center (LMIC 1993) was used, which was obtained from the DNR's Minnesota Geospatial Data Office.

Concern #4-
"We are opposed to the wasteful use of taxpayer resources to addressing bacteria standards on Class 7 waters, which are highly unlikely to be used for aquatic recreation."

MPCA response: Class seven (7) waters often flow into other classes of waterbodies and thus can have direct impacts to water quality and aquatic recreation downstream. Water quality standards are reviewed every three years and public comments are welcomed during this process. The following MPCA website has more detailed information about the triennial review process:
http://www.pca.state.mn.us/iryp1405.

Concern #5-
"Section 4.1 of the draft reports provides an overview of fecal coliform sources, but does not include research conducted in the Minnesota River Basin by Dr. Michael Sadowsky, funded by the citizens of Minnesota through Clean Water Funds. This report, which is attached, reveals that fecal coliform bacteria may be living in and even reproducing outside of the intestines of warm blooded animals. This finding makes the TMDL statement "though the mechanisms cited above have a possible effect on the values of pollutant calculated in this report, they are not quantifiable at this time" even more ominous. The development of load allocations should be undertaken with great caution."

MPCA response: Upon receipt of comments during the public comment period, MPCA staff carefully reviewed and considered the Sadowsky study. In addition, MPCA staff discussed the Sadowsky study and specifically whether the natural background discussion contained within the proposed draft Cottonwood River and Redwood River Fecal Coliform TMDLs should be altered in light of the Sadowsky study's findings.

The MPCA staff also contacted and met with Dr. Sadowsky, the author of the study. The meeting focused entirely on the potential implications of Dr. Sadowsky's findings in light of the proposed draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Dr. Sadowsky cautioned about translating the results of his work to load allocations, and about the extrapolation of the results from the Seven Mile Creek watershed to the Cottonwood River and Redwood River watersheds.

MPCA staff worked with Dr. Sadowsky and Dr. Adam Birr (former Minnesota Department Agriculture Research Coordinator) to develop language additions and changes which were drafted for the draft Cottonwood River Fecal Coliform TMDL, but also apply to the draft Redwood River Fecal Coliform TMDL.

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.1 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs:

> "Two Minnesota studies describe the presence and growth of "naturalized" or "indigenous" strains of *E. coli* in watershed soils (Ishii et al., 2006) and ditch sediment and water (Sadowsky et al., 2010). The latter study, supported with Clean Water Land and Legacy funding, was conducted in the Seven Mile Creek watershed, an agricultural landscape approximately 30 miles to the east of the mouth of the Cottonwood River. DNA fingerprinting of *E. coli* from sediment and water samples collected in Seven Mile Creek from 2008-2010 resulted in the identification of 1568 isolates comprised of 452 different *E. coli* strains. Of these strains, 63.5% were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. Discussions with the primary author of the Seven Mile Creek study suggest that while 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study period, this percentage is not directly transferable to the concentration and count data of *E. coli* used in water quality standards and TMDLs. Additionally, because the study is not definitive as to the ultimate origins of this bacteria, it would not be appropriate to consider it as "natural" background. Finally, the author cautioned about extrapolating results from the Seven Mile Creek watershed to other watersheds without further studies."

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.2.4 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs and changes the title of these sections from "Wildlife Sources" to "Wildlife/Natural Background Sources."

> "Section 4.1 discusses the potential of "naturalized" or "indigenous" bacteria in soils, ditch sediment, and water as an additional source. However, the studies cited are not definitive as to the magnitude of this contribution. Additionally, the

> studies are not definitive as to the ultimate origins of this bacteria, so it may not be appropriate to consider it as "natural" background."

In addition to the changes as outlined immediately above, Dr. Adam Birr suggested MPCA include a statement of the pragmatic implications of the Sadowsky study:

> "From a pragmatic standpoint, this study suggests that there is a fraction of bacteria that may exist regardless of most traditional implementation strategies that are employed to control the sources of *E. coli*."

The MPCA hereby incorporates the language contained above into Section 4 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Concern #6-

"We find it curious that the discharge of partially or untreated human sewage would ever by described as "legal" (section 4.2.1)."

MPCA response: The word "legal" has been deleted and new language has been developed for this paragraph to clarify circumstances in which municipal wastewater bypasses occur. The new language is as follows:

> "Municipal bypasses are emergency discharges of partially or untreated human sewage from waste water treatment facilities. Municipal wastewater facilities shall not allow an anticipated bypass to occur unless the bypass is unavoidable to prevent loss of life, personal injury, or severe damage to the facility or private property. Municipal bypasses sometimes occur during periods of heavy precipitation, when treatment facilities become hydraulically overloaded. Conditions for bypasses are detailed in the facility's NPDES permit and Minn. R. 7001.1090."

Concern #7-

"The discussion of urban stormwater in section 4.2.1 states that "Fecal coliform concentrations in urban runoff can be as great as or greater than those found in cropland runoff and feedlot runoff' citing a 2001 USEPA source. Did the authors attempt to determine actual fecal coliform concentrations and/or loads from urban runoff? The permit for cities falling under stormwater regulation are required to perform "a range of actions that will ultimately reduce the impact of stormwater", but monitoring to determine effectiveness is rarely conducted and would be extremely useful in both source identification and evaluating implementation effectiveness."

MPCA response: The authors of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs did not attempt to determine the actual loads from urban sources. Rather, estimates of urban loadings were taken from the Source Assessment section in the USEPAs 2001 Protocol for Developing Pathogen TMDLs, which is cited as a reference in Section 11 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

The comment about effectiveness monitoring is acknowledged.

Concern #8-
"Did the authors attempt to determine the extent of manure handling and land application methods in the watershed beyond the stated analysis that "the majority of livestock producers in the watersheds are most likely handling their manure and conducting land application consistent with current rules, guidelines, and University recommendations"? A scientific assessment should not be based on "most likely". Was there an effort to quantify or characterize the manure management practices of farmers in the watersheds? Further, this section also suggests that "even if less than 1% of the land applied manure enters surface waters, it could account for violations of water quality standards. Again, this statement appears to be based on conjecture, not science. What if the correct estimate is 0.1%, or 0.01%? Will similar use of conjecture be applied equally to all sources and to resulting 1oad allocations?"

MPCA response: There was not an effort to quantify or characterize manure management practices; rather the comment is intended to recognize the observation of local water quality professionals that in general citizens of the watershed try to do the right thing.

The statement "even if less than 1% of the land applied manure enters surface waters, it could account for violations of water quality standards" was not based on conjecture. It was a calculation based on the animal units of land applied manure known, calculated bacteria content per animal unit type applied to the watershed, and actual calculated TMDLs of the systems. At the low flow rates equal to the 90th percentile, historic flows on the Cottonwood River would be exceeded if only 0.74% of all land applied manure reached the river; the Redwood River would be exceeded under the same flow conditions (90th percentile) by only 0.53% of available manure reaching the river.

Concern #9-
"According to section 5.2.1 of the draft report, "As long as WWTFs discharge at or below their permit limit, they will not cause violations of the fecal coliform water quality standard." Is this always true, given that discharge could contain bacteria which settle into stream sediments, then be re-suspended by subsequent events? As stated in the report, under low flow conditions, waste water treatment facilities contribute as much as 1996%, of daily load capacity. Also as stated in the report, actual WWTF effluent concentration cannot exceed the stream concentration as stream flow must be at least 100% of WWTF discharge. However, this may allow for storage of excess bacteria in stream sediments."

MPCA response: The reference in the draft Redwood River Fecal Coliform TMDL to WWTF contributing 1996% has been clarified in all of the applicable loading capacity and allocation tables. The correct wasteload allocation for these low flow zones is calculated by multiplying the maximum daily flow of the WWTFs by 200 organisms per 100 mL.

The discharge of wastewater containing concentrations of fecal coliform bacteria that are less than or equal to 200 organisms/100 mL (or 126 *E. coli* organisms/100 mL) will not cause violations of the water quality standard. NPDES permit effluent limits for fecal coliform bacteria are based on the understanding that discharges in compliance with permit limits do not cause or contribute to violations of the applicable water quality standard. Also, wastewater effluent disinfection usually provides a nearly complete bacterial kill, particularly when chlorine is used and as a result effluent concentrations are usually well below the permitted effluent limitations. Questions relating to the deposition and re-suspension of viable fecal coliform or *E. coli* organisms in flowing waterbodies are the subject of ongoing research and discussion.
The load duration analysis does not address bacteria re-growth in sediments, die-off, and natural background levels. Sampling of bottom sediment is not done to determine impairments. Only samples of the water column are taken, and bottom sediment is not part of the water column. The current bacteria standard is written to protect human health while swimming in water. The margin of safety helps to account for the variability associated with these conditions.

Concern #10-
“The reserve capacity discussion in section 5.2.4 includes a comment suggesting that livestock numbers "appear to be concentrated in fewer operations." Are the authors suggesting a relationship between bacteria-related water impairments and the size of farm operations? If so, is the relationship direct or inverse? If the authors are not suggesting such a relationship, this sentence should be deleted.”

MPCA response: The statement was not meant to imply a relationship between the bacteria-related water impairments and the size of farm operations. Rather it was a simple demographic observation. This comment is acknowledged but results in no changes to the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Concern #11-
“The Seasonal Variation discussion in section 7.0 states that summer is the peak season of "agriculture" and that soil is "presumably at peak seasonal load for fecal coliform by mid-summer". What assessment tools were used to define "agriculture's" peak season? Could this information be used elsewhere to assess manure management practices?”

MPCA response: The comment intended to make the point that most land application of manure occurs prior to crop growth in the spring. In the summer, then, the land has the most manure of the season when rainstorms can wash it away. The comment also intended to make the point that summer is the peak season of crop growth, not simply “agriculture.” This paragraph has been removed from both draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Concern #12-

“The implementation strategy outlined in section 9.1estimates that the cost to put "animal agricultural activities under manure management and feedlot runoff mitigation plans" at around $25 million. What is the basis for this estimate?”

MPCA response: As section 9.1 in the draft Cottonwood River and Redwood River Fecal Coliform TMDLs states, this estimation was based on EQIP payment history and the number of non-NPDES permitted animal units listed in the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

The following comments were received from the Minnesota State Cattlemen’s Association (MSCA):

Comment MSCA #1:
“The Minnesota State Cattlemen’s Association (MSCA) requests the MPCA withdraw the current Total Maximum Daily Load (TMDL) plan for the Redwood and Cottonwood Rivers and re-engage local stakeholders to discuss monitoring, allocation and remediation issues related to bacteria.”

MPCA response: The MPCA declines the request to withdraw the draft Cottonwood River and Redwood River Fecal Coliform TMDLs. The draft Cottonwood River and Redwood River Fecal Coliform TMDL studies were conducted in a manner consistent with EPA guidance, MPCA protocol, and previous EPA approved bacteria TMDLs. A Stakeholder/Technical Advisory process was established and utilized in the development of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs. A collaboration of interest groups, organizations, and citizens were invited and participated in this process as well as local, state, and federal agencies to provide input in the development of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs. Stakeholder/Technical Advisory meetings were held February 2008, April 2008, May 2008 and June 2008 in Redwood Falls. An electronic mail message was sent August 2010 from RCRCA to the Stakeholder/Technical Advisory group to request review and provide comments on the final draft Cottonwood River and Redwood River Fecal Coliform TMDLs prior to the public notice comment period. No comments were received from the Stakeholder/Technical Advisory group. The draft Cottonwood River and Redwood River Fecal Coliform TMDLs were revised based on EPA comments and responses sent to EPA in November 2010.

Comment MSCA #2:
“<u>Lack of local livestock stakeholder involvement and engagement</u>
As you know, civic engagement and a formal stakeholder process are required under the Clean Water Legacy Act. Area cattle farmers do not feel they have had an adequate opportunity to provide input into this process nor had time to fully evaluate the ramifications. The MSCA also requests the MPCA clarify the consequences of the TMDL to current NPDES permitted cattle farms in the watershed.”

MPCA response: The public notice comment period for the draft Cottonwood River and Redwood River Fecal Coliform TMDLs was April 25, 2011 to May 25, 2011. The draft

Cottonwood River and Redwood River Fecal Coliform TMDLs were posted on the MPCA web site along with a press release and a copy of the mailing sent to interested parties. The timeline for this public comment period was consistent with the length of other TMDLs, and the MPCA feels that due diligence was fulfilled in making interested parties aware of the Cottonwood River and Redwood River Fecal TMDL development. Also, the stakeholder group included area cattle farmers.

As the draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs states in section 5.2.1, “livestock facilities that have been issued NPDES permits are assigned a zero wasteload allocation. This is consistent with the conditions of the permit, which allow no pollutant discharge from the livestock housing facilities and associated sites. 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 draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs, provided the manure is applied in accordance with the permit”. The draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs will not change the requirements of the current NPDES permit for existing permitted cattle farms.

Comment MSCA #3:
“Questions over designated use
There is uncertainty over what is the actual designated use the Minnesota Pollution Control Agency (MPCA) is attempting to address through these TMDL plans. Clarification is needed whether this TMDL is focused on restoring aquatic recreation or aquatic life. As you know, the measures that must be taken to address the different designated uses will vary significantly.

If the designated use is aquatic recreation, the MSCA requests the MPCA to identify which recreation and swimming areas in the watershed are effected. If the designated use if aquatic life, the MSCA requests the MPCA to identify specific strategies that will address water temperature and tree plantings along riparian areas.”

MPCA response: Impairments for fecal coliform bacteria, such as the ones in the draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs, are impairments of the beneficial use of aquatic recreation.

All of the reaches identified in the draft Cottonwood River Fecal Coliform and Redwood River Fecal Coliform TMDLs are waters of the state. People are free to recreate (which includes but is not limited to swimming) in waters of the state wherever they wish.

Comment MSCA #4:
“Questions over monitoring and correct accounting for sources of bacteria
As you know, accounting for bacteria numbers and sources is a highly technical matter with evolving science. I would point out recent research by Dr. Sadowsky that suggests some strains of coliform bacteria are capable of surviving, being re-suspended and

multiplying in soil or steam sediments. If this is the case, strategies to eliminate existing bacteria must be employed, rather than simply focusing on eliminating new sources.

We would also question the assumption that bacteria loadings are primarily caused by manure application. The MSCA requests additional information from the MPCA in terms of failing septic systems and municipal waste water discharges and their potential loadings to area watersheds. Furthermore, the MSCA requests that MPCA deliver genetic fingerprinting data that validates the sources of the bacteria."

MPCA response: Upon receipt of comments during the public comment period, MPCA staff carefully reviewed and considered the Sadowsky study. In addition, MPCA staff discussed the study and specifically whether the natural background discussion contained within the proposed draft Cottonwood River and Redwood River Fecal Coliform TMDLs should be altered in light of the Sadowsky study's findings.

The MPCA staff also contacted and met with Dr. Sadowsky, the author of the study. The meeting focused entirely on the potential implications of Dr. Sadowsky's findings in light of the proposed draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Dr. Sadowsky cautioned about translating the results of his work to load allocations, and about the extrapolation of the results from the Seven Mile Creek watershed to the Cottonwood River and Redwood River watersheds.

MPCA staff worked with Dr. Sadowsky and Dr. Adam Birr (former Minnesota Department Agriculture Research Coordinator) to develop language additions and changes which were drafted for the draft Cottonwood River Fecal Coliform TMDL, but also apply to the draft Redwood River Fecal Coliform TMDL.

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.1 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs:

> "Two Minnesota studies describe the presence and growth of "naturalized" or "indigenous" strains of *E. coli* in watershed soils (Ishii et al., 2006). and ditch sediment and water (Sadowsky et al., 2010). The latter study, supported with Clean Water Land and Legacy funding, was conducted in the Seven Mile Creek watershed, an agricultural landscape approximately 30 miles to the east of the mouth of the Cottonwood River. DNA fingerprinting of *E. coli* from sediment and water samples collected in Seven Mile Creek from 2008-2010 resulted in the identification of 1568 isolates comprised of 452 different *E. coli* strains. Of these strains, 63.5% were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. Discussions with the primary author of the Seven Mile Creek study suggest that while 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study period, this percentage is not directly transferable to the concentration and count data of *E. coli* used in water quality standards and TMDLs. Additionally, because the study is not definitive as to the ultimate origins of this bacteria, it would not be

> appropriate to consider it as "natural" background. Finally, the author cautioned about extrapolating results from the Seven Mile Creek watershed to other watersheds without further studies."

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.2.4 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs and changes the title of these sections from "Wildlife Sources" to "Wildlife/Natural Background Sources."

> "Section 4.1 discusses the potential of "naturalized" or "indigenous" bacteria in soils, ditch sediment, and water as an additional source. However, the studies cited are not definitive as to the magnitude of this contribution. Additionally, the studies are not definitive as to the ultimate origins of this bacteria, so it may not be appropriate to consider it as "natural" background."

In addition to the changes as outlined immediately above, Dr. Adam Birr suggested MPCA include a statement of the pragmatic implications of the Sadowsky study:

> "From a pragmatic standpoint, this study suggests that there is a fraction of bacteria that may exist regardless of most traditional implementation strategies that are employed to control the sources of *E. coli*."

The MPCA hereby incorporates the language contained above into Section 4.1 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Information with respect to failing septic systems can be found in MPCA's "2011 Annual Report Summary Minnesota Subsurface Sewage Treatment Systems" at: http://www.pca.state.mn.us/index.php/view-document.html?gid=17868

Information with respect to municipal waste water discharges can be found in section 5.3 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs. The wasteload allocations for permitted wastewater treatment facilities (WWTF's) in the draft Cottonwood River and Redwood River Fecal Coliform TMDLs are the potential loadings to the Cottonwood and Redwood River watersheds. Further information regarding municipal waste water discharges for specific facilities can be obtained by making an information request to the MPCA DataDesk at datadesk.mpca@state.mn.us.

DNA fingerprinting of *E.coli* bacteria was not done as part of these TMDLs. At this time the MPCA does not plan to do this testing. The MPCA feels the protocols used to delineate sources and loadings in the TMDLs are sufficient to meet TMDL goals.

The following comments were received from the Minnesota Pork Producers Association (MPPA):

Comment MPPA#1:

"It is known that some strains of coliform bacteria are capable of multiplying in soil or steam sediments (Sadowsky). As indicated in section 4.1 of the report, survival of fecal coliform in terrestrial and aquatic environments is poorly understood, exacerbating efforts to track sources. The report also acknowledges that bacteria survival and reproduction in stream sediments, and subsequent re-suspension in the water column, could have an effect on bacteria calculations, but that the magnitude of such processes cannot be quantified at this time.

If one accepts that notion that "pollution" is the result of human activity, should natural background also include naturalized populations of bacteria residing in sediments or soil?"

MPCA response: Upon receipt of comments during the public comment period, MPCA staff carefully reviewed and considered the Sadowsky study. In addition, MPCA staff discussed the study and specifically whether the natural background discussion contained within the proposed draft Cottonwood River and Redwood River Fecal Coliform TMDLs should be altered in light of the Sadowsky study's findings.

The MPCA staff also contacted and met with Dr. Sadowsky, the author of the study. The meeting focused entirely on the potential implications of Dr. Sadowsky's findings in light of the proposed draft Cottonwood River and Redwood Rivers Fecal Coliform TMDLs.

Dr. Sadowsky cautioned about translating the results of his work to load allocations, and about the extrapolation of the results from the Seven Mile Creek watershed to the Cottonwood and Redwood River watersheds.

MPCA staff worked with Dr. Sadowsky and Dr. Adam Birr (former Minnesota Department Agriculture Research Coordinator) to develop language additions and changes which were drafted for the draft Cottonwood River Fecal Coliform TMDL, but also apply to the draft Redwood River Fecal Coliform TMDL.

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.1 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs:

> "Two Minnesota studies describe the presence and growth of "naturalized" or "indigenous" strains of *E. coli* in watershed soils (Ishii et al., 2006) and ditch sediment and water (Sadowsky et al., 2010). The latter study, supported with Clean Water Land and Legacy funding, was conducted in the Seven Mile Creek watershed, an agricultural landscape approximately 30 miles to the east of the mouth of the Cottonwood River. DNA fingerprinting of *E. coli* from sediment and water samples collected in Seven Mile Creek from 2008-2010 resulted in the identification of 1568 isolates comprised of 452 different *E. coli* strains. Of these strains, 63.5% were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. Discussions with the primary author of the Seven Mile Creek study suggest that while 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study

> period, this percentage is not directly transferable to the concentration and count data of *E. coli* used in water quality standards and TMDLs. Additionally, because the study is not definitive as to the ultimate origins of this bacteria, it would not be appropriate to consider it as "natural" background. Finally, the author cautioned about extrapolating results from the Seven Mile Creek watershed to other watersheds without further studies."

The MPCA staff propose and the MPCA hereby incorporates the following language to Section 4.2.4 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs and changes the title of these sections from "Wildlife Sources" to "Wildlife/Natural Background Sources."

> "Section 4.1 discusses the potential of "naturalized" or "indigenous" bacteria in soils, ditch sediment, and water as an additional source. However, the studies cited are not definitive as to the magnitude of this contribution. Additionally, the studies are not definitive as to the ultimate origins of this bacteria, so it may not be appropriate to consider it as "natural" background."

In addition to the changes as outlined immediately above, Dr. Adam Birr suggested MPCA include a statement of the pragmatic implications of the Sadowsky study:

> "From a pragmatic standpoint, this study suggests that there is a fraction of bacteria that may exist regardless of most traditional implementation strategies that are employed to control the sources of *E. coli*."

The MPCA hereby incorporates the language contained above into Section 4.1 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

Comment MPPA #2:
"Did the authors attempt to quantify "legal emergency discharges of partially or untreated human sewage from waste water treatment facilities"? (section 4.2.1) Such discharges may not lead to immediate violations of water quality standards, due to dilution, but could settle in stream sediments and contribute to exceeding the standard in the future. "As long as WWTFs discharge at or below their permit limit, they will not cause violations of the fecal coliform water quality standard." (Section 5.2.1)

Is this always true, given that discharge could contain bacteria which settle into stream sediments, then be re-suspended by subsequent events? As stated in the report, under low flow conditions, waste water treatment facilities contribute as much as 1996%, of daily load capacity. Also as stated in the report, actual WWTF effluent concentration cannot exceed the stream concentration as stream flow must be at least 100% of WWTF discharge. However, this may allow for storage of excess bacteria in stream sediments."

MPCA response: The word "legal" has been deleted and new language has been developed for this paragraph to clarify circumstances in which municipal wastewater bypasses occur. The new language is as follows:

> "Municipal bypasses are emergency discharges of partially or untreated human sewage from waste water treatment facilities. Municipal wastewater facilities shall not allow an anticipated bypass to occur unless the bypass is unavoidable to prevent loss of life, personal injury, or severe damage to the facility or private property. Municipal bypasses sometimes occur during periods of heavy precipitation, when treatment facilities become hydraulically overloaded. Conditions for bypasses are detailed in the facility's NPDES permit and Minn. R. 7001.1090."

The reference in the draft Redwood River Fecal Coliform TMDL to WWTF contributing 1996% has been clarified in all of the applicable loading capacity and allocation tables. The correct wasteload allocation for these low flow zones is calculated by multiplying the maximum daily flow of the WWTFs by 200 organisms per 100 mL.

The discharge of wastewater containing concentrations of fecal coliform bacteria that are less than or equal to 200 organisms/100 mL (or 126 *E. coli* organisms/100 mL) will not cause violations of the water quality standard. NPDES permit effluent limits for fecal coliform bacteria are based on the understanding that discharges in compliance with permit limits do not cause or contribute to violations of the applicable water quality standard. Also, wastewater effluent disinfection usually provides a nearly complete bacterial kill, particularly when chlorine is used and as a result effluent concentrations are usually well below the permitted effluent limitations. Questions relating to the deposition and re-suspension of viable fecal coliform or *E. coli* organisms in flowing waterbodies are the subject of ongoing research and discussion.
The load duration analysis does not address bacteria re-growth in sediments, die-off, and natural background levels. Sampling of bottom sediment is not done to determine impairments. Only samples of the water column are taken, and bottom sediment is not part of the water column. The current bacteria standard is written to protect human health while swimming in water. The margin of safety helps to account for the variability associated with these conditions.

Comment MPPA #3:
"Did the authors attempt to determine actual fecal coliform concentrations and/or loads from urban runoff? (section 4.2.1) Permitted cities falling under stormwater regulation are required to perform "a range of actions that will ultimately reduce the impact of stormwater", but monitoring to determine effectiveness is rarely conducted."

MPCA response: The authors of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs did not attempt to determine the actual loads from urban sources. Rather, estimates of urban loadings were taken from the Source Assessment section in the USEPAs 2001 Protocol for Developing Pathogen TMDLs, which is cited as a reference in Section 11 of the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

The comment about effectiveness monitoring is acknowledged.

Comment MPPA #4:
"The reserve capacity discussion (section 5.2.4) includes a comment suggesting that livestock numbers appear to be concentrated in fewer operations. Do the authors have data supporting a link between bacteria-related water impairments and the size of farm operations? It would be inaccurate to imply that larger farms are more likely to contribute to pollution problems. It appears that animal units are the only consideration, and that management activities have little or no influence on determining load allocations. Proximity to surface waters (for all potential sources) does not seem to factor in to the load allocation. MPPA also takes issue with the statement: "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." Do the authors have any data to support that comment?"

MPCA response: The statement was not meant to imply a relationship between the bacteria-related water impairments and the size of farm operations. Rather it was a simple demographic observation. This comment is acknowledged but results in no changes to the draft Cottonwood River and Redwood River Fecal Coliform TMDLs.

The statement "even if less than 1% of the land applied manure enters surface waters, it could account for violations of water quality standards" was not based on conjecture. It was a calculation based on the animal units of land applied manure known, calculated bacteria content per animal unit type applied to the watershed, and actual calculated TMDLs of the systems. At the low flow rates equal to the 90th percentile, historic flows on the Cottonwood River would be exceeded if only 0.74% of all land applied manure reached the river; the Redwood River would be exceeded under the same flow conditions (90th percentile) by only 0.53% of available manure reaching the river.

Comment MPPA #5:
"The fecal coliform bacteria standard is intended to protect the designated use of aquatic recreation, yet the report does not include any discussion on the extent of aquatic use of the designated stream reaches, particularly the presence of swimming beaches. The reports do cite low recreational value periods as justification for allowing wastewater treatment facilities utilizing pond systems to discharge prior to June 30 and after September 1 (section 4.2.1). The report also includes stream sections designated as class 7 waters (limited resource value). While we recognize the importance of working to protect surface waters, it seems that limited monitoring resources could be better utilized on increasing coverage of water bodies that are more likely to be used for aquatic recreation."

MPCA response: Class seven (7) waters often flow into other classes of waterbodies and thus can have direct impacts to water quality and aquatic recreation downstream. Water quality standards are reviewed every three years and public comments are welcomed during this process. The following MPCA website has more detailed information about the triennial review process:
http://www.pca.state.mn.us/iryp1405.

Impairments for fecal coliform bacteria, such as the ones in the draft Cottonwood River and Redwood River Fecal Coliform TMDLs, are impairments of the beneficial use of aquatic recreation.

All of the reaches identified in the draft Cottonwood River and Redwood River Fecal Coliform TMDLs are waters of the state. People are free to recreate (which includes but is not limited to swimming) in waters of the state wherever they wish.

Comment MPPA #6
"In general, the draft Redwood River Fecal Coliform Total Maximum Daily Load Report is filled with too many assumptions and very little actual data in terms of accurate source load allocations. We realize that actual data can be very time consuming and expensive to obtain; however, when estimates can be off by wide margins, the potential to waste significant resources while having minimal impact on water quality is a huge concern."

MPCA response: Comment acknowledged.

Comment MPPA #7:
"MPPA is pleased to see MPCA acknowledge that the TMDL may need to be reopened if adjustments are required (section 5.2.4). Is this an indication that the "adaptive management" that has been heralded for several years might finally actually be used?"

MPCA response: Adaptive management is an important part of watershed management, and the intent is to evaluate and modify TMDL implementation using this technique.

The following comment was received from a citizen regarding the Cottonwood River Fecal Coliform TMDL:

"It is my belief that runoff from farming operations is a major contributor to the poor quality of many of our rivers within the state of MN. For the MPCA to essentially give them a pass and continue to increase the discharge regulations on cities is fundamentally flawed. Without addressing the non-point-source contamination, the water quality of our rivers will continue to degrade. Regulation of the farming industry is long overdue. It is an industry and should be treated as such! Fresh water seems abundant, until you don't have any. I urge you, the MPCA and the EPA to begin taking steps to curb the farm runoff contamination of our waterways."

MPCA response: MPCA's regulatory authority is limited by state statute. It is unclear what specific "steps to curb the farm runoff contamination of our waterways" the commenter would like the MPCA and the EPA to begin to take with respect to the draft Cottonwood River Fecal Coliform TMDL. The comment is acknowledged but results in no change to the draft Cottonwood River Fecal Coliform TMDL.